Space and Society
Series Editor-in-Chief: Klara Anna Capova

Jörg Matthias Determann

Diversity, Equity, and Inclusion in Astronomy

A Modern History

Springer

Space and Society

The Space and Society series explores a broad range of topics in astronomy and the space sciences from the perspectives of the social sciences, humanities, and the arts. As humankind gains an increasingly sophisticated understanding of the structure and evolution of the universe, critical issues arise about the societal implications of this new knowledge. Similarly, as we conduct ever more ambitious missions into space, questions arise about the meaning and significance of our exploration of the solar system and beyond. These and related issues are addressed in books published in this series. Our authors and contributors include scholars from disciplines including but not limited to anthropology, architecture, art, environmental studies, ethics, history, law, literature, philosophy, psychology, religious studies, and sociology. To foster a constructive dialogue between these researchers and the scientists and engineers who seek to understand and explore humankind‘s cosmic context, the Space and Society series publishes work that is relevant to those engaged in astronomy and the space sciences, while also being of interest to scholars from the author‘s primary discipline. For example, a book on the anthropology of space exploration in this series benefits individuals and organizations responsible for space missions, while also providing insights of interest to anthropologists. The monographs and edited volumes in the series are academic works that target interdisciplinary professional or scholarly audiences. Space enthusiasts with basic background knowledge will also find works accessible to them.

The series was founded by Springer together with Founding Editor **Douglas A. Vakoch**.

Jörg Matthias Determann

Diversity, Equity, and Inclusion in Astronomy

A Modern History

Springer

Jörg Matthias Determann
Virginia Commonwealth University
Doha, Qatar

ISSN 2199-3882 ISSN 2199-3890 (electronic)
Space and Society
ISBN 978-3-031-46112-5 ISBN 978-3-031-46113-2 (eBook)
https://doi.org/10.1007/978-3-031-46113-2

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To the memory of my grandparents:
Isolde and Günther
Gisela and Fritz

Preface

In June 2019, the National Aeronautics and Space Administration (NASA) unveiled a new "sign of progress": a street sign. NASA Administrator Jim Bridenstine lifted black cover from the words "Hidden Figures Way" that now designated the location of the NASA headquarters in Washington, DC. Also participating in the ceremony was Margot Lee Shetterly, author of the book *Hidden Figures: The American Dream and the Untold Story of the Black Women Who Helped Win the Space Race.* Her work, and the Oscar-nominated film that was based on it, followed the lives of Katherine Johnson, Dorothy Vaughan, and Mary Jackson, who had overcome race- and gender-based discrimination at NASA. "These were the three hidden figures in a very prominent book that became a magnificent movie that started a movement that brought all of us here today," Bridenstine said. "Here we are, 50 years after the landing of the Apollo 11 Moon lander, celebrating those figures who were, at the time, not celebrated." Shetterly, whose own father had also worked at NASA, added: "Naming this street Hidden Figures Way serves to remind us, and everyone who comes here, of the standard that was set by these women, with their commitment to science and their embodiment of the values of equality, justice and humanity."[1]

Commemorated by a successful book and movie, Katherine Johnson, Dorothy Vaughan, and Mary Jackson are now part of the historical record. However, there are many more scientists and activists whose story still remains to be told. According to the NASA press release, the Hidden Figures Way was also meant to memorialize "all women who honorably serve their country, advancing equality, and contributing to the United States space program."[2] These female space scientists were also part of a broader social movement that gained ever more strength from the 1960s onwards. The leaders of this movement championed ideals that they sought to capture with universal terms like diversity, equity, and inclusion. In different times and places, also other words like equality and decolonization were used. However,

[1] Northon (2019).

[2] Northon (2019).

whatever language they used, activist astronomers promoted notions of social justice alongside knowledge of the stars.

To Boldly Go Where No Activist Has Gone Before

I am not an astronomer myself, and I do not have a personal connection to NASA, although my paternal grandfather Fritz Determann programmed telescope software for Carl Zeiss AG in Germany. However, utopian ideas of equality in outer space fascinated me from an early age. Long before writing this book, my first experiences with the intersection of diversity and astronomy came through science fiction. Growing up in Vienna, Austria, I loved watching the different iterations of the television show *Star Trek* that were dubbed in German. I appreciated not only the voyages through planetary systems with various physical properties, but also the encounter with diverse characters, human and non-human, flesh-and-blood and robotic. I found it fascinating to follow crewmembers of different abilities, genders, ethnicities, and races as they were navigating the universe on their spaceships. Despite the numerous conflicts that added suspense to the plots, I admired the utopian visions of people from Earth, Vulcan, and other worlds being united in their quest to reach distant stars.

After moving to Qatar in 2013, I further enjoyed learning about Arab and Muslim visions of the future. I read countless accounts of and by Middle Eastern scientists, not only medieval astronomers, but also modern astronauts. I was especially thrilled to find many books about girls and young women who are interested in the stars. In 2020, I was honored to be consulted by Hamad Al-Khater on his video game *Nightscape*, in which the character Layla interacts with the constellations and summons astral powers. At the Doha International Book Fair in 2022, I found dozens of titles with female protagonists reaching for the sky. I bought a whole series entitled *Knights of Mars* (*Fursān al-Mirrīkh*) by Ḥasan al-Saʿdī. Set in 2034, two girls and three boys go on a mission aboard the space shuttle *UAE1*.[3]

While I dived into new waves of Arabic science fiction, research assistants further broadened my views of inclusion and space exploration. Although I was not able to get enough funding for a spacecraft, the Student Employment Program at Virginia Commonwealth University (VCU) allowed me to assemble a ground-based team of investigators who spoke Bengali, Hindi, Kazakh, Japanese, Malay, Russian, and Urdu. At the time, they were studying in different campuses in Qatar's Education City: Fareeduddin Mohammed at Hamad Bin Khalifa University, Linda binti Ridzuan Chun and Shaheer Liaqat at Georgetown, Kara Dauletkanova and Mila Zhanat at Northwestern, plus Mahpuza Akter and Tami Kaldari at my own institution, VCU. Each of them used their cultural and linguistic expertise to examine fictional representations of otherwise underrepresented groups in space exploration.

[3] Al-Saʿdī (2018).

Mila and Kara, for instance, examined Russian movies about kids as astronauts, such as Valentin Selivanov's *A Great Space Voyage* from 1975.[4] In this film, a girl from Bukhara and two boys from Donetsk and Moscow win the All-Union Children's Space Competition. Their prize is a ticket to fly aboard the *Astra*. Linda for her part read "Program #Angkasaraya2030," a short story by Anuar Shah from 2020. It imagines a Malaysian spacecraft with a crew of six. While each has specific abilities, they also represent different ethnic groups.[5]

Because science fiction often featured characters from underrepresented groups as explorers, it inspired astronomers from across the world during the twentieth and twenty-first centuries. *Star Trek* was especially influential on some of the activists portrayed in this book. The franchise shows that "anyone can be a Starfleet officer, and even captain of a starship," wrote the American astrophysicist Chanda Prescod-Weinstein. "From a Black captain in Captain Sisko, a woman captain in Captain Janeway, to a Black woman lead in Commander Burnham, Star Trek has continued in the tradition of putting in positions of leadership and prominence faces and identities that disrupt dominant ideologies of white men as the only people capable of brave, bold leadership."[6] Prescod-Weinstein herself was friends with Gates McFadden, who played Beverly Crusher in the *Star Trek: The Next Generation*.[7] Joan Schmelz, another prominent American astronomer, found Kathryn Janeway in *Star Trek: Voyager* particularly inspiring. "I used to watch her every week thinking that's the way that I can lead my teams," Schmelz told me. "Kathryn Janeway helped me invent my leadership style." Jesse Shanahan, a scientist of a younger generation, went so far as to name a computer she used for research after Janeway. "She's definitely one of those common inspirational women to look up to," Shanahan said to me in an interview.

Astro-activism

As much as many astronomers loved to immerse themselves in science fiction, they rarely worked in the realms of fantasy. Only occasionally did they make cameo appearances in works like *Star Trek.* While watching the sky or watching television, they usually remained on the ground of present politics. Rather than forming part of the United Federation of Planets, scientists were citizens or residents of nation states. In the *Star Trek* shows, hardly anybody ever asks how much the building of Starfleet's ships cost. In contrast, money was a constant concern for many who wanted to construct a new instrument in the twentieth and twenty-first centuries. Even accessing existing telescopes often required the purchasing of time. As money

[4] Selivanov (1975).

[5] Shah (2020).

[6] Prescod-Weinstein (2019).

[7] Prescod-Weinstein (2021).

was very unevenly distributed, so were opportunities to engage in research. The sky was not the limit, funding was.

However, just like writers and filmmakers, many astronomers were equally dedicated to pushing the frontiers of the known physical universe and the boundaries of the political and social worlds. They were frequently as dissatisfied with their nation-states as they were with current states of research. Progress for them meant not just scientific advancement, but also steps toward social justice. Their aims included equal opportunity for members of underrepresented and underserved groups. Numerous astronomers thus also identified as activists. Some had formal careers as outreach professionals while others did equity work on top of a day job as a researcher.

Despite being very busy transforming their discipline, dozens of scientists took additional time to share their stories with me. Besides allowing me to interview them, many sent me material from their personal archives. The treasures included photographs, old newspaper clippings, unpublished papers, and detailed curricula vitarum. As I was not able to travel much during the COVID-19 pandemic, I was very blessed to be connected to the interlocutors via the internet. I made especially heavy use of Zoom, LinkedIn, and Twitter. I also used GoTranscript for the transcription of interviews.

I am further grateful for several opportunities to discuss the ideas in this book. In 2021, I was fortunate to give a presentation on the topic at the conference of the Canadian Society for the History and Philosophy of Science. During the same year, I also spoke at the 26th International Congress of History of Science and Technology in Prague. I had the additional honor of moderating a Space Week panel at the Women's Pavilion at Expo 2020 Dubai. In 2022, I spoke at the History of Science Society Annual Meeting in Chicago. The following year, I presented at the Fifteenth Biennial History of Astronomy Workshop at the University of Notre Dame. There, Charlotte Bigg, Sarah Reynolds, and Thomas Hockey made particularly useful suggestions to me. In between various events, I was appreciative of the conversations in the Virtual HistSTM Community started by Sarah Qidwai in 2020.

At Virginia Commonwealth University, I participated in numerous discussions about equity, diversity, and inclusion. Patty Paine provided extremely valuable mentorship and guidance in this field and my work in general. I learned a huge amount from Tim Davey, Ryad Ghanam, and our fellow participants in the Recruitment Inclusive Champion program under the Office of the Provost. Besides, Radha Dalal, Josh Rodenberg, Byrad Yyelland, and other members of our Diversity and Inclusion Committee offered unique insights. Fikria El Kaouakibi and Roshni Tarcar of the Office of Research and Development invited me to workshops led by members of the Alliance for the Arts in Research Universities (a2ru) in early 2022. There, my colleague Michael Wirtz suggested to me the term "astro-activism." Later that year, I presented about astronomer-activists or "astro-activists" during my campus's Research Week.

At Springer, I was extraordinarily fortunate to enjoy feedback from my outstanding editor Michael Maimone and the reviewers he shared my manuscript with. Ramon Khanna, Thomas Hempfling, Christoph Baumann, and Niyati Naudiyal

gave further crucial support. Nivetha Moorthi and Alicia Richard managed the production process in collaboration with Jeffrey Taub and others. On top of that, I benefitted from numerous informal exchanges. The following protagonists of this book all commented on draft chapters: Gibor Basri, Wanda Díaz-Merced, Noreen Grice, Jarita Holbrook, Charles McGruder, George Miley, Amelia Ortiz-Gil, Chanda Prescod-Weinstein, Jesse Shanahan, Mike Simmons, Keivan Stassun, Fiorella Terenzi, and Meg Urry. Several historians of astronomy, including Cliff Cunningham, also read parts of my manuscript. I further thank David DeVorkin for his advice about sources on the history of the American Astronomical Society. I am very grateful to Larry Marschall for sending me old copies of the Newsletter of the International Astronomical Union's Commission 46. Simon Kraus provided me with copies of articles by Gerhard Henschel from the 1960s.

This book would also have been impossible without access to massive collections of information. Amy Andres, Beena Noorudeen, and their colleagues from the VCU Libraries ordered numerous books for me. VCU and the Qatar National Library also enabled me to use their rich databases. One of them is The HistoryMakers Digital Archive with its detailed interviews with African American scientists. Beyond such subscription-based services, I regularly consulted the Internet Archive, the Astrophysics Data System (ADS), and Wikipedia. The *AASWomen Newsletter* pointed me to further material that I would have missed otherwise. Günther Bräuhofer, Lea Lernpeiss, and Arijane Sommeregger kindly allowed me to access the physical holdings of the Astronomy Library at the University of Vienna despite restrictions related to the COVID-19 pandemic. Bräuhofer was especially generous in showing me uncatalogued papers by Anneliese Schnell on women in astronomy. Ellen Bouton from the National Radio Astronomy Observatory Archives in Charlottesville, Virginia, was immensely helpful in pointing me to the treasures she keeps.

Last but not least, I have to give credit to my family. My wife, Jeanne Vaz, has done more for me than I could ever possibly list, including proofreading much of my academic writing. My daughter Maria has been another source of great inspiration. Thanks to her, I acquired a small library of Arabic science fiction for children and young adults, including *Knights of Mars*. I express further gratitude to Marilou Magsayo Semetara for taking care of our family and home. As nurseries closed during the coronavirus pandemic, the childcare she provided was invaluable. My brothers Claudius Determann and Christian Pils often discussed science fiction and social justice with me. My parents Michael and Sibylle Determann and my parents-in-law Peter and Sophia Vaz always expressed interest in my work and supported me in numerous ways. The same goes for my friends and Maria's godparents Jimmy and Sarah Roach. I owe Jimmy in particular much knowledge of science and science fiction, including *Star Trek*. Live long and prosper!

References

Al-Saʿdī, Ḥasan. 2018. *Wa-badaʾat al-mughāmarah*. Dubayy: Qindeel.

Northon, Karen. 2019. "Sign of Progress: NASA Pays Tribute to Hidden Figures." National Aeronautics and Space Administration. http://www.nasa.gov/feature/sign-of-progress-street-renaming-puts-nasa-headquarters-on-hidden-figures-way.

Prescod-Weinstein, Chanda. 2019b. "Dispatches from #STLV: Holodeck-Inspired VR Transforms Conversation About Diversity." Star Trek. https://intl.startrek.com/news/star-trek-las-vegas-holodeck-inspired-vr-transforms-conversation-about-diversity.

Prescod-Weinstein, Chanda. 2021. *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred*. New York: Bold Type Books.

Selivanov, Valentin. 1975. *Bol′shoe kosmicheskoe puteshestvie.* Tsentral′naia kinostudiia detskikh i iunosheskikh fil′mov imeni M. Gor′kog.

Shah, Anuar. 2020. "Program #Angkasaraya2030." In *2020: An Anthology*, edited by Foo Sek Han and Leon Wing. Buku Fixi.

Contents

Chapter 1
A More Diverse Universe

September 2020 was a challenging month for many people on Earth. The coronavirus pandemic had swept all regions of the globe, causing disruptions on a scale unseen since World War II. Depending on infection counts, governments opened and closed spaces for human activities of all kinds. These were unpredictable, ad-hoc and temporary measures, as mass vaccination campaigns were still months away in most countries. It was thus an unlikely time to organize almost anything that was not COVID-19-related. Nevertheless, a group of women in Africa reached across the national borders that separated them. They established the African Network of Women in Astronomy (AfNWA, Fig. 1.1) as part of the African Astronomical Society (AfAS). One of their main objectives was to improve the status of working female scientists. Another one was to use astronomy to inspire young girls as a generation of the future.

If the name of the African Network of Women in Astronomy suggested a continental scope, its leaders had connections that stretched even further. Two of the co-founders, Mirjana Pović and Carolina Ödman, were from Europe. Pović, who was born in former Yugoslavia, had completed doctoral and postdoctoral research in Spain before joining the Ethiopian Space Science and Technology Institute. Ödman, from Switzerland, had worked in Italy and the Netherlands before settling in South Africa. Both Pović and Ödman also brought to their network the reputation and resources of organizations that operated worldwide. In 2018, the Serbian had won an award for inspiring women in science by Nature Research and the Estée Lauder Companies.[1] During the same year, her Swiss counterpart received a special price for outreach and education from the International Astronomical Union.[2]

As Europeans, Pović and Ödman helped extend the reach of the African Network of Women in Astronomy. However, native scientists from the continent had their

[1] Dance (2018).

[2] Universe Awareness (2018).

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*,
Space and Society, https://doi.org/10.1007/978-3-031-46113-2_1

Fig. 1.1 The initial group forming the African Network of Women in Astronomy in 2020. (Courtesy of Carolina Ödman-Govender)

own international links as well. Take Somaya Saad of Egypt's National Research Institute of Astronomy and Geophysics, for example. After studying in Cairo, she had worked as a postdoctoral researcher at Seoul National University in Korea and at the Czech Academy of Sciences. Although she had returned to her home country thereafter, she remained an active member in the International Astronomical Union and the International Society of Muslim Women in Science. In 2018 as well, she oversaw an International School for Young Astronomers. While the students came from African countries, lecturers also arrived from China, Mexico, Norway, Russia, Spain, and the United States.[3]

Despite its many contacts, the African Network of Women in Astronomy possessed only limited funds. International prizes earned Pović and Ödman much publicity, but relatively little money. Nature Research and the Estée Lauder Companies granted the Serbian astrophysicist up to $10,000 for work related to women in science. Her Swiss peer got about half that amount from the International Astronomical Union. She received €2500 personally, with another €2500 reserved for an outreach, development or education project of her choice.[4] Such sums could make a big difference for teaching in any poor setting. Nonetheless, they paled in comparison to the millions spent on infrastructure in South Africa or Ethiopia. With Chinese help, the East African nation launched its first satellite in 2019. In the meantime, South

[3] Nahar (2019).

[4] Universe Awareness (2018).

Africa collaborated with Australia, Britain and other countries in the development of the Square Kilometre Array, a gigantic radio telescope.

While the financial capital of the African women's network was small, its challenges were huge. "Globally we are facing a huge gender gap in science," Pović and her colleagues noted. They cited a United Nations report from 2019, according to which the share of female researchers in the world was around 30%. In most African countries more specifically, women scientists made up less than 25%. As possible reasons, the astronomers identified "poverty and access to education, social constraints, cultural biases and beliefs, lack of female mentors and role models." Because of all these factors, the astrophysicists warned that "we are losing huge potential that could benefit our society. We will never be able to reach the UN Sustainable Development Goals (SDGs) without giving our best to empower ~ 50% of world populations made up of girls and women."[5]

Seeing the study of the heavens as dependent on social situations on Earth, the African Network of Women in Astronomy did not confine its activism to the academy. As space science was growing in Africa, Pović and her peers sought to "guarantee female participation at all levels." They explained that "AfNWA objectives however cannot be achieved without the full support and participation of the whole society."[6] The astronomers therefore dedicated much of their time to public outreach and education. They argued that astronomy itself could be a tool for socioeconomic development. Reduction in poverty would in turn also improve the status of women in general and ultimately lead to more female scientists. "Astronomy occupies a special place among the many efforts to address development challenges," argued Vanessa McBride, another founding member of the network. "It has a unique ability to stimulate thoughts of 'what is possible' in the minds of marginalised communities, women and children."[7]

The Sustainable Development Goals may have seemed similarly far away from the African astronomers as some of the celestial objects they were studying. Could gender equality or the absence of poverty and hunger ever be reached in the lifetime of these scientists? What difference could a small group of women make who had come together in the middle of a global public health emergency? Even their limited funding was suddenly put at risk by the coronavirus. Lockdowns put economies under enormous pressure, noted McBride. "In South Africa, for instance, in 2020 the national science budget was reduced by 15% – a direct result, the government confirmed, of the pandemic's effects. In May 2021 it was increased, but only by 1.4% – below inflation." She worried that curiosity-driven "blue skies" research was especially vulnerable to cuts. Astronomy, she noted, "is just about as 'blue skies' as one can get."[8]

[5] African Astronomical Society (2021).

[6] African Astronomical Society (2021).

[7] McBride (2018).

[8] McBride (2021).

Whatever the odds for success might be, the scientists making up the AfNWA were not people who gave up easily. Even those members who were originally from Europe were used to dealing with tough circumstances. Born in 1981, Pović was 9 years old when the Yugoslav Wars had started. When they ended, she was almost 20. As the Earth was shaking beneath her feet at the time, she turned her gaze toward the stars. Frequent power outages cleared the sky of light pollution. "During all this time, living in a crazy reality out of which we were not able to escape, the night sky above our heads was a place to dream about another kind of world and to not lose hope that better times will come." The public universities of Serbia and Spain enabled her to turn her dreams into a career. "If I didn't have an access to free education, I would never be able to study and become a scientist."[9]

Compared to Serbia, Carolina Ödman's home country of Switzerland was much more affluent and peaceful. Her undergraduate institution, the École polytechnique fédérale de Lausanne (EPFL) was well-funded by any standards. However, she too struggled as one of few women at this institute of technology. When she enrolled in physics, her parents asked, "Why would you want to do that?" Being one of seven or eight girls in a class of 150, she stood out. "It was a very male culture," she found, "very testosterone-driven." Male colleagues only befriended her in order to date her. "The conversations I witnessed, it was just about scoring girls and getting laid and then criticizing their bodies. It was ruthless." Lacking support from her family, Ödman was expected to fail, which she did at the beginning. She had to repeat both her first and second year, as she told me.

When Ödman finally graduated after six instead of the regular 4 years, her social environment hardly improved, as she reported in a long interview with me. In 2000, she joined Lausanne's university hospital as a research engineer, modelling blood flows with computers. When she explained her work to one of the doctors, he responded, "What a waste! You're just going to get married and have kids anyway." Leaving Switzerland did not help either. When she moved to Cambridge, England, to pursue a doctorate in astrophysics, she encountered another male-dominated sphere. Further travel hardly allowed for any escape. In the second year of her doctoral studies, she attended a research school in Sicily. Being one of only two women among 35 PhD students, she was confronted with an "incredible manifestation of machismo." One evening, her male peers were boasting about how they got into their graduate programs, "trying to outdo one another." When it was her turn, she blurted out, "I'm at Cambridge University. I got in because I give bloody good blowjobs." The conversation suddenly stopped, and she was like, "That's what you guys wanted to hear. That's what you guys think. There I gave it to you."

Ödman's particular reaction in Sicily was perhaps spontaneous. However, it was also part of a longer pattern of resistance against patriarchy that she described to me. Already during her undergraduate studies, she had worked at EPFL's equity office. She had surveyed female alumni and soon found out that many of them were not working in engineering or held jobs "for reasons of putting food on the table" rather

[9] European Platform of Women Scientists (2021).

than out of interest in science. “I thought these gender problems have been resolved but clearly, they’re not.” Feminism to her had an image of being a thing from the 1970s. “It was about growing hair in the armpits and not wearing a bra.” Ödman did not hide her outrage at the inequities she discovered. Friends soon labeled her a “feminist” and considered her “scary, big time.”

Despite the tensions between Ödman and many of her classmates, she did fall in love with one of them. At Cambridge, she began a relationship with Robert Izzard, a fellow doctoral student in astronomy. Upon graduating, they encountered the two-body problem common in academia. Both applied for Marie Curie fellowships from the European Commission. She received one for research at Sapienza University in Rome, but he did not, as she mentioned to me. Ödman’s boyfriend therefore faced the choice of following her to Italy without a job or looking for employment elsewhere. He wanted to stay close to Ödman, but without giving up his career. The couple’s solution was to set up their own Carolune Institute for Quality Astronomy (CIQuA) in 2004. This virtual organization provided Izzard with an affiliation and remote access to computers in Cambridge. Although he did not have a salary, he could use this infrastructure for the development of stellar evolution models. With the CIQuA fellowship to his name, he found employment at Utrecht University in the Netherlands. This time, it was her who followed him.

CIQuA’s goal was not just quality, but also equality in astronomy. In 2005, Ödman and Izzard presented about “The Reality of a Virtual Institute” at the 4th European Conference on Gender Equality in Higher Education in Oxford. By that time, it had become more common for professorial candidates to request provisions for spouses. However, “post-docs are not in a position to make such requests,” the young couple argued. “CIQuA remains very relevant for that large group of researchers.”[10] In 2006, the two scientists promoted their organization as a possible “idea for the future” in the magazine *Astronomy & Geophysics.* They stressed that the two-body problem can affect both genders, as it had in their case. However, they acknowledged that it might be more prevalent among female academics. “A majority of women scientists are married to scientists while this is true only for a small fraction of their male counterparts,” they claimed.[11]

To give their initiative permanence, Ödman and Izzard sought to register CIQuA with the British Charity Commission. However, they wanted their virtual institute to provide more than simply “charity” for trailing spouses. If scientists could remain in research, they argued, their disciplines and the wider society were to benefit. In contrast, a forced career change represented “a personal sacrifice on their part and a loss for the scientific community.” In other words, it would result in “brain drain.” Astronomers’ expertise would also “not be used to its full extent when joining another profession.”[12]

[10] Carolune Institute for Quality Astronomy (2006).

[11] Odman and Izzard (2006).

[12] Odman and Izzard (2006).

The Carolune Institute for Quality Astronomy may, indeed, have been an "idea for the future." However, it was perhaps also ahead of its time. "People were a little bit shy of becoming members of a virtual institute that didn't have a pedigree," Ödman told me. In addition to junior scientists, CIQuA was trying to attract senior astronomers by offering them honorary fellowships. This form of association was meant to raise "awareness among decision-makers to couples of researchers" and to create "a network of couple-conscious academics."[13] Christopher Tout, the John Couch Adams Astronomer at the University of Cambridge, received this recognition for the support he provided to Izzard and the institute. However, despite this connection, CIQuA struggled to get resources beyond the computing equipment in Cambridge. In the meantime, Ödman and Izzard's own romantic relationship ended. The couple split up, and their project soon fizzled out.

If the Carolune Institute for Quality Astronomy with its links to Cambridge closed after a few years, what are the chances of the African Network of Women in Astronomy for success? In the mid-2000s, Carolina Ödman had only been a postdoc, whereas 15 years later she was an associate professor at the University of the Western Cape. In parallel, she served as associate director for development and outreach at South Africa's Inter-University Institute for Data Intensive Astronomy. In addition to being an established academic herself, she had contacts across the world. Her husband, Kevin Govender, whom she had met in South Africa after breaking up with Izzard, directed the International Astronomical Union's Office of Astronomy for Development. Even before creating AfNWA, she was thus part of a network that stretched across the world. Other members of her group, including Vanessa McBride and Somaya Saad, had left the initial postdoc stage behind and established themselves as faculty members as well.

The seniority reached by some of its leaders should give AfNWA some permanence. The network even survived the death of Carolina Ödman herself from cancer in 2022. "The response at the time of loss has been nothing short of overwhelming – huge numbers of messages and condolences pouring in – more than I can keep up with or respond to," said her husband. "The whole world seems to be in mourning."[14] In her memory, the African Network for Women in Astronomy created the "Prof. Carolina Ödman Early Career Award." The prize was first given to Alshaimaa Hassanin, an Egyptian researcher on solar activity and space weather. Vanessa McBride commented that the recognition "acknowledges Dr Hassanin's excellent contribution in science, efforts to advance women's representation in science at different stages of their lives, and mentoring the next cohort of female astronomers." McBride added that Hassanin "places her advocacy for women in science into practice by creating an atmosphere in which female researchers, especially mothers, can thrive."[15]

[13] Odman and Izzard (2006).

[14] Thebus (2022).

[15] McBride (2023).

The founders of the African Network of Women in Astronomy thus quickly promoted junior peers who could follow in their footsteps. Moreover, even if AfNWA happened to dissolve like CIQuA did, its members would still be able to continue their exchanges through other organizations. Mirjana Pović, for instance, was also a member of the Working Group on Astronomy for Equity and Inclusion that belonged to the International Astronomical Union. Moreover, she participated in the Society of Ethiopian Women in Science and Technology plus Spain's Asociación de Mujeres Investigadoras y Tecnólogas (AMIT). Nana Klutse of the University of Ghana, another AfNWA founding member, did not have a similar women's organization in her own country. Arguably, this had encouraged her to look internationally. Already back in 2006, she had joined three bodies: the International Federation of University Women (IFUW), the International Network of Women Engineers and Scientists (INWES), and the Third World Organization for Women in Science (TWOWS).

The large associations Klutse was part of were welcoming people of any faith and none. However, even Saad's International Society of Muslim Women in Science (ISMWS) was much bigger than AfNWA. It had been established 10 years earlier, in 2010, by Sultana Nahar, a Bangladeshi-American physicist at the Ohio State University. Within a decade, ISMWS had counted over 300 members from over 30 countries.[16] The society addressed adherents of a specific religious tradition. Its charter ended with the words: "May Allah bless us with success." Nonetheless, Nahar also encouraged collaboration with non-denominational organizations like the International Network of Women Engineers and Scientists and the American Association for Women in Science (AWIS).[17]

Despite the failure of the Carolune Institute for Quality Astronomy, Ödman had also demonstrated her ability to rally astronomers for women's causes repeatedly during her life. Back in 2007, she had posted a simple statement on a website of hers called Astrocast: "Astronomy Has No Gender." The Swiss scientist responded to what she considered "degrading" comments about women made by the prominent English amateur astronomer Patrick Moore. One of them was a complaint about political correctness in science fiction television series: "I used to watch Doctor Who and Star Trek, but they went PC – making women commanders, that kind of thing. I stopped watching." Within 4 months, Ödman had collected close to 100 signatures under her statement, including by many astronomers. One of her backers was her future husband, Kevin Govender from South Africa.[18]

Ödman's statement from 2007 had appeared in the early years of social media. Twitter, for instance, was fewer than 18 months old when the Swiss astronomer started collecting signatures. Subsequently, the potential reach of protest notes like hers rapidly increased. This was shown by a controversy involving the British biochemist and Nobel laureate Tim Hunt in 2015. At the World Conference of Science Journalists in Seoul, South Korea, he made remarks about women in the laboratory

[16] Nahar (2020).

[17] Nahar (2010).

[18] Odman (2007).

that were widely deemed sexist. "Let me tell you about my trouble with girls," he reportedly said. "You fall in love with them, they fall in love with you, and when you criticise them they cry." He subsequently told the *BBC* that he was "really sorry" about what he had said. His remarks had been "intended as a light-hearted, ironic comment," but had been "interpreted deadly seriously" by his audience. Under pressure, he resigned from his position as honorary professor at University College London.[19]

By the mid-2010s, digital media spread news about sexism in science quickly and across national and disciplinary boundaries. The *BBC News* website quoted responses from scientists in different countries and fields to Hunt's comments. Emily Rice, an astrophysics professor at the College of Staten Island in New York, stated that sexist attitudes were "ingrained." She added, "We know how to be objective, we know how to be rational, we know how to be logical when it comes to our data, and we're not always as good about doing that about ourselves."[20] Sarah Tuttle, another astronomer based in the United States, took to Twitter with greater anger. "We honestly think that you have no place in science," she told Tim Hunt in a tweet. "We honestly think that your attitudes are backwards, draconian, and inappropriate." Many people agreed with Tuttle's tweets, and the American website *BuzzFeed News* lauded them as "the perfect response" to Hunt's comments.[21]

Like Sarah Tuttle, Carolina Ödman had been an early user of Twitter. Tuttle had joined the social network service in 2008, and Ödman in 2007. The latter's handle @carolune thus also far outlived the Carolune Institute for Quality Astronomy. However, over time, Ödman had become less confrontational. When I spoke to Ödman in 2021, a year before her death, she told me that she had learned to refrain from public shaming. She acknowledged that in her undergraduate days, she must have been "frightening" to people around her. "I've seen and I've experienced how with activism, you just lose people because of fragility." Because she had been so passionate, she had found it "very difficult to take a step back and not be threatening." Subsequently, she had become "much more diplomatic." She avoided calling out bad behavior or even changing someone's opinion directly. Instead, she was "trying to gently nudge perspectives." She added, "the great thing of astronomy is that it gives us perspective. If we're able to change perspective, then we can use our mind to make the world a better place in all sorts of cool ways."

Not all members of the African Network of Women in Astronomy had come to evade direct confrontation like Ödman did. Nana Klutse's research as a space scientist focused on climate change, a heated topic in many spheres. As if this kind of work was not political enough, she was also an active member of the National Democratic Congress (NDC), a center-left party. In 2019, she was the only female candidate in the primary election that was held in her constituency. During this contest, according to the site *GhanaWeb*, she threatened to sue a rival politician over

[19] BBC (2015).

[20] BBC (2015).

[21] Silver (2015).

claims that she had been deceiving voters. Her lawyers demanded a retraction and apology for comments he had made in a radio interview. "Your defamatory statements have injured the image of our client and brought her hard-won reputation into discredit and reproach within the NDC fraternity," the attorneys argued in a letter. "Should you fail to comply with her demand immediately above we have her instructions to commence legal proceedings against you in which we are to seek maximum damages in law against you."[22]

Klutse's quest to become a Member of Parliament herself was unsuccessful, as she lost the primary in 2019. However, just as Ödman, she was not easily discouraged by failures. In her activism, she believed in a Ghanaian saying that "it is the girl who frequently fetches water from the stream that occasionally breaks the pot." In other words, if a person was not experiencing disappointments, they were not trying enough.[23] In 2020, the university lecturer was earning praise for engaging in volunteer work that was normally "reserved for party foot-soldiers." She was seen climbing up one pole after another to put up NDC flags in her constituency.[24]

In combination, the different members of the African Network of Women in Astronomy possessed an arsenal of tools and a wealth of experience spanning decades. Even if they lacked funds, they thus had the clear potential to make an impact on their discipline and on wider society. What further increased their chances of success was that they were part of a global movement for diversity, equity and inclusion in astronomy. In the twentieth and twenty-first centuries, astronomers from all corners of the world had learned to work together to change the composition of their profession. They thus contributed to a social revolution that was of similar magnitude as the Copernican Revolution. Patrick Moore may have resented *Star Trek*'s utopian vision of women leading human space exploration. However, an increasing number of scientists strove to make it a reality. Moreover, they supported not just women, but marginalized and oppressed groups of all kinds.

Celestial Movement

"Infinite Diversity in Infinite Combinations" – with these words Spock and other Vulcans celebrate the variability of the universe as imagined by the creators of *Star Trek*. The extraterrestrial philosophy and its insignia, referred to as IDIC, appear onboard many fictional spaceships in the franchise. However, during the twentieth and twenty-first centuries, diversity became similarly important to humans who were exploring the stars from Earth. Astronomers thus followed biologists[25] in embracing broad variety. As physical scientists, they were less concerned with

[22] Kaku (2019).

[23] Odehyia Media (2021).

[24] Vanguard (2020).

[25] Sepkoski (2020).

biodiversity, of course. Instead, they focused on the social makeup of their own profession in the context of the general human population. They sought to promote underrepresented groups and adopted other terms related to social justice, including equality, equity and inclusion. Their vision was that the people behind the telescopes ought to be reflective of the wider society with its numerous identities. This meant advancing all those who suffered from discrimination and who were excluded from leadership positions in science.

Not all human astronomers were as appreciative of diversity as the Vulcan space explorers, of course. Social-justice work encountered plenty of resistance within the profession. Patrick Moore was only one of many conservative voices. A scientist of a similar generation was the American James Felten. As early as 1978, he criticized the then-president of the American Astronomical Society (AAS), Margaret Burbidge, for supporting the Equal Rights Amendment to the US Constitution. "The AAS, as an organization, is not at all political in purpose," he argued, "and should not allow itself to be used in this way." He asked in an open letter, "Why should an organization which failed to take a stand on desegregation, or on the Vietnam war, suddenly start now?" He worried that "Once the precedent of political involvement is set, there are likely to be similar demands for action on other controversial issues; e.g. public funding of abortions, or homosexual rights."[26]

Conservative astrophysicists fought liberals over many issues and over decades. In 1994, Felten opposed a boycott by the American Physical Society (APS) against the state of Colorado, which was accused of failing to protect homosexuals. At the time, the APS Council had resolved to stop holding meetings in any locality that was discriminating on the basis of gender and sexual orientation. "Shouldn't we boycott the entire USA?" he asked, pointing out that the country's military "continues discrimination against homosexuals and to some extent against women." The astrophysicist, who was then based at NASA's Goddard Space Flight Center in Maryland, was also concerned that the demand for solidarity might be extended to those who were sexually attracted to children or animals. "What if pedophiles and bestials come to us and demand a similar boycott?" He mentioned that the former already had their own advocacy group, the North American Man/Boy Love Association (NAMBLA).[27]

Nonetheless, the idea of diversity became so appealing that even people like Felten employed it when confronted with the threat of becoming a minority themselves. In 1996, the Goddard researcher complained about the list of officer candidates produced by the Nominating Committee of the American Astronomical Society. In a letter to the editor of the *AAS Newsletter*, he criticized the slate's lack of "charisma and balance." It contained "a large number of junior and lesser-known astronomers." He added that "the grapevine says that this resulted from one person's effort to nominate astronomers in non-elite positions." Moreover, he noted that "the majority of candidates are female (9 of 16; 5 of 11 for Council positions)." Felten

[26] Felten (1978).

[27] Felten (1994).

was especially alarmed by the lack of representation of conservatives. "More disturbing is the ideological homogeneity among some nominees," he wrote.[28]

If some conservatives were already on the defensive in the 1990s, two decades later, there was a widespread sense that "a social movement is taking over the field."[29] More and more astrophysicists were interested not just in events "a long time ago in a galaxy far, far away," but also in their society here and now. Many still researched stellar and galactic phenomena that transcend human spaces and timescales by orders of magnitude. Yet, in parallel, they sought to change the institutions that affected themselves in more immediate ways. Many took on the role of activists in their spare time. However, a few also found employment as professionals in education and public outreach. Between 2005 and 2010, Carolina Ödman, for instance, had worked as international project manager for Universe Awareness (UNAWE). This initiative, which was based at Leiden University in the Netherlands, had used astronomy to inspire vulnerable and underprivileged children in forty countries.

This book charts the history of the broader movement for social change within astronomy. This push became more and more noticeable over time. Astronomers of different identities existed for as long as humans have looked up to the sky and wondered about the universe. Yet the few professional scientists among them, those with paid positions at princely courts or observatories, were often scattered. Only in the nineteenth century, when means of communication and transportation became faster, did they organize themselves in formal associations. The Royal Astronomical Society, founded in 1820, was the oldest of them. After that came the Astronomische Gesellschaft established in 1863. However, the number of people making a living from astronomy was still small. It took the expansion of higher education and state investment in research globally during the twentieth century for a critical mass of scientists to emerge. Legislation that broadened university access in the decades after World War II gave new opportunities to groups previously excluded. This gave visibility to a broader range of astronomers while also highlighting persistent injustice and inequality.

As the word "movement" itself suggests, the drive to reform astronomy was in flux and hard to capture. Depending on the time period and location, activists used different words to express their ideas: affirmative action, equal opportunity, diversity, inclusion, equity, justice, freedom, and decolonization, to name a few. The names of those who ought to be liberated and included changed too: foreigners, women, gays, lesbians, queer persons, blacks, people of color, handicapped, disabled, et cetera. However, the various feminist, anti-racist and other efforts had a common goal: to end exclusion and to broaden participation in astronomy.

How urgent and necessary did the scientists cum activists consider this equity work? Among the many fields of knowledge, astronomy was perhaps especially inclusive to begin with. The subject of research, the sky, was in principle accessible to almost anybody. Indeed, Shazrene Mohamed, a Zimbabwean member of the

[28] Felten (1996).

[29] Posselt (2020), 127.

African Network of Women in Astronomy, declared: "The Sky Is for Everyone."[30] Of course, industrialization and electrification polluted views in many urban centers in modern times. However, it was impossible for a single observatory to successfully restrict and monopolize views of the stars. For the most part, telescopes were not secret technology either. For these reasons, a venerable tradition of amateur astronomy continued alongside increasingly professionalized institutions. Self-taught star watchers thus persisted in greater numbers than non-professional experimental physicists, for example. They were perhaps comparable to bird watchers, who equally benefited from an open sky.

If astronomy was more open than other branches of physical science, it was still shaped by some of the same forces. Astronomers had long benefited from a close relationship with rulers who provided patronage for observations of the heavens. Even Harlow Shapley, the director of the Harvard College Observatory as a private institution, saw his field as closely associated with governments. "In ancient times the rulers made use of the charlatan astrologers to guide their acts and justify their sins," he wrote in *Science* magazine in 1948. In modern times, he saw this relationship as even more significant. "The great Royal Observatory in Greenwich was founded by Charles II," he recounted. "The Russian observatory in Pulkowa, which until its destruction in the recent World War held a dominant place in European astronomy, was founded by Czar Nicholas I; Germany's famous observatory at Potsdam was created at the request of the Crown Prince who became Kaiser Friedrich."[31]

Besides lending prestige to royal courts, scholars of the heavens offered practical information for navigation and timekeeping to the builders of empires. Even as many monarchies gave way to republics in the twentieth century, astronomers stayed in proximity to power. During the Cold War, governments saw the physical sciences in general as vital to the arms and space race. The African-American astrophysicist Neil deGrasse Tyson, a graduate of Harvard University, went so far as to call his discipline an "accessory to war." He dedicated a book about *The Unspoken Alliance Between Astrophysics and the Military* to "everybody who has ever wondered why astrophysicists have jobs at all."[32] In aligning themselves with the goals of defense establishments, observatories and laboratories thus received more money, but their hierarchies reflected those of their sponsors. The social make-up of astronomical elites thus frequently mirrored that of a country's leadership overall.

Closeness to the powerful arguably fueled exclusionary attitudes. If a level of elitism existed in all the sciences, it was even higher in subjects like physics. The astrophysicist Hakeem Oluseyi explained to me that having grown up as an African American in the South, he had learned certain "survival techniques." One of them was a "racist radar" that warned him of persons he ought to avoid. "One of the things that triggers racist radar is people behaving as if they think they're superior

[30] Mohamed (2022).

[31] Shapley (1948), 315.

[32] Tyson and Lang (2018).

to you," he joked. "Now, that's how physicists treat just about everybody." A strong belief in meritocracy further reinforced such hierarchical thinking. If a person of privileged background went on to win a Nobel Prize, it must be due to his individual genius and hard work rather than because of a biased system.

Even many black scientists who had experienced racial discrimination personally still held on to a meritocratic system as an ideal. "One of the greatest features of science is that it doesn't matter where you were born, and it doesn't matter what the belief systems of your parents might have been," Neil deGrasse Tyson once told NBC News. "If you perform the same experiment that someone else did, at a different time and place, you'll get the same result." Having grown up in New York, he was painfully aware that access to educational opportunities was far from universal even in a wealthy country like the United States. At the same time, he stressed that "not everyone is equal in everything." He explained, "That's why we take exams. Some people do better than others, and some people get lax, and other surpass them."[33]

Aware of the military uses of space technology, Tyson did not view astronomy as essentially pure or arcane. However, he wished to see it as separate, or at least as separable, from politics. "When politics shows up in science, in almost every case, it gets in the way," he explained. "To the extent that it's a barrier, it can show an ugly head, and express itself in the form of sexism, racism, creedism," he elaborated. "And this can affect employment opportunities, salaries, office space." Fortunately, he thought that politics was still affecting science less than business. He believed that on a given day, somebody in an observatory or laboratory had to engage in much less politics than someone in an office cubicle.[34]

What probably contributed to the sense of meritocracy in astronomy and physics specifically was the reliance on numerical values. In 2019, Stefania Varano of the Italian National Institute for Astrophysics presented about "The Impartiality of the Universe" at a symposium on Astronomy for Equity, Diversity and Inclusion. She described modern astronomy as a "democratic" and "fair science." Its "observations are impartial because they are mainly made of numbers, representing the physical features of the observed object."[35] For colleagues of hers, not just distant stars were objective measures, but even citations. In 2018, Alessandro Strumia of the University of Pisa gave a presentation at a workshop on high-energy theory and gender at CERN, the European Organization for Nuclear Research. He claimed that male authors were cited more than female ones and equally so by peers of both genders. He argued that this pattern was due to merit rather than sexism. He therefore concluded that "physics is not sexist against women."[36]

Very familiar with statistical methods, physical scientists were critical of them as well, however. Strumia's particular lecture failed to convince not just many of the

[33] Boyle (2007).

[34] Boyle (2007).

[35] Varano (2019).

[36] Strumia (2018).

workshop participants, but also others who heard about it. Chanda Prescod-Weinstein even co-authored a statement condemning the Italian's presentation. "The thin veneer of scientific rigor with which Strumia's talk began was followed by open discrimination," Prescod-Weinstein and her fellow critics claimed. They questioned whether men's higher citation counts had truly been earned, as "choice of references is subject to unconscious bias." They further emphasized that "citations accrue for all kinds of reasons, some laudable and some not, and using them as a substitute for scientific quality is very problematic." According to Prescod-Weinstein and her co-authors, citation counts could not be held as evidence for differences in intrinsic abilities between men and women. Numerous other prominent physicists and astronomers, including Lucianne Walkowicz of the Adler Planetarium, agreed and added their signatures to the statement.[37]

Strumia was nowhere close in fame to Nobel laureate Tim Hunt. Nevertheless, the celebrity status of CERN as a research organization still drew media attention to his talk and the controversy surrounding it. The BBC covered the event, quoting Strumia as saying: "People say that physics is sexist, physics is racist. I made some simple checks and discovered that it wasn't."[38] In a comment to *Physics World*, he also dismissed the condemnation by Prescod-Weinstein and others. He considered them a "US-centric small fraction of the physics community [that] defends the gender theory which is mainstream in 'politically-correct' academias." Prescod-Weinstein, however, remained firm in her criticism of her Italian peer: "It's about letting the young, and particularly the young women and women of color who are particularly underrepresented in the field, know that there are many of us who don't think the way that he does, and that he won't be able to get away with doing those kinds of things."[39]

Media attention not only put Strumia under pressure, but also CERN itself. Within days, the organization produced its own statement, emphasizing that it stood for diversity. "CERN is a culturally diverse organisation bringing together people of many different nationalities. It is a place where everyone is welcome, and all have the same opportunities, regardless of ethnicity, beliefs, gender or sexual orientation." The European Organization for Nuclear Research quickly suspended the Italian scientist from any activity at its facilities. It also removed his workshop slides from its online repository.[40] Strumia was nonetheless able to publish his research in *Quantitative Science Studies*, a journal of the International Society for Scientometrics and Informetrics.[41] He commented: "It's reassuring that a journal followed the normal scientific practice instead of failing to cancel culture. I am now the only speaker of the CERN conference who got results published."[42]

[37] Buckley et al. (2018).

[38] Ghosh (2018).

[39] Banks (2018).

[40] CERN (2019).

[41] Strumia (2021a).

[42] Strumia (2021b).

Revolutionary Scientists

By using the term "cancel culture," Alessandro Strumia saw himself as the victim of a twenty-first century phenomenon connected to the #MeToo and Black Lives Matter movements. Indeed, some of his opponents such as Chanda Prescod-Weinstein and Lucianne Walkowicz frequently called out individuals who spoke about gender or race in ways they deemed unacceptable. However, attempts to boycott astronomers and physicists for what they said on social and political topics went back much further. In the modern history of astronomy, those targeted included scientists on the left as well as on the right. An example from a hundred years earlier than Strumia was the Dutch astronomer and Marxist theorist Anton Pannekoek, a contemporary of Harlow Shapley's. Well-known as a writer on historical materialism, he was prevented by the conservative Dutch government from taking up a position at the Leiden Observatory. Officials argued that a communist should not be teaching at a state university. Fortunately for Pannekoek, the University of Amsterdam, a municipal rather than a state institution, was able to able hire him instead.[43]

At the end of World War I, when revolutions toppled monarchies across Central and Eastern Europe, Pannekoek's leftist thought was seen as dangerous by some politicians in the Kingdom of the Netherlands. Nonetheless, he was able to gain international recognition for astronomical research while maintaining an audience for his communist writings. Although he tried to keep these two spheres of activity separate from one another, he ultimately considered both of them "science."[44] In 1936, Harvard University conveyed honorary degrees to thirty-nine distinguished international scholars on the occasion of its three-hundredth anniversary. Among the recipients was Pannekoek for "'contributions of high merit in many fields of astronomy." Prior to attending the tercentenary conference, he addressed the members of the Workers' Socialist Party of the United States in Boston.[45]

Helpful for Pannekoek's receipt of an honorary doctorate from Harvard University was his alignment with the director of its observatory, Harlow Shapley. The Dutch astronomer's measurement supported his American peer's model of a larger Milky Way than previously assumed. Although the Harvard College Observatory had long benefitted from the donations of wealthy philanthropists, Shapley also shared with Pannekoek a critical attitude toward capitalism. In 1946, as anti-communism was on the rise in the United States, the American gave a lecture in which he identified individual and corporate greed as an obstacle for the "welfare of mankind." "We do not even like to call greed, greed," Shapley chided his fellow citizens. "We prefer words like thrift, wealth, success. And we are inclined to treat as un-American and subversive any talk about human rights transcending property rights." In this atmosphere, he also felt almost guilty for raising the question why

[43] Tai (2017), 211–12.

[44] Steen (2019).

[45] Tai (2017), 201.

the "American delegation on the International Atomic Energy Commission should be composed almost wholly of financiers and of industrialists whose professional expertness is in the competitive accumulation of wealth."[46]

Pannekoek and Shapley were two particularly prominent revolutionary scientists. However, they were hardly alone. Already in the late nineteenth century, communists, socialists and anarchists in France and elsewhere were attracted to astronomy, seeking to find a new cosmology for the revolutions they pursued.[47] Spreading modern knowledge of the heavens, they thus also sought to replace religious worldviews with scientific ones and to dismantle older hierarchies. Perhaps more radical in his life overall than either Pannekoek or Shapley was the Belgian Marcel Minnaert. He was vegetarian, teetotal and strongly opposed to many forms of oppression. During World War I, he joined the Flemish movement that sought to promote the Dutch language in French-dominated Belgium. He taught physics at a Dutch-speaking university in Ghent. Because this institution was supported by the German occupation, he subsequently had to flee to the Netherlands in order to escape being convicted of collaboration with the enemy. He continued his career in Utrecht and turned from being a Flemish nationalist to a communist and internationalist.[48] After considerable bureaucratic difficulties, he became director of the director of the Utrecht observatory in 1937.[49] Located at Sonnenborgh (literally Castle of the Sun), this facility was an appropriate place for Minnaert as a scientist who was especially interested in solar physics. However, the skies above him soon darkened again.

During World War II, Minnaert experienced German occupation for the second time in his life. He did not conceal his anti-fascist attitudes and protested against the injustice done to the Jewish faculty members at Utrecht University at the end of 1940.[50] In the middle of the war, he was imprisoned by the Nazi paramilitary Schutzstaffel (SS) for 2 years, worrying whether he might get executed. He made the best of this unfortunate situation by teaching astronomy to his fellow prisoners.[51] In the meantime, his deputy at the observatory, Jakob Houtgast, hid students who refused to work in war factories in Germany.[52]

Minnaert's negative experiences with politics only further encouraged him to strive for a better world. After the liberation of the Netherlands, he continued to take the side of the persecuted and to work for peace and mutual understanding between different countries.[53] He was active in the International Astronomical Union and promoted "radical solutions" like the "introduction of Esperanto as an auxiliary

[46] Shapley (1946), 412–13.
[47] Mathieu (2022).
[48] Baneke (2019), 99.
[49] Unsöld (1972), 63.
[50] Jager (1971), 339.
[51] Müller (1972), 5.
[52] Jager (1971), 339.
[53] Unsöld (1971), 4.

scientific language."[54] He also took great interest in the Cuban Revolution and the Vietnam War. As a result, he had difficulty visiting the United States for much of the 1950s. In 1951, when the Astronomical Society of the Pacific had awarded him the Bruce Medal, he was denied entry to the country. His Russian-American peer Otto Struve, who was no stranger to political activities either, thus brought the decoration to the Netherlands.[55] When Minnaert received another invitation to a scientific meeting in 1957, his American colleagues carefully paved the way with the State Department a year in advance. This time, the Belgian-born Dutch scientist received a visa, but barely in time for event.[56]

Pannekoek and Minnaert were only two astronomers – and from just one country – among many more who fought inequalities and discrimination, such as those against Jewish scientists. Chapter 2 of this book will focus on the many allies they had in breaking down barriers. It tells the story of the IAU's Commission 38 on Exchange of Astronomers over which Minnaert presided. It also sheds light on amateur astronomers who reached out to peers in countries excluded from the international scientific community, like Iran. Their efforts went much beyond securing visas for people marginalized because of nationality and other political markers.

After narrating efforts to combat discrimination based on nationality, this volume continues with an account of the struggle for gender equality. Chapter 3 follows activists who fought for the rights of women in astronomy. The number of outspoken feminists in the discipline has been so large that it is impossible even to cover all leading figures worldwide.[57] The best known include Maria Mitchell and Vera Rubin, both of whom have observatories named after them. Fortunately, I can refer you to excellent biographies written by Renée Bergland[58] and Jacqueline and Simon Mitton.[59] I will restrict myself to the growth of the movement from the 1970s onwards, a decade that saw a broader sexual revolution. This was reflected also in works of science fiction, like the 1975 anthology *Women of Wonder: Science Fiction Stories by Women about Women*. Its pioneering editor was the American feminist author Pamela Sargent, who also collaborated on *Star Trek* novels.[60] In the following decades, gender activists increasingly also advocated for people other than heterosexual ciswomen.

Gender also intersected with ethnicity and race, thus leaving many inhabitants of our planet disadvantaged in multiple ways. The struggle by physical scientists against racial oppression also had too many actors to feature in a single volume. A vast literature exists on the eighteenth-century African American astronomer

[54] Minnaert (1955), 10.

[55] Unsöld (1971), 4.

[56] Goldberg (1978).

[57] Trimble and Weintraub (2022).

[58] Bergland (2008).

[59] Mitton and Mitton (2021).

[60] Sargent (1975).

Benjamin Banneker who pled with Thomas Jefferson for justice for his "brethren."[61] Albert Einstein's fight against anti-Jewish and anti-black racism in Germany and the United States also left enough documents for at least one major book.[62] As in the case of gender activists, my attention will be given primarily to later and lesser-known figures. Most of them emerged at the same time as minorities gained increased access to higher education in many countries in the second half of the twentieth century.

From the pursuit of rights for ethnic and racial minorities, I am moving to disability justice. Astronomers have included people of manifold abilities and medical conditions among their numbers. Deafness, for instance, affected space scientists in many countries. Examples include the Americans Annie Jump Cannon and Robert Grant Aitken, the Norwegian Olaf Hassel and the Russian Konstantin Tsiolkovsky.[63] However, even more debilitating for optical astronomers was blindness. Therefore, Chap. 5 takes special interest in those who were trying to make the science of the stars more accessible to people with visual impairments.

The sixth and final chapter, like this introduction, tries to tie together more general themes from the various spheres of activism. It will take you to some of the most recent developments in astronomical activism, including the calls for decolonization in places as far apart from one another as Hawaii and South Africa. The concluding section will also attempt to make some prediction of future trends. They include the quest to avoid the more divisive aspects of identity politics and to reach a planetary solidarity.

References

African Astronomical Society. 2021. "African Network of Women in Astronomy (AfNWA)." African Astronomical Society. http://www.africanastronomicalsociety.org/afnwa/.

Baneke, David. 2019. "Pannekoek's One Revolution: Anton Pannekoek and the Modernization of the Dutch Astronomical Community." In *Anton Pannekoek: Ways of Viewing Science and Society*, edited by Chaokang Tai, Bart van der Steen, and Jeroen van Dongen, 87–108. Amsterdam: Amsterdam University Press.

Banks, Michael. 2018. "Thousands of Physicists Sign Letter Condemning 'disgraceful' Alessandro Strumia Gender Talk." *Physics World*. https://physicsworld.com/a/thousands-of-physicists-sign-letter-condemning-disgraceful-alessandro-strumia-gender-talk/.

BBC. 2015. "Sir Tim Hunt Resigns from University Role over Girls Comment." *BBC News*. https://www.bbc.com/news/uk-33090022.

Bergland, Renée. 2008. *Maria Mitchell and the Sexing of Science: An Astronomer Among the American Romantics*. Boston: Beacon Press.

Boyle, Alan. 2007. "From Black Holes to Black History." NBC News. https://www.nbcnews.com/id/wbna16971750.

[61] Ray (1998).

[62] Jerome and Taylor (2006).

[63] Lang and Meath-Lang (1995).

Buckley, Matthew, Sean Carroll, Kyle Cranmer, Djuna Croon, Sonia El Hedri, Daniel Harlow, Seyda Ipek, et al. 2018. "A Statement on a Recent Talk at CERN." Particles for Justice.

Carolune Institute for Quality Astronomy. 2006. "CIQuA Presented at the 4th European Conference on Gender Equality in Higher Education." Carolune Institute for Quality Astronomy. http://www.ciqua.org/index.php?page=genderconf.

CERN. 2019. "Updated Statement: CERN Stands for Diversity." CERN. https://press.cern/news/press-release/cern/updated-statement-cern-stands-diversity.

Dance, Amber. 2018. "Meet the space researcher smoothing the path for women in science across Africa." *Nature* 563, no. 7729: 148–148.

European Platform of Women Scientists. 2021. "Woman Scientist of the Month: Mirjana Pović (07/2021)." European Platform of Women Scientists. https://epws.org/woman-scientist-mirjana-povic/.

Felten, James E. 1978. "Reflections, Refractions: Letters and Comment." *Astronomy Quarterly* 2, no. 6: 107–9.

Felten, James E. 1994. "Council's Threatened Boycott over Homosexuality Must Be Avoided." *APS News*, June 1994, 7.

Felten, Jim. 1996. "Nominating Committee's Slate Lacks Charisma and Balance." *AAS Newsletter* 83: 2.

Ghosh, Pallab. 2018. "Cern Scientist: 'Physics Built by Men – Not by Invitation.'" BBC News. https://www.bbc.com/news/world-europe-45703700.

Goldberg, Leo. 1978. Interview by Spencer Weart. Niels Bohr Library & Archives, American Institute of Physics, College Park.

Jager, C. de. 1971. "Marcel Gilles Josef Minnaert." *Quarterly Journal of the Royal Astronomical Society* 12, no. 3: 338–41.

Jerome, Fred, and Rodger Taylor. 2006. *Einstein on Race and Racism*. New Brunswick: Rutgers University Press.

Kaku, Daniel. 2019. "Aspiring NDC Parliamentary Candidate Threatens to Sue MP." GhanaWeb. https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Aspiring-NDC-parliamentary-candidate-threatens-to-sue-MP-767057.

Lang, Harry G., and Bonnie Meath-Lang. 1995. *Deaf Persons in the Arts and Sciences: A Biographical Dictionary*. Westport: Greenwood Press.

McBride, Vanessa. 2018. "A Big Moment for Africa: Why the MeerKAT – and Astronomy – Matter." The Conversation. http://theconversation.com/a-big-moment-for-africa-why-the-meerkat-and-astronomy-matter-99714.

McBride, Vanessa. 2021. "COVID-19 Budget Pressures Threaten Curiosity-Driven Science. That's a Bad Thing." The Conversation. http://theconversation.com/covid-19-budget-pressures-threaten-curiosity-driven-science-thats-a-bad-thing-156586.

McBride, Vanessa. 2023. "Award Recognises Top Female Early Career Astronomer in Africa." African Network of Women in Astronomy. https://afnwa.org/award-recognises-top-female-early-career-astronomer-in-africa/.

Minnaert, M. 1955. "International Co-Operation in Astronomy." *Vistas in Astronomy* 1: 5–11.

Mitton, Jacqueline, and Simon Mitton. 2021. *Vera Rubin: A Life*. Cambridge: Belknap Press of Harvard University Press.

Mohamed, Shazrene. 2022. "The Sky Is for Everyone." In *The Sky Is for Everyone: Women Astronomers in Their Own Words*, edited by Virginia Trimble and David A. Weintraub, 411–22. Princeton: Princeton University Press.

Müller, Edith A. 1972. "Dedication to Marcel Gilles Jozef Minnaert." *Annals of the New York Academy of Sciences* 198, no. 1: 5–7.

Odehyia Media. 2021. "Profile Of Dr.Nana Ama Browne Klutse." Odehyia News. https://odehyianews.com/profile-of-dr-nana-ama-browne-klutse/.

Odman, Carolina. 2007. "Astronomy Has No Gender." Astrocast. http://www.astrocast.org/astronomy_has_no_gender/.

Odman, C J, and R G Izzard. 2006. "Virtual Institutes: An Idea for the Future?" *Astronomy & Geophysics* 47, no. 1: 1.8.

Mathieu, Florian. 2022. “Usages politiques et populaires du savoir astronomique : entre science et utopies révolutionnaires (France, 1871–1939).” Thèse de doctorat, université Paris-Saclay.
Nahar, Sultana N. 2010. “ISMWS Charter.” Ohio State University. http://www.astronomy.ohio-state.edu/~nahar/ismws/ismws-charter.pdf.
Nahar, Sultana N. 2019. “The 40th International School for Young Astronomers in Egypt.” *APS News* 28, no. 9.
Nahar, Sultana N. 2020. “International Society of Muslim Women in Science (ISMWS).” Ohio State University. http://www.astronomy.ohio-state.edu/~nahar/ismws.html.
Posselt, Julie R. 2020. *Equity in Science: Representation, Culture, and the Dynamics of Change in Graduate Education*. Stanford: Stanford University Press.
Ray, Angela G. 1998. “‘In My Own Hand Writing’: Benjamin Banneker Addresses the Slaveholder of Monticello.” *Rhetoric & Public Affairs* 1, no. 3: 387–405.
Sargent, Pamela, ed. 1975. *Women of Wonder: Science Fiction Stories by Women about Women*. New York: Vintage Books.
Sepkoski, David. 2020. *Catastrophic Thinking: Extinction and the Value of Diversity from Darwin to the Anthropocene*. Chicago: University of Chicago Press.
Shapley, Harlow. 1948. “The One World of Stars.” *Science* 108, no. 2804: 315–21.
Silver, Laura. 2015. “This Astrophysicist Just Delivered The Perfect Response To Tim Hunt’s Sexist Comments.” BuzzFeed News. https://www.buzzfeed.com/laurasilver/this-astrophysicist-just-delivered-the-perfect-response-to-t.
Strumia, Alessandro. 2018. “Bibliometrics Data about Gender Issues in Fundamental Theory.” Presentation at the 1st Workshop on High Energy Theory and Gender, CERN.
Strumia, Alessandro. 2021a. “Gender Issues in Fundamental Physics: A Bibliometric Analysis.” *Quantitative Science Studies* 2, no. 1: 225–53.
Strumia, Alessandro. 2021b. “ENG – Update 2021: gender paper published.” Alessandro Strumia. https://alessandrostrumia.home.blog/update/.
Tai, Chaokang. 2017. “Left Radicalism and the Milky Way: Connecting the Scientific and Socialist Virtues of Anton Pannekoek.” *Historical Studies in the Natural Sciences* 47, no. 2: 200–254.
Thebus, Shakirah. 2022. “Death of Astrophysicist Professor Carolina Ödman Leaves Loved Ones Feeling Profound Loss.” *Independent Online*. https://www.iol.co.za/capeargus/news/death-of-astrophysicist-professor-carolina-oedman-leaves-loved-ones-feeling-profound-loss-8bbf92b7-116e-424c-a58f-d98db6c2143a.
Shapley, Harlow. 1946. “The Scientist Outside the Laboratory.” *American Scholar* 15, no. 4: 411–15.
Steen, Bart van der. 2019. “‘A New Scientific Conception of the Human World’: Anton Pannekoek’s Understanding of Scientific Socialism.” In *Anton Pannekoek*, edited by Bart van der Steen, Chaokang Tai, and Jeroen van Dongen, 137–56. Ways of Viewing Science and Society. Amsterdam University Press.
Trimble, Virginia, and David A. Weintraub, eds. 2022. *The Sky Is for Everyone: Women Astronomers in Their Own Words*. Princeton: Princeton University Press.
Tyson, Neil deGrasse, and Avis Lang. 2018. *Accessory to War: The Unspoken Alliance Between Astrophysics and the Military*. New York: W. W. Norton.
Vanguard. 2020. “Legon Varsity Lecturer Joins NDC Foot-Soldier Works.” The Vanguard. https://thevanguardgh.com/2020/08/17/legon-varsity-lecturer-joins-ndc-foot-soldier-works/.
Universe Awareness. 2018. “Special IAU Prize Awarded to First Universe Awareness Project Manager.” Universe Awareness. https://www.unawe.org/updates/2018_IAU_Prize_Carolina_Odman-Govender/.
Unsöld, Albrecht. 1971. “In Memoriam Marcel Gilles Jozef Minnaert.” *Solar Physics* 17, no. 1: 3–5.
Unsöld, Albrecht. 1972. *Sterne und Menschen*. Berlin: Springer.
Varano, Stefania. 2019. “The Impartiality of the Universe.” Astronomy for Equity, Diversity and Inclusion. https://iau-oao.nao.ac.jp/iaus358/talk-session-2-2/.

Chapter 2
Visas and Vistas

"I am still amazed that the most important thing that I contributed to was religion," Harlow Shapley told his colleague Owen Gingerich toward the end of his life. The former director of the Harvard College Observatory was not referring to his affiliation with the Institute on Religion in an Age of Science beginning in the 1950s, however. Instead, he was thinking of a discovery he had made decades earlier while working at the Mount Wilson Observatory. "If a thing like that happened to me now, I think that I would see a philosophical and religious complex and a revolution for man that would make the Copernican thing small."[1] Another former Harvard astronomer, Bart Bok, agreed in an obituary published in the *Quarterly Journal of the Royal Astronomical Society* in 1974. "His name will be forever linked with his proof, at which he arrived single-handedly, that the Sun is not anywhere near the centre of our Galaxy, but that instead it occupies a peripheral position in our Milky Way system," Bok eulogized Shapley. "In the year of Copernican celebrations we can feel proud that our generation of astronomers produced a man who did for our Milky Way system what Copernicus achieved for our Solar System."[2]

Owen Gingerich, a historian as well as an astronomer, disagreed with Shapley about the religious impact of his research on the structure of the Milky Way. "Shapley always spoke of the move of the sun from the center to the edge of the galaxy as making man peripheral, but, alas, I suppose it is the astronomers who are now peripheral in forging man's view of himself," Gingerich wrote. "Much as Shapley would have liked to have seen his work as another trauma to man's self-image, I feel that it has created rather little stir." The twentieth century was simply too different from the sixteenth, in which Nicolaus Copernicus had published his book *On the Revolutions of the Heavenly Spheres*. The opus of the Renaissance polymath had appeared "at a time when man's entire world view was bound up with

[1] Gingerich (1973), 23.

[2] Bok (1974), 51.

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*,
Space and Society, https://doi.org/10.1007/978-3-031-46113-2_2

the geocentric universe," Gingerich argued. "However, once man's home was set into motion about a distant central sun, any further move lost its shock value."[3]

"In the end, it was Shapley's irrepressible vanity that led him to search for a philosophical impact in his work," Gingerich wrote about his former colleague in the year after his death in 1972.[4] Shapley's scientific publications were certainly not seen anywhere near as threatening to religious dogma as *On the Revolutions of the Heavenly Spheres* had been during the early modern period. Long gone was the Roman Curia's general prohibition of books that challenged geocentrism. The Harvard astronomer even won a papal prize in 1941.[5] Nevertheless, he was targeted by a form of inquisition, but one unrelated to the Catholic Church. In 1946, he was subpoenaed to appear before an investigative committee of the United States House of Representatives. The *New York Times* reported: "A turbulent hearing of the House Un-American Activities Committee, held behind closed doors, broke up today with the witness, a famous astronomer, facing contempt proceedings, and all who took part in it, in a rage." The paper further stated that the scientist "alleges 'Gestapo' hearing."[6]

The "un-American activities" Shapley was suspected of had more today with his Earth-bound politics than with any theorizing about our solar system's place within the larger universe. The House Un-American Activities Committee (HUAC) asked the scientist to produce the records of four left-wing organizations with which he was affiliated: the Political Action Committee of the Congress of Industrial Organizations (CIO-PAC), the National Citizens Political Action Committee, the Joint Anti-Fascist Refugee Committee, and the Independent Citizens Committee of the Arts, Sciences, and Professions.[7] Shapley refused to comply with HUAC, and was never again called to testify in front of it. He had to endure further threats from conservative members of the US Congress, however. In 1950, Senator Joseph McCarthy named him as a member of the Communist Party. Three years later, Senator Robert Taft accused him of having attended every important communist meeting in the country. Shapley protested to Taft that he was "much misinformed." He explained that the Soviet purges under Joseph Stalin during the 1930s had meant that "naturally no American astronomer has been pro-communism since that time, however pro-humanity we may be."[8] Shapley had been especially horrified by the disappearance of his friend Boris Gerasimovich, the director of the Pulkovo Observatory outside Leningrad, in 1937.[9] As in Shapley's own case, Gerasimovich's international contacts had aroused suspicions of disloyalty.

[3] Gingerich (1973), 23–24.

[4] Gingerich (1973), 24.

[5] New York Times (1941).

[6] Morris (1946).

[7] Wang (1999), 118.

[8] Wang (1999), 129.

[9] Price (1973), 129.

Gerasimovich's earlier downfall had in part been the result of being undermined by ambitious junior staff members. The astronomer had been publicly denounced by one of them, Viktor Ambartsumian, as an "enemy of the people."[10] In contrast, Shapley received much support from colleagues and students against the witch-hunters of Washington. After having been accused of contempt of Congress by a member of the House Un-American Activities Committee, he was nervous. However, upon returning home from Washington to Cambridge, Massachusetts, he found that more than a thousand students had signed a pledge to back up his "courageous stand against the action of the committee." He later commented, "Coming from Harvard students it was something tremendous, because they were then naturally conservative. Maybe some of them signed blindly." The American Association of Scientific Workers also condemned the House committee. In what Shapley considered as another sign of protest against the "red-hunters," the American Association for the Advancement of Science elected Shapley as its president in 1947.[11]

Having the support of many of his peers, Shapley survived the anticommunism of the 1940s and 1950s. After his hearing in 1946, he had lunch with James Conant, then President of Harvard University. "He does not understand Congressmen," Shapley stated. "But he didn't fire me!"[12] The relationship between Conant and Shapley remained tense, however. In reaction to Shapley's political activities, the university administration restructured the hierarchy of the observatory. Shapley remained director, but ceded control to a new Observatory Council.[13] He also never received the distinguished title of "University Professor" and instead retired as "Professor Emeritus" in 1952.[14] In the meantime, he also needed to assist his wife Martha who was deemed guilty by association. When she innocently brought back home some data on eclipsing binary stars, someone informed the authorities that she was stealing state secrets. She thus temporarily lost her job at the Massachusetts Institute of Technology, before she was able to clear herself with legal counsel.[15]

His wife Martha was not the only woman whom Shapley encouraged in her astronomical work. As director of the Harvard College Observatory, he continued a tradition of employing female "computers" started by Edward Pickering in the late nineteenth century. Even though many of them had college degrees, they were paid significantly less than male astronomers. Shapley was thus able to employ more staff and process more data with the same budget. "I introduced the term 'girl hours'," he said. "One job took several kilo-girl hours to get it through."[16] While he was increasingly dedicated to administration and activism, two women became particularly well-known for their science: Annie Jump Cannon and Cecilia

[10] Eremeeva (1995), 310.
[11] Shapley (1969), 154–55.
[12] Shapley (1969), 154.
[13] Sobel (2016), 254–55.
[14] Palmeri (2000), 173–74.
[15] Welther (1986).
[16] Shapley (1966).

Payne-Gaposchkin. Both were among very few women to be elected to the American Philosophical Society.[17] Cannon also earned the honorary doctorate from the University of Oxford,[18] and Payne-Gaposchkin later became a professor and department head at Harvard.[19]

If the employment of women, albeit for lower wages, at a male-dominated institution like Harvard was progressive, it was hardly the reason for why Shapley had become a target for HUAC. Far more important in making Shapley suspicious to anticommunists was his strong internationalism. Back in the 1930s, he had become alarmed by the rise of Nazism and the dismissal of Jewish and other academics from their posts in Germany. He thus participated in the Emergency Committee in Aid of Displaced German (later Foreign) Scholars.[20] In 1945, he was involved in setting up the United Nations Educational, Scientific and Cultural Organization (UNESCO). On behalf of the US State Department, he travelled to London to participate in the writing of its charter. He later commented, "There was some difficulty about a passport for me because I was a 'dangerous character', and rather proud of it."[21] The charter itself began with the declaration that "since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed."[22] This episode also contributed to Senator McCarthy's accusation that Shapley was one of the communists in the State Department.

Shapley denied having been either a member of the Communist Party or an employee of the State Department.[23] Nonetheless, in his activism he reached out to the other side of the Iron Curtain that had divided Europe since the beginning of the Cold War. He played a leading role in the National Council of Arts, Sciences and Professions, an American socialist organization. In 1948, it endorsed the World Congress of Intellectuals in Defense of Peace held in Wroclaw, Poland. The following year, the organization held a Cultural and Scientific Conference for World Peace in New York in 1949. At both events, speakers from the Eastern Bloc condemned American imperialism, while the Soviet government secretly sought to catch up with the US in the development of atomic bombs.[24]

Like many scientists who had witnessed the Great Depression and the rise of fascism, Shapley had socialist sympathies.[25] Yet, his concern for social justice extended far beyond the working class. As part of the Emergency Committee in Aid of Displaced German Scholars, he sought to defend an academy that was inclusive of a wide range of people. In 1933, he signed a statement that called upon fellow

[17] Rossiter (1995), 327.
[18] Yost (1943), 29.
[19] Wayman (2002).
[20] Jones (1984).
[21] Shapley (1969), 149.
[22] Shapley (1946), 108.
[23] Shapley (1969), 156–57.
[24] Rossi (1985).
[25] Kuznick (1987).

faculty members to "maintain their historic duty of welcoming scholars, irrespective of race, religion, and political opinion, into academic society."[26] In 1948, the astronomer wrote, "I am neither Negro, nor Jew, nor Jesuit, nor Communist. So far as I understand them, I do not hold with Catholicism, Communism, or Judaism. But I am a fellow-traveller of all of these minorities in turn when their constitutional rights are invaded by a thoughtless majority or by malicious aggressors who seek political advantage, material gain, or sadistic satisfaction through persecution."[27]

While Shapley's activism extended far beyond his discipline, it also contributed to diversity in astronomy specifically. At the Rockefeller Foundation, Harvard was informally called "the broken English observatory because there are so many foreigners there."[28] One of the first learned refugees whom he helped leave Germany was the Russian astronomer Sergei Gaposchkin, who had been dismissed from a position at the Berlin-Babelsberg Observatory in 1933. Having fought in the White Army, the enemy of the Bolsheviks' Red Army, he had no possibility of returning to the Soviet Union. Shapley immediately presented his case to the Emergency Committee. "He is now living on a houseboat in the vicinity of Potsdam … doomed to be a total loss." However, Shapley was able to offer Gaposchkin a job at the Harvard College Observatory, where he would remain until his retirement in 1965.[29] Together with his wife, Cecilia Payne-Gaposchkin, he thus formed a dual-career couple, with her as the more prominent scientist.[30]

Shapley was especially prominent among astronomer activists. However, he was not the only one who was trying to overcome the divisions of the world and the discrimination based on nationality and other criteria at the time. Before Shapley's politicization in the 1930s, other scientists had already fought the new exclusions in the world that had emerged at the end of the Great War. Inequalities of access were built into the International Astronomical Union as an organization that identified scientists not only by sub-disciplines and fields of interest, but also by the nation states to which they belonged. In fact, before the IAU started collecting data on the gender of its membership systematically toward the end of the century, nationality was of overwhelming importance as an identity marker. Nevertheless, perhaps because many astronomers were used to grappling with phenomena of enormous scale, they were hardly discouraged from challenging the regimes of passports and visas on our planet.

[26] Jones (1984), 209.

[27] Palmeri (2000), 122.

[28] Shapley (1966)

[29] Jones (1984), 210.

[30] Kidwell (1987).

International Observatories

As much as the International Astronomical Union (IAU) sought to be inclusive, it also reflected the systems of exclusion among nation-states at any given point in time. Founded in 1919, the IAU's parent organization, the International Research Council (IRC), adopted three categories of countries on the basis of the order enshrined in the Paris Peace Conference. First, the victorious Allies of World War I were founding members of the IRC. Second, the neutral nations could become additional members. Third, the defeated Central Powers were barred from membership. At the same time as the International Astronomical Union sought to promoted cooperation in Europe, it denied participation by German, Austrian, Hungarian, Bulgarian and Turkish scientists.[31]

Discrimination based on nationality was blatantly political, and therefore almost immediately challenged. Some of the loudest critics came from countries that had stayed out of the war, such as the Netherlands. In 1919 itself, the Dutch astronomer Jacobus Kapteyn wrote to his American colleague George Ellery Hale: "I for one cannot, I tell you honestly, reconcile myself to the attitude taken by the allied nations and the US in the matter of international scientific cooperation. Many of us, and among them I am one, deeply regret the schism in science." Hale objected to the idea of reestablishing friendly ties with the Germans in particular. Having visited France in 1916, he had realized "the enormity of the offense against civilization committed by the Central Powers." He further explained to Kapteyn that he had seen "no evidence that the German men of science are not in full sympathy with their army and navy."[32]

While several neutral countries were admitted to the International Astronomical Union within a few years, lobbying on behalf of the defeated continued. In 1922, Denmark, the Netherlands, Norway, and Spain became part of the union. So did Czechoslovakia, even though it was one of the successor states of Austria-Hungary. Yet, none of the other former enemies of the Entente did.[33] The narrowness of the new union was met with protest by the secretary of the Norwegian Academy of Sciences. In 1924, he gave the following notice: "the Int. Astr. Union must be prepared for the repeal of our subscription, at any rate if the Astr. Union should not be developed into a really international institution, without exclusion of or restrictions for science of the 'central powers' of the war." Willem de Sitter, another Dutch astronomer, also warned about damage to the discipline as a result of existing statutes. "Austria, Bulgaria, Germany and Turkey are excluded ad eternitates, even if they have honestly fulfilled the conditions of the treaty of Versailles, and will have become members of the League of Nations," he wrote to members of the IAU's Executive Committee in 1925. "Astronomy is the most international of all sciences,

[31] Wielen (2019), 205.

[32] Blaauw (1994), 60.

[33] Blaauw (1994), 7.

and for many of its large undertakings the cooperation of observatories all over the world is necessary."[34]

Even if scientists from Allied countries had been more accommodating, problems within Germany in particular would have precluded a quick adherence to the union. The Astronomische Gesellschaft had already existed as an older competitor to the new organization. Although centered in Germany, it had many foreign members, including de Sitter. German scientists mistrusted the International Research Council, considering it a political body working against the interests of their country. Finally, the financial situation in the aftermath of the war and the Treaty of Versailles was so dire that German institutions would have struggled to pay the IAU membership fees. In the early 1930s, when the Great Depression brought further hardship, the subscription cost would have amounted to 3600 gold francs.[35]

As World War II divided the scientific community again, German adherence to the International Astronomical Union was delayed further. Having suffered directly during this conflict, even people in countries like the Netherlands were now less willing to reach out to their European neighbors. Ahead of the IAU meeting in Copenhagen in 1946, the Dutch astronomer Jan Oort felt that the Germans "should be made aware of the deep hatred they have caused among the people in occupied countries." He added, "After the fierce and unequal fight we have gone through these last years, here around us, an aversion has grown in me against resuming contact again, even in astronomical matters." While he still did not want to support "formal exclusion," he thought that the tragic rupture in the astronomical "family" should not be disguised either.[36]

It thus took the reordering of the world during the early Cold War to end the exclusions built into the founding of the International Astronomical Union. A new internationalism emerged with the United Nations replacing the League of Nations. The United Nations Educational, Scientific and Cultural Organization (UNESCO), to whose establishment Harlow Shapley had contributed, became one of the main funders of the IAU. The victors dominated the UN as well, but they were less punitive this time. Although the Japanese had invaded the Dutch East Indies during World War II, Jan Oort was against formally expelling them from the IAU. "A possibility is, perhaps, to tacitly suspend their membership until they have become independent again and free from the occupying nations," he wrote in 1946. A similar attitude was expressed by the French André-Louis Danjon: "for the moment, German and Japanese astronomers should not be admitted to the Union. Under present circumstances Germany and Japan are not ruled by their own governments."[37] However, by 1948, Harold Spencer Jones, the English Astronomer Royal, stated that "the time has come when Japan can be invited to adhere again to the IAU."[38]

[34] Blaauw (1994), 72–73.

[35] Wielen (2019).

[36] Blaauw (1994), 148.

[37] Blaauw (1994), 148–49.

[38] Blaauw (1994), 160.

Re-adherence was formally easier for Japan, as it had been among the Allies of World War I and had first joined the IAU in 1920. However, an atmosphere of reconciliation during the late 1940s and 1950s also benefitted the former Central Powers. Hungary, by then a satellite of the Soviet Union, was the first among them to join the IAU in 1947. Despite the division of Germany into East and West, the country adhered through the Astronomische Gesellschaft in 1951. At the next assembly, the new IAU president, the Russian-American Otto Struve, noted: "This action represented the healing of a wound which had threatened the very life of the Union from its beginning."[39] Austria followed in 1955, and Bulgaria in 1957. Although it had largely stayed out of World War II, Turkey was the last of the former Central Powers to become a member in 1961.

In the spirit of post-war internationalism, the IAU created new bodies tasked with binding its members together. One of them, Commission 38, was dedicated to the exchange of astronomers. Using money from UNESCO, it gave grants to astronomers who wanted to access facilities in other countries. The IAU thus sought to compensate for currency restrictions and lack of funds in post-war Europe and Asia. The sums made available by UNESCO were modest – 2000 US dollars in total for 1947, and 3000 for 1948. Nevertheless, they enabled some travel. A Polish recipient stayed 6 months at St Andrews Observatory in Scotland. A Chinese astronomer worked in Greenwich, England, and took up a fellowship at Radcliffe College in the United States.[40]

Although funding remained limited, the International Astronomical Union quickly extended its grants to astronomers of nations it had previously excluded. In 1949, the UNESCO funding was increased to 4000 dollars annually. Even before Turkey adhered to the union, one of its citizens used a grant to visit observatories in Switzerland, Germany and Italy. A German visited Britain in order to compare photometric investigations with research back at home. A Japanese astronomer was one of several who used money from Commission 38 to conduct work in Cambridge, England.[41]

As Commission 38 sought to transcend borders, it was still limited in its scope. It primarily targeted individuals. Yet, in parallel, the IAU pursued a more ambitious aim: the creation of international observatories that would be owned and operated by astronomers from all countries. In 1945, Harvard's Harlow Shapley proposed an International Copernican Memorial Observatory. "Some German scholars claim that Copernicus was a German, and Polish scholars insist that Copernicus was a Pole," he noted. "But I suggest that both misrepresent the true situation. Copernicus was a Terrestrial." Terrestrials, Shapley argued, were those scientists whose "work and influence have flowed beyond all national boundaries."[42]

[39] Blaauw (1994), 162.

[40] Stratton (1950).

[41] Stratton (1954).

[42] Shapley (1945), 16.

While Shapley used the word "memorial," he did not simply want to erect a structure that would remind people of the past. The observatory "should not be a cold and inert monument, but rather a living memorial that continues to advance knowledge in the field that Copernicus most effectively graced," the American wrote. After the construction is completed, the institution should have an annual budget of at least 50,000 dollars. It should be managed by an "International Council of Astronomers," composed in a similar way to the United Nations Security Council and with a rotating chair. While a location in Poland is possible, it should "be ultimately selected from the standpoint of accessibility, of nearness to useful libraries and shop facilities, and of climatic conditions."[43]

Shapley's notes on the International Copernican Memorial Observatory were first published in the *Kosciuszko Foundation Bulletin* in 1945. This periodical belonged to a charity devoted to Polish-American exchange. However, the International Astronomical Union soon took up the idea. Commission 39, formally established in 1948, was tasked with studying the feasibility of such a facility. In order to complement the many stations in Europe and North America, the group concluded that an international telescope should be established in the southern hemisphere. The preferred location would be either in South Africa or South America. Yet, not all the astronomers who wanted to use the observatory needed to be based there. An international laboratory, perhaps located in a smaller European country, could examine photographic plates and compute data collected by the telescope.[44]

Although more global than any existing institution, the observatory imagined by Shapley and Commission 39 was not the only one with an international character. During their discussions in the late 1940s, a French member drew attention to a station above the Jungfraujoch in Switzerland which had been "operating with great success for several years." It had been established in collaboration with colleagues in France, Britain, Belgium, Germany and Austria.[45] Observatories in South Africa, Australia, the United States and other countries also engaged in cooperative projects. By the mid-1950s, Shapley, the president of the commission, noted that "several large observatories have become essentially international in that they make special arrangements for the researches of visiting scientists." Plans for new telescopes in Egypt and elsewhere also contained provisions for guest researchers.[46]

Even though many scientists were internationalists, a single observatory owned by the United Nations became less realistic. The facilities envisioned by Commission 39 required much more funding than the couple of thousand dollars UNESCO was paying for travel by individual astronomers annually. At the same time, money was now harder to come by. Shapley reflected that after World War II, hopes had been "high for prompt international collaboration in scientific research, even in fields that

[43] Shapley (1945), 16.

[44] Shapley (1950).

[45] Shapley (1950), 422.

[46] Shapley (1957), 560.

were unrelated to and independent of military or political operations." However, due to the "increasingly difficult political situation," programs of the United Nations turned away from basic research in fields like astronomy. The most favored projects focused on "increasing food supply, enlarging the world's habitable areas, making agricultural and economic surveys, rehabilitating the war-torn countries and cultures."[47]

When Shapley wrote about an "increasingly difficult political situation," he was referring to the exacerbated rivalry between the United States and the Soviet Union that affected many international organizations. The Soviet government virtually boycotted UNESCO for the first 9 years of its existence, fearing the effects of an intellectual exchange that it did not control directly.[48] The Soviet representative on the IAU Executive Committee at the time, Viktor Ambartsumian, thus also abstained from voting on applications for aid from UNESCO.[49] The Korean War further hindered the holding of an IAU General Assembly in either Russia or America during the first half of the 1950s, despite both countries' leadership in astronomy. In September 1951, the Swedish president of the IAU, Bertil Lindblad, justified the postponement of a planned meeting in Leningrad with the follow words: "In December the general international atmosphere got so troubled that according to my experience about the opinion in various countries we must ask ourselves seriously if not the participation to be expected would sink below what is permissible for a successful meeting, in fact below that is worthy of our hosts and of our Union."[50]

While the Soviet Union itself refrained from engagement with UNESCO, its representatives protested the delay of an IAU meeting on its soil. A Soviet delegation put the blame for the IAU's failure to convene in Leningrad on the US: "The true reason for the postponement of the Congress is possibly the fact that the governments of some countries and especially that of the United States would not like to give their scientists the permission to visit the Soviet Union."[51] Ambartsumian complained to the rest of the Executive Committee in 1951 that "To decline the invitation of the Astronomical Council of the U.S.S.R. means to throw the IAU into the flames of political passions, which would in no way contribute to the progress of our science." He emphasized that "true international cooperation and friendship in science is possible only on the principles of equality between all countries, and it cannot be based on the discrimination of some of them."[52]

During the Korean War, the height of McCarthyism and the last years of Joseph Stalin, political pressures would have, indeed, precluded large-scale mutual visits between American and Russian astronomers. At a meeting of the American Astronomical Society (AAS) in 1950, members wishing to travel to Leningrad for

[47] Shapley (1954), 606.

[48] Armstrong (1954), 217.

[49] International Astronomical Union (1950), 3.

[50] International Astronomical Union (1951), appendix A.

[51] International Astronomical Union (1951), appendix B.

[52] International Astronomical Union (1951), appendix C.

an IAU General Assembly were informed about "the possibilities of obtaining transportation, passports, and financial assistance." The AAS Secretary noted that the "first two look hopeful, but the last almost hopeless." Earlier during the AAS conference, a phone call from Washington had stirred up excitement. "Everybody thought it was from the FBI and suspense remained high." Too their relief, it turned out it was not the Federal Bureau of Investigation, but only the "National Research Council which was asking for information."[53]

During the early 1950s, the holding of General Assemblies in smaller countries was thus more promising than in any of the superpowers. In 1952, the union thus convened in Italy. Britain offered to host the next general assembly. However, Ambartsumian worried that it could be difficult for Soviet astronomers to obtain the necessary visas. He also felt that it was as difficult for him to accept a British invitation as it had been for his counterparts to accept the earlier Soviet invite. The Executive Committee then deliberated between going to either Poland or Ireland, ultimately deciding on the latter.[54]

As even the organization of congresses was fraught with political problems, the long-term functioning of a large IAU observatory became less and less likely. After only a few years of formal work, Commission 39 gave up its plans and disbanded. Shapley wrote that a "fully international observatory appears not feasible but smaller or regional co-operative plans are manageable." He thus wondered whether the group should be renamed "Commission on International Co-operative Projects" instead of "Commission for the Creation of International Observatories." In the end, the members decided to abolish their committee at the General Assembly in Ireland in 1955. The Dutch delegate Marcel Minnaert, however, hoped that "the idea of a truly international observatory, which embodies much more than the regional plans that are now in operation or about to go into effect, was too beautiful an idea to abandon lightly."[55]

If a true form of internationalism was more dream than reality, a strong push for Western European integration during the 1950s encouraged at least a few countries to operate telescopes jointly. Locations in the southern hemisphere were especially attractive for common projects. When Harvard's Boyden Station in South Africa ran into financial difficulties, Belgium, Ireland, West Germany and Sweden stepped in to prevent its closure.[56] Around the same time, Jan Oort and others began planning what would become the European Southern Observatory (ESO). South Africa was considered as a location for its telescopes, until tests of viewing conditions showed the Andes as preferable. Belgium, Germany, France, the Netherlands and Sweden formally established ESO in 1962 and chose Chile as a site a year later.[57]

[53] Huffer (1950), 314.

[54] Oosterhoff (1952).

[55] Shapley (1957).

[56] Jarrett (1976).

[57] Blaauw (1991).

After the deaths of Joseph Stalin and Joseph McCarthy, the relations between the US and the USSR improved temporarily. This provided a window of opportunity for the IAU to finally meet in both superpowers. In 1958, a General Assembly was held in Moscow, followed by another one in Berkeley in 1960. "Science needs peace," wrote Ambartsumian in *Cosmos*, the newspaper of the Moscow congress.[58] His American counterpart, Otto Struve, expressed the same spirit in a statement printed in *Cosmos*, although he did not travel to Moscow. Struve said that the launch of *Sputnik* the previous year "represents a step toward the recognition that there is only One World and that our understanding of it must be fostered by the methods of free inquiry engaged in cooperatively by the scientists of all nations."[59]

At the same time as some of the wounds of two world wars began to close through the European Southern Observatory, the Cold War continued to create further patterns of exclusion. When the IAU planned to hold a General Assembly in the United States, the organizers worried about whether they would be able to welcome all participants. The State Department was reluctant to issue visas to nationals of communist countries or even suspected communist sympathizers from elsewhere. Moreover, for it to support a meeting of the IAU on its soil, the American government wanted the organization to accept Taiwan as a member.[60] In 1958, after American prompting, the newly established Astronomical Society of the Republic of China applied for this status. The following year, after some discussion, the island also known as Formosa was admitted. This pronouncement provoked protests from Yu Che Chang, president of the Astronomical Society of the People's Republic: "Taiwan is an inseparable part of Chinese territory, it is a province of China," he wrote to Jan Oort, the then-president of the IAU. If the organization did not "rescind the illegal decision," he threatened, his country "will resolutely and definitely withdraw from the IAU." The IAU leadership did not budge, and mainland China ceased to be a member.[61]

While the IAU's decision to admit Taiwan pleased the US government, it led to further protest from the Eastern Bloc. The Polish and Bulgarian academies of sciences immediately condemned the move. When the union held its General Assembly in Berkeley in 1961, the US government pledged to allow all "bona fide participants" on its soil.[62] However, not all those who came expressed satisfaction with the surrounding politics. Czechoslovak and Soviet representatives also requested that the Republic of China's membership be revoked. The Soviets stated that the decision had "already brought harm to the interests and prestige of the Union and to the international co-operation of astronomers." It further "runs counter to the letter and

[58] Ambarzumjan (1958).

[59] Struve (1958).

[60] Blaauw (1994), 220.

[61] Blaauw (1994), 193–94.

[62] Blaauw (1994), 224.

the spirit of the Statutes of the Union." Nonetheless, a vote rejected the combined Czechoslovak and Soviet demand.[63]

As the 1960s progressed, the Sino-Soviet split dampened Moscow's support for its Maoist neighbor. Yet, rather than contributing to peace and reconciliation, this development only turned the bipolar Cold War into a tripolar one. In the meantime, new obstacles for new obstacles to movement and exchange were being erected across Eurasia. In the same year as the General Assembly in Berkeley, the construction of the Berlin Wall began. The entrenched division of Germany made it impossible for the Astronomische Gesellschaft to represent both halves of the country within the IAU. Instead, the Council of West German Observatories and the East Berlin Academy of Sciences took over this duty.[64]

As bleak as the international situation seemed to be, popular culture offered alternatives to the partitioning of the world. In 1966, *Star Trek* premiered on American television. It offered a vision of the future, in which people of American, Japanese, Russian and Scottish backgrounds were exploring the universe together. During the same year, a West German production, *Space Patrol*, presented similar cooperation: "Here is a fairy tale from the day after tomorrow," says the voice-over at the beginning of each episode. "There are no nation-states anymore. There are only humanity and her colonies in space."[65] The commander of the starship *Orion* is American, and his lieutenants have Swedish, Italian, Japanese, French and Russian names.

Like the science-fiction producers, many astronomers were hopeful to bring the nations of Earth back together. The absence of peers from mainland China from IAU activities was particularly concerning. In the 1960s, Chinese scientists felt especially isolated from the rest of the world. After the People's Republic had received many visitors and much equipment from the Soviet Union during the 1950s, this flow of people and material stopped with the breaking of relations between Beijing and Moscow. Moreover, the famine and purges that occurred during the Great Leap Forward and the Cultural Revolution left many Chinese institutions in disarray, just as similar developments had done in the Soviet Union during the 1920s and 1930s. An extremely populous country with a scientific tradition stretching back thousands of years thus suddenly lacked the human and material resources for advanced research.

Despite the death of millions of Chinese during the period, a few foreign astronomers were still attracted by the country behind the Bamboo Curtain. One of them was Chris Christiansen of the University of Sydney in Australia. His interest had begun decades before the establishment of the People's Republic. When he was a child, an aunt had worked as matron of a missionary hospital. Later, he read the book *Red Star Over China* by the American journalist Edgar Snow. As he got ready to attend a meeting in Japan in 1961, he thought, "Why don't I try to get into China?"

---

[63] Blaauw (1994), 195–96.

[64] Blaauw (1994), 162.

[65] Kniesche (2007), 160.

He thus wrote to the Chinese Academy of Sciences, introducing himself as a representative of its Australian counterpart. After waiting for some time, he received a warm invitation to give lectures in 1963.[66]

A group of radio astronomers was especially excited to meet Christiansen. One of them was Shouguan Wang from the Chinese Academy of Sciences. Earlier in his career, he had worked extensively with peers from other countries. Back in the years 1950 to 1952, he had been an assistant at the University of London Observatory in England. After his return to China the following year, he collaborated with Eastern European scientists and engineers in renovating and setting up telescopes.[67] Yet, these exchanges came to a halt after several years. "In the early 1960s, our contact with Russia had fallen to a low ebb, and our contact with the West was nil," Wang would later remember. Nevertheless, he and his colleagues were determined to construct a copy of the Chris Cross, a solar observatory named after Christiansen. When they found out that the Australian astronomer was planning to visit, "it was like a happiness that had fallen from heaven."[68]

Wang thus enthusiastically embraced his Australian counterpart, and the two radio astronomers began a long friendship. The Chinese scientist described his separation from Western peers as a "wall." In 1963 then, "a small door would open in this wall, and who should come through that door but the very man we most wanted to meet." He and his colleagues thus showed him as much hospitality as possible and invited him back many times.[69] In return, Christiansen shared much information and even electronic components for the creation of telescope arrays.[70] As a result, the US State Department, which continued to boycott Mao Zedong's regime, denied the Australian scientist entry visas for many years.[71] In contrast, senior Chinese officials honored him. Christiansen met the Zhou Enlai, the first premier of the People's Republic, and toward the end of his life was elected a Foreign Member of the Chinese Academy of Sciences.[72]

Being based in Australia, it made geographical sense for Christiansen to reach out to scientists in Asia. The pioneering radio astronomers helped construct telescopes not only in China, but also in India, Japan, and near Lake Baikal in Russia.[73] However, he also encouraged peers far away from the Pacific Rim to visit the People's Republic. One of them was George Miley, a young Irish staff member at Leiden Observatory in the Netherlands. Politically leftwing, he opposed the demonization of communist China in many Western media. Through Christiansen as an intermediary, Miley received an invitation to visit the country as he was attending

[66] Frater et al. (2017), 85.
[67] Wang (2016).
[68] Wang (2009), 33–34.
[69] Wang (2009), 34.
[70] Orchiston and Swarup (2019), 373.
[71] Kellermann et al. (2021), 41.
[72] Wang (2009), 36.
[73] Swarup (2008), 194.

the fifteenth General Assembly of the IAU in Sydney in 1973. On the way back from Australia to Europe, he stopped in the Middle Kingdom as a guest of the Chinese Academy of Sciences, as he told me.

Being still in an early phase of his career, Miley had less to offer the Chinese in terms of knowledge or equipment. However, he was able to bring his hosts to greater attention of the international astronomical community. He wrote sympathetic articles about them in the *Irish Independent* as well as American periodicals. In *Sky & Telescope*, he described a 60-centimeter telescope "built entirely in modern China." Used for determining the orbits of two Chinese satellites, he found it side by side with older "ingenious astronomical instruments beautifully constructed by ancient Chinese astronomers."[74] Writing for the US National Radio Astronomy Observatory's publication *The Observer*, he even saw "beneficial results" in Maoist indoctrination. He compared communist schools to the Catholic institutions he experienced growing up in Ireland. "A Chinese peasant talks about 'correctly applying the thoughts of Chairman Mao' just as an Irish farmer says 'God willing'," Miley commented. He acknowledged that "some intellectuals must have found this religious atmosphere difficult to stomach," but the communist work ethic was impressive. "The selfless dedication of hundreds of millions of people has been a major factor in the incredible transformation that has taken place in China during the past two decades."[75]

Helpful for Miley's outreach was the greater role of Beijing on the world stage. In 1971, the United Nations recognized the People's Republic as the only legitimate representative of China and expelled Chiang Kai-shek's government. Although the United States voted against this particular resolution, it sought the resumption of harmonious relations with mainland China. In 1972, President Richard Nixon visited Beijing, Hangzhou and Shanghai, and met with Mao Zedong and Zhou Enlai.[76] Another American president, this time of the IAU, also put China on his agenda. In his speech at the General Assembly in Sydney in 1973, Leo Goldberg said that none of his tasks was "more urgent than finding some way to effect the return of our colleagues from China to the IAU."[77]

Just like Nixon, Goldberg wanted to make an overture to Beijing without breaking ties with Taipei. At the next General Assembly in Grenoble in 1976, the IAU president reported that "the Executive Committee has found no way acceptable to the Chinese of reinstating their membership in the IAU without expelling Taiwan, an action that would violate the statutes of the Union." He also responded to a question he had heard: "if the U. N. can dismiss Taiwan, why can't the IAU do the same?" His answer was that "all astronomers have the right to be represented in the organization, regardless of political considerations. The U. N. chooses its membership on political grounds; the IAU does not." Although the United Nations had

[74] Miley (1974a), 148–49.

[75] Miley (1974b), 20.

[76] Liu (2019), 225.

[77] Goldberg (1974), 63.

expelled Taipei's representatives, the leadership of the astronomical organization was unwilling to follow.[78]

For Christiansen, Miley and a few others in Goldberg's audience, this impasse was unacceptable. They immediately responded in a letter to the General Assembly's newspaper. They expressed sadness that "China, a country comprising nearly 20 % of the world's population with several flourishing observatories and many hundred astronomers should not be represented in the IAU." To the Australian and his peers, this situation was not only embarrassing, but also "unjust and unrealistic." While they did not want to see Taiwanese scientists expelled either, they did consider the decision to admit the island in 1958 a "mistake." They thus called upon the Executive Committee to recognize the offence it had caused and to change the official title from "Republic of China" to "Province of Taiwan, China." "Those who consider our action as 'bringing politics into the IAU' should remember that by its very structure (adherence of countries), politics is an unavoidable part of our organization," they explained. "In fact, by admitting 'The Republic of China' on Taiwan to membership at the height of the cold war the IAU took a decision that had wide political consequences."[79]

Goldberg's 3-year term as IAU president ended in 1976. It was thus left to his successor, the Dutchman Adriaan Blaauw to work out a compromise that would re-integrate mainland China without excluding Taiwan. At the beginning of his presidency, Blaauw received a document from Miley "On the Legality of the adherence of 'The Republic of China (Taiwan) to the IAU." The young Irish astronomer argued that the organization's decision to admit Taiwan "contravened the statutes of the IAU and was therefore invalid."[80] Blaauw sent this document to lawyers of the European Southern Observatory for comment. In walking through this legal and political minefield, the Dutchman was further helped by Patrick Wayman, the IAU's assistant secretary general. The Chinese Academy of Sciences invited the latter to visite Beijing, Nanjing and Shanghai in the spring of 1979. In return, a delegation headed by Yu Che Chang, the president of the Chinese Astronomical Society, attended the IAU General Assembly in Montreal later that year. The two sides finally agreed on the membership of a single China through two organizations in Nanjing and Taipei: the Chinese Astronomical Society and the Academia Sinica. Financial contributions thus were to come from two separate bodies. The official wording was nonetheless careful to avoid suggesting the existence of either two Chinas or one China and one Taiwan.[81]

The re-admission of mainland China to the IAU after around 20 years was a cause of relief and celebration among astronomers worldwide. "All countries that maintain any appreciable research activity in astronomy are now IAU member countries," Wayman noted in 1981. "No countries are excluded from IAU

[78] Müller and Jappel (1977), 20.

[79] Booth et al. (1976).

[80] Miley (2022), 319.

[81] Blaauw (1994), 200–203.

membership and the IAU in fact has to accommodate representatives of every kind of national endeavour, whether it be capitalist, colonialist, communist, 'developing', neutralist, etc."[82] Zdeněk Kopal of the University of Manchester was still worried about future conflicts, however. In an article in 1982, he asserted that the international organization "has really never been free of political interference from many directions." He warned that similar exclusions to those of Germany and China could happen again "as long as the present structure of the I.A.U. remains unchanged – i.e., as long as it remains in effect only a Union of National Committees; with little strength at grass-roots."[83]

Astronomy for Development

While IAU presidents and secretaries general were especially focused on the participation of larger countries like China and Germany, others on the lower levels of the union were dedicated to broader exchange. This included the mobility of astronomers at the grassroots level. Although Commission 39 on international observatories had ceased its work in 1955, Commission 38 provided an increasing number of travel grants. After giving five to ten grants annually at first, it awarded fifteen to twenty every year by the 1960s.[84] The group's budget had increased to 7500 US dollars, which was enough to make the commission president, Marcel Minnaert, enthusiastic. "All efforts should be made to stimulate the mobility of astronomers and to make effective use of the wonderful possibilities now available," he reported in 1966. "It should be stressed that the IAU grants can be awarded for a stay of any duration of time, and that practically all applications are answered positively and quickly."[85]

Attempting to lift the Iron Curtain, Commission 38 reported in 1960 that "every effort should be made to promote East-West exchange." Travel occurred mostly in one direction, however. In the previous years, a Polish astronomer had received a grant to visit the Paris Institute of Astrophysics, and two Czechoslovak peers went to Manchester and Marseilles.[86] Subsequently, three Czechoslovaks also went to Utrecht in the Netherlands. One Dutchman traveled the other way, spending time at the Ondřejov Observatory southeast of Prague in the early 1960s.[87] Nonetheless, on the whole, Eastern European countries sent far more scientists than they received through the IAU's program.

[82] Wayman (1981), 6.

[83] Kopal (1982).

[84] Hearnshaw (2019), 375.

[85] Minnaert (1966), 80.

[86] Stratton (1960).

[87] Minnaert (1966), 80.

Besides trying to overcome the division of Europe, Commission 38 sought to bridge the growing gaps between developed and developing countries. In 1962, the group was tasked with supporting the training of young astronomers abroad. These scientists included the nationals of "new" countries emerging from colonial rule. One of the problems highlighted by Minnaert and others was brain drain. Studies overseas "should not be directed towards permanent emigration but towards a return to the home country." Another issue was isolation. "There is always the danger that the young foreign scientists, after completion of their studies in Europe or the U.S.A., go back to their country and are able to find only very subordinate positions, where they lose all contact with science." Commission 38 therefore advised developing countries to "to send some of their best students abroad, and to have them guarantee more or less that these shall get suitable positions when they return, so that the knowledge which they have acquired may be put to good use."[88]

After initially awarding most of its grants to Europeans, Commission 38 provided more and more support for people from other parts of the world. However, travel for training purposes was a topic so large that it merited a separate committee. Commission 46, established in 1964, organized International Schools for Young Astronomers (ISYA). While locations of the programs varied, the aim was always to bring students from developing and developed countries together. The first summer school, a 6-week event in Manchester in 1967, was initiated by Zdeněk Kopal and others. It had participants from India, Egypt, Poland, Portugal, the United States and other countries.[89] The next three schools were held in Italy, India and Argentina respectively.[90]

Besides the International Schools for Young Astronomers, Commission 46 started a project of visiting professors. Whereas the grants given by Commission 38 mostly supported travel for research purposes, this new program focused on education. Minnaert wrote in a letter that "it is not sufficient to enable a few young astronomers from such countries to work for some time in more developed parts of the world." He added that "it might be more useful and economic if experienced astronomers were prepared to stay for some time in countries wishing a closer participation in modern astronomical research." Peers in India and Indonesia immediately expressed interested in hosting foreign lecturers.[91]

Although the lecture topics centered on other celestial bodies, some members of Commission 46 were also committed to political causes on Earth. One of them besides Minnaert himself was Edward Kononovich of Moscow University. He first served as vice-president and then as president of the group during the 1970s. "The Universe needs urgently the Earth as a peaceful, developing planet of the Solar System," he wrote in 1979. "The duty of mankind is to keep the Earth in safety and prosperity." As Earth is the only planet on which the existence of life has been

[88] Minnaert (1966), 86.

[89] Schatzman (1968), 229.

[90] Gerbaldi (2007), 222.

[91] Müller (1970), 562.

proven, it has a special place in the cosmos. "The World Astronomical Educational System is demonstrating to all people, countries and governments this simple and essential idea. This is our modest contribution to the Peace Security Movement throughout the world."[92]

New initiatives to spread astronomical knowledge rarely lacked enthusiasm. Yet, despite UNESCO support, money was more difficult to come by. In 1971, Commission 46 reported that funding was one of the problems faced by its visiting professors project. "In some cases living expenses for the duration of the visit can be provided by the host institution, but travel expenses are quite another matter."[93] Little had changed by the end of the decade. "The chief difficulty of the Commission work is the scarcity of funds," Kononovich reported in 1979.[94] The Executive Committee granted the group 8000 dollars for its annual school for young astronomers. On top of that, the receiving countries were expected to contribute financially to educational activities. Here, the wealth gap across the world was an obstacle. "Even small sums provide difficulties for developing countries (the developed ones do not need help)," explained Kononovich.[95]

Despite limited resources, Commission 46 increasingly focused on the developing world. In 1979, it formed a Working Group on the Education of Astronomers from Developing Countries. Operating jointly with Commission 38, it was trying to formulate ways to introduce the science "to countries with no or little astronomy."[96] Although some nations in the Global South, like India or Indonesia, had modern research facilities, astronomers were struggling in many other places to get support for their discipline. Mazlan Othman from the National University of Malaysia commented that astronomy was widely regarded as an "abstract science" with "no bearing whatsoever on the advancement of the country." It was therefore "not favoured in any country where immediate practical applications are preferred and where the foundation for basic science is still weak."[97]

As governments differed greatly in their willingness to fund telescopes, inequality further increased, to the great alarm of many in the IAU. "One of the great divisions of our age is informed access to technology," complained Derek McNally from the University of London Observatory. "Two classes of astronomer are being formed – those who possess the latest in technological development and who know how to use it and those who do not have it/do not know how to use it."[98] The gap further widened with the next generation of students. Even those scientists who were trying to catch up, could end up in a catch-22 situation. "Without experience

[92] Kononovich (1979a), 198.
[93] Müller and Swihart (1971), 237.
[94] Kononovich (1979a), 191.
[95] Kononovich (1979b), C.
[96] Wentzel (1982), 633.
[97] Othman (1984), 5.
[98] McNally (1985), 3.

they cannot credibly formulate proposals for such instrumentation and without the instruments they cannot gain experience."[99]

Of course, the exchange programs of the International Astronomical Union had long familiarized visiting researchers with equipment available in other countries. However, McNally considered such sponsored trips far from sufficient. The summer schools were restricted to a few weeks. Longer stays were possible for research scientists, but rarely available for technical staff from developing countries. He thus conceived of the idea of a Travelling Telescope (TT). "If the developing countries cannot come to the technology then the technology must come to the developing countries," he wrote in 1986.[100] Large radio telescopes were not easily transportable, but an eight-inch optical instrument with a computer could be loaded onto a commercial airplane.

Even though the Travelling Telescope was small, it still required funds that Commission 46 did not have. "Is there a company manufacturing fine telescopes and willing to supply a telescope and tripod? (Do not underestimate the publicity value!)," McNally asked. "Who will pay for the transport? We are optimistic (we would not be astronomers if we were not so endowed) that we can persuade national airlines to transport the items free of charge."[101] Colleagues of McNally successfully applied to a new program by the Canadian Commission for UNESCO and the Canadian International Development Agency. At 15,000 Canadian dollars, theirs was the largest of the forty grants awarded, out of more than 400 applications. With the money, they purchased a 20-centimeter Celestron telescope, a photometer, a spectrograph and other accessories. Ownership of the instruments was to rest with the International Astronomical Union.[102]

Although the funding could be found, the logistical challenges of the Travelling Telescope remained formidable. One of its first trips was from Canada to Malaysia in support of a school for young astronomers in 1990. The instrument was loaded onto a plane in Toronto, but was bumped in transit at Heathrow in order to make way for a backlog of other cargo. It landed in Kuala Lumpur several days late, only to be held up by customs. The accompanying astronomer from Canada, Dieter Brückner, commented that retrieving the telescope "turned out to be agonizingly slow, as the necessary paperwork worked its way through the usual system of university administrators, brokers, airline agents, and customs officials."[103] In the meantime, the Malaysian hosts worried whether they had to come up with a 10,000-dollar bond as advised by customs. Although the telescope was finally released without such a payment, it arrived late for the 3-week school and was of limited use. The students were interested in it, but did not have enough time for focused research with it.

[99] McNally and West (1986), 7.

[100] McNally and West (1986), 7.

[101] McNally and West (1986), 7.

[102] Brückner and Percy (1990), 416.

[103] Brückner (1991), 3.

Even if airlines and customs were supportive, Commission 46 found the Travelling Telescope difficult to manage. The New Zealand astronomer John Hearnshaw, a vice-president of the group, later noted that "it proved very expensive to ship 300 kg of crates around the world." Additional issues were the need for supervision while overseas and for maintenance on the telescope's return. As part of the visiting professors program, the photometer and spectrograph, but not the telescope, went to Paraguay in 1992. Ultimately, travel stopped, as Hassan II University in Casablanca, Morocco, acquired the instrument. Hearnshaw commented that "although it was a great idea in principle, the TT project never really thrived." It was "largely a failure."[104]

In order to serve developing countries more effectively, the International Astronomical Union restructured its initiatives at the beginning of the new millennium. In 2000, Commission 38 was merged into Commission 46. The expanded unit included program groups for "Teaching Astronomy for Development" (TAD) and for "World-Wide Development of Astronomy."[105] Its members were especially interested in supporting poorer countries in Africa, Asia and Latin America. By 2004, TAD had activities in Vietnam, Costa Rica, El Salvador, Honduras and Morocco. New operations were planned for Mongolia, Nigeria and Rwanda. Funding remained always limited, however. The IAU's Executive Committee noted: "Unfortunately TAD cannot support all countries that approach it, so careful consideration based upon reports and analyses submitted to TAD by visiting astronomers, is always given to the likelihood of good outcomes in a given country."[106]

The enlarged Commission 46 was also keen to re-establish ties with North Korea as another country at the margins of the international scientific community. Although the Democratic People's Republic of Korea had originally joined the IAU in 1961, its membership lapsed in 1995 because of non-payment of its dues for 5 years. This had happened during a period of famine and economic crisis after the loss of Soviet support. In the late 2000s, however, North Korean astronomers were ready to engage with their foreign colleagues again. In 2007, Ed Guinan, then chair of the Program Group on Teaching for Astronomy Development, entered into discussions with the North Korean Embassy in Kuala Lumpur on the occasion of an International School for Young Astronomers in Malaysia. Two North Korean scientists attended the training program. Subsequently, the Pyongyang Astronomical Observatory was added to a list of libraries that received complimentary copies of IAU publications.[107]

In reaching out to his North Korean peers, Ed Guinan worked closely with George Miley, who in 2006 had become a vice president of the IAU with the portfolio for education and development. After having campaigned for the return of the People's Republic of China to the organization during the 1970, Miley now turned his attention to the Democratic People's Republic of Korea. In 2008, Miley met

[104] Hearnshaw (2019), 380–81.

[105] West (2001), 248–49.

[106] International Astronomical Union (2004).

[107] Miley (2022), 319.

Jong Sok, the director of the Pyongyang Astronomical Observatory on the sidelines of an International School for Young Astronomers in Mongolia. Sok was worried that the annual dues would be a substantial burden. However, Miley assured him that developing countries usually received more in benefits from IAU membership than the cost of their fees. In 2011, Miley sent an official letter to the North Korean Academy of Sciences, inviting it to rejoin. At the IAU's General Assembly in Beijing, China, the following year, North Korea was finally re-admitted.[108]

During his exchange with Sok, Miley said that the global development of astronomy was part of the IAU's core mission.[109] In order to bolster the activities that Commission 46 engaged in, the Irish radio astronomer wrote a strategic plan for the decade beginning in 2010. His ambition included the establishment of the Office of Astronomy for Development (OAD), which was realized in 2011. The IAU located the new unit in South Africa, justifying this decision with the following words: "South Africa's status as a G20 country, combined with its ethnic diversity (African, Asian, European), places it in an ideal position not only to enhance "South-South" but also 'North-South' relations, thus 'bridging the gap' between developed and developing countries."[110] To strengthen this hub, Commission 46 transferred its funded activities to the new office.[111]

One Sky

However limited the funding for some IAU programs was, leading professional scientists like George Miley still commanded institutional resources that exceeded those of most private individuals. Nevertheless, a number of amateur astronomers also dedicated themselves to overcoming barriers based on nationality. For eclipse enthusiasts in particular, crossing borders was often a necessity. In order to witness the spectacle of daytime darkness, they had to go wherever the Moon's shadow was predicted to fall. Mike Simmons, a medical researcher at the University of California, Los Angeles, was one of many who chased total solar eclipses in his free time. After missing one in Mexico in 1970, he made a promise to himself that he would see the next one coming to the northwestern United States 9 years later. He took his family for a holiday to the state of Washington for the occasion and got hooked. "I felt I had 'seen the light (darkness?)'," he later wrote.[112]

Eclipses also took amateurs to countries that lacked major observatories or strong ties with the International Astronomical Union. In 1994, Simmons travelled to Bolivia, one of the poorest nations in South America. Together with ten intrepid

[108] Miley (2022), 319–21.

[109] Miley (2022), 320.

[110] International Astronomical Union (2010), 22–23.

[111] Hearnshaw (2019), 383.

[112] Mike Simmons (2003a).

mountaineers, he set out to observe a total solar eclipse from Nevado Sajama, an extinct volcano near the border with Chile. Climbing Bolivia's highest peak was a challenge, and a good view of the Sun far from secured. "We would have no weather forecast or any other contact with civilization for a week before the eclipse," he noted. "And there were no guarantees that we would even reach our chosen observing site on the summit." He and his companions only brought binoculars, as telescopes would have been too heavy to carry to an elevation of over 6000 meters. In the end, Simmons neither reached his desired location nor got the weather he wanted. He only got to a ridge of close to 5000 meters rather than to the summit and viewed the eclipse through thin clouds. Nevertheless, he considered the trip a great experience. "It proves that some eclipse chasers will do almost anything to get to the best observing site around," he reflected.[113]

If Bolivia's highest mountain was hard to reach due to geography, other locations were difficult to access because of politics. They included Iran whose formal diplomatic relations with the United States had ended in 1980, just as Beijing and Washington had normalized their ties. After the Islamic Revolution, the war with Iraq and sanctions inhibited Iran's engagements with the international community. Although the country had become a member of the International Astronomical Union in the late 1960s, it struggled to pay its dues under the new regime. Only in 1983, 4 years after the revolution, the Islamic Republic paid its arrears.[114] Subsequently, Yousef Sobouti from Shiraz received a grant through Commission 38 to travel to Italy, Belgium and the US. The IAU's Executive Committee hoped that "fruitful interaction with Iranian astronomers will follow."[115] Yet, the Iran–Iraq War further isolated scientists in Shiraz and elsewhere in the country. After hearing "no news" when it came to Iran's membership by 1987, the IAU's president was forced to write to them.[116] Sobouti attempted to ascertain the position of his country and to get the most recent arrears paid.[117]

After the end of the war against Iraq in 1988, Iran's economic situation improved and international connections slowly resumed. In 1991, the IAU's Executive Committee noted that the Islamic Republic was one of three countries (alongside Argentina and Venezuela) to "have either paid off or made arrangements to pay off their arrears." They were therefore permitted to vote in the organization's General Assembly.[118] In 1997, Sobouti directed an International School for Young Astronomers at the Institute for Advanced Studies in Basic Sciences in Zanjan. The IAU's Executive Committee considered the event, which was sponsored through Commission 46, a "success" and acknowledged "with thanks the work of its

[113] Mike Simmons (2003b).

[114] International Astronomical Union (1983), 5.

[115] International Astronomical Union (1984), 7.

[116] International Astronomical Union (1987), 3.

[117] International Astronomical Union (1988), 2.

[118] International Astronomical Union (1991), 2.

organizers."[119] The same year, Mohammad Khatami won the Iranian presidency on a platform of liberalization and reform. In contrast to the theory of a "clash of civilizations," he proposed a "dialogue among civilizations."

In this atmosphere of openness, a solar eclipse occurred over Iran in 1999. Mike Simmons and his wife Sherri were initially hesitant to make the trip, as he told me. When one of his acquaintances in Bolivia first suggested it to him, he responded, "But I am Jewish." "Yes, so am I," commented his associate. Simmons knew hardly anything about his co-religionists living under the Islamic Republic. As Americans, he and his spouse also received numerous warnings from friends. "Some said I would come back in a body bag," wrote Sherri, "and one asked if she could have the lovely bronze statues in my house if I never made it back!" As a woman, she was told to expect extreme discrimination and segregation. "I was warned to walk behind the men and to never look at nor speak to any men (except my husband) because if I did, I could be stoned to death." Other people in her circle simply thought she was crazy. "Who do you think you are, the Queen of Sheba?," she was asked.[120]

The Simmons' apprehensions quickly turned out to be unjustified. Mike wondered about the reactions of immigration officers and hotel clerks when handing over his US passport. Yet, other than needing to complete extra paperwork, "all went smoothly."[121] Sherri dressed modestly, and any transgressions of local norms were overlooked. "Iranians are an extremely polite and kind people," she explained, "and foreigners are not expected to know all Iranian etiquette rules."[122] Mike and Sherri had expected some hospitality, but were surprised by the warmth of welcome in Tehran and elsewhere (Fig. 2.1). Staff and volunteers with the magazine *Nojum* (Astronomy) accompanied them to the observing site in Nahavand in the Zagros Mountains. They were hosted by a governor and offered tea by villagers and nomads whom they encountered along the way. When revealing that they were from America, they were wished a good trip. Iranians often made the point that they love the American people though not the US government. When Mike responded that he did not like his government much either, he always elicited smiles.[123]

While the eclipse over Iran was a passing phenomenon, the friendliness of its people and the richness of its culture and nature had a lasting impact on the Simmons. "We found a country with diversity and contrasts we had never imagined and we have stayed in touch with the Iranian friends and fellow astronomers we met," Mike wrote. Similar to his home state of California, Iran had temperate rainforests, high mountains and hot deserts. "We were also stunned by a cultural diversity that rivals any place on Earth," he confessed. "From Alexander the Great to Genghis Khan, at some time most came through ancient Persia" and contributed to its mixed

[119] International Astronomical Union (1997), 6.

[120] Sherri Simmons (2004a, b).

[121] Mike Simmons (2008a, b).

[122] Sherri Simmons (2004a, b).

[123] Mike Simmons (2008a, b).

Fig. 2.1 Students at the University of Tehran showing Mike Simmons (right) around their telescope making shop in 2002. (Courtesy of Sherri Simmons)

population.[124] The Simmons were so attracted to the old nation that they revisited it multiple times. In 2002, Mike participated in an amateur astronomers' workshop at the University of Tehran. Two years later, he led a group of Westerners to the Islamic Republic to observe the transit of Venus.

Based on his own experiences, Mike Simmons tried to challenge the negative image of Iran common in American media. In 2001, he wrote in *Sky & Telescope* that "the country has put out its welcome mat for tourists and amateur astronomers alike." He also noted that despite hostile government rhetoric, "Most of the people of Iran have never lost their fascination for all things American."[125] During his travels in 2002, he wrote a series of articles for the American magazine *Astronomy*. They were not printed, however, as he shared with me. He heard later from a friend that somebody had challenged the editor, "Why are you publishing these things about our enemies?" When advertising his trip for the transit of Venus, he thus still had to answer basic questions like whether Iran was safe for Westerner travelers. His short answer was: "Yes, it's safe, and the people love American visitors." As for anti-US demonstrations, they were few and only drew a tiny fraction of the country's population. "I have yet to see one despite hoping to see it for myself," he commented in 2004.[126]

[124] Mike Simmons (2002a).

[125] Mike Simmons (2001).

[126] Mike Simmons (2004a, b).

Simmons's desire to transcend borders was shared by his Iranian counterparts, even those who had not been able to travel as extensively as he had. One of them was Mansour Vesali, an assistant professor at Shahid Rajaee Teacher Training University and co-founder of *Nojum*. "Amateur astronomy is about loving the sky," he said, "And the sky is accessible to everyone."[127] To both Simmons and Vesali, their science had no geographical boundaries. An astronomer's address was simply "Earth." Vesali emphasized, "We all see the same sky."[128] Babak Tafreshi, another editor of *Nojum*, also believed in the subject's universal appeal. "We try to bring astronomy to even the most remote sectors of society, taking telescopes to share the beauty of astronomy with children and even young adults in a youth prison," he wrote.[129] Tafreshi also drew large audiences to his television program. "They say they like the show because it is not connected with any problems in society, politics or religion."[130]

Encouraged by his meeting with like-minded people in Iran, Simmons reached out to further countries sanctioned by the United States. He attended a peace conference at the University of Baghdad in Iraq in January 2003, just 2 months before the American invasion. Somewhat jokingly, he was also waiting for an invitation to visit North Korea,[131] thus defying President George W. Bush's rhetoric of an "axis of evil" at the time. In the meantime, the war did not discourage him from returning to Iraq. In 2006, one of the deadliest years of the conflict, he travelled to the Kurdistan region in order to report about the damaged Iraqi National Astronomical Observatory for *Scientific American*.[132] By this point, the country had been largely excluded from the global astronomical community for over a decade. Back in the 1990s, Iraq's membership in the IAU, just like North Korea's, had ended after the state had failed to pay its dues for more than 5 years in a row.[133] Exacerbating the exclusion from international organizations were the destruction of infrastructure and the emigration of members of the intelligentsia.

Deprived of much contact with foreign scientists under the conditions of war and embargo, astronomers in Iraq welcomed Simmons's visits just as their Iranian peers had done. The American did not come empty-handed either. He and others in the US were distressed by the difficulties his hosts had in ordering telescopes and other items from abroad. Without access to instruments, books and magazines from elsewhere, amateurs in northern Iraq felt "isolated and forgotten by the rest of the world," he found. During his second trip 2006, he thus delivered surplus equipment donated by Orange County Astronomers. The feeling of being connected with

[127] Mike Simmons (2001).

[128] Mike Simmons (2002b).

[129] Tafreshi (2003).

[130] Al Jazeera (2005).

[131] Mike Simmons (2003c), 81.

[132] Mike Simmons (2007b).

[133] International Astronomical Union (1994), 3.

fellow enthusiasts elsewhere in the world led the Amateur Astronomers Association of Kurdistan to proclaim in its newsletter: "We Are Not Alone Anymore!"[134]

Simmons's experience with the Kurds led him to institutionalize his work. "When amateurs back home in the US hear me tell of the plight of less fortunate colleagues in undeveloped countries, they respond with great generosity," he said. To him, taking telescopes to poor and isolated parts of the world could also contribute to peace. "It's not just wallets that open but minds as well," he explained. "We imagine our fellow enthusiasts on the other side of the globe and can't help but wonder about their lives." After having retired from his day job at the University of California, Los Angeles, he thus started an organization called Astronomers Without Borders (AWB) in 2007. He was planning to share resources and sponsor global star parties in which amateurs in different locations were observing the same objects. Such collaboration would also have a positive psychological effect, he hoped. "Real faces supersede media images. And relationships, support, and personal connections supplant stereotypes."[135]

Astronomers Without Borders gained enthusiastic support from Mike Simmons' colleagues in Iran. Babak Tafreshi embraced the organization as a vehicle for pursuing a project of his own called The World At Night (TWAN). The idea went back to teenage years, in which he had seen Pale Blue Dot, a photograph of Earth taken by *Voyager 1*. "The image showed us all on a single planet, and I realized how fascinating it would be to see the same sky above different symbols of civilizations, like a temple, mosque, and church," he said.[136] With the help of Simmons, he recruited photographers to capture world heritage and other beautiful sites against a stunning background of the heavens. The intended message was: "the stars shine equally upon all nations and regions." Despite political differences on the ground, "dazzling Venus hovers in the Texas twilight just hours after it's seen by skygazers in Iran."[137]

Tafreshi brought not just ideas, but also connections, to Astronomers Without Borders. Through him Simmons met Anousheh Ansari, an Iranian American engineer and entrepreneur. After having made a fortune in telecommunications, she had become famous as one of the first space tourists. In 2006, she participated in a Soyuz mission to the International Space Station. Impressed by AWB, she agreed to sit on its Board of Advisors. There, she was joined by another well-known figure among space enthusiasts: the television producer Rod Roddenberry, son of the *Star Trek* creator Gene Roddenberry. With his wide network then, Simmons quickly became a useful partner for the International Astronomical Union. It formed an Organizational Node for the International Year of Astronomy (IYA) 2009. One of its projects, Sharing Telescopes and Resources (STAR), gathered surplus instruments and other materials in developed countries and passed them onto places where they were difficult to acquire. AWB also led a 100 Hours of Astronomy Cornerstone

[134] Mike Simmons (2007a).

[135] Mike Simmons (2007a).

[136] Grant (2010).

[137] Tafreshi and Simmons (2008), 82–84.

Project involving global webcasts and star parties.[138] Images of The World At Night were chosen for a travelling exhibition.[139]

The International Year of Astronomy was thus also an important connector between professional and amateur astronomers and between both groups and the wider public. As the name suggested, inclusion of different countries in the scientific enterprise was a central concern of this global event. However, in line with the United Nations Millennium Development Goals, many astronomers also sought to address gender equality. A cornerstone project of the IYA was called She Is an Astronomer (SIAA). It gathered the "profiles of living and historic female astronomers, a largely invisible part of the astronomy community in the past."[140] The focal point was a website with information on and for female scientists. In addition, professionals reached out to girls by visiting schools and holding camps.

If female astronomers lacked visibility, this was not because their numbers were low. A group in Spain constructed a panel with the portraits of more than one hundred Spanish women astronomers alone. For a calendar, the team selected also selected predecessors "from different epochs and countries": "Hypathia of Alexandria, Fátima of Madrid, Maria Winckelmann Kirch, Nicole-Reine Lepaute, Caroline Herschel, Wang Zhenyi, Maria Mitchell, Williamina Fleming, Annie J. Cannon, Henrietta S. Leavitt, Cecilia Payne, and Paris Pismis."[141] Neither was there a dearth of information about many such figures. As part of its own contributions to She Is an Astronomer, Australia launched an entire book about the "pioneering radio astronomer" Ruby Payne-Scott, a colleague of Chris Christiansen.[142] Like George Miley, Harlow Shapley and Marcel Minnaert, she had also been politically left-wing. Often referred to as "Red Ruby," she had even been a member of the Communist Party of Australia.[143] The Commonwealth Investigation Service (CIS) had a dossier on her,[144] just as the FBI had been closely monitoring leftist scientists and scholars in the United States. A CIS report from 1950 had listed her as one of five suspicious radio physicists within the Commonwealth Scientific and Industrial Research Organisation.[145]

If there was little public awareness of women astronomers before the International Year of Astronomy, it was not due to a lack of gender activism either. Many scientists strove for gender equality long before Millennium Development Goals. The CIS report from 1950 described Payne-Scott as a "queer girl." It added: "It is thought that she is in a Feminist Group and that she may be a supporter of Jessie Street." The latter was a prominent women's rights and peace activist and Australia's only female

[138] Mike Simmons (2008b).

[139] Simmons and Tafreshi (2008).

[140] Walker (2010), 275.

[141] Márquez (2011), 90–91.

[142] Walker (2010), 277.

[143] Goss and McGee (2010), 6, 245.

[144] Goss and McGee (2010), 238.

[145] Goss and McGee (2010), 243.

delegate to the founding of the United Nations in 1945.[146] Many astrophysicists before and after Payne-Scott campaigned against gender-based discrimination while making important discoveries about the universe. They thus left their marks on professional associations as well as maps of the heavens. Although She Is an Astronomer was planned for a specific year, it was the culmination of decades of concerted efforts that spanned countries and continents.

References

Al Jazeera. 2005. "Stars Seize Iranian Imagination." Al Jazeera. https://www.aljazeera.com/news/2005/10/13/stars-seize-iranian-imagination.

Ambarzumjan, V. 1958. "Science Needs Peace." *Cosmos: Newspaper of the Organizing Committee for the Xth General Assembly of the International Astronomical Union*. August 12, 1958.

Armstrong, John A. 1954. "The Soviet Attitude Toward UNESCO." *International Organization* 8, no. 2: 217–33.

Blaauw, Adriaan. 1991. *ESO's Early History: The European Southern Observatory from Concept to Reality*. Garching: European Southern Observatory.

Blaauw, Adriaan. 1994. *History of the IAU: The Birth and First Half-Century of the International Astronomical Union*. Dordrecht: Kluwer Academic Publishers.

Bok, Bart J. 1974. "Harlow Shapley." *Quarterly Journal of the Royal Astronomical Society* 15: 51–55.

Booth, R.S., W.N. Christiansen, R. Fanti, J.M. Greenberg, T. Kiang, G.K. Miley, and M. Rowan Robinson. 1976. "China and the IAU." *La Gazette d'Uranie*. August 31, 1976.

Brückner, Dieter W. 1991. "Travels with the Travelling Telescope." *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 33: 2–5.

Brückner, Dieter W., and John R. Percy. 1990. "The Travelling Telescope." In *The Teaching of Astronomy*, edited by Jay M. Pasachoff and John R. Percy, 415–17. Cambridge: Cambridge University Press.

Eremeeva, A. I. 1995. "Political Repression and Personality: The History of Political Repression against Soviet Astronomers." *Journal for the History of Astronomy* 26, no. 4: 297–324.

Frater, R. H., W. M. Goss, and H. W. Wendt. 2017. *Four Pillars of Radio Astronomy: Mills, Christiansen, Wild, Bracewell*. Cham: Springer.

Gerbaldi, Michèle. 2007. "International Schools for Young Astronomers (ISYA): A Programme of the International Astronomical Union." In *Astronomy for the Developing World*, edited by J.B. Hearnshaw and P. Martinez, 221–28. Cambridge: Cambridge University Press.

Gingerich, Owen J. 1973. "Harlow Shapley and Mount Wilson." *Bulletin of the American Academy of Arts and Sciences* 26, no. 7: 10–24.

Goldberg, L. 1974. "Then the New President, Professor L. Goldberg Spoke as Follows." In Transactions of the International Astronomical Union, edited by G. Contopoulos and A. Jappel, XVB: 62–63. Dordrecht: D. Reidel.

Goss, W. M., and Richard X. McGee. 2010. *Under the Radar: The First Woman in Radio Astronomy: Ruby Payne-Scott*. Berlin: Springer.

Grant, Andrew. 2010. "Five Questions for Babak Tafreshi." *Discover* 31, no. 4: 18–18.

Hearnshaw, John B. 2019. "Commission 38 (Exchange of Astronomers) and Commission 46 (Teaching of Astronomy): Two Commissions That Played a Unique Role in the History and Development of the IAU." In *Under One Sky: The IAU Centenary Symposium*, edited by Christiaan Sterken, John Hearnshaw, and David Valls-Gabaud, 374–87. Cambridge: Cambridge University Press.

[146] Goss and McGee (2010), 242.

Huffer, C. M. 1950. "The Eighty-Third Meeting of the American Astronomical Society." *Popular Astronomy* 58, no. 7: 313–18.
International Astronomical Union. 1950. "Summary of Decisions Taken by the Executive Committee of the International Astronomical Union at Its Meeting in Stockholm, September 25-27, 1950." International Astronomical Union.
International Astronomical Union. 1951. "Summary of Decisions taken by the Executive Committee of the International Astronomical Union at its meeting in Paris, September 4-6, 1951." International Astronomical Union.
International Astronomical Union. 1983. "Fifty-First Meeting of the Executive Committee, Garching bei München, FRG, 12-15 September 1983: Proceedings." International Astronomical Union.
International Astronomical Union. 1984. "Fifty-Second Meeting of the Executive Committee, Ile d'Yeu , France, 10-13 September 1984: Proceedings." International Astronomical Union.
International Astronomical Union. 1987. "Fifty-Sixth Meeting of the Executive Committee, Santa Cruz, Ca., U.S.A., September 9-12, 1987: Draft Minutes." International Astronomical Union.
International Astronomical Union. 1988. "Fifty-Eighth Meeting of the Executive Committee, Baltimore, U.S.A., August 11, 1988: Draft Minutes." International Astronomical Union.
International Astronomical Union. 1991. "Sixty-First Meeting of the Executive Committee, Buenos Aires, Argentina, 1991 July 21, 22 & 30: Minutes." International Astronomical Union.
International Astronomical Union. 1994. "Executive Committee: 65th Meeting: Draft Minutes." International Astronomical Union.
International Astronomical Union. 1997. "Executive Committee: 69th Meeting, KICH – Kyoto, Japan, August 17, 18, 19, 20 & 25, 1997: Draft Minutes." International Astronomical Union.
International Astronomical Union. 2004. "Executive Committee, 79th Meeting, May 24-26, 2004, UNAM, Mexico City, Mexico: Draft Minutes." International Astronomical Union.
International Astronomical Union. 2010. "Office for Astronomy Development." *IAU Information Bulletin* 106: 21–27.
Jarrett, A. H. 1976. "Recent Developments in Astronomy at Bloemfontein." *Monthly Notes of the Astronomical Society of South Africa* 35: 112–13.
Jones, Bessie Zaban. 1984. "To the Rescue of the Learned: The Asylum Fellowship Plan at Harvard, 1938–1940." *Harvard Alumni Bulletin* 32, no. 3: 205–38.
Kellermann, Kenneth I., Ellen N. Bouton, and Sierra S. Brandt. 2021. *Open Skies: The National Radio Astronomy Observatory and Its Impact on US Radio Astronomy*. Cham: Springer.
Kidwell, Peggy A. 1987. "Cecilia Payne-Gaposchkin: Astronomy in the Family." In *Uneasy Careers and Intimate Lives: Women in Science 1789–1979*, edited by Pnina G. Abir-Am and Dorinda Outram, 216–38. New Brunswick: Rutgers University Press.
Kniesche, Thomas W. 2007. "Germans to the Final Frontier: Science Fiction, Popular Culture, and the Military in 1960s Germany: The Case of *Raumpatrouille*." *New German Critique*, no. 101: 157–85.
Kononovich, E. V. 1979a. "46. Teaching of Astronomy." In *Transactions of the International Astronomical Union*, edited by Edith A. Müller, XVIIA-Part 1:191–98. Dordrecht: D. Reidel.
Kononovich, E. 1979b. "Circular Letter N5." *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 5.
Kopal, Zdeněk. 1982. "The IAU – the First 60 Years: Reminiscences and Reflections." *Astrocosmos*. August 18, 1982: 5.
Kuznick, Peter J. 1987. *Beyond the Laboratory: Scientists as Political Activists in 1930s America*. Chicago: University of Chicago Press.
Liu, Xiaowei. 2019. "The China Crisis." In *Under One Sky: The IAU Centenary Symposium*, edited by Christiaan Sterken, John Hearnshaw, and David Valls-Gabaud, 222–27. Cambridge: Cambridge University Press.
Márquez, Isabel. 2011. "'She Is an Astronomer' in Spain; the International Year of Astronomy 2009 and Beyond." In *Highlights of Spanish Astrophysics VI*, edited by M. R. Zapatero Osorio, J. Gorgas, J. Maíz Apellániz, J. R. Pardo, and A. Gil de Paz, 89–96. Madrid: Spanish Astronomical Society.

McNally, D. 1985. “A Travelling Observatory?” *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 17: 3–5.
McNally, D., and R. M. West. 1986. “A Travelling Telescope.” *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 19: 7–8.
Miley, G. K. 1974a. “Astronomy in China Today.” *Sky & Telescope* 47: 148–52.
Miley, George. 1974b. “Remoulding the Chinese Intellectuals.” *Observer* 15, no. 4: 19–20.
Miley, George. 2022. “Building International Bridges with Astronomy.” In *Astronomers as Diplomats: When the IAU Builds Bridges Between Nations*, edited by Thierry Montmerle and Danielle Fauque, 311–22. Cham: Springer.
Minnaert, M. G. J. 1966. “38. Commission pour l’échange des astronomes.” In *Transactions of the International Astronomical Union*, edited by J.-C. Pecker, XIIB:80–89. Blackwell.
Morris, John D. 1946. “Rankin Clashes With Dr. Shapley.” *New York Times*, November 15, 1946.
Müller, Edith A. 1970. “46. Teaching of Astronomy.” In *Transactions of the International Astronomical Union*, edited by Cornelis de Jager, XIVA:559–66. Dordrecht: D. Reidel.
Müller, Edith A., and Arnost Jappel, eds. 1977. *Transactions of the International Astronomical Union* XVIB. Dordrecht: D. Reidel.
Müller, E. A., and T. L. Swihart. 1971. “Commission 46: Teaching of Astronomy.” In *Transactions of the International Astronomical Union*, edited by C. De Jager and A. Jappel, XIVB:236–41. Dordrecht: D. Reidel.
New York Times. 1941. “Prof Shapley Wins Pius XI Prize.” *New York Times*, December 1, 1941.
Palmeri, JoAnn. 2000. “An Astronomer beyond the Observatory: Harlow Shapley as Prophet of Science.” Doctor of Philosophy dissertation, University of Oklahoma.
Oosterhoff, P. Th. 1952. “Minutes of the Meetings of the Executive Committee of the International Astronomical Union on September 3, 8, 10 and 12, 1952 at the Occasion of the Eighth General Assembly at Rome.” International Astronomical Union. https://www.iau.org/static/administration/ecminutes/ec14minutes.pdf.
Orchiston, Wayne, and Govind Swarup. 2019. “The Emergence of Radio Astronomy in Asia: Opening a New Window on the Universe.” In *The Growth and Development of Astronomy and Astrophysics in India and the Asia-Pacific Region*, edited by Wayne Orchiston, Aniket Sule, and Mayank Vahia, 325–83. Singapore: Springer.
Othman, Mazlan. 1984. “Astronomy in a Developing Country.” *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 15: 5–6.
Price, Don K. 1973. “The Scientist as Politician.” *Bulletin of the American Academy of Arts and Sciences* 26, no. 7: 25–34.
Rossi, John P. 1985. “Farewell to Fellow Traveling: The Waldorf Peace Conference of March 1949.” *Continuity: A Journal of History* 10: 1–31.
Rossiter, Margaret W. 1995. *Women Scientists in America: Before Affirmative Action, 1940–1972*. Baltimore: Johns Hopkins University Press.
Schatzman, E. L. 1968. “46. Commission pour l’enseignement de l’astronomie.” In *Transactions of the International Astronomical Union*, edited by L. Perek, XIIIB:223–29. Dordrecht: D. Reidel.
Shapley, Harlow. 1945. “Notes on the International Copernican Memorial Observatory.” *Kosciuszko Foundation Bulletin* 1: 15–18.
Shapley, Harlow. 1946. “The Charter and Challenge of UNESCO.” *American Scientist* 34, no. 1: 106–14.
Shapley, Harlow. 1950. “39. Commission pour la creation d’observatoires internationaux.” In *Transactions of the International Astronomical Union*, edited by J. H. Oort, 7:418–29. Cambridge: Cambridge University Press.
Shapley, Harlow. 1954. “39. Commission pour la creation d’observatoires internationaux.” In *Transactions of the International Astronomical Union*, edited by P. Th. Oosterhoff, 8:606–9. Cambridge: Cambridge University Press,.
Shapley, Harlow. 1957. “39. Commission pour la creation d’observatoires internationaux.” In *Transactions of the International Astronomical Union*, edited by P. Th. Oosterhoff, 9:560–62. Cambridge: Cambridge University Press.

Shapley, Harlow. 1966. Session I. Interview by Charles Weiner and Helen Wright. Niels Bohr Library & Archives, American Institute of Physics, College Park.
Shapley, Harlow. 1969. *Through Rugged Ways Through the Stars*. New York: Charles Scribner's Sons.
Simmons, Mike. 2001. "Amid the Treasures of Persia." *Sky & Telescope* 101, no. 4: 76–81.
Simmons, Mike. 2002a. "An Astronomer Visits Iran, Part I: Anticipating the Journey." Mike Simmons. http://www.mssimmons.com/ms/Iran/Iran2002/Introduction/Astronomony.com1.html.
Simmons, Mike. 2002b. "An Astronomer Visits Iran, Part VIII: Reflections on Iran." Mike Simmons. http://www.mssimmons.com/ms/Iran/Iran2002/Conclusion/Astronomony.com8.html.
Simmons, Mike. 2003a. "Washington State, USA: The Total Solar Eclipse of February 26, 1979." Mike Simmons. http://www.mssimmons.com/ms/Washington/Report.html.
Simmons, Mike. 2003b. "Nevado Sajama in Bolivia: Climb to the Total Solar Eclipse of November 3, 1994." Mike Simmons. http://www.mssimmons.com/ms/Bolivia/Report.html.
Simmons, Mike. 2003c. "Sun and Snow: Mount Wilson Observatory's Summer Program." *Sky & Telescope* 105, no. 4: 77–81.
Simmons, Mike. 2004a. "Is Iran Safe for Westerner Travelers?" Transit of Venus. http://www.vtransit.com/vt/travel/safety.asp.
Simmons, Sherri. 2004b. "Women in Iran: From Queen of Sheba…to 'Zee Queen.'" Transit of Venus. www.vtransit.com/vt/travel/women.asp.
Simmons, Mike. 2007a. "Build Bridges Through the Sky." *Sky & Telescope* 113, no. 5: 102.
Simmons, Mike. 2007b. "Seeing Stars in Iraq." *Scientific American* 296, no. 1: 23–25.
Simmons, Mike. 2008a. "Report on the Total Solar Eclipse of 1999 August 11." MrEclipse. http://www.mreclipse.com/SEreports/TSE1999reports/TSE99Simmons.html.
Simmons, Mike. 2008b. "Astronomers Without Borders: An IYA2009 Organizational Node Dedicated to Connecting Groups Worldwide." In *Preparing for the 2009 International Year of Astronomy: A Hands-On Symposium*, edited by Michael G. Gibbs, Jonathan Barnes, James G. Manning, and Bruce Partridge, 358–62. Astronomical Society of the Pacific.
Simmons, Mike, and Babak A Tafreshi. 2008. "The World At Night: A New International Year of Astronomy 2009 Project." *Communicating Astronomy with the Public* 2: 17–21.
Sobel, Dava. 2016. *The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars*. New York: Penguin.
Stratton, F. J. M. 1950. "38. Commission pour l'échange des astronomes." In *Transactions of the International Astronomical Union*, edited by J. H. Oort, 7:414–17. Cambridge: Cambridge University Press.
Stratton, F. J. M. 1954. "38. Commission pour l'échange des astronomes." In *Transactions of the International Astronomical Union*, edited by P. Th. Oosterhoff, 8:601–5. Cambridge: Cambridge University Press.
Stratton, F. J. M. 1960. "38. Commission pour l'échange des astronomes." In *Transactions of the International Astronomical Union*, edited by D. H. Sadler, X:591–93. Cambridge: Cambridge University Press.
Struve, Otto. 1958. "International Scientific Collaboration Should Be Strengthened." *Cosmos: Newspaper of the Organizing Committee for the Xth General Assembly of the International Astronomical Union*. August 12, 1958.
Swarup, Govind. 2008. "Reminiscences Regarding Professor R.N. Christiansen." *Journal of Astronomical History and Heritage* 11, no. 3: 194–202.
Tafreshi, Babak A. 2003. "Nojum: Iran's Astronomy Magazine." *Mercury* 32, no. 1: 37.
Tafreshi, Babak A., and Mike Simmons. 2008. "Earth & Sky United." *Sky & Telescope* 115, no. 5: 82–86.
Walker, Helen J. 2010. "The IYA2009 Cornerstone Project She Is An Astronomer." In *Women in Astronomy and Space Science: Meeting the Challenges of an Increasingly Diverse Workforce*, edited by Anne L. Kinney, Diana Khachadourian, Pamela S. Millar, and Colleen N. Hartman, 275–79. National Aeronautics and Space Administration.

Wang, Jessica. 1999. *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War*. Chapel Hill: University of North Carolina Press.

Wang, Shouguan. 2009. "Personal Recollections of W.N. Christiansen and the Early Days of Chinese Radio Astronomy." *Journal of Astronomical History and Heritage* 12, no. 1: 33–38.

Wang, Shouguan. 2016. "Reminiscence of My Sixty-Five Year Voyage in Astronomy." *Research in Astronomy and Astrophysics* 16, no. 6: 86.

Wayman, P. A. 1981. "Dunsink Observatory, Chinese Astronomy and the IAU." *Irish Astronomical Journal* 15: 2–8.

Wayman, Patrick A. 2002. "Cecilia Payne-Gaposchkin: Astronomer Extraordinaire." *Astronomy & Geophysics* 43, no. 1: 1.27–1.29.

Welther, B. L. 1986. "Guilt by Association: How Mrs. Harlow Shapley Lost Her Job." *Bulletin of the American Astronomical Society* 18: 1055.

Wentzel, D. G. 1982. "46. Teaching of Astronomy." In *Transactions of the International Astronomical Union*, edited by Patrick A. Wayman, XVIIIA:633–34. Dordrecht: D. Reidel.

West, R. M. 2001. "Commission 38: Exchange of Astronomers." In *Transactions of the International Astronomical Union*, edited by Hans Rickman, XXIVB:247–49. Astronomical Society of the Pacific.

Wielen, Roland. 2019. "Germany's Difficulties in Becoming a Member of the International Astronomical Union." In *Under One Sky: The IAU Centenary Symposium*, edited by Christiaan Sterken, John Hearnshaw, and David Valls-Gabaud, 205–13. Cambridge: Cambridge University Press.

Yost, Edna. 1943. *American Women of Science*. Philadelphia: Frederick A. Stokes.

Chapter 3
Binary Stars

What could possibly go wrong with giving an award for women astronomers to one of the discipline's most respected female researchers? By the early 1970s, Margaret Burbidge was a very accomplished scientist whose career had spanned the United Kingdom and the United States. She had studied at University College London and acted as caretaker at University of London Observatory during World War II. She first came to the US during the McCarthy era, when getting a visa was "not all that easy," as she put it.[1] She subsequently worked at the Yerkes and Mount Wilson observatories and became a professor at the University of California, San Diego. In addition to being skilled at telescopes and spectroscopes, she was known for her theorizing. One of her seminal papers, published in 1957, had spread the idea of the synthesis of chemical elements in stars.[2] Two years later, she and her husband and co-author Geoff had jointly received the Helen B. Warner Prize from the American Astronomical Society (AAS) for their work.

Burbidge's prominence made it all the more embarrassing to her peers when she declined another recognition from the AAS in 1971: the Annie Jump Cannon Award, which was reserved for women. "I believe that it is high time that discrimination in favor of, as well as against women in professional life be removed," she wrote to the society's secretary, "and a prize restricted to women is in this category." She suspected that the award was part of a whole system that prevented women from holding powerful positions in her profession. "It would be interesting to know," she contemplated, "how often our names have been excluded from consideration for professorships, directorships, or chairmanships of major astronomical institutions because we are women.[3]

[1] Burbidge (1978).

[2] Burbidge et al. (1957).

[3] Golbeck (2017), 325.

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*,
Space and Society, https://doi.org/10.1007/978-3-031-46113-2_3

Burbidge herself had much experience with discrimination on both sides of the Atlantic. Very early in her career, she had left a job after the first day. This happened just as her supervisor had taken her out for lunch. "I thought this was kind of a social thing, making a new employee welcome," she later remembered. "But something nasty came through." She thought the senior astronomer "had designs" on her, that he was "a dirty old man."[4] Later, she struggled not only to attain academic positions, but also access to observing sites. "Standards reasons" for barring women from the Mount Wilson Observatory at the time included the lack of separate bathrooms for them as well as objections by technicians to work under them.[5]

Burbidge persevered, and many recognitions followed the one she had rejected. In 1972, she became head of the Royal Greenwich Observatory, but, unlike her predecessors, was not made Astronomer Royal. Four years later, during a time of heated debates over the proposed Equal Rights Amendment (ERA) to the US Constitution, she was chosen as the first female president of the American Astronomical Society. In 1981, she was elected head of the American Association for the Advancement of Science. Another 4 years after that, President Ronald Reagan bestowed on her the National Medal of Science at a White House ceremony.[6]

Although Burbidge's refusal of the Annie Jump Cannon Award might seem like a blip in an exceptional career, it stimulated debates about women in astronomy in general. Over the following decades, these discussions would occupy working groups, committees, and conference participants. Moreover, just as Burbidge's career crossed continents, so did the feminist currents in the astronomical profession. Finally, with a number of astronomers becoming public figures themselves, debates spilled over into the realms of popular media. As a wider spectrum of activists and commentators got involved, concerns further shifted from binary understandings of men and women to a broader range of gender identities.

The Status of Women

Because Burbidge had been so accomplished and well-known, her rejection forced the American Astronomical Society to set up a special committee evaluating the Cannon prize altogether. The award had originally been established in 1933 by Annie Jump Cannon, while she was working under Harlow Shapley at the Harvard College Observatory. For the endowment, she donated $1000 in prize money that she had received from the Association to Aid Scientific Research by Women a year earlier. Beginning in 1934, the award that bore Cannon's name was given to a different female astronomer at a banquet of the AAS about every 3 years. After four

[4] Burbidge (1978).

[5] Burbidge (1994), 18.

[6] Yount (1996), 48.

decades, a group of four women and three men were tasked with the question whether to change this tradition.[7]

The special committee found it difficult to reach consensus. In May 1972, the chairman, George Preston, reported that "Two women wanted to open the award to men and women or abolish it, two women to keep it as is or abolish it, and the three men sat on the fence." Eventually, the group recommended that the administration of the prize be transferred to the American Association of University Women. Preston and his peers further suggested that the recipients should be in the early stages of their career and chosen through a competition.[8] Although the Council of the AAS accepted these recommendations, broader problems of gender-based discrimination in astronomy had hardly been solved.

In order to address the broader issues, the AAS Council took up another recommendation by the special committee: the formation of a Working Group on the Status of Women in Astronomy. In 1973, this new body found that "women astronomers face greater obstacles in almost all aspects of their professional careers than do their male counterparts." Yet, the working group stressed that the "astronomical community can only be enriched by the employment and acceptance of women as colleagues." They group urged the AAS Council to aim for "equal encouragement, equal acceptance, equal recognition, equal employment, and equal salary for astronomers of equal ability and achievement, without regard to sex."[9]

Despite Burbidge's position as president of the American Astronomical Society during the 1970s, progress was slow. In 1978, the AAS Council established yet another taskforce: an ad-hoc Committee on the Status of Women in Astronomy (CSWA). This group mirrored a recently established Committee on the Status of Women in Physics (CSWA), which belonged to a sister organization of the AAS, the American Physical Society. The CSWA found that the "status of women has changed very little since 1973. Although women are employed in proportion to their numbers, they are poorly represented in the highest-ranking jobs." The major recommendations were for the Council to pass resolutions on equal opportunity and flexibility in hiring as well as to turn the ad-hoc committee into a standing organ of the society.[10]

As president, Burbidge herself was also involved in debates about how the American Astronomical Society could contribute to change beyond the academy. She knew about other scientific associations boycotting parts of the United States that had not ratified the Equal Rights Amendment (ERA). Although Congress had approved this amendment to the Constitution, ratifications by mainly Southern state legislatures were still missing. The astronomer was aware that because AAS meetings were small, they had a "purely moral" rather than "financial impact on a convention city." The membership was divided on whether the ERA mattered to

[7] Humphreys (2018).

[8] Humphreys (2018).

[9] Cowley et al. (1974).

[10] Liller et al. (1980), 624.

astronomy. Some worried about the politicization of the society. They said, "Well, if you get involved in this, it's going to be lobbying and you'll lose the tax-exempt status."[11]

While Burbidge's discussions of women in astronomy during the 1970s took place against a specific American legal background, similar concerns arose in other countries. John Percy of the University of Toronto in Canada found exceptional figures like Burbidge also across the Atlantic. They included Edith Müller in Switzerland, Margherita Hack in Italy as well as Irmela Bues and Waltraut Seitter in Germany. For the *Newsletter* of the IAU's Commission 46, Percy solicited articles on women in astronomy. In 1981, he published four pieces that described the situation in France, Poland, the Soviet Union as well as the US. He concluded that women started careers "in reasonable proportions especially in Europe." Yet, they "are often prevented by various factors from reaching the highest levels of the astronomical community."[12]

Although the Soviet Union had a high proportion of female scientists, a discrepancy at the top remained. "It is well known that in the U.S.S.R. women enjoy equal rights with men in all fields of social, political and cultural life," stressed Edward Kononovich of Moscow University in his contribution to the *Newsletter*. "Possessing natural abilities equal to those of men, women have free access to science in the U.S.S.R." They made up about 40% of the total scientific staff. Moreover, women were earning doctorates at a similar rate as men and enjoyed equal pay. However, "There is a second doctor's degree which, being of a higher rank, is usually awarded to the most prominent scientists whose contribution includes the development of some new scientific trend." He acknowledged, "Usually women cannot afford to devote all their life to obtaining this degree."[13]

Cecylia Iwaniszewska described a similar legal situation in Poland, but was more negative about the actual careers of women. In general, there was no "difference in rights between men and women," she stated. "Women may be elected to parliament, they may be given the posts of ministers, of directors in various branches of industry, or university presidents, and everywhere they get salaries equal to those of men." Yet, in practice, women were disadvantaged. "If they have their own families, then they can't spend as much time as they should working on astronomical problems," she stated. "It is still worse if they have to spend some nights at the observatory and must leave the care of children to the husband, a paid baby-sitter, or perhaps grandmother." Mothers of young children found it "nearly impossible" to travel.[14]

Despite national specificities, most astronomical institutions anywhere were thus male-dominated. Women experienced this not just in terms of formal power structures, but also through informal culture. When Kathy Mead first worked at the US National Radio Astronomy Observatory (NRAO) at Kitt Peak in 1980, she found

[11] Burbidge (1978).

[12] Percy (1981), 1.

[13] Kononovich (1981).

[14] Iwaniszewska (1981), 4.

Playboy magazines "everywhere." They were "in the control room as well as in the trailers. Not just a current and couple of back issues, but piles of them." Men were reading them right in front of her. When she felt bold enough to ask about them, she was told that a scientist had given a subscription to the observatory.[15] At the United States Naval Academy, Gerald Calame, a physics professor, even assigned a science fiction story published in *Playboy* to his students. He found "A Meeting with Medusa" by Arthur C. Clarke "appropriate to a discussion of Jupiter." Calame commented: "This on-the-spot assignment was welcomed by the class, for reasons which I suspect had very little to do with the course!"[16]

While a sci-fi story like "A Meeting with Medusa" may have had some educational value, *Playboy*'s nude photographs on the whole were still disturbing to many. "How is pornography appropriate in the workplace?" Mead wondered. "State of the art equipment should be enough to keep even a man's mind occupied." However, some technical infrastructure was itself used to reproduce nude images. Joan Schmelz found printouts of naked women in the offices of the NRAO computer operators among other places.[17] Meg Urry similarly encountered nudity in unexpected places. As a graduate student at Johns Hopkins University, she once found, on her desk, a copy of *Playgirl* magazine open to the naked-man centerfold. Her fellow students just stared at her, waiting for her reaction. She was "shocked and embarrassed," but simply took the magazine and asked "Who does this belong to?"[18] Although she tried to act cool, such incidents continued to affect her. In the mid-1980s, she worked as a postdoctoral researcher at the Massachusetts Institute of Technology. There, she witnessed Antoine Labeyrie, a colloquium speaker from France, beginning his presentation about the importance of high resolution in optical imaging with an out-of-focus slide. As he sharpened the focus to make his point, a topless woman on a Hawaiian beach gradually appeared. The male students laughed, but Urry and the only other woman in the audience shared an appalled look. Urry intended to talk to Labeyrie, but left the colloquium after about twenty minutes, after having realized that she had stopped listening.[19]

Although Schmelz and Urry found nude pictures offensive in academic settings, they typically had limited consequences for the careers of those who displayed them. "For years I composed letters to him in my head, explaining what was wrong with what he did," Urry said to me about Labeyrie, "but in the end, I never sent anything." Ironically, the Frenchman won the American Astronomical Society's Beatrice M. Tinsley Prize a few years later, in 1990. This award had been named after a prominent female professor of astronomy at Yale University. The following year, Labeyrie became a professor at the Collège de France. In 1994, he was further elected to the membership of the French Academy of Sciences.

[15] Schmelz (2011c).

[16] Calame (1973), 187.

[17] Schmelz (2011c).

[18] Urry (2022), 271.

[19] Urry (2005).

Although Urry did not confront Labeyrie, others openly objected to naked images of women at academic institutions. At the forefront were members of the Five College Astronomy Department in Massachusetts. This consortium included two institutions for female students only: Mount Holyoke and Smith. After finding that individual complaints about posters and magazines were either dismissed or ignored, women astronomers from the Five Colleges submitted a letter to the *AAS Newsletter* in 1987. They expressed the hope that "that a united voice on this issue will make the astronomical community aware of the seriousness of this problem and of the legal basis for our complaints." They argued that the images they encountered were a form of sexual harassment. "The presence of this material creates a hostile work environment for women, in violation of Title VII of the Federal Civil Rights Law of 1964." They thus requested that "all observatories and national astronomical facilities adopt policies prohibiting the presence of degrading images of women."[20]

While many male astronomers supported this request, others pushed back. James Felten of the Goddard Space Flight Center considered a ban on posters a "threat" to the freedoms protected by the First Amendment to the US Constitution. "An astronomer of either sex who posts a pinup is expressing a point of view on sexuality," he argued. "Feminists who demand the removal of such posters are asking for censorship powers not granted to any other pressure group." He thus urged that no committee of his professional society should become involved in "writing censorship codes for observatories."[21] George Stanley Brown, a former collaborator of Beatrice Tinsley[22] who had gone to work in the defense industry, felt less threatened. Yet, he was equally unimpressed by the petition from the Five Colleges. "The people who signed the letter are attempting to force their social preconceptions on other people." He claimed, "What is degrading, like beauty, is in the eye of the beholder." Brown added, "Smoking is a proven health hazard. Images are not."[23]

The leadership of the American Astronomical Society was largely indifferent at the time too. After publishing the letters by Felten and Brown in 1988, the editor of the *AAS Newsletter* declared: "Now that both sides have expressed their opinions, this issue is closed." It thus took women from outside astronomy to make a difference in debates about sexual harassment: One of the most important was Anita Hill, who taught law at the University of Oklahoma. In 1991, in front of television audiences, she accused Supreme Court nominee Clarence Thomas. She claimed that he had made multiple sexual and romantic overtures to her while she had been his subordinate at the Department of Education and the Equal Employment Opportunity Commission. Although Thomas was confirmed to the Supreme Court by the Senate, the negative publicity of the hearings made the government take harassment more seriously. The posters of naked women in national observatories disappeared practically overnight. Schmelz herself also became able to put the behavior of her own

[20] Allen et al. (1987).

[21] Felten (1988).

[22] Brown and Tinsley (1974).

[23] Brown (1988).

doctoral advisor in clearer terms. "He never said, 'Sleep with me if you want an 'A'.' What he did to me was much more subtle, but what he did to me did not have a name […] until Anita Hill testified before congress." Schmelz's husband, the South African–born Gerrit Verschuur, too came to understand why she had to write her thesis largely without supervision.[24]

Women Hold Up Half the Sky

In the United States at least, Anita Hill raised the hopes of many for an end to sexual harassment. "Now, it's going to stop and people are going to behave better," Meg Urry thought.[25] Just the previous year, she had received – and accepted – the Annie Jump Cannon Award. Moreover, she had become an assistant astronomer at the Space Telescope Science Institute (STScI) in Baltimore, Maryland. Although still at the beginning of her career, she was already well-known for her studies of active galactic nuclei.[26] Nonetheless, she still felt that there was much to do to improve the situation of women in astronomy in general. Fortunately, at the institute, she found colleagues who were similarly determined to push for change.

Overseeing the research with the multi-billion-dollar Hubble Space Telescope, which had been launched in 1990, the STScI hosted a large number of scientists. Like the Five Colleges put together, it thus also had the potential to gather a critical mass of young women. Urry certainly had high hopes for the institute. During the 1980s, she was "regularly told how much easier women had it, because of affirmative action. Institutions would be so eager to hire women." She thus imagined that as "a brand-new institution," STScI "would embody this new world of gender equity." Yet, when she first came to the institute in 1987, she found that only one out of about sixty tenure-track scientists was female. Despite a supposedly new era in recruitment, "they were almost all white men." When Urry challenged this hiring practice on one occasion, she provoked angry reactions: "We don't care about gender," colleagues of hers said, "we just want the best." Other comments included: "We are gender blind." Or, "What does gender have to do with anything?"[27]

The director of the Space Telescope Science Institute, Riccardo Giacconi, listened to Urry's concerns. He initially defended himself, dismissing any bias against women. His mother had taught mathematics and physics, he told Urry, and he had appointed women to his leadership team. Yet, he also agreed that for a new institution with no long history of discriminatory hiring, there was no reason to have such a gender-unbalanced staff. At the next recruitment meeting, he asked: "How many women are on the list?" Once the head of the STScI placed value in gender parity,

[24] Schmelz (2010).

[25] Dreifus (2018).

[26] Space Telescope Science Institute (1990).

[27] Urry (2019).

others lower in the hierarchy followed. The institute also ran broader job advertisements and attracted a wider range of candidates.[28]

More and more women thus joined the Space Telescope Science Institute over time. Especially important for Urry were two early hires: Anne Kinney and Laura Danly, who had joined the STScI in 1985 and 1987 respectively. Like Urry, both had studied at overwhelmingly male university departments. They thus lacked role models and mentors of their own gender. Regarded as an oddity, Kinney had also attracted much unwanted attention. As an undergraduate at the University of Wisconsin–Madison, she had once worn a skirt to an optics class. Forty pairs of eyes followed her, as she entered the room. It took her 5 years to wear a skirt again. In 1982, by then a graduate student at New York University, she gave her first poster presentation at a meeting of the American Astronomical Society. A senior astronomer from Harvard University seemed very interested. However, during the conversation, he kept looking at her breasts instead of her eyes.[29]

Scientists like Kinney found such behavior not just annoying, but also destructive for careers. Being a woman in astronomy "is like having bad parents," she thought. "It takes you longer to grow up because of the bad and inappropriate attention that you receive."[30] After she moved from being a postdoctoral researcher to a tenure-track astronomer in 1988, she realized that she did not have long-term goals. Because her previous departments had no senior women, she assumed she would fail soon anyway.[31] Urry's experience at MIT had been similar. Once, two professors had a dinner conversation in her presence about the inferiority of women scientists who had been hired because of affirmative action. Although she sometimes received encouragement to pursue an academic career, a faculty member told her at one point: "Oh, we would never hire you."[32]

Like Urry, Kinney and Danley were committed to overcome the discrimination they had endured for many years. Well-resourced and ultimately accountable to taxpayers, the Space Telescope Science Institute had both means and interest in public outreach. This enabled Laura Danly to start a Women's Science Forum in 1991. On a monthly basis, she organized lectures for high school girls. "I'm just trying to provide them with the type of experience I wish I had at their age," she said. She sought to make of make the sessions free from gender-based pressures.[33] The seminars were conducted by women scientists and discussed astronomical research, careers, and female role models across different fields.[34]

While the Women's Science Forum primarily targeted students, another event of the institute addressed the whole astronomical profession. The idea originated with

[28] Urry (2019).

[29] Kinney (1993), 193–94.

[30] Kinney (1993), 194.

[31] Kinney (1993), 194.

[32] Urry (2005).

[33] Hill (1992).

[34] Danly and Jan (1993).

Goetz Oertel, the president of the Association of Universities for Research in Astronomy (AURA), which managed the STScI for NASA. Following his suggestion, Urry, Danly and Kinney teamed up with others to hold a 2-day meeting on the status of women in astronomy in Baltimore in 1992. Over 200 participants, including Margaret Burbidge, listened to talks about statistical representation in the discipline, the historical role of women, best practices for recruitment and retention, and prevention of sexual harassment (Fig. 3.1). Sponsors of the meeting included NASA, the National Science Foundation, and the Computer Sciences Corporation.[35]

Despite having national funders, the STScI's meeting on women in astronomy was also an international event. Even two scientists from the recently collapsed Soviet Union, Vera Izvekova and Svetlana Suleymanova, presented reflections on female radio astronomers there. "The socialistic slogan of total equality sounds very positive," they acknowledged, "but in practice it results in a psychological atmosphere in which women try to imitate men's style of working – that is, to be 'a good fellow' in those fields which are usually male-dominated." Yet, "imitation seldom leads to success." Instead, they argued that women and men "complement each other." Therefore, "progress in different branches of science is possible only as a result of the harmonious combination of men's and women's mentality."[36]

Unlike Danly's Women's Science Forum, the 2-day conference welcomed male participants. Around twenty-five came, many of them fathers of daughters[37] or husbands of scientists. One of them was Geoff Marcy, an associate professor at San Francisco State University. He was married to a lecturer in chemistry at Berkeley. Moreover, he was a member of the Committee on the Status of Women in Astronomy, which was then chaired by Debra Elmegreen of Vassar College. In this capacity, he and Elmegreen presented the results of a survey of North American institutions about equitable treatment, mentoring, hiring, promotion and child care. The two

Fig. 3.1 Women at Work: A Meeting on the Status of Women in Astronomy, 1992. (Source: NASA)

[35] Livio et al. (1993), 563.

[36] Izvekova and Suleymanova (1993), 132–33.

[37] Griffin (2019), 504.

also announced an initiative to make women better known in the profession. "To help improve the situation of women, the AAS CSWA this fall plans to start a voluntary women's list of potential speakers and committee members, arranged by astronomical specialty ," concluded Marcy and Elmegreen.[38]

While much of the conference was dedicated to past and present experiences, the participants created a document for the future as well. Ricardo Giacconi, the director of the STScI, who had suggested that the meeting produce a code of conduct governing gender issues.[39] "For the first day we shared stories and slung mud," Elizabeth Griffin who was then at the University of Cambridge later remembered it. "It was cathartic, necessary and vital in order to get down to work seriously."[40] The following day, the scientists produced the Baltimore Charter for Women in Astronomy. Urry and her colleagues envisioned it as a "a Magna Carta for diversity."[41] It began with a Chinese saying that "women hold up half the sky." This was a quote by Mao Zedong, as it turned out, although Urry and her peers had initially thought it to be much older. The charter asserted that both genders were "equally capable of doing excellent science." Yet, recruitment, training, evaluation and award systems were often preventing equal participation. The document recommended affirmative action for achieving "diversity in all aspects of the profession," including hiring, invited talks, committees and awards. Women – if necessary from outside an institution – should participate in selection processes. Their criteria should recognize different pacing of careers, care of family members, and demands of dual-career couples. The charter further called for the use of gender-neutral language and illustrations and for an end to sexual harassment.[42]

The Baltimore Charter quickly spread. The text appeared in the STScI's *Newsletter* and *Status*. It was also published in the official conference proceedings, which were distributed among the participants and among US astronomy and physics departments.[43] Urry, Danly and others further presented the document at the semi-annual meeting of the American Astronomical Society in Berkeley in June 1993.[44] The Association of Universities for Research in Astronomy endorsed the text,[45] as did the AAS Council.[46] Silvia Torres-Peimbert of the National Autonomous University of Mexico quoted the charter at a Workshop of Women in Astronomy that formed part of General Assembly of the International Astronomical Union in The Hague in the Netherlands in 1994.[47]

---

[38] Marcy and Elmegreen (1993).

[39] Urry (1993c), 3.

[40] Griffin (2019), 504.

[41] Urry (1993d), 8.

[42] Space Telescope Science Institute (1993).

[43] Urry (1993a).

[44] Urry et al. (1993).

[45] Urry (1993b).

[46] American Astronomical Society (1995), 1031.

[47] Torres-Peimbert (1995).

While the Baltimore Charter received much acclaim, it met some criticism. The Committee on the Status of Women in Astronomy recognized complaints about "discrimination against men" as one of its "key issues" for the year 1993.[48] James Felten warned the Council not to endorse the Charter, which he considered "essentially a press release by a feminist special-interest group." Feminists ought to "control their anger and avoid scapegoating and stereotyping." Instead, he found the document "bigoted and divisive." When the Charter called for "serious goals," he feared "highly objectionable quota proposals." He also asked, "How would the male members of a faculty search committee regard a woman from outside the department brought in to join their deliberations simply because she is a woman?" He therefore concluded the proposals "would retard, not advance, the acceptance of women as equals in astronomy."[49]

It did not help the Committee on the Status of Women in Astronomy that one of its members, Geoff Marcy, was himself accused of sexual harassment. Back in graduate school at the University of California, Santa Cruz, he had apparently had a formative physical experience. As he was studying for an exam, a professor put an arm around him and said, "Geoff, let me just tell you, you're gonna make it." Through that touch Marcy felt that his teacher was genuinely on his side. This encounter left an impression on him. "I could tell that many professors didn't really care about the human aspect of their teaching," he said. "I thought, I would like to make the experience for my students human, welcoming, and warm."[50] Yet, many of his female mentees were uncomfortable with his gestures.

One of the first to report harassment by Marcy was Lynda Williams, who took an introductory class to astrophysics at San Francisco State University in 1994. The two became friends, and Marcy hired her to build a website for the CSWA, which included information on women astronomers in history. However, their conversations did not remain confined to the study of the heavens. Williams claimed that Marcy had told her at Halloween in 1995: "I wish you were a piece of chocolate so I could melt you in my mouth." A few days later, another student confided to her that Marcy was behaving in overtly sexual ways to her. "It creeps me out to be in that small windowless lab with him," she said. "I can't sleep." Williams called Marcy, but allegedly found him dismissive. From his perspective, he was trying to be friendly to his students, make them comfortable, and boost their self-esteem by paying attention to them. Within weeks, she confronted her teacher in an email. "You are such an active 'feminist' and yet you sexually harass female students!" she wrote. "Maybe you are not aware of what sexual harassment is." Williams also complained to an officer of the university, who told her professor: "you can't do this, and if you continue, your career will end."[51] Instead, it was about to take off.

[48] American Astronomical Society (1993), 991.

[49] Felten (1994).

[50] Wilson (2016).

[51] Williams (2016).

Despite the tough exchanges, consequences for Marcy were limited. Williams's complaint to the sexual harassment officer at San Francisco State University remained informal. She refrained from reporting him to his department chair or colleagues in order to avoid retaliation or being branded as a "trouble maker." In 1996, she started a doctoral program in physics pedagogy at the University of Nebraska–Lincoln. While she sought to avoid Marcy, he became famous as a pioneering discoverer of exoplanets.[52] His research was featured in a cover story of *Time* magazine in 1996[53] and in a long article in the *New York Times* one year later.[54] Around the same time, he received an Alumni Achievement Award from his alma mater, the University of California, Santa Cruz.[55] After being promoted to a distinguished professorship at San Francisco State University, he moved to a position at Berkeley. In 2002, he – like Antoine Labeyrie before him – even won the American Astronomical Society's Beatrice M. Tinsley Prize.

As Marcy was celebrated for his research, his fellow member of the CSWA Laura Danly was pushed out of the Space Telescope Science Institute. Unlike him, she had been one of the signatories of the Baltimore Charter. Besides studying the Milky Way's halo gas, she dedicated herself to outreach as a project scientist for education. While she loved talking to the public, colleagues looked upon her activities as "soft." As her position received funding, while the overall budget of the institute was cut, her work became controversial. "It's education, we are here to help the kids," she thought. At the same time, she considered herself "not savvy at all about internal politics." She encountered roadblocks and felt increasingly isolated. "It was brutal," she later remembered. "I wanted out." In 1996, she accepted a position as visiting assistant professor at Pomona College in California. From there, she moved to Denver, Colorado.[56]

Despite Danly's departure, Meg Urry was able to develop the Space Telescope Science Institute as a hub for women's advocacy. Her position was more secure, as she had been promoted to associate astronomer with tenure in 1995.[57] Four years later, she became head of the Science Program Selection Office, which determined the observations the Hubble Space Telescope would undertake. One of her goals in this role was to achieve balance among sub-disciplines.[58] At the same time, she did not lose sight of the aim of gender parity. She served on the CSWA[59] and, together with a colleague from the STScI, took over the editorship of the newsletter *Status*. Their first issue in January 1999 was sent to over 700 people.[60] In 2001, she also

[52] Williams (2016).

[53] Lemonick (1996).

[54] Wilford (1997).

[55] UC Santa Cruz (2022).

[56] Feder (2015).

[57] Space Telescope Science Institute (1996).

[58] Urry (1999a), 21.

[59] American Astronomical Society (1996), 1011.

[60] American Astronomical Society (1999), 1280.

became responsible for the electronical bulletin AASWOMEN, using a mailing list server hosted at the institute.[61]

Now a major figure at her own institution, which was itself leading, Meg Urry reflected about the meeting on women in astronomy back in 1992. She recognized that there had been "no mass movement to endorse the Baltimore Charter or to implement its recommendations widely." Discrimination still existed. Nevertheless, the number of women and their acceptance had increased. Urry further claimed that the conference itself had its "most profound impact" on the more than 200 attendees themselves. "The experience of listening, learning, thinking positively, reinforcing one another, and forming a consensus for action, more than the actual Charter words, affected many participants," she wrote. "Students felt fortified in their ambitions, junior astronomers felt hopeful and determined, and senior astronomers and officials felt renewed determination to make change."[62]

The positive memory of the event encouraged Urry to repeat it. In 2000, she became chair of the Committee on the Status of Women in Astronomy. In this forum, she began discussing possible locations, support and scope for a second meeting.[63] She received $15,000 from the National Science Foundation for a conference entitled Women in Astronomy II. Scheduling the event for 2003, she promised her funders that this event would "assess the progress made in the last 10 years." Individual speakers and working groups would address "current demographics and trends, retention of women in the scientific workforce, the importance of diversity, and how to affect institutional and attitudinal changes." This time, the conference took place on the West Coast of the US, at the California Institute of Technology in Pasadena.[64]

In contrast to its predecessor, Women in Astronomy II also gave more attention to people of color. One session was specifically devoted to the issues for underrepresented minorities in astronomy. Such groups made up 25% of the US population, but only 2–3% of astronomers. The dearth of astrophysicists of color was thus an "order-of-magnitude" problem far bigger than the underrepresentation of white women.[65] Urry further noted in the *AAS Newsletter* that "the career paths for many young minorities are quite different from those of young women, and involve undergraduate community colleges, Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges and Universities." She thus recommended developing "strong links to those institutions, building pathways that will enable underrepresented minorities to succeed in the top research schools and to have outstanding careers in astronomy."[66]

---

[61] American Astronomical Society (2001), 971.

[62] Urry (1999b), 8, 10.

[63] American Astronomical Society (2001), 972.

[64] Urry (2003a).

[65] Urry (2003b), 4.

[66] Knezek and Urry (2003), 11.

Embracing a broader concept of diversity, Women in Astronomy II produced a detailed successor document to the Baltimore Charter. It was called "Equity Now: The Pasadena Recommendations for Gender Equality in Astronomy." The main authors included Urry and the new chair of the CSWA, Pat Knezek, who led the editing and approval process. The document noted that only one quarter of astronomers were women and they were "still less likely to advance than their male colleagues." The authors, who included Urry, warned that without "continued positive action, progress toward diversity could halt or even reverse." They called upon their peers to "improve the diversity of the community, draw on a broader talent pool, and thus remove impediments to achieving excellence in science." Specific proposals sought to maximize equal opportunity in tenure-track hiring, career advancement and recognition. In 2005, the Pasadena Recommendations also received endorsement from the Council of the American Astronomical Society.[67]

The new proposals encountered less public resistance than their predecessors. However, members of a younger generation of women still found Women in Astronomy II limited. Beth Holmes, a postdoctoral researcher at the Jet Propulsion Laboratory, wished to have had more conversations about the subtler forms of harassment and discrimination. This included "awkward situations at work when a male colleague acted inappropriately."[68] Jane Rigby, a graduate student at the University of Arizona, wanted to see further discussion of other marginalized groups. She worried that "by focusing only on the status of women in astronomy, we don't see the larger context: the problems of 'otherness'." She asked in *STATUS*, "In a field that traditionally belonged to white men, how do the experiences of women compare to the experiences of astronomers who are ethnic minorities, who are gay, who were born in the developing world?" She herself had overheard "several groups at the meeting wondering why there was no discussion of how the issues of women in astronomy relate to issues facing lesbian, gay, bi, and transgender (LGBT) astronomers." She acknowledged that some older members of her profession "may find this question inappropriate, but astronomers my age generally see it as an obvious question of workplace diversity and fairness."[69]

Although Urry was about a generation older than Rigby, she sympathized with the graduate student's criticism. She acknowledged in the *AAS Newsletter* that "Only a few words were said at the Women in Astronomy meeting about minorities with respect to sexual orientation (and none about physical handicap, religious conviction, or several other potential areas of discrimination)." She clarified: "That these groups are so far less visible in astronomy should not be misconstrued to imply that their issues are less critical." Urry, however, still mainly lamented that men were insufficiently interested in promoting women. "The only true pity of the conference was that the attendance of senior astronomers was low, particularly

[67] Committee on the Status of Women in Astronomy (2005).

[68] Holmes (2004).

[69] Rigby (2004), 4.

among our male colleagues, who have historically been less involved than the women, yet who hold most of the power positions in the hierarchy."[70]

Variable Stars

It still took a number of years for the American Astronomical Society as a whole to move beyond a binary understanding of gender as meaning either men or women. According to Jane Rigby, LGBT researchers convened an informal networking dinner at AAS meetings for years, but "you had to know it existed."[71] Meg Urry thought of herself as an ally to this group. However, laws and dominant discourses still worked against it. Rigby wrote in *STATUS* in 2004, "it is still legal in 37 states to fire, refuse to hire, or refuse to promote based on sexual orientation. This helps keep LBGT astronomers and staff silent." The graduate student considered this a problem for all women's activism. She quoted an anonymous professor, "As long as it's dangerous to your career to be a lesbian, then any opinionated, outspoken woman astronomer, gay or not, can be labeled a lesbian and thus marginalized." Rigby added, "When labels commonly used against strong women ('too bitchy', 'too masculine', 'a real ball-breaker', 'a dyke') lose their power, then and only then all women will feel safer speaking up."[72]

Not just women, but also men were still afraid in the early 2000s, and even in a state with a liberal reputation such as California. In 2001, Rolf Danner, a German-born researcher at the Jet Propulsion Laboratory, attended a semi-annual meeting of the AAS in Pasadena. He met up with a group of other openly gay astronomers. "I was struck by how common it still is to worry about that colleague, that faculty position, or that post-doc offer when it comes to affirming who we are and whom we love," he wrote in the *AAS Newsletter*. He considered himself lucky as his institution was prohibiting discrimination based on sexual orientation and was offering benefits for a domestic partner of the same sex. However, he still sometimes hesitated to answer when someone in a professional context asked him: "So, are you married?"[73]

At the time, even the broader popular culture only slowly began to recognize homosexuality. Despite their long commitment to diversity, the makers of *Star Trek*, for instance, had largely excluded gays and lesbians from their vision of the future. One of the first queer television episodes of the franchise was "Chimera" from the seventh season of *Star Trek: Deep Space Nine*. First aired in 1999, it was described by fans as "Odo's coming out." It portrayed a veiled and dangerous affair between the changeling Odo, head of security for the space station Deep Space Nine, and a

[70] Knezek and Urry (2003), 11.

[71] Walker (2014).

[72] Rigby (2004), 4.

[73] Danner (2001).

fellow shapeshifter. In the end of the story, however, Odo reaffirms his love for Kira Nerys and thus his commitment to a heterosexual relationship.[74]

Unlike the fictional character of Odo from the twenty-fourth century, astronomers and actors became increasingly confident in expressing their sexual orientation in the beginning of the twenty-first century. When Rolf Danner was interviewed for a job at the aerospace company Northrop Grumman, he stated that he was openly gay and asked the decision maker what the work environment was like. He also contacted his prospective colleagues to "gauge their comfort level" with homosexual relationships. Reassured by the responses, he accepted the job. After joining in 2004, he got in touch with the company's LGBT affinity group.[75] The following year, George Takei, who had played Hikaru Sulu in the original *Star Trek* series, publicly disclosed that he was in a long-term relationship with another man.[76]

Scientists like Danner were also inspired by the long-term activism of Frank Kameny, an astronomer who had been driven out of the profession half a century earlier. Back in 1956, Kameny had earned a doctorate under Cecilia Payne-Gaposchkin at Harvard University for observations and photoelectric measurements of variable stars. He had then taught for a year at Georgetown University before joining the US Army Map Service. However, he was soon fired because of his homosexuality. Barred from federal employment, he had dedicated himself to gay rights activism. He gained increasing recognition during the 2000s. The US Office of Personnel Management formally apologized to him in 2009, and President Barack Obama thanked him for his work. The American Association of Variable Star Observers rediscovered his dissertation and added his observations to their international database. In 2012, the American Astronomical Society awarded him a certificate of appreciation posthumously.[77] The same year, the International Astronomical Union approved the naming of an asteroid after him.[78]

Besides this gesture, the AAS formalized its commitment to inclusion of homosexuals in another way. In January 2012, it chartered the Working Group on LGBTIQ Equality (WGLE). The chair was Van Dixon, yet another activist scientist affiliated with the Space Telescope Science Institute. Other members included Rolf Danner, Jane Rigby and Chanda Prescod-Weinstein. WGLE was tasked with promoting lesbian, gay, bisexual, transgender, intersex, and questioning individuals in the profession. Dixon and his colleagues aimed to end "discrimination on the basis of sexual orientation and gender identity or expression." They stressed not just the legal vulnerability of its community in many jurisdictions. They also noted that gay astronomers were "compensated systematically less," as many employers did not offer

[74] Scheer (2004).

[75] Levine (2016).

[76] Satter (2006).

[77] Kinne (2011).

[78] Zongker (2012).

same-sex partner benefits. Beyond its focus on discrimination, WGLE sought to "create a professional climate that respects and values diversity."[79]

Already the formal creation of WGLE changed the atmosphere within the AAS. The anonymous blogger AstroDyke reported that in 2013, a regular meeting of the society formally included an LGBT reception for the first time. It was organized by Danner and supported by his employer, Northrop Grumman. Officially announced and advertised, the event attracted at least eighty people, "a happy buzzing crowd, enjoying and building community. It was the Coming Out party for LGBT inclusion and diversity in astronomy." The AAS president David Helfand attended, as did Meg Urry, the incoming president. So did department heads, faculty members, postdocs and students. "Even a few people whom I feel weren't very helpful in the past, were there proudly showing their support now." AstroDyke added, "Folks sipped wine (sponsored by a defense contractor, sigh), and talked about how to build a more inclusive profession. Then the queers went off to a fabulous networking dinner, marveling at how times have changed."[80]

AstroDyke drew a sharp contrast between the official reception in 2013 and an earlier unofficial LGBT networking dinner she had attended. The previous event had been more that of an independent self-help group: "We bitched about some of the hurtful comments we'd gotten, we sympathized about the difficulty of living apart from partners because we couldn't find jobs together, or couldn't get visas." They had shared some positive stories as well about relatively tolerant institutions, accepting straight colleagues and successful queer ones. However, they had also expressed criticism of the Committee on the Status of Women in Astronomy. "We lamented that many of the activists for women in astronomy wanted us to go away, because lesbians weren't 'real women' in science -- we were an unsympathetic distraction from their goal of enabling the straight woman scientist to raise a wholesome nuclear family."[81] Meg Urry had never questioned the womanhood of lesbian astronomers, but she too recognized that the CSWA was insufficient in representing them. She had supported the establishment of WGLE as a separate committee, as she thought that queer people should be the leading advocates rather than straight people who did not know their concerns and priorities.

If the atmosphere at professional meetings had been suddenly transformed, wider politics and society had not yet. As the Working Group on LGBTIQ Equality saw some forms of discrimination as legal and systemic, they acknowledged that they were "beyond the power of the AAS to redress."[82] Nevertheless, WGLE sought to address others by recommending changes in institutional policies. In 2014, the group published a set of best practices for academic departments. They included the promotion of LGBT+ individuals by actively recruiting them as students, inviting them as speakers and placing them in positions of power. Further recommendations

[79] Dixon (2012).

[80] AstroDyke (2013).

[81] AstroDyke (2013).

[82] Dixon (2012).

encompassed inclusive health insurance, all-gender restroom options, and the possibility to change names and genders in records.[83]

Although WGLE's members sought to change US institutions primarily, they recognized that American laws and policies affected astronomers of various nationalities. A Supreme Court decision in 2013 required the federal government to recognize same-sex marriages. In a poster presented at a subsequent AAS meeting, Jane Rigby argued that a previous ban of such recognition had "particularly affected astronomers." This was because "astronomers are more likely than the general US population to be foreign nationals, to have a foreign-born spouse, or to work for the federal government." Rigby shared the story of Stefano Meschiari, an Italian postdoctoral fellow at the University of Texas at Austin. He worried about his immigration status despite being in a long-term relationship with an American man. Within weeks of the court's ruling, Meschiari and his boyfriend got married in California. He rejoiced that he was now able to apply for a green card. Rigby, although American herself, benefited considerably as well. Her employer NASA no longer classified her as "single." She, her wife, and their baby could be covered by a single health insurance plan, saving them around $2000 per year. If Rigby was to die early, NASA would have to pay her partner survivor benefits. The astronomer commented, "It's such a relief to finally be paid and taxed the same as everyone else. It's even better to have respect and equality!"[84]

Concerned about their foreign peers, members of the American Astronomical Society sought to prevent backlashes against gay rights in other countries too. In 2014, David Helfand, the AAS president, sent a letter to Ajit Kembhavi, his counterpart at the Astronomical Society of India, in response to a recent court decision that criminalized homosexual acts. "We believe this to be a step backwards for your country and are upset by the invidious discrimination it establishes," Helfand wrote. He acknowledged that "many cultures have tried exclusivity, bigotry and discrimination." Yet, such attempts "have never worked to advance humanity, but have only held it back." He thus urged Kembhavi "both as a citizen of India and as the President of the Astronomical Society of India" to welcome members of the LGBTIQ community and work within his political system to "overturn this regressive court decision."[85]

Promoting the rights of homosexuals on a more permanent basis, the AAS turned its Working Group on LGBTIQ Equality into a standing Committee for Sexual-Orientation and Gender Minorities in Astronomy (SGMA) in 2015. Under the influence of these communities, the professional society slowly moved towards a non-binary understanding of gender. In 2015, Richard Fienberg, the AAS Press Officer, reported that he had made an addition to the organization's style guide based on a WGLE recommendation. Whenever a form asks about gender, it needs to provide three possible answers: "Male, Female, and Other." He also allowed the

[83] Atherton et al. (2014).

[84] Rigby (2014).

[85] Helfand (2014).

use of "they" as a gender-neutral singular pronoun instead of he or she. In other words, a statement like "Every astronomer should belong to the AAS, shouldn't he?" could be rewritten as "shouldn't they"? Nevertheless, Fienberg acknowledged that such usage grated upon his ears, "rightly or wrongly." He a preferred rewriting to avoid the singular: "All astronomers should belong to the AAS, shouldn't they?"[86]

In order to further move away from duality, homosexual astronomers sought to involve transgender people – and thus put the T into the AAS's LGBT activism. One person they found was Jessica Mink – who had been assigned a male gender and named Douglas at birth. Mink had first felt an ambiguous gender identity at the age of six.[87] Nevertheless, she got married to a woman soon after reaching adulthood. The astronomer attended a "Space for Women" meeting at the Harvard–Smithsonian Center for Astrophysics (CfA) in 1975. Her spouse was working as a programmer at the CfA and was among the organizers. Mink's own participation in the event was largely restricted to getting drunk on champagne at the closing reception, she confessed.[88] However, around the same time, she read a short story by John Varley entitled "Picnic on Nearside" in which people change back and forth between genders. Mink thought, "Wow! That's a future where I want to live!"[89]

Despite early feelings, Mink only started an outward transition from male to female in the 2000s, when she was in her fifties. By that point, she was decades into a successful career in astronomy. Despite never earning a doctorate, she had worked as a research associate at Cornell University and the Massachusetts Institute of Technology, before joining the CfA as a software developer. She had helped discover the rings of Uranus and Neptune. Moreover, she had written applications for processing astronomical data that contributed to other advances. She was also a member of both the American Astronomical Society and the International Astronomical Union, but not very active in its diversity initiatives. This changed after Mink came out as a transwoman in 2011. That year, the scientist travelled – still as a man – to Paris for the twenty-first conference on Astronomical Data Analysis Software and Systems. She attended a workshop in the afternoon and switched before the evening reception. "Wait for me," she told her friends as she got into the hotel elevator, "I'll come back down." In her room, she put on makeup, a skirt, a blazer and boots, and headed down again.[90]

Mink's friends were startled by the transition from Douglas to Jessica. Nevertheless, they and her colleagues were accepting. One of her superiors at the CfA was worried that she might leave and reassured her how valuable her work was.[91] A co-author was surprised to receive an email from "Jessica Mink." At first, he worried that this was a message about Mink's death from the astronomer's wife.

[86] Fienberg (2015).

[87] Committee for Sexual-Orientation & Gender Minorities in Astronomy (2020).

[88] Mink (2016a).

[89] Mink (2021).

[90] Committee for Sexual-Orientation & Gender Minorities in Astronomy (2020).

[91] Clark (2015b).

He then simply asked, "OK, so how do you want your name in the final paper?" She found changing her name in the membership records of the American Astronomical Society straightforward too. Still, Mink was unable to alter the documentation in all her software. She thus continued to be addressed as Douglas in occasional correspondence. However, the Astrophysics Data System linked her old and new names, making all her publications appear in a single search.[92]

Mink's transition was arguably smooth in part because it occurred on the back of a successful career. She acknowledged that she had long benefited from privileges as a white male astronomer.[93] Now, however, she strove for equal opportunities for women, cis and trans. She gave interviews on gender transition for the *Harvard Business Review* as well as to the AAS.[94] In 2015, she and Jane Rigby presented a poster on "Recent Advances for LGBT Astronomers" at the General Assembly of the International Astronomical Union in Honolulu.[95] The same year, she joined the Committee on the Status of Women in Astronomy in order to serve as liaison with the Committee for Sexual-Orientation and Gender Minorities in Astronomy. She also wanted to "learn more about the issues of women in astronomy and bring a slightly different perspective to them." At the same time, she acknowledged: "I still have a ways to go to reach my original goal of becoming a woman astronomer."[96]

Astronomy Underground

As Mink's gender transition occurred late in her career, she felt less vulnerable overall. "I'm probably too old to experience the harassment that younger women seem to get almost everywhere," she wrote in the *Women in Astronomy* blog in 2016. "By missing that kind of experience, I won't ever quite feel what other women in science (or elsewhere, for that matter) feel."[97] Despite decades-long activism, students and junior researchers remained at particular risk. John Johnson, a professor at Harvard University, called Geoff Marcy's "inappropriate actions" around women "one of the biggest 'open secrets' at any exoplanets or AAS meeting." Johnson, himself a former student of Marcy's, further claimed that "underground" networks of women were passing information to younger scientists "in an attempt to keep them safe."[98] Johnson himself also published what he called "The Serial Harasser's Playbook" to warn the community of strategies allegedly used by his former

[92] Committee for Sexual-Orientation & Gender Minorities in Astronomy (2020).
[93] Mink (2016b).
[94] Clark (2015a).
[95] Dixon et al. (2015).
[96] Mink (2015).
[97] Mink (2016c).
[98] John Johnson (2015a).

teacher.[99] However, Johnson, an African American, must have felt vulnerable early in his career too. He worked with Marcy quietly and only started denouncing him after becoming a tenured professor at Harvard University.

While Marcy was especially prominent among those accused of sexual misconduct, he was not alone among senior members of his profession. Another subject of repeated allegations was Tim Slater, whom the University of Arizona had hired as an associate professor of astronomy in 2001. Three years later, several individuals complained to the institution's Equal Opportunity and Affirmative Action Office about a hostile work environment. An investigative report found a "continual practice of sexual joking, direct sexual discourse, and *innuendo*" particularly within Slater's team. Slater characterized himself as "flirtatious" and "flattering." He also confirmed that he was "sexually overt" and "touchy." Yet, he argued that he did not cross a certain line. He denied the allegation that he had once snapped a female's underwear through her dress. Nevertheless, the report concluded that he had violated his university's policy on sexual harassment.[100]

Despite being formally reprimanded, Slater continued a successful career in the academy. He was recognized as a leader in astronomy education who promoted the use of innovative pedagogical methods and material, including science fiction. He proposed capturing student interest in the dilemmas of astrobiology by discussing *Star Trek*'s Prime Directive, for instance.[101] In the meantime, the investigative report by the Equal Opportunity and Affirmative Action Office was filed as "confidential." He had to complete a training on matters of sexual harassment that "worked really well," as he claimed. "One of the things I realized," he later said, "is that science can be a real tough place for women." He remained at the University of Arizona until 2008, when the University of Wyoming appointed him to an endowed professorship in science education. His new employer had inquired about "an allegation of sexual harassment," but probably did not receive the report. It thus found "no barriers" to hiring him.[102]

Bureaucratic secrecy about sexual harassment was not just an American, but a global phenomenon. Between 2008 and 2016, Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted at least sixteen investigations into alleged professional misconduct within its astronomy department. One of the cases involved Ilana Feain, a project scientist working on the Square Kilometer Array (SKA), a radio telescope for the southern hemisphere. In 2012, she filed a lengthy complaint in which she accused a senior colleague of unprofessional attention over several years. The internal investigation remained confidential, and Feain was barred from discussing it. The accused was counselled, and an adverse finding placed on his file. Yet, he remained in his position. In the meantime, Feain left

[99] John Johnson (2014b).

[100] McAndrew and Kleespie (2005).

[101] Slater (2006).

[102] Kramer and Hernandez (2016).

CSIRO. Turning from radio astronomy to radiotherapy, she founded a company in cancer care.[103]

While institutions tended to keep internal investigations confidential, individuals sent warnings across the boundaries of observatories, universities and often countries. One of them was Carole Mundell, a professor of extragalactic astronomy at Liverpool John Moores University (LJMU) in England. She was concerned over the hiring of her colleague Chris Simpson as chief scientist for the South African operations of the Square Kilometre Array in 2014. At the time, Simpson was reportedly under investigation for sexual harassment and assault against a student at LJMU. Yet, he received a positive reference from his supervisor, Mike Bode, which made no mention of the proceedings. Mundell thus decided to write her own emails to Anthony Foley of the SKA and to Kartik Sheth of the US National Radio Astronomy Observatory. As cited in a later court document, she had argued that Simpson's disciplinary process would "undoubtedly have resulted in his dismissal for gross misconduct." He managed to delay it, she claimed, "possibly with the collusion of our HR and Institute management, who have been keen to coverup their previous cover ups." In December 2014, Simpson was able to cancel the proceeding against him by resigning.[104]

Mundell's notices prevented Simpson's hiring for the Square Kilometre Array, but did not end his work in astronomy. In February 2015, Renée Kraan-Korteweg of the University of Cape Town wrote an email to peers at the SKA Organisation about the allegations against Simpson. "We are extremely worried about this unfortunate situation which potentially is highly damaging to South Africa's reputation."[105] Eventually, the SKA appointed Fernando Camilo of Columbia University as chief scientist in 2016. During the same year, Simpson joined the Gemini Observatory in Hawaii as data process developer. In his own narrative, he did so after having grown "disenchanted with the English weather."[106]

While covert efforts had an effect in certain cases, senior scientists sought to move the struggle against sexual misconduct out of the shadows. One of them was Joan Schmelz, who had by then attained a professorship at the University of Memphis. In 2008, she became chair of the Committee on the Status of Women in Astronomy. At an AAS conference 3 years later, she organized a town hall meeting on "How Men Can Help Women in Astronomy." Although she had been a victim of harassment early in her career, she thought that it "was a thing of the past" by this point. However, in her new role as head of the CSWA, she heard more and more stories to the contrary. "Sexual harassment didn't stop," she realized, "it just went underground."[107]

[103] Cohen (2016).

[104] Warby (2016).

[105] Warby (2016).

[106] Gemini Observatory (2017).

[107] Schmelz (2015).

In response to a request by a younger member of her profession, Schmelz decided to publicize her own experiences in the *AAS Newsletter* and the *Women in Astronomy* blog. "If sharing my story could help even one young victim realize that she was not alone, would I do it?" she asked. Before making her revelation in 2011, she consulted with AAS lawyers in a teleconference. They advised her that in order to avoid liability, she should neither name her harasser nor the institution that had employed her at the time. However, she shared other unpleasant memories, such as the individual saying to her: "I wish I could keep you in my pocket and take you out when it's convenient." She ended by calling upon others to talk about what happened to them as well. "The harassment experience can be very isolating, but you don't have to tough it out alone," she wrote. "CSWA can help."[108]

Whereas Schmelz anonymized her abuser, others increasingly called out those they saw as contributing to a hostile climate for women. One of those widely named and shamed was Matt Taylor, a British astrophysicist with the European Space Agency (ESA) and fan of heavy metal. In 2014, he participated in a press conference on the landing of Philae spacecraft on the comet 67P/Churyumov–Gerasimenko. For the special day, he put on the "birthday shirt" that he had received from Elly Prizeman, a friend working in a tattoo parlor. It showed images of scantily-clad women in sexy poses. "I love the female form," Prizeman said, "and these pinup prints and pictures are unique and beautiful."[109] Yet, many commentators found them entirely inappropriate for a scientific event. "I don't care if you landed a spacecraft on a comet, your shirt is sexist and ostracizing." So read the title of an article on the website *The Verge*. The subtitle was: "That's one small step for man, three steps back for humankind." A science journalist tweeted sarcastically: "No no women are toooootally welcome in our community, just ask the dude in this shirt."[110]

As the ESA mission had a high profile, Taylor's sartorial choice generated much public controversy. "The shirt I wore this week," the scientist choked up during his apology, "I made a big mistake and I've offended many people and I'm very sorry about this."[111] However, others rushed to defend him, including Boris Johnson, who was then the mayor of London. "There must be room in our world for eccentricity, even if it offends the prudes, and room for the vague other-worldliness that often goes with genius," the British politician wrote in the newspaper *The Telegraph*. "Dr Taylor deserves the applause of our country, and those who bash him should hang their own heads and apologise."[112]

Hashtags, such as #shirtgate and #shirtstorm, took the debate beyond the European context on social media. This time, the leadership of the American Astronomical Society responded in a statement written by its then-president Meg Urry. "We do appreciate the scientist's sincere and unqualified apology," she stated.

---

[108] Schmelz (2011a, b).

[109] Wofford (2014).

[110] Plante and Duhaime-Ross (2014).

[111] Rogers (2014).

[112] Boris Johnson (2014a).

At the same time, she defended those "who rightly brought this issue to the fore." She cited the association's anti-harassment policy from 2008, which prohibits "a display of sexually suggestive objects or pictures." She made clear that had the images appeared "under the auspices of the AAS," they would have been "in clear violation of our policies." She concluded that "only when all astronomers feel welcome and supported in the profession can our discipline realize its full potential for excellence."[113]

Harnessing the power of social media, feminists became increasingly vocal about scientists who treated their community like a boys club. One of their next targets was Shrinivas Kulkarni, an Indian-born professor at the California Institute of Technology. "Many scientists, I think, secretly are what I call 'boys with toys,'" he said in an interview for the National Public Radio in May 2015. Numerous female scientists responded by posting pictures of themselves next to telescopes, robots, particle accelerators, and other instruments with the hashtag #girlswithtoys.[114] Ed Bertschinger, a professor at the Massachusetts Institute of Technology, also criticized Kulkarni on the *Women in Astronomy* blog. "Words matter," he wrote. "When a leading scientist excludes girls, it sends the message, whether intended or not, that girls should not apply because they do not belong."[115]

As the naming and shaming of prominent scientists became more prevalent, it was perhaps only a matter of time before Geoff Marcy as one of astronomy's stars would be called out. Despite allegations of inappropriate behavior against him, he was still celebrated for his discoveries of exoplanets. In 2012, *The Atlantic* magazine featured him as one of its "brave thinkers."[116] Two years later, the *New York Times* profiled him as the "Finder of New Worlds," while describing him as "aggressively empathetic."[117] Thomson Reuters listed him among its "Citation Laureates," likely candidates for a Nobel Prize. "I feel scared," Marcy said of the prospect of winning. "I've heard people say that your life gets kind of turned upside down, and everybody wants you to give a speech at their fundraising event."[118]

In 2015, Marcy's life did, indeed, take a radical turn, just as was reaching a new peak in his career. In the summer of that year, he became principal investigator of Breakthrough Listen, a $100-million project to search for extraterrestrial intelligence.[119] Around the same time, an investigation at the University of California, Berkeley, found that he had violated its sexual harassment policies between 2001 and 2010. He was alleged to have engaged in inappropriate behavior with students, including groping, kissing and massaging them. He was informed that further transgressions could lead to his "suspension or dismissal." For many, this warning was

[113] Fienberg (2014).
[114] Diep (2015).
[115] Bertschinger (2015).
[116] Garber (2012).
[117] Overbye (2014).
[118] Chiara (2013).
[119] Sanders (2015).

far from enough. “After all of this effort and trying to go through the proper channels, Berkeley has ultimately come up with no response,” said a disappointed Joan Schmelz. “I’ve seen sexual harassers get slaps on the wrist before,” she added. “This isn’t even a slap on the wrist.”[120] The Committee on the Status of Women in Astronomy also declined to publish an open letter of apology sent by Marcy.

It was not just the CSWA that put pressure on Marcy and his employer. James Guillochon, then a postdoctoral researcher at the Harvard–Smithsonian Center for Astrophysics sent an email to other junior astronomers calling for a “boycott” of an open faculty position at Berkeley. This was his response to what he called the university’s “complete refusal to remove Geoff Marcy for at least a decade of repeated (and admitted) sexual harassment.” Guillochon added, “Until UCB acts, I think it is in the best interest of all postdocs to refuse considering a position at their university.” Marcy’s former student John Johnson posted Guillochon’s call on his blog. Johnson lauded his Harvard colleague for “bravely and correctly leveraging his privilege to force much-needed and long-overdue changes in a very broken system.”[121]

Initially, Marcy’s superiors at the university still tried to protect him. However, he was ultimately forced out of his positions. “Of course, this is hardest for Geoff,” wrote Gibor Basri, then the acting department chair, in an email to faculty and postdocs in October 2015. “For those who are willing and able, he certainly can use any understanding or support they can offer.”[122] Basri was worried that the controversy could drive Marcy, a close friend of his, into suicide, as he shared with me. Yet, many of Marcy’s peers and members of the wider public were unforgiving. Major periodicals and websites picked up the story, which had first been broken by Azeen Ghorayshi, a Berkeley graduate, in *BuzzFeed News*. Numerous people signed petitions and tweeted using the hashtag #astroSH. Ultimately, even friends like Basri considered him no longer a viable member of their department. Marcy thus stepped down as professor, as principal investigator of the Breakthrough Listen project, and as co-organizer of a major conference on exoplanets. He did continue publishing papers after his formal retirement from the university, albeit with difficulty.[123]

Because Marcy had been so prominent, the American Astronomical Society issued a statement written by its president, Meg Urry. Rather than staying neutral or even defending one of her discipline’s stars, she sided with those who had complained about him. “The AAS deplores sexual harassment and expresses its unequivocal support for the people who risk their own professional status by speaking publicly in order to protect others from similar abuse,” she wrote. Urry also announced the creation of a task force that would come up with procedures against those who commit ethical violations. She concluded by affirming a broad commitment to diversity: “If we pay attention to climate and accessibility in our teaching,

[120] Ghorayshi (2015).

[121] John Johnson (2015b).

[122] Basri (2015).

[123] Langin (2023).

learning, and research spaces, we will benefit from a broader talent pool, new ideas, and new energy."[124]

Encouraged by Marcy's rapid downfall, activists continued to go after other scientists with a history of harassment. Their targets included Tim Slater, whose confidential report had been released by the University of Arizona in 2010. In November 2015, Pamela Gay of Southern Illinois University Edwardsville got hold of it and sought to discredit him further in front of fellow members of the International Astronomical Union.[125] They realized that the organization had no mechanism for reviewing offenses, however. "Had someone committed murder, we wouldn't be able to do anything to forcibly remove them," she acknowledged in an email to David McKinnon of Edith Cowan University in Australia. "Thus, Geoff Marcy is still a member." Nevertheless, Gay urged her peers that "it is the IAU's best interests to not have Tim Slater in a leadership position." In addition to bringing up the Arizona investigation, she stated: "I (like what feels like countless women) have had my butt slapped by Slater at conferences (plural), and have been subjected to sexually loaded dialogue and situations."[126]

Although underground networks did not force Slater from his professorship at the University of Wyoming, they did limit his opportunities within the profession. In a blog post in October 2015, he admitted that back in the early 2000s, he had violated the University of Arizona's policies by "allowing a hostile work environment to exist that was characterized by sexual joking, banter, and innuendo." Yet, he now considered himself a "different and more mature person." "Becoming a Christian and having the good fortune of recently marrying a solidly-grounded, Christian woman has helped me tremendously to have more compassion and deeper empathy," he explained. Nevertheless, he complained about continuously being disadvantaged: "Even many years later, I still have been suddenly removed from professional mentoring-programs, asked not to speak at conferences, been denied grant funding to do faculty workshops at minority institutions, been questioned about if I should chair certain committees, and have been morally chastised online by people I have never met or spoken to, all because of what people continue to imply about an alleged and inflated history of sexual harassment."[127]

Slater argued that those who spread stories of harassment not just hurt him, but astronomy in general. "In the United States where I am a citizen, an individual's employer is the mandated, competent authority for investigating sexual harassment violations. Not a Facebook group, not a committee of a professional society," he wrote in the blog. His own universities did not find any evidence after 2005, he stressed. Yet, "too many astronomers use a what-does-the-gossip-say filter before they think." He warned that the "astronomy community, and the broader college STEM teaching community, is cracking under the weight of the ongoing,

[124] Urry (2015).

[125] Kramer and Hernandez (2016).

[126] Gay (2015).

[127] Slater (2015).

destructive rumor mill." He concluded that "this gossip is stopping everything, especially our ability to be good teachers."[128]

As Slater considered his entire profession under threat, he also expressed his concerns to the leadership of the American Astronomical Society directly. In January 2016, he sent an open letter to the AAS Council in which he protested against the activism of members of the Committee on the Status of Women in Astronomy, such as Joan Schmelz. He complained that they engaged in "self-organized investigations into the ethical and harassing behavior of members of the astronomy community, and have further, aggressively solicited, collected, and perhaps distributed names of suspected harassers." Slated doubted that such activities would be supported by the majority of AAS members. He also believed that the society as a whole lacked the mandate, training and expertise for conducting investigations.[129]

While Slater was mainly worried about what he considered smear campaigns by fellow scientists, he came into the focus of politicians too. Jackie Speier, a lawyer and member of the US House of Representatives, criticized the handling of sexual harassment by universities. "The Slater case, while lurid, is just a symptom of a much larger problem," she wrote in a letter to the US Department of Education in January 2016. "In some ways, the situation is reminiscent of the Catholic Church's coddling of child-molesting priests. As in the Church, universities protect perpetrators with slap-on-the-wrist punishment and secrecy, while victims are left alone to try to put their academic careers and lives back together." She named Slater in a speech on the floor of the House of Representatives, commenting that "students enter astronomy to study the stars, not their professor's sex life."[130]

As public opinion turned against astronomers accused of misconduct, they felt obliged to express themselves anonymously. Also in January 2016, the AAS Council and many individual members received an open letter signed by "The Astronomy Underground." It asked "with what license AAS has acted to investigate its members, damaging their careers, their personal lives, and the health of the Society in the process." The Astronomy Underground was worried that especially their junior peers were preferring "social engineering over the business of advancing our science." The letter thus urged the AAS to "redirect" younger members of the "social justice movement" associated with the Committee on the Status of Women in Astronomy. Finally, the AAS Council was called upon to "repair the reputation of astronomy on the national landscape, for the purposes of future recruitment and funding."[131]

After complaints to the American Astronomical Society proved unsuccessful, Slater fought back through the court system. Within less than 2 years of having had his case mentioned in the US Congress, he filed two separate lawsuits. One targeted the University of Arizona for releasing the original investigative report from 2005,

[128] Slater (2015).

[129] Astronomy Rebel (2016).

[130] Kramer and Hernandez (2016).

[131] Astronomy Underground (2016).

despite its label as "confidential." The other one accused Pamela Gay of further distributing the document and sending out slanderous and libelous emails. He sought more than $30 million in damages. He argued that the leaking of the document had made it "impossible" for him to become a highly-paid university vice president. He further claimed that his speaking engagements were drying up and that he had lost potential collaborators in research. Moreover, his chances of winning future grants were diminished.[132] Like Marcy, Slater did not stop publishing after the controversy, however. In 2019, for instance, he co-authored article on how to leverage science fiction conventions for science education in Hawaii, thus seeking to benefit "some of the most diverse and poverty-stricken communities in the U.S."[133]

Despite the threat of litigation, activists and journalists continued to expose alleged perpetrators of gender-based harassment. In January 2016, Christian Ott, a German associate professor at the California Institute of Technology, came into the spotlight of *BuzzFeed News* and other websites. Considered a rising star in theoretical astrophysics for his research on supernovae, neutrinos and gravitational waves, he had won grants worth hundreds of thousands of dollars from the National Science Foundation. However, he was also unorthodox. Caltech once reprimanded him for making up a scientist named Ursula or Uschi Gamma. She appeared as a co-author of two papers and was thanked in the acknowledgements of nine others. In an email in December 2013, he had asked his students to add Gamma to the author list of a talk "for fun(~ding) reasons." One journalist wondered: "Does he have some inkling that the agencies or that the funders are more likely to fund him if he shows some diversity of authors?"[134]

If Ott's creation of a fake team member was ethically questionable, his relationship with his real students was even more so. He allegedly first became infatuated with one of them and then told her to look for another advisor, thus upending her research plans. He reportedly confessed his behavior to another mentee in increasingly emotional exchanges. In 2015, both students filed complaints against him, leading Caltech to suspend him. "He's obviously a talented researcher, but that's not all that his job entails," commented Joan Schmelz. "In his current state, should he be advising students and postdocs? I think no."[135] Many students agreed and protested his return to campus even after mandatory "rehabilitative" training. Eventually, Ott resigned from Caltech in 2017.[136]

Tracked by fellow scientists and *BuzzFeed News*, the German astrophysicist was prevented from restarting this academic career in Europe. Initially, he was offered a 2 year-position at the University of Turku in Finland. The vice rector sought to reassure: "Christian Ott is going to work as a senior researcher without any teaching or

[132] Kingkade (2017).

[133] Slater and Slater (2019), 70.

[134] Ghorayshi (2017a).

[135] Ghorayshi (2016).

[136] Ghorayshi (2017b).

supervising responsibilities."[137] However, the university administration cancelled the job offer after many astronomers expressed their concerns. "If people who have been found guilty of sexual harassment or gender-based harassment can simply move to a new institute, then this sends a message to people who have been the targets of harassment that the same thing can just continue," Syksy Räsänen, a cosmologist at University of Helsinki, told *BuzzFeed News*.[138]

If an attitude of zero tolerance toward sexual harassment encouraged many people to speak up, it also silenced others. "The past few years shows that many visible people have been forced to leave their jobs in astronomy and physics research by people who enforce 'diversity and inclusion', but without any court of law," Geoff Marcy told me in 2021. This was not just a tragedy for individuals in his opinion. "The structure of research in the western world is suffering deeply," he said. "And thousands of scientists know, but are frightened to speak about it publicly." Marcy's friend and former supervisor Gibor Basri was also concerned about the effects of cancel culture. "'Canceling' can be quite abused and usually occurs outside of any organized procedure," Basri told me in 2022. "Now there is even a movement to cancel folk's prior work or remove them from legitimate publications. I think that is bad for the field." Marcy's former colleague and supervisor added, "Geoff's punishment greatly exceeded his crimes. It doesn't seem to be quite the time yet, but there will need to be consideration of a way for those genuinely repentant to earn redemption."

Whether gender activists dealt damage to astronomy or not, their actions were certainly felt, and sometimes painfully so. Many careers were deeply affected by sexual harassment or the efforts to put a stop to it. Even those who rose to leadership positions like Meg Urry or Joan Schmelz paid a price, if only in the time they lost for their own research. Despite winning numerous other accolades, Margaret Burbidge was never recognized with a Nobel Prize. However, the discipline as a whole was transformed between the 1970s and the 2020s. "One of the things that keep me going is I can remember what it was like then and I can see what it's like now," Schmelz explained to me in 2021. "It's different, it's better for all of the ways that we could possibly think or imagine or measure diversity, equity, and inclusion issues."

While women's rights activists were particularly numerous, they had to share the credit for making astronomy more inclusive with a range of other identity entrepreneurs. As the oppression of people of color was a problem of similar magnitude as discrimination against women, anti-racists were as devoted to their cause as many feminists. They also had much in common, not least in the intersectional identities – such as women of color – they were championing. In the end, however, organizations like the American Astronomical Society gave rise to separate committees on women and minorities rather than a single diversity group.

[137] Ghorayshi (2018a).

[138] Ghorayshi (2018b).

References

Allen, L., J. Alonso, S. Cabrit, G. Cortes-Medellin, W. Dent, N. Devereux, D. Dutkevitch, et al. 1987. "Degrading Posters in Observatories." *AAS Newsletter*, December 1987.

American Astronomical Society. 1993. "1991–92 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 25: 981–95.

American Astronomical Society. 1995. "1994 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 27, no. 3: 1029–52.

American Astronomical Society. 1996. "1995–96 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 28: 991–1018.

American Astronomical Society. 1999. "1998–1999 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 31: 1251–84.

American Astronomical Society. 2001. "2000–2001 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 33: 939–74.

AstroDyke. 2013. "Out of Breath at the AAS." The AstroDyke. http://astrodyke.blogspot.com/2013/01/out-of-breath-at-aas.html.

Astronomy Rebel. 2016. "Open Letter to AAS Council." The Real Astronomy. https://realastronomy.com/2016/01/03/open-letter-to-aas-council/.

Astronomy Underground. 2016. "AAS Investigating Members?: Open Letter to the AAS Council." The Real Astronomy. https://realastronomy.com/2016/01/19/aas-investigating-members-open-letter-to-the-aas-council/.

Atherton, Timothy, Ramón Barthelemy, Carolyn Brinkworth, Wouter Deconinck, Van Dixon, Elena Long, Merav Opher, et al. 2014. *Supporting LGBT+ Physicists & Astronomers: Best Practices for Academic Departments*. V. 2.1. lgbt+physicists, AAS Working Group on LGBTIQ Equality.

Basri, Gibor. 2015. Email to faculty, postdocs. "A Difficult Day." October 10, 2015.

Bertschinger, Ed. 2015. "#GirlsWithToys." Women in Astronomy. https://womeninastronomy.blogspot.com/2015/05/girlswithtoys.html.

Brown, G. Stanley. 1988. "Degrading Images and the First Amendment." *AAS Newsletter*, March 1988, 2.

Brown, G. Stanley, and Beatrice M. Tinsley. 1974. "Galaxy Counts as a Cosmological Test." *Astrophysical Journal* 194: 555–58.

Burbidge, E. Margaret. 1978. Oral history interview by David DeVorkin. Niels Bohr Library & Archives, American Institute of Physics, College Park.

Burbidge, E. Margaret. 1994. "Watcher of the Skies." *Annual Review of Astronomy and Astrophysics* 32: 1–36.

Burbidge, E. Margaret, G. R. Burbidge, William A. Fowler, and F. Hoyle. 1957. "Synthesis of the Elements in Stars." *Reviews of Modern Physics* 29, no. 4: 547–650.

Calame, Gerald P. 1973. "The Science in Science Fiction: A Seminar Course." *American Journal of Physics* 41, no. 2: 184–87.

Chiara, Claire. 2013. "4 UC Berkeley Professors Named on Firm's List of Top Nobel Contenders." *The Daily Californian*. https://www.dailycal.org/2013/10/04/four-uc-berkeley-professors-placed-list-nobel-laureate-predictions/.

Clark, Dorie. 2015a. "Managing Your Professional Identity During a Gender Change." *Harvard Business Review*. https://hbr.org/2015/02/managing-your-professional-identity-during-a-gender-change.

Clark, Dorie. 2015b. "What to Do When Your Colleague Comes Out as Transgender." *Harvard Business Review*. https://hbr.org/2015/02/what-to-do-when-your-colleague-comes-out-as-transgender.

Cohen, Hagar. 2016. "CSIRO Covered up Sexual Harassment and Bullying at Astronomy Department, Say Top Scientists." ABC Radio National. https://www.abc.net.au/news/2016-11-18/sexual-harassment-and-bullying-covered-up-at-csiro-astronomers/8036582.

Committee for Sexual-Orientation & Gender Minorities in Astronomy. 2020. "SGMA Interviews: Jessica Mink." American Astronomical Society. https://aas.org/comms/sgma/sgma-interviews-jessica-mink.

Committee on the Status of Women in Astronomy. 2005. "Equity Now: The Pasadena Recommendations for Gender Equality in Astronomy." American Astronomical Society. https://cswa.aas.org/Equity_Now_Pasadena.pdf.

Cowley, A., R. Humphreys, B. Lynds, and V. Rubin. 1974. "Report to the Council of the AAS from the Working Group on the Status of Women in Astronomy–1973." *Bulletin of the American Astronomical Society* 6: 412–23.

Danner, Rolf. 2001. "A Good Time To Be Gay in Astronomy?" *AAS Newsletter* 106: 2.

Danly, L., and M. Jan. 1993. "The Women's Science Forum: A Targeted Outreach Program at ST ScI." In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 175–78. Baltimore: Space Telescope Science Institute.

Diep, Francie. 2015. "Everything Wrong With Calling Scientists 'Boys With Toys.'" *Pacific Standard.* https://psmag.com/social-justice/billion-dollar-taxpayer-toys.

Dixon, Van. 2012. "An Introduction to the AAS Working Group on LGBTIQ Equality." *AAS Newsletter* 163: 22.

Dixon, Van, Jane Rigby, Rebecca Oppenheimer, and Jessica Mink. 2015. "Recent Advances for LGBT Astronomers in the United States." Poster presented at the XXIX General Assembly of the International Astronomical Union, Honolulu, Hawaii.

Dreifus, Claudia. 2018. "Fighting Sexism in Science: Five Questions for Meg Urry." *Undark Magazine*. https://undark.org/2018/07/19/five-questions-meg-urry/.

Feder, Toni. 2015. "Following the fun." *Physics Today*, August 5, 2015.

Felten, James E. 1988. "Degrading Images and the First Amendment." *AAS Newsletter*, March 1988, 2.

Felten, James E. 1994. "Sexist 'Baltimore Charter' Should Not Become AAS Policy." *Status: The Committee on the Status of Women in Astronomy*, January 1994.

Fienberg, Richard. 2014. "AAS Issues Statement on 'Shirtgate'/'Shirtstorm'." American Astronomical Society. https://aas.org/posts/news/2014/11/aas-issues-statement-shirtgateshirtstorm.

Fienberg, Richard. 2015. "A Question of Singular Importance." American Astronomical Society. https://aas.org/posts/news/2015/04/question-singular-importance.

Garber, Megan. 2012. "Geoff Marcy." *The Atlantic*. https://www.theatlantic.com/magazine/archive/2012/11/geoff-marcy/309133/.

Gay, Pamela. 2015. Email to David McKinnon. "Re: Symp 326: Resignation to the SOC." November 28, 2015.

Gemini Observatory. 2017. "Astronomy Educator Profiles." Gemini Observatory. https://www.gemini.edu/images/pio/jttu/2017/2017Educators_bios.pdf.

Ghorayshi, Azeen. 2015. "Famous Berkeley Astronomer Violated Sexual Harassment Policies Over Many Years." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/famous-astronomer-allegedly-sexually-harassed-students.

Ghorayshi, Azeen. 2016. "He Fell In Love With His Grad Student – Then Fired Her For It." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/ott-harassment-investigation.

Ghorayshi, Azeen. 2017a. "Astronomer Who Harassed Women Was Also Investigated For Faking A Female Researcher." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/harasser-faked-female-scientist.

Ghorayshi, Azeen. 2017b. "A Caltech Professor Who Harassed Two Female Students Has Resigned." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/christian-ott-has-resigned.

Ghorayshi, Azeen. 2018a. "This Ex-Caltech Professor Resigned After Harassing Two Students. Now He Has A New Job." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/caltech-christian-ott-professor-harassment-turku.

Ghorayshi, Azeen. 2018b. "Astrophysicist Christian Ott Was Just Fired From His New Job In Finland After Harassment Scandal." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/christian-ott-fired-turku-harassment.

Golbeck, Amanda L. 2017. *Equivalence: Elizabeth L. Scott at Berkeley*. Boca Raton: CRC Press.

Griffin, Elizabeth. 2019. "Under One Sky: the IAU and Women in Astronomy." In *Under One Sky: The IAU Centenary Symposium*, edited by Christiaan Sterken, John Hearnshaw, and David Valls-Gabaud, 502–4. Cambridge: Cambridge University Press.

Helfand, David. 2014. Letter to A. K. Kembhavi. https://sgma.aas.org/sites/sgma.aas.org/files/Letter_Astronomy_AAS_377.pdf.
Hill, Michael. 1992. "Seminars teach girls the sky's the limit in science: Dearth of women prompts seminars." *The Baltimore Sun*, February 16, 1992.
Holmes, Beth. 2004. "The Postdoc Perspective on the Women in Astronomy II Conference." *Status: A Report on Women in Astronomy*, January 2004, 5.
Humphreys, Roberta. 2018. "The award rejection that shook astronomy." *Physics Today*.
Iwaniszewska, Cecylia. 1981. "The Education and Astronomical Careers of Women in Poland." *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 10, no. 2: 3–4.
Izvekova, Vera, and Svetlana Suleymanova. 1993. "Women in Russian Radio Astronomy: Reflections by Two Russian Radio Astronomy Women." In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 131–34. Baltimore: Space Telescope Science Institute.
Johnson, Boris. 2014a. "Dr Taylor's Shirt Made Me Cry, Too – with Rage at His Abusers." *The Telegraph*, November 17, 2014.
Johnson, John. 2014b. "Fed Up With Sexual Harassment: The Serial Harasser's Playbook." Women in Astronomy. http://womeninastronomy.blogspot.com/2014/05/fed-up-with-sexual-harassment-serial.html.
Johnson, John. 2015a. "The Long Con." Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2015/10/the-long-con.html.
Johnson, John. 2015b. "Open Letter RE: The Berkeley Boycott." Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2015/10/open-letter-re-berkeley-boycott.html.
Kingkade, Tyler. 2017. "A Professor's Sexual Harassment Case Came Out In Congress, And He's Fighting Back." BuzzFeed News. https://www.buzzfeednews.com/article/tylerkingkade/a-professors-sexual-harassment-case-came-out-in-congress.
Kinne, Richard. 2011. "Franklin E. Kameny (1925–2011)." *Bulletin of the American Astronomical Society* 43.
Kinney, Anne. 1993. "Astronomizing at ST ScI." In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 193–202. Baltimore: Space Telescope Science Institute.
Knezek, Patricia, and Meg Urry. 2003. "Status of Women in Astronomy." *AAS Newsletter* 118: 10–12.
Langin, Katie. 2023. "Authorship Listing for a Harasser Roils Astronomy." *Science* 380, no. 6646: 680–81.
Liller, M. H., A. P. Cowley, P. W. Hodge, F. J. Kerr, and N. D. Morrison. 1980. "Report Of The Committee On The Status Of Women." *Bulletin of the American Astronomical Society* 12: 624–35.
Livio, M., J. Lowenthal, N. Panagia, and S. Toolan. 1993. "Space Telescope Science Institute." *Bulletin of the American Astronomical Society* 25, no. 1: 563–80.
Kononovich, E. 1981. "Women in Astronomy in the U.S.S.R." *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 10, no. 2: 5–6.
Kramer, Miriam, and Sergio Hernandez. 2016. "Congresswoman Reveals Prominent Astronomy Professor's History of Sexual Harassment." Mashable. https://mashable.com/2016/01/12/astronomy-professor-sexual-harassment-university-of-arizona/.
Lemonick, Michael D. 1996. "Searching for Other Worlds." *Time* 147, no. 6: 52–57.
Levine, Alaina G. 2016. "Diversity in the Workplace." *Physics World*. https://physicsworld.com/a/diversity-in-the-workplace/.
Marcy, Geoff, and Debra Meloy Elmegreen. 1993. "University Approaches to Affirmative Action." In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 107–16. Baltimore: Space Telescope Science Institute.
McAndrew, Millay Kate, and Jeanne M. Kleespie. 2005. "Investigative Report." University of Arizona Equal Opportunity and Affirmative Action Office. https://www.documentcloud.org/documents/2655517-U-AZ-EOAAO-Investigative-Report-Timothy-Slater.html.

Mink, Jessica. 2015. "On Becoming a Woman Astronomer." Women In Astronomy. http://womeninastronomy.blogspot.com/2015/11/on-becoming-woman-astronomer.html.
Mink, Jessica. 2016a. "Astronomy Without a PhD." Women In Astronomy. http://womeninastronomy.blogspot.com/2016/01/astronomy-without-phd.html.
Mink, Jessica. 2016b. "Astronomer Privilege." Women In Astronomy. http://womeninastronomy.blogspot.com/2016/06/astronomer-privilege.html.
Mink, Jessica. 2016c. "Losing Privilege and Gaining Something Else." Women In Astronomy. http://womeninastronomy.blogspot.com/2016/11/losing-privilege-and-gaining-something.html.
Mink, Jessica. 2021. "Jessica's Transgender Library." MassPaths. http://www.masspaths.net/mink/tgbooks.html.
Overbye, Dennis. 2014. "Finder of New Worlds." *New York Times*. https://www.nytimes.com/2014/05/13/science/finder-of-new-worlds.html.
Percy, John R. 1981. "Women in Astronomy." *International Astronomical Union Commission 46 – Teaching of Astronomy Newsletter* 10, no. 2: 1–2.
Plante, Chris, and Arielle Duhaime-Ross. 2014. "I Don't Care If You Landed a Spacecraft on a Comet, Your Shirt Is Sexist and Ostracizing." The Verge. https://www.theverge.com/2014/11/13/7213819/your-bowling-shirt-is-holding-back-progress.
Rigby, Jane. 2004. "A Graduate Student's Perspective on the Women in Astronomy II Conference." *Status: A Report on Women in Astronomy*, January 2004, 1–4.
Rigby, Jane. 2014. "How Did the Supreme Court Ruling on DOMA Affect Astronomers?" Poster presented at the 223rd Meeting of the American Astronomical Society, National Harbor, Maryland.
Rogers, Kaleigh. 2014. "Rosetta Scientist Matt Taylor Is Really Sorry About That Shirt." *Vice*. https://www.vice.com/en_us/article/vvbpk4/rosetta-scientist-matt-taylor-is-really-sorry-about-his-shirt.
Sanders, Robert. 2015. "Internet Investor Yuri Milner Joins with Berkeley in $100 Million Search for Extraterrestrial Intelligence." Berkeley News. https://news.berkeley.edu/2015/07/20/breakthrough-search-for-extraterrestrial-intelligence/.
Satter, James. 2006. "The Hidden Homosexual: Reexamining *Star Trek*'s Sulu." *Science Fiction Studies* 33, no. 2: 379–82.
Scheer, Uta. 2004. "Gefährliche Liebschaften: Formwandler und Homosexualität in »Star Trek: Deep Space Nine« aus einer queeren Perspektive." In *Identitätsräume: Nation, Körper und Geschlecht in den Medien. Eine Topografie*, edited by Brigitte Hipfl, Elisabeth Klaus, and Uta Scheer, 292–337. Bielefeld: transcript.
Schmelz, Joan. 2010. "The Legacy of Anita Hill." AASWOMEN. http://womeninastronomy.blogspot.com/2010/10/aaswomen-for-october-22-2010.html.
Schmelz, Joan. 2011a. "Coming Out of the Shadows: A Sexual Harassment Story." Women In Astronomy. http://womeninastronomy.blogspot.com/2011/02/coming-out-of-different-type-of-closet.html.
Schmelz, Joan. 2011b. "Coming Out (of a Different Type of Closet)." *AAS Newsletter* 158: 13–14.
Schmelz, Joan. 2011c. "How Things Have Changed (for the Better!)." Women In Astronomy. http://womeninastronomy.blogspot.com/2011/09/how-things-have-changed-for-better.html.
Schmelz, Joan. 2015. "Woman Astronomer of the Month: Joan Schmelz." Women In Astronomy. http://womeninastronomy.blogspot.com/2015/10/woman-astronomer-of-month-joan-schmelz.html.
Slater, Timothy. 2006. "Capturing Student Interest in Astrobiology through Dilemmas and Paradoxes." *Journal of College Science Teaching* 35, no. 6: 42–45.
Slater, Tim. 2015. "How Sexual Harassment Gossip Interrupts Improving Astronomy Teaching." CAPER Astronomy Faculty Lounge. https://astronomyfacultylounge.wordpress.com/2015/10/12/how-sexual-harassment-gossip-interrupts-improving-astronomy-teaching/.
Slater, Timothy, and Stephanie Slater. 2019. "Improving Hawaiian Science Education by Leveraging Science Fiction Conventions." *SFRA Review* 330: 70–74.
Space Telescope Science Institute. 1990. "Staff News." *Space Telescope Science Institute Newsletter* 7, no. 2: 15.

Space Telescope Science Institute. 1993. “The Baltimore Charter for Women in Astronomy.” *Space Telescope Science Institute Newsletter* 10, no. 2: 39–40.
Space Telescope Science Institute. 1996. “Tenure for Meg Urry.” *Space Telescope Science Institute Newsletter* 13, no. 2: 19.
Torres-Peimbert, Silvia. 1995. “Workshop of Women in Astronomy.” In *Highlights of Astronomy*, edited by I. Appenzeller, 10:93–94. Dordrecht: Kluwer Academic Publishers.
UC Santa Cruz. 2022. “Alumni Achievement Award.” UC Santa Cruz. https://alumni.ucsc.edu/programs-services/awards/achievement-award.html.
Urry, Meg. 1993a. “The Baltimore Charter.” *Space Telescope Science Institute Newsletter* 10, no. 1: 28.
Urry, Meg. 1993b. “Baltimore Charter Released at AAS Meeting.” *Space Telescope Science Institute Newsletter* 10, no. 2: 41.
Urry, C. Megan. 1993c. “Preface.” In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, vii–viii. Baltimore: Space Telescope Science Institute.
Urry, C. Megan. 1993d. “Introduction to WIA Meeting.” In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 5–9. Baltimore: Space Telescope Science Institute.
Urry, Meg. 1999a. “How the New Cycle 9 Review Process Worked.” *Space Telescope Science Institute Newsletter* 16, no. 4: 21–22.
Urry, Meg. 1999b. “The Baltimore Charter and the Status of Women in Astronomy.” *Status: A Report on Women in Astronomy*, June 1999, 6–10.
Urry, C. Megan. 2003a. “Women in Astronomy II Conference.” National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=0335032.
Urry, Meg. 2003b. “Report from the Committee on the Status of Women in Astronomy.” American Astronomical Society.
Urry, Meg. 2005. “Diminished By Discrimination We Scarcely See.” *Washington Post*, February 6, 2005.
Urry, C. 2015. “AAS Statement on Sexual Harassment by Faculty.” American Astronomical Society. https://aas.org/posts/news/2015/10/aas-statement-sexual-harassment-faculty.
Urry, Meg. 2019. “Riccardo’s Impact on Gender Equity.” Memorial Symposium to Honor Riccardo Giacconi. https://hea-www.cfa.harvard.edu/Giacconi/Leadership/5_Urry_Leadership.pdf.
Urry, Meg. 2022. “The Gentlemen and Me.” In *The Sky Is for Everyone: Women Astronomers in Their Own Words*, edited by Virginia Trimble and David A. Weintraub, 267–78. Princeton: Princeton University Press.
Urry, C. M., L. Danly, E. J. Schreier, and S. Tobias. 1993. “The Baltimore Charter for Women in Astronomy.” *Bulletin of the American Astronomical Society* 25: 913.
Walker, Cameron. 2014. “Equality: Standing Out.” *Nature* 505, no. 7482: 249–51.
Warby, Mr. Justice. 2016. Bode v Mundell [2016] EWHC 2533 (QB), No. HQ15D05233 (High Court of Justice, Queen’s Bench Division, October 19, 2016).
Wilford, John Noble. 1997. “In a Golden Age of Discovery, Faraway Worlds Beckon.” *New York Times*, February 9, 1997.
Williams, Lynda. 2016. “#AstroSH Part 1: Geoff Marcy and the Physics Showgirl.” Lynda Lovon. http://lyndalovon.blogspot.com/2016/02/astrosh-part-1-geoff-marcy.html.
Wilson, Robin. 2016. “Geoff Marcy’s Downfall.” *Chronicle of Higher Education*. http://www.chronicle.com/article/Geoff-Marcy-s-Downfall/235380.
Wofford, Taylor. 2014. “An Interview with the Woman behind the #Shirtgate Shirt.” *Newsweek*. https://www.newsweek.com/interview-woman-behind-shirtgate-shirt-285877.
Yount, Lisa. 1996. *Twentieth-Century Women Scientists*. New York: Facts On File.
Zongker, Brett. 2012. “Asteroid Named for Gay Rights Pioneer Frank Kameny.” Yahoo! https://www.yahoo.com/asteroid-named-gay-rights-pioneer-frank-kameny-171708427.html.

Chapter 4
Visible Spectrum

When Margaret Burbidge served as president of the American Astronomical Society during the late 1970s, she was interested in promoting not only women, but also members of ethnic and racial minorities. In this role, she quickly came to see the "pitiful representation" of these groups as potential obstacles for gaining government funding. She met John Slaughter, a black engineer who had just become the National Science Foundation's assistant director responsible for astronomy. She intended to talk to him about a small instrumental aid for beginning astronomers. He asked her: "How many black astronomers are there?" She could only think of three.[1]

The handful of African Americans in astrophysics known to Burbidge at the time were relatively prominent. George Carruthers, an engineer at the Naval Research Laboratory, had invented the Far Ultraviolet Camera/Spectrograph, which was used in the Apollo 16 mission in 1972. The following year, he received the American Astronomical Society's Helen B. Warner Prize.[2] Ben Peery of Indiana University was known for research on stellar structure nucleosynthesis. Flooded by calls about sightings of unidentified flying objects, he had also coined the word "UFOria."[3] Behind the scenes, he had served on the special committee on the Cannon prize, which was set up after Burbidge's refusal of this recognition. In addition, he headed the Committee on Manpower and Employment in Astronomy.[4] Finally, Art Walker of Stanford University had published on the sun's atmosphere. He was further chairing a special advisory committee on the Sacramento Peak Observatory, as it

[1] Burbidge (1978).

[2] Bok (1973), 3.

[3] Vincennes Sun-Commercial (1973).

[4] Humphreys (2018).

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*,
Space and Society, https://doi.org/10.1007/978-3-031-46113-2_4

was transferred from the US Air Force to the Association of Universities for Research in Astronomy (AURA).[5]

These few senior African American astronomers during the 1970s were as busy as they were successful. As such, they were also less available for an AAS organ explicitly dedicated to minorities. In 1977, Ben Peery moved from Indiana to Howard University, a historically black institution in Washington, to build up an astrophysics program. This left him with little time for his own research or for additional service to the AAS. Burbidge felt that Peery was already struggling as chairman of the AAS Committee on Manpower and Employment. "So we thought, we'd better not overload him with yet another committee," she said in 1978.[6]

Junior astronomers were not being produced fast enough to stand in for professors like Peery during the 1970s. Young people at the time did not benefit from as large an investment in higher education and scientific research as the previous generation. The older Peery, like millions of other servicemen, had received federal aid to attend college after World War II. "That GI Bill was a godsend," he later said. He studied at the universities of Minnesota and Michigan. As he completed his doctorate in 1961, at the beginning of the Cold War space race, finding a job in the physical sciences was easy. "It's hard for young astronomers to believe this," he later remembered, "but in those days, you didn't call them – they called you!"[7]

Starting in the 1970s, it became much tougher for early-career researchers to secure permanent positions at universities and observatories. The end of the Apollo program coincided with an oil crisis, as an Arab embargo targeted countries in support of Israel. "The employment situation in Astronomy today is far from rosy," said AAS president Bart Bok in 1973. "Following the cheerful picture of most of the 1960's, the beginning of an employment crisis in astronomy was noted during 1971, and it is a sad fact for me to have to state that several of our younger colleagues are now just plain unemployed."[8] Peery was still pessimistic, as he took over the Committee on Manpower and Employment in 1977. "Universities have stopped expanding," he noted, "and there is a corresponding reduction in new job openings. Moreover, attrition due to death or retirement is slight."[9]

With people like Peery remaining rare, the Committee on the Status of Women in Astronomy had to wait for an equivalent commission for other underrepresented groups. A Committee on the Status of Minorities in Astronomy would, indeed, only be established in 1997. Nevertheless, other organs sought to help blacks or Hispanics as well. As vacancies at universities and observatories became scarce during the 1970s, the AAS sought to help graduates find jobs in high schools and planetariums.

[5] Zirker (1978), 309.

[6] Burbidge (1978).

[7] Peery (1977).

[8] Bok (1973), 7.

[9] Reed (1977), 28.

It thus created a Task Group on Education in Astronomy (TGEA) which was open to anybody interested in the topic.[10]

People who experienced racial segregation and its consequences became especially involved in the TGEA. Its co-chair, the South African Gerrit Verschuur, had been a teenager when the Bantu Education Act of 1953 enforced the separation of educational facilities. Another active contributor to the TGEA was Bill Straka. He taught at Jackson State University, which had been the Jackson College for Negro Teachers until 1967. Many activities of the TGEA, such as the Harlow Shapley Visiting Lectureships, targeted institutions without doctoral programs in astronomy, including historically black colleges.[11] The AAS also co-sponsored a summer program at the Kitt Peak National Observatory in Arizona, in which minority students worked as research assistants. However, this particular initiative became threatened by funding cutbacks at the National Science Foundation during the administration of President Ronald Reagan in the 1980s. This happened ironically after John Slaughter had become director of the NSF.[12]

Although the American Astronomical Society would ultimately establish separate committees for women and members of ethnic and racial minorities, the struggle for equal opportunity was often connected across different groups. Art Walker at Stanford University mentored a diverse cast of people. His doctoral student Sally Ride would become the first American woman in space in 1983.[13] Later, Jane Rigby, co-founder of the Working Group on LGBTIQ Equality, would come to see Ride as a role model, even without knowing that she was also lesbian.[14] Gerrit Verschuur met fellow radio astronomer Joan Schmelz at an AAS meeting in 1985. The two fell in love, got married a year later, and moved together from place to place over the following decades.[15]

Sharing oppression alone did not make allies, of course. Neil deGrasse Tyson, for instance, endured much racism as one of few black graduate students at the University of Texas at Austin during the early 1980s. “I was stopped and questioned seven times by University police on my way into the physics building,” he later recounted.[16] Despite racial profiling by law enforcement officers, he was able to pursue a stellar career at the American Museum of Natural History in New York. As a planetarium director, writer and television host, he inspired millions of people of different identities. Yet, he also became a target of sexual misconduct allegations in the wake of the Me Too movement. Between 2010 and 2018, four different women, including a former classmate and a past assistant, publicly accused the African

[10] Bishop (2002), 219–20.

[11] Shipman (1983), 1018.

[12] Shipman (1981), 930.

[13] Glanz (2001).

[14] Committee for Sexual-Orientation & Gender Minorities in Astronomy (2020).

[15] Schmelz (2015).

[16] Cahalan (2012).

American scientist of rape and harassment.[17] However, in contrast to Geoff Marcy's case, Tyson kept his job after the completion of confidential investigations.[18]

Activists frequently discussed whether and how to address sexism and racism together. Such conversations occurred during the planning of the meeting on women in astronomy at the Space Telescope Science Institute in 1992. The organizers decided to focus on gender as the areas they were "most familiar with and could most easily affect." Meg Urry explained, "We thought the dismal numbers of minority astronomers meant the problems were fundamentally different and more severe." After making that decision, however, she realized that "the problems of women and minorities are very much the same: essentially being the 'outsiders' in a culture defined by a set of white, male insiders." She speculated that "the problems for women are less severe, perhaps because it's easier for a woman to look like a man than for a person of color to look white."[19] In the end, the preamble to the Baltimore Charter read: "Our focus is on women but actions taken to improve the situation of women in astronomy should be applied aggressively to those minorities even more disenfranchised."[20]

Over the years, even the juxtaposition of women and minorities came to be debated. In 2014, Chanda Prescod-Weinstein, then a postdoctoral fellow at the Massachusetts Institute of Technology, posted about "the intersection of gender, race and sexuality" on the *Women in Astronomy* blog. "As a queer Black (cis) woman, I live at the intersection of multiple minority statuses," she explained. To her, the word "and" in the phrase "women and minorities" appeared to function as "or." She thus stressed the importance of "recognizing that not all the women are white, nor are all the Blacks (for example) men."[21]

Nevertheless, it took decades of activism for such a consciousness of intersecting identities to become widespread in astronomy. Back in 2009, Meg Urry had co-organized another conference on Women in Astronomy and Space Science at the University of Maryland. The third event in the series, it bore the subtitle "Meeting the Challenges of an Increasingly Diverse Workforce." It was dedicated to the memory of Beth Brown, an African American astrophysicist at the Goddard Space Flight Center. Still, Prescod-Weinstein complained that the talks made almost no "substantive mention of race."[22] When she pointed out that it was mostly white women whose numbers were increasing, somebody responded: "I don't even see why race matters when we talk about women in science."[23]

The activism for minorities in astronomy was sustained by people who were themselves of very diverse backgrounds. Prescod-Weinstein, who was born in Los

[17] Ghorayshi (2018).

[18] Harris (2019).

[19] Urry (1993), 7.

[20] Space Telescope Science Institute (1993), 39.

[21] Prescod-Weinstein (2014).

[22] Prescod-Weinstein (2014).

[23] Nicola Jones (2018).

Angeles, was both black and Jewish. Her mother's family hailed from Barbados and was of West African origin. Her father's Yiddish-speaking ancestors had been forced out of the Russian Empire by pogroms. However, she did not consider herself as unusual in her mixed background. She estimated that because rape had been so prevalent under slavery, more than half of African Americans had some European heritage.[24]

Black Suns

If blacks were few among American astronomers, more existed in the larger discipline of physics. Apart from committees of the American Astronomical Society, one of the most important promoters of minorities in the space sciences was the National Society of Black Physicists (NSBP). Chanda Prescod-Weinstein remembered that she had met Neil deGrasse Tyson at an NSBP conference in 2003, when she was twenty. It left an "extremely lasting impression" on her. He gave a speech about how the assembly was a place where he did not have to check any of his identities at the door. A year later, she emailed him when she was "feeling a bit out of place at the whitest campus in all of the University of California," that is, Santa Cruz. He called her, encouraging her to complete her graduate studies, which she did. "He told me I could do it."[25]

Neil deGrasse Tyson not only inspired younger African Americans at the meetings of the National Society of Black Physicists. He himself also found solidarity at the organization. At an earlier meeting of the NSPB in 2000, he and other attendees shared stories about encounters they had had with the police. "Among my other stories, I had been stopped by campus police while transporting my home supply of physics textbooks into my newly assigned office in graduate school," he recounted. Over two or three hours, the other delegates told of similar incidents. "We were guilty not of DWI (Driving While Intoxicated), but of other violations none of us knew were on the books: DWB (Driving While Black), WWB (Walking While Black), and of course, JBB (Just Being Black)."[26]

The common experience of racial oppression contributed to cohesion among members of the National Society of Black Physicists. "The truth is that Black academics (Blackademics) usually know what's up with Black people in departments across campus, even when they hate each other," claimed Prescod-Weinstein in an article in *Scientific American* in 2018. "It's also the case that Blackademics are often loath to air our dislike of each other in front of white people. We know that the bar for being seen as 'good' is higher for us than others, and we tend to be forgiving of people who may not be our favorites." Nevertheless, the accusations of sexual

[24] Prescod-Weinstein (2015).

[25] Prescod-Weinstein (2016).

[26] Tyson (2020).

misconduct against Tyson also made her reflect about tensions within her community. Without wanting to rush to judgement on the specific case of her role model, she stated: "Black patriarchy is real and the harm specifically to Black women is significant." She recalled that at another conference, she and other black women academics had discussed "another unfortunately common experience: each of us had been sexually harassed and/or assaulted by a fellow Black male academic."[27]

What facilitated the creation of solidarity was the holding of NSBP meetings at institutions with many African American students. The 2003 assembly, where Prescod-Weinstein had first met Tyson, was hosted by Spelman College in Atlanta, Georgia. The gathering held 3 years prior had been at the North Carolina Agricultural and Technical (A&T) State University. Like many activities of the Task Group on Education in Astronomy, the NSBP had, indeed, long been centered on historically black colleges. Formally established at Morgan State University in Baltimore in 1977, the society had emerged out of lectures and award ceremonies during the preceding years. Morehouse College in Atlanta had hosted meetings on "Physics in the Black Colleges" and "Pre-Graduate Preparation of Minority Students in Physics."[28] At gala dinners at Fisk and Howard universities, senior scientists were recognized for their "distinguished service to physics and society" and for their enrichment of the "black experience."[29]

Besides minority-serving colleges, the National Society of Black Physicists had a strong foothold in national laboratories. These facilities were not only a major employer of scientists, but, as federal institutions, also had to show special commitment to equal opportunities. One of the founders of the NSBP was Walter Massey, who in 1979 became the first African American director of the Argonne National Laboratory outside of Chicago. Another pioneering officer of the society was James Davenport of Virginia State University.[30] He coordinated summer programs for minority students at the Fermi National Accelerator Laboratory (Fermilab), also near the Windy City.[31]

Funded first by the US Atomic Energy Commission and later the Department of Energy, the national laboratories had budgets of a different order of magnitude than those of many colleges. They could thus easily support events for underrepresented groups. In 1974, Fermilab sponsored a "Conference on Minority Physics."[32] Seven years later, it hosted the eighth annual day of lectures of the National Society of Black Physicists. Walter Massey delivered a banquet address, and scientists from NASA and other institutions gave talks on topics ranging from high-energy

[27] Prescod-Weinstein (2018).

[28] Davenport (1999), 7

[29] Mickens (2002), 111.

[30] Mickens (2002), 112.

[31] Fermi National Accelerator Laboratory (1974a).

[32] Fermi National Accelerator Laboratory (1974b).

astrophysics to semiconductors. Ninety students from high schools in the Chicago area also attended.[33]

Over the following decades, further federal organizations came to fund NSBP events. The 1990 meeting was sponsored by Lawrence Livermore National Laboratory in California, NASA, and the Office of Naval Research.[34] The latter belonged to the Department of the Navy, which had been one of the first desegregated sections of the US federal government. Held at Southern University in Louisiana, the 1990 conference again covered astronomical topics, such as black holes. Charles McGruder of Western Kentucky University lectured on a quasar's jet, for instance.[35] In 1998, the annual NSBP meeting was held jointly with the National Conference of Black Physics Students. The combined event, held at the University of Kentucky, attracted additional sponsorship from the National Science Foundation and Oak Ridge National Laboratory in Tennessee.[36]

Although organizations like the Department of Energy or the Office of Naval Research were tasked with preserving national security, NSBP conferences were far from secret gatherings. Findings were not classified, and the events had international participants as well, including scientists from Africa. McGruder's paper at the 1990 meeting was co-authored by Chidi Akujor of the University of Nigeria, where he had previously worked.[37] The Lawrence Livermore National Laboratory hosted Francis Allotey of the University of Science and Technology in Ghana as a special guest. At a banquet address, he conveyed "warm and fraternal felicitations from Africa." As founding president of the Society of African Physicists and Mathematicians, he asked for help from black Americans as his "brothers and sisters." Because foreign currency was scarce in countries like Ghana, he expressed the need for an American foundation to aid research and development on his continent. "I hope there will be generous contribution from all African Americans and others."[38]

Most individual scientists of the African diaspora lacked the resources for large philanthropy. Many did have an interest in, and affection for, their cultures of origin, however. Jarita Holbrook, a postdoctoral researcher at the University of California, Los Angeles, delivered a paper on "African Astronomy" at the 1998 meeting of the NSBP.[39] Present at the same event was Hakeem Oluseyi, a graduate student of Art Walker at Stanford University.[40] Born in New Orleans as James Plummer, he had recently changed his name in order to show his connection to Africa. Hakeem was Arabic for "wise," and Oluseyi was Yoruba for "God has done this."[41] Neil deGrasse

[33] Fermi National Accelerator Laboratory (1981). *Physics Today* (1982).

[34] Reed (1990), iv.

[35] McGruder and Akujor (1990).

[36] MacKellar (1998).

[37] McGruder and Akujor (1990).

[38] Allotey (1990).

[39] Holbrook (1998).

[40] MacKellar (1998), 223.

[41] Maya Jones (2016).

Tyson did not go quite as far in embracing his African roots. However, as a science communicator, he did respond to questions from the public about African cultural astronomy. He once received a query from a high school teacher "concerning the Dogon's prediction of the star Sirius being a binary star before its confirmation via telescope." Tyson explained that "Sirius, the brightest in the nighttime sky, was important to the Dogon tribe of Mali in West Africa, and to other cultures as well, including the ancient Egyptians." However, he cautioned that "without the assistance of technology, it is physically impossible for the human eye to see the binary companion star to Sirius." Supposing otherwise would carry "Afrocentrism further than the data warrant."[42]

Concerned with science development in Africa, members of the National Society of Black Physicists gained further institutional support for exchange with their peers on the continent. In 1988, the International Centre for Theoretical Physics (ICTP) in Italy hosted the first "Edward Bouchet International Conference on Physics and Technology." It was named after a physicist known to be the first African American to earn a PhD from any university in the United States. This event gave rise to the Edward A. Bouchet-ICTP Institute with meetings in the US and different African countries. It was later renamed the Edward Bouchet Abdus Salam Institute, as the ICTP itself became the Abdus Salam International Centre for Theoretical Physics. Charles McGruder participated in one of the Institute's gatherings in Atlanta in 1992, which was again sponsored by the Office of Naval Research. He chaired a discussion with points such as the following: "Pressure must be exerted on the National Science Foundation to put funds into its Sub-Sahara Program."[43]

Compared with institutes for theoretical physics, large telescopes usually required greater financial commitment. This did not discourage scientists from both sides of the Atlantic Ocean to plan new observatories. The end of apartheid in South Africa offered opportunities for development and the involvement of blacks in all aspects of research. The new government identified astrophysics as a key area of further scientific and technological investment, seeking to capitalize on existing infrastructure and clear skies. The South African Astronomical Observatory had a 1.9-m telescope and other instruments in the arid and elevated area near the town of Sutherland. It was keen to add to them the Southern African Large Telescope (SALT) with a mirror about five times as big. African American scientists were equally enthusiastic to be part of post-apartheid projects. Charles McGruder, then president of the NSBP, won funding from the National Science Foundation for a "US-South Africa Planning Visit in Astronomy" in 2001.[44]

In order to maximize the use of facilities like SALT, the South African scientists needed not just foreign partners, but also more homegrown talent. Patricia Whitelock of the South African Astronomical Observatory noted that the planning process had identified "identified the lack of appropriately qualified local scientists, particularly

[42] Tyson (2019), 42–45.

[43] McGruder (1992).

[44] McGruder (2001).

black scientists, as the single biggest threat to the future of astronomy in South Africa, as well as to the country at large."[45] Originally from Britain, Whitelock herself had long been part of activist circles fighting for South Africa's black majority. During apartheid, she had participated in various protests and supported political prisoners.[46] Under democracy, she wanted to expand access to astronomy education for poorer blacks. The University of Cape Town thus hosted a National Astrophysics and Space Science Programme (NASSP) to take students through honors and graduate education. Thanks to the support of the Ford Foundation and other organizations, the program provided what Whitelock called "realistic bursaries." She explained that these were "a crucial factor when poverty is commonplace among the families of many prospective students."[47]

Starting in 2003, the National Astrophysics and Space Science Programme produced dozens of graduates from South Africa and neighboring countries within a few years. Twenty-seven percent were women, including some of the top students. "Obviously we aim for more," Whitelock noted in 2009, "but this is better than any of the other mathematical or physical sciences in South Africa." Yet, she complained that NASSP attracted "too few" black South Africans and that too many of those failed or dropped out. She attributed this to the legacy of the apartheid education system. Only a tiny fraction of black children had the qualifications to study subjects like physics. Most of those who did opted for actuarial science, medicine or engineering, which offered more predictable incomes and career paths.[48]

In order to provide black South Africans with additional support, the University of Cape Town launched an extended honours programme (EHP) in 2008. It sought to admit only "previously disadvantaged" South Africans. These were black students who either attended historically non-white universities or who had received low grades at white ones. Recruitment took place at a winter school at the South African Astronomical Observatory that allowed researchers to judge the students' commitment. The EHP covered physics, mathematics, computational methods, English language and introductory astronomy. After passing through it, the students would continue their studies within the National Astrophysics and Space Science Programme.[49]

While the National Astrophysics and Space Science Programme was based in South Africa, support from the United States was crucial. In the early 2000s, $175,000 from the Ford Foundation made the NASSP possible in the first place.[50] In 2007, the W. K. Kellogg Foundation awarded over $355,000 to the US National Society of Black Physicists to enable their members to serve as teachers and

[45] Whitelock (2004), 55.
[46] Whitelock (2022), 166.
[47] Whitelock (2004), 55–56.
[48] Whitelock (2009), 11–12.
[49] Whitelock (2009), 12.
[50] Whitelock (2020).

mentors for the NASSP.[51] This allowed Charles McGruder, Hakeem Oluseyi and others to travel to South Africa repeatedly over 6 years. Whitelock stressed that the "participation of African Americans lecturers in the EHP has been important in demonstrating to the students that it is possible for black people to succeed despite backgrounds of poverty and disadvantage."[52]

Initially, bridging the cultural gap for the visiting American scientists was not as easy as flying across the Atlantic. "At first, my South African students didn't identify with me at all," Oluseyi later recounted. "To them, I was an affluent American astrophysicist and professor. They had grown up in poor Black townships and villages." However, he was able to share with him his own struggles to overcome feelings of inferiority and gain the acceptance of fellow academics in white-dominated institutions. He then went on to teach cosmology and quantum field theory, subjects that were considered the apex of physics. "Once they conquered the apex, they'd know they could learn anything – and they'd believe in their futures as scientists."[53]

Beyond teaching the science that was prized in the Western academy, African American visitors learned about indigenous knowledge. One of the NSBP members who went furthest in studying African astronomical traditions was Jarita Holbrook. Although her doctoral dissertation was on star formation, she quickly became more interested in ethnography and the history of science. In 1998, she began a study of contemporary stellar navigators in Tunisia and Eritrea. Subsequently, she collaborated with Johnson Urama of the University of Nigeria and Thebe Medupe of the South African Astronomical Observatory. Together, they researched the influence of Islamic astronomy on West African cultures.

For Holbrook, studying African traditions was also about diversifying the discipline in which she had been trained. "Astronomy lacks gender and ethnic diversity," she argued, "which is reflected in both the history of astronomy and the way that astronomy is presented." Non-Western cosmologies were often excluded, because they were considered "non-scientific." However, ethnoastronomy showed how the night sky had inspired art that was culturally and locally unique. Even in the West, knowledge of the sky reached beyond astronomers into the worlds of science fiction authors and filmmakers. She concluded an article from 2008 with the statement that "ethnoastronomy brings diversity to astronomy in that the astronomy knowledge of people of color, women, and non-scientists are included."[54]

Holbrook identified diversity not just as a goal of her investigations. Her fluency in this discourse arguably also helped her gain funding in the first place. In 2004, she won a grant of around $10,000 from the National Science Foundation for a planning visit to strengthen her collaboration with Johnson Urama and Thebe Medupe. "The project team is gender diverse, and includes both African and African American

[51] W.K. Kellogg Foundation (2007), 67.

[52] Whitelock (2009),12.

[53] Oluseyi and Horwitz (2021), 341.

[54] Holbrook (2008).

researchers, as well as junior faculty," her abstract explained.[55] Five years later, she received about $23,000 for a workshop on Arabic astronomical documents found in Africa. Under "broader impacts," she specified that the conference comprised "junior faculty and students from the USA, which include women and underrepresented minorities in STEM fields."[56]

Some elements of this diversity discourse were specific to the United States, where blacks were a demographic minority. Holbrook's African collaborators often used different expressions. Yet, they shared her passion for promoting a variety of astronomical knowledge. "During apartheid," Medupe said, "we were told that Africans have never been interested in science, and certainly not astronomy."[57] He himself was one of the first blacks to earn a doctorate in the discipline from the University of Cape Town. However, he was determined to show that he had predecessors. He thus collaborated with filmmakers on a documentary about traditional star lore. Released under the title *Cosmic Africa* in 2003, it was screened in South African theaters and at US festivals.[58]

In *Cosmic Africa*, Medupe tried to reconcile the astronomy he learned with the one of his ancestors. He declared his mission at the beginning of the film: "I need to discover whether my science has a place in Africa, and whether Africa has a place in my science." His journey took him to the Ju'hoansi in Namibia, the Dogon in Mali, and the site of an ancient Egyptian observatory. During his visits, he learned about how traditional calendars have been used in agriculture and mythical stories told about the heavens. "For the first time I see how the stars affect the way people live," the astrophysicist noted. "My science and my Africa are beginning to come together." In the Egyptian desert, he sees an assembly of stones used for tracing the movement of the sun. "The origin of astronomy, its measuring and predicting, is in Africa," he commented. "Stones took the place that my computer takes now."[59]

The attempt to connect modern astronomy to traditional knowledge of the sky also met skepticism. In 2004, Kai Horsthemke, a German philosopher at the University of the Witwatersrand, reviewed *Cosmic Africa* in an article on misconceptions of indigenous knowledge. He called it "unfortunate" that Medupe and his collaborators "never explore any of the tensions between traditional, indigenous and scientific world views." In trying to unite his Africa with his science, Medupe failed to "account for the contradictions he has encountered between spirituality and astronomy."[60] In another paper from 2008, Horsthemke criticized the documentary again and argued against the concepts of "ethnoastronomy" and "indigenous science." In his view, practices and beliefs could be "indigenous," but not science or

[55] Holbrook and Brown (2004).

[56] Holbrook (2009).

[57] Bohannon (2004).

[58] Abraham (2005).

[59] Horsthemke (2004), 40–41.

[60] Horsthemke (2004), 41.

knowledge per se.[61] He continued this line of thinking in a further piece on the idea of "epistemological diversity" from 2017. The view that ethnic groups had distinctive "epistemologies" or ways of knowing was "unhelpful" and "misleading," argued the German scholar.[62]

The application of the label "science" to African traditions met with hostility not just from a philosopher, but also from physical scientists. In 2006, Jarita Holbrook led the organization of a meeting on "African Cultural Astronomy" in Ghana, which coincided with a total solar eclipse. Urama and Medupe joined her for this event, as did Hakeem Oluseyi. Yet, she also encountered what she called a "splinter group" of the Edward Bouchet Abdus Salam Institute that was keen on "boundary maintenance" between "pure" and "impure" science. This group was spearheaded by Kennedy Reed of the Lawrence Livermore National Laboratory, himself a previous president of the National Society of Black Physicists. Holbrook and Oluseyi complained that their peers disrupted their sessions and took over communications infrastructure for their own coverage of the eclipse. The cultural astronomers had planned a broadcast that included interviews with local fishermen about their knowledge of the sky. Yet, they were prevented from transmitting it at the time of the eclipse, as their competitors used the available satellite connection for a more sanitized portrayal of the astronomical event. In Holbrook and Oluseyi's words, Reed had "internalised the physical science lesson of shunning what cannot be empirically proven."[63]

For Holbrook, her experience in Ghana in 2006 was not an isolated event, but part of wider "science wars." She and Oluseyi wrote that many of their American colleagues had the "the perception that social scientific and humanistic research is not real science." Methods of data collection in these disciplines were seen as "suspect, unreliable and not replicable."[64] Holbrook had thus long struggled to get recognition for her investigations of African traditions. "Since I moved into cultural astronomy, I have lived the life of an interdisciplinary scholar in the margins," she noted in an NSBP blog in 2010. Condescending responses by other scientists pushed her to seek external funding in order to be taken seriously. However, she found her choices consistent with those of others like herself. "Women and minorities tend to find success at the margins of STEM disciplines rather than in the mainstream," she wrote. While she frequently switched employers, she enjoyed "intellectual freedom."[65]

Despite tensions over epistemological diversity, many black astronomers expressed a strong desire for pan-African unity. At a meeting of the Edward Bouchet Abdus Salam Institute in Cape Town in 2008, several scientists resolved to form the African Physical Society (AfPS). They thus effectively relaunched Francis Allotey's

[61] Horsthemke (2008).

[62] Horsthemke (2017), 262.

[63] Holbrook et al. (2012), 777, 779–80.

[64] Holbrook et al. (2012), 777, 780.

[65] Holbrook (2010).

Society of African Physicists and Mathematicians. At its formal inauguration in Dakar, Senegal, in 2010, a number of academics agreed to establish a parallel African Astronomical Society (AfAS). The National Society of Black Physicists provided financial and logistical support, and Hakeem Oluseyi was elected the new association's first president.[66] As an American, he had the benefit of being an outsider to the continent and perceived to be neutral amidst regional rivalries.

In spite of her challenges with the broadcast of the eclipse over Ghana, Holbrook continued the use of video to document the work of scientists like Oluseyi. She aimed to promote them as role models for black children in particular. She co-produced a documentary entitled *Hubble's Diverse* Universe, which came out in 2009. It portrayed African and Hispanic American astrophysicists, including Oluseyi and McGruder, as they discussed the role of the Hubble Space Telescope in their research. In 2012, she filmed Oluseyi again for *Black Suns*, as he followed another solar eclipse. She promised the National Science Foundation, which awarded her about $23,000, that "the broader impacts goal is to increase minority participation in STEM fields." In addition to submitting *Black Suns* to festivals, she partnered with minority-serving institutions for screenings.[67]

Building Bridges

Due to decades of efforts by organizations like the National Society of Black Physicists, the number of African American members of the American Astronomical Society significantly increased as well. By the time Frank Shu, himself a Chinese-American, served as AAS president in the mid-1990s, a large-enough pool had been created for a standing organ on minorities. At the same time, the Committee on the Status of Women in Astronomy was reluctant to take on the concerns of other groups. "We feel that this expansion could become too broad for a single committee," wrote CSWA chair Debra Elmegreen in 1995. She added that "there is a growing need for a separate minority committee." The CSWA suggested the formation of such an organ to the AAS Council.[68]

In 1997, the Committee on the Status of Minorities in Astronomy began its work with Art Walker and Charles McGruder as members. Ben Peery of Howard University, another veteran member of the NSBP, joined a few years later. The first chair of the committee, however, was another scientist in the San Francisco Bay Area: Geoff Marcy's friend and collaborator Gibor Basri.[69] He had been a former classmate of Sally Ride's at Stanford University. Subsequently, he had become a professor at the University of California, Berkeley. Like Chanda Prescod-Weinstein,

[66] McGruder et al. (2011).

[67] Dave and Holbrook (2012).

[68] Elmegreen (1995).

[69] American Astronomical Society (1998).

he was both black and Jewish. His mother was from Jamaica, and his father from Iraq – his last name meaning "of Basra."[70] In collaboration with McGruder, whom he had met through the NSBP, Basri was also involved in developing astronomy in post-Apartheid South Africa. In addition to visiting townships and schools, he helped with the planning of the Southern African Large Telescope. However, in other ways, he had a unique trajectory that had taken him beyond America and Africa already early in his life.

While being the child of immigrants, Gibor Basri was also part of the middle class. His father, Saul Basri, had studied at a Jesuit school in Baghdad before earning a degree in physics at the Massachusetts Institute of Technology. For his graduate studies, Saul had moved to Columbia University and met his future wife, Phyllis Whyte, at New York's International House. Saul subsequently taught physics at Colorado State University, and Phyllis gave lessons in ballet and other dances. Giving the young Gibor experiences abroad as well, he participated as a lecturer in the Fulbright Program and took his family to Burma and Ceylon. In the country that would later be renamed Sri Lanka, the teenage Gibor met the British science fiction writer Arthur C. Clarke. The latter was then collaborating with Stanley Kubrick on the film *2001: A Space Odyssey*.[71]

In the years after the Civil Rights Act of 1964, Gibor Basri benefitted not just from having Ivy League–educated parents, but also from programs to support African Americans. After winning a National Achievement Scholarship, he received numerous solicitations, about three a day during his senior year in high school: "Please apply to our college." Helping him choose, his father recommended the California Institute of Technology for physics. "No thanks," said Gibor to what he called an "all boys' school." He thus went to Stanford instead. He subsequently returned to Colorado for his doctorate, only to come back to the San Francisco Bay Area once more. The newly created Chancellor's Postdoctoral Fellowship Program, which aimed at minority scholars, provided him with a road to a faculty position at Berkeley.[72]

Berkeley also provided Basri with resources for pioneering research. His university was involved in the construction of the Keck telescopes on Mauna Kea in Hawaii. Upon completion during the 1990s, they were the largest in the world, with ten-meter-aperture primary mirrors. Basri used these instruments to discover brown dwarfs, a new class of astronomical objects bigger than planets and smaller than stars. He later described this research as the "highlight" of his astrophysical career.[73] Together with the detection of the first exoplanets, in which his colleague and friend Geoff Marcy was involved, Basri's discovery also contributed to a broader debate

[70] Basri (2011).

[71] Basri (2011).

[72] Basri (2011).

[73] Basri (2014).

about the classification of substellar objects. Various definitions of "planets" were proposed, and not even the astronomers at Berkeley agreed with one another.[74]

Distinguishing a planet from a brown dwarf or asteroid was for many people a matter of wider social significance. "We live on a planet," Basri said, "it would be nice to know what that was." Marcy, for his part, wanted to avoid locking astronomers into a taxonomy that could soon be challenged by more discoveries of exoplanets. Nevertheless, he did not escape questions of definition either. In 2001, talk show host David Letterman quizzed him about an object seventeen times the mass of Jupiter. "We don't know what to call it," Marcy admitted. "Is it a planet? Is it a star?" Letterman asked, "Well, what the hell are we going to do?" The astronomer confessed, "We're screwed." His host quipped, "Run for your life, everybody."[75] At the other end of the scale were worlds that appeared tiny in comparison. Scientists argued about whether to keep Pluto as a planet after the discovery of similar bodies beyond the orbit of Neptune, notably Eris. Basri was in favor, but the General Assembly of the International Astronomical Union in Prague voted against it in 2006. Pluto was downgraded to a dwarf planet, an object of planetary mass that failed to dominate its region of space.

The controversy over whether Pluto should be called a planet also transcended the astronomical community. "The Plutocracy, as I like to call it, is greater than we want to admit to ourselves," joked Neil deGrasse Tyson of the American Museum of Natural History. When he lumped Pluto together with comets at the edge of the solar system for an exhibit back in 2000, it was already controversial. "I still have folders of hate mail from third-graders," he said 5 years later.[76] Even after the IAU vote, Tyson's relationship to the planet caused trouble. One of the sexual harassment accusations he faced surrounded an alleged incident at a meeting of the American Astronomical Society in 2009. Fellow scientist Katelyn Allers claimed that he had been examining her tattoo of the solar system, putting his hand under her dress and saying that he was looking for Pluto. Tyson commented on the allegation: "While I don't explicitly remember searching for Pluto at the top of her shoulder, it is surely something I would have done in that situation." He added, "I have professional history with the demotion of Pluto, which had occurred officially just three years earlier. So whether people include it or not in their tattoos is of great interest to me."[77]

Although well-known for his discoveries, Gibor Basri was nowhere near as exposed to accusations as a public figure like Tyson. Nevertheless, controversies over planetary definitions also hardened the Berkeley astronomer for the debates over diversity in which he increasingly became involved. He and others at his university found social inequality a more challenging topic than their research. "People say, 'I'm not a rocket scientist,'" Basri said. "Well, rocket scientists have it easy compared to this subject." Robert Birgeneau, a fellow physicist and former

[74] Sanders (2003).

[75] Sanders (2003).

[76] Roberts (2005).

[77] Harris (2019).

chancellor of Berkeley, agreed. "For people who are nonscientists, physics is the most difficult, most complicated thing that you'd stay as far away from as possible," he said. "Actually, from my point of view, compared to complicated human interaction, physics is pretty simple."[78]

As one of few African American faculty members in the physical sciences, Basri became quickly overburdened with professional and community service. Within the University of California, he served on review committees for scholarships and postdoctoral fellowships. Outside the walls of this institution, he spent much time on outreach initiatives in neighboring Oakland. These activities left him with relatively little time for the AAS Committee on the Status of Minorities in Astronomy. "This year ended up as one of relatively little action, which is disappointing," he reported in 2000. By then, his group had mostly focused on surveying astronomers and building a website. He added, "It is crucial that at least one activist member be found for the Committee."[79]

Among his many duties, Basri ultimately focused on efforts within the University of California. Between 2003 and 2006, he served on the University Committee on Affirmative Action and Diversity as well as on the President's Taskforce on Faculty Diversity. He further helped launch the Berkeley Diversity Research Initiative and a campus diversity website. All this work culminated in him becoming Berkeley's first vice chancellor for equity and inclusion in 2007 (Fig. 4.1). The division that he led quickly grew to over dozens of employees and a budget of millions of dollars. It was large enough to become the target of much criticism. An article in *California*

Fig. 4.1 Gibor Basri as vice chancellor for equity and inclusion at the University of California, Berkeley. (Courtesy of Gibor Basri)

[78] Dinolfo (2014).

[79] American Astronomical Society (2000), 910.

Patriot, a student-run magazine, called Basri the "lord of equity and inclusion" who favored "political correctness" over "free speech."[80] In the *National Review*, Heather Mac Donald, a conservative commentator, described Berkeley's "diversity apparatus" as "utterly typical" of American colleges. "The Big Lie of the campus diversity industry," she argued, "has been that without constant monitoring by diversity bureaucrats, faculty and other administrators would discriminate against minority and female professors and students."[81]

Despite heading a large team, Basri encountered almost insurmountable obstacles in his efforts to promote African Americans on campus. Back in the 1990s, in compliance with an amendment to the state's constitution known as Proposition 209, the University of California had formally abolished race-based preferences in admissions, hiring and contracting. Tuition fees had risen since, in part to make up for a lack of public funds and in part to pay for large administrative divisions – as Basri's critics were quick to point out. As the Bay Area with its many technology companies boomed economically, cities like Berkeley became gentrified. This drained their black population and culture. With the number of African American students on campus dropping, the remaining ones assessed the climate as "quite poor," he found.[82]

Although Basri earned a high salary as a senior academic administrator and full professor, he did not escape some of the experiences of poorer blacks either. One day, he was cleaning the flowerpots on his home's balcony not far from campus. Suddenly, two police cars pulled up and officers ran into the yard pointing guns. When Basri's wife opened the door, they offered to rush her to safety from a burglary. She looked up and said, "Oh, that's my husband." The police were embarrassed and explained that they had been alerted about something strange going on. "Something strange was happening," she quipped, "It's very unusual when my husband does any household chores." Basri himself later commented about the incident: "It is hard for someone who has not experienced a sense of pervasive negative stereotyping based on appearance alone to appreciate how incredibly wearing it can be."[83]

While Basri struggled on numerous fronts at Berkeley, one of his students and protégés named Keivan Stassun revitalized the Committee on the Status of Minorities in Astronomy. Stassun likewise had family roots in both the Americas and the Middle East. His mother was Mexican, and his father Iranian. Fitting for a future astronomer, his first name, Keivan, meant "Saturn" in Persian. His class background was very different to Basri's, however. His father had left the family when he was an infant. His mother, who had first crossed the border to the United States at the age of twenty, worked as a cleaner in Los Angeles and subsisted on food stamps and welfare. Studying late into the night for her high school equivalency and her

[80] Lincoln (2012).

[81] Mac Donald (2011).

[82] Williams (2015).

[83] Evans (2015).

American citizenship, she inspired Keivan in his academic drive. After attending a school for gifted children, he became a Chancellor's Scholar at Berkeley. Advised by Basri, he wrote a thesis on T Tauri stars and graduated with honors in 1994.[84]

From Berkeley, Stassun moved to the University of Wisconsin for doctoral research in astronomy. Although he kept his eyes on the stars, he did not forget his humble origins. In 2000, he completed a dissertation with a very complex title: "A Test of Star Formation Theory: The Connection between Rotation, Accretion, and Circumstellar Disks Among Low-Mass Pre-Main Sequence Stars." On the acknowledgements page, he expressed regrets over his text's lack of accessibility. "It seems somewhat perverse to dedicate to my mother (who has struggled with the English language for over thirty years) a document too abstract even for most native English speakers to understand," he reflected. "And it seems almost comical to dedicate to my father (who made his livelihood beautifying trees) so much pulp covered with gobbledygook." Nonetheless, Stassun retained an identity that was broader than the specialist circles who were able to fully comprehend his research. "As a citizen, I have insisted on being an active participant in my community."[85]

Like his mentor Basri, Stassun thus dedicated himself to outreach. In 1998, during his graduate studies, he started "Scopes for Schools." This program provided teachers with resources and training in astronomy. After completing his dissertation, he stayed at Wisconsin as a postdoctoral fellow. During that time, he helped design and administer a K-Through-Infinity Professional Development Partnership. In 2003, he became an assistant professor at Vanderbilt University in Nashville, Tennessee. While this institution expected him to be a productive researcher, it also gave him freedom for other pursuits. "As a faculty member at a place like Vanderbilt, you're basically an entrepreneur," he said to me. "If you can build your brand successfully, then good for you, and if it makes the institution better in the process, great." Partnering with Nashville's historically black university, he promoted the Fisk-Vanderbilt NASA Roadshow, which brought an inflatable planetarium to schools. In its first year, he claimed, this initiative had reached more than 3000 students across Tennessee. Sixty percent of them were of "under-represented minority backgrounds."[86]

Alongside his various outreach programs, Stassun took over the leadership of the Committee on the Status of Minorities in Astronomy. First appointed to this group in 2000, he hosted its first website and edited its newsletter *Spectrum.* Subtitled *A Report on Underrepresented Minorities in Astronomy*, it mirrored the longstanding *Status* publication by the Committee on the Status of Women in Astronomy.[87] In the second issue from 2002, he highlighted the "important role" played by minority-serving institutions in preparing future astronomers. They included historically black, Hispanic-serving and tribal colleges. Though they rarely awarded doctorates

[84] Stassun (2020a).

[85] Stassun (2000), ii.

[86] Stassun (2005), 27.

[87] Stassun (2002a).

in the physical sciences, they educated many members of minorities to the level of bachelor or master's degrees.[88]

Being based in Nashville, Stassun had the advantage of proximity to Fisk University as a venerable minority-serving institution. Ronald Mickens, a founding member of the Edward A. Bouchet-ICTP Institute, had done his undergraduate studies at Fisk and his graduate work at Vanderbilt during the 1960s. Four decades later, Stassun institutionalized such a transition through the Fisk-Vanderbilt Master's-to-PhD Bridge Program. Supported by the National Science Foundation, the initiative provided students with a predictable path towards a doctorate. Minority students were actively recruited in collaboration with the NSBP and the National Society of Hispanic Physicists, which had been established in 1996.[89] By the early 2010s, the program had become one of the top producers of African American graduate-degree holders in the physical sciences.[90]

The Fisk-Vanderbilt Master's-to-PhD Bridge Program boasted not just large numbers of graduates, but also high retention rates. Stassun attributed this success to a nurturing environment as well as to a holistic evaluation of student abilities. He argued that standardized tests, like the Graduate Record Examinations (GRE), were unable to detect grit or the strength of an individual's character. "The GRE can't read traits like perseverance, experience with failure, working through adversity, and communication and networking skills," he said. However, these were what got people through a PhD program.[91] Moreover, quantitative GRE scores seemed to favor white and Asian men. For that reason, Stassun disregarded the test for admission to his program.[92] To measure a candidate's grit, he interviewed candidates about their interest in science, their fears, past obstacles and how they had overcome them.

Although Stassun was not black himself, he collaborated with Charles McGruder and others in building bridges to Africa. Together with Patricia Whitelock of the South African Astronomical Observatory, he initiated a Vanderbilt-Cape Town Partnership. In 2007, they held a planning meeting in that city, which Thebe Medupe also attended. With a new telescope at Sutherland, they intended to search for Earth-like planets outside our solar system. In addition, they sought to study transient phenomena, such as binary stars and supernovae. Another part of their plan were student exchanges involving both the Fisk-Vanderbilt Master's-to-PhD Bridge Program and the National Astrophysics and Space Science Programme.[93]

Whereas Gibor Basri had used the enormous Keck telescopes in Hawaii, his protégé went the other way in terms of instrument size. At the center of Stassun's collaboration with his South African partners was the Kilodegree Extremely Little

[88] Stassun (2002b).

[89] Stassun (2005), 26.

[90] Stassun et al. (2011)

[91] Szrom (2015).

[92] Stassun (2013).

[93] Vanderbilt University (2007).

Telescope (KELT). Observatories with large mirrors were usually designed to produce high-resolution images of faint objects in small sections of the sky. KELT, in contrast, measured the light coming from millions of bright stars at once without looking at any of them in detail. Regular dimming could be a sign of an exoplanet crossing in front of the star. Two stations, KELT-North in Arizona and KELT-South in Sutherland, enabled the astronomers to hunt for other worlds from both hemispheres. The Fisk-Vanderbilt program was then also a way to train students to crunch the incoming data. Their task was to pick out whether variations in a star's brightness were due to the transits of an extrasolar planet or clouds on Earth. In order to gain additional support for such activities, Stassun started the Vanderbilt Initiative in Data-intensive Astrophysics (VIDA) in 2007.

Beyond contributing to specific areas of research, like exoplanets, Stassun's creation of VIDA was about participating in a transformation of his entire discipline. "For over two hundred years, the usual mode of carrying out astronomical research has been that of a single astronomer or small group of astronomers performing observations of a small number of objects," he wrote. "This traditional approach is now undergoing a dramatic and very rapid change, driven by a revolution – in telescope and detector technology, in computing power and cyber-infrastructure, and in information science." He imagined researchers from Fisk and the University of the Western Cape using large databases for statistical analysis and visualization.[94]

Intersecting Orbits

Through measures like dropping standardized tests as admissions requirements, the Fisk-Vanderbilt Master's-to-PhD Bridge Program came to accept many women of color in particular. However, the employment of many female scientists for number-crunching alone was far from revolutionary. Already a hundred years before Keivan Stassun's initiatives, women had participated in astronomy by drawing star maps, constructing catalogs and serving as "computers." The Harvard College Observatory under Harlow Shapley and previous male directors was especially known for offering skilled women employment at relatively low wages.[95] "These positions were less prestigious, and the women were not given equal status," Jarita Holbrook noted. Some of them "were not even considered astronomers." In the twenty-first century, she encountered clusters of Chinese women at American astronomy data centers. Although they held degrees from leading universities, they were often "stuck at the same level," moving from project to project without ascending in the hierarchy.[96]

Whether collaborations such as those between Fisk and Vanderbilt actually contributed to diversifying astrophysics was thus also linked to the extent to which they

[94] Stassun (2020b).

[95] Sobel (2016).

[96] Holbrook et al. (2018).

produced future leaders in the profession. One possible candidate was Fabienne Bastien, who had been born in Washington to Haitian parents. At the age of four, a bedtime story had provided her with the first inspiration to become an astronomer. Desperate to get her to sleep, her mother told her to look for her guardian angel in the sky outside her window. Books and the National Air and Space Museum provided further fascination. They led her to pursue a bachelor's degree in astronomy at the University of Maryland.[97]

Although Bastien completed her studies, she still had to overcome doubts about whether she could make it as a scientist. By the time she graduated in 2005, she had given up on her dream, thinking that she "just wasn't good enough." She drifted away from the subject, but then felt the pull again. "I even half-jokingly told myself that it was ok for me to be the worst astronomer in the world, as long as I was an astronomer." She started her way back into the field by volunteering at the University of Maryland Observatory. This led to a part-time job, then to a full-time research assistantship and ultimately to recruitment into the Fisk-Vanderbilt program.[98]

While Bastien did not excel at standardized tests, she impressed Stassun with her self-awareness and her determination to become an astronomer. He described her GRE score as "typical of her ethnicity and gender," but found her grit to be off the chart. "That's a person who will start graduate school way ahead of the game," he commented, "with all the resources and skills that go beyond smarts: self-discipline, organization, follow-through."[99] Her success soon proved him right. Even before she completed her doctorate in 2014, she published a paper in the journal *Nature*. Together with Stassun and Gibor Basri, she had found a correlation between stellar brightness variations and surface gravity.[100] Observing the flicker of a star thus allowed for a determination of its properties. This reminded Bastien's Danish colleague Jørgen Christensen-Dalsgaard of a popular rhyme: "Twinkle, twinkle little star, how I wonder what you are."[101]

Bastien's discovery earned much praise, but also raised questions about the social makeup of her discipline. In a blog post, John Johnson of Harvard University called her "the first Black female astronomer to ever publish a first-author *Nature* article." At the same time, he exclaimed, "why the hell is this record being set in 2013 and not 1985?!" He thus considered this achievement also a "commentary on the sad state of diversity (or the lack thereof) in astronomy." Harvard's astronomy department, he acknowledged, had just admitted its first black graduate student in about 30 years. He thus urged his fellow scientists to seek out and train "game-changers" like Bastien. "It behooves us all to increase inclusion so as to hasten our

[97] Bellovary (2016).

[98] Bellovary (2016).

[99] Powell (2013).

[100] Bastien et al. (2013).

[101] Christensen-Dalsgaard (2013), 405.

understanding of the Universe (more minds, more progress) and give back to the greater society."[102]

Although her profession was hardly welcoming of African Americans, Bastien herself had good chances on the academic job market. Johnson predicted that based on her "impressive publication record and standing," she would probably receive much consideration for positions. In 2013, she was invited to speak at the Harvard–Smithsonian Center for Astrophysics[103] The following year, she was offered three postdoctoral fellowships by NASA and the University of California, Berkeley. She thus had to decline two of them. She continued her studies of stellar flicker and, in 2019, became an assistant research professor at the Pennsylvania State University.

While Bastien stood out, she was not the only black female astronomer to come out of the Fisk-Vanderbilt partnership. Equally successful was Jedidah Isler. Growing up in Virginia Beach, she had shared with Bastien an early fascination with the sky. "I really just thought it was beautiful," she said, "and I remember feeling a sense of calm whenever I looked up."[104] Her family led a comfortable middle-class life until her father left, as she was about to start her college education. A full scholarship enabled her to earn a bachelor's degree in physics at Norfolk State University, another historically black institution. Through the American Physical Society, she found out about the Fisk-Vanderbilt program and became a member of its first cohort.[105] Like Bastien, Isler impressed professors with her grit. "She sees a goal and goes at it with a lot of energy and enthusiasm," said Kelly Holley-Bockelmann. "She's got that ability to persevere."[106]

Determined in her own ways, Isler completed her master's degree at Fisk without proceeding to pursue her doctorate at Vanderbilt. Instead, she moved to Yale University in Connecticut. Holley-Bockelmann took her to lunch and tried to convince her to stay in Nashville. However, she knew that she was in a losing battle when Isler walked into the restaurant wearing a Yale T-shirt. "When she made her decision, she went with our blessing, but we kept in touch in the intervening years," Stassun said. "There were times when I think she really turned to the community here for support."[107]

Yale challenged Isler not just academically, but also socially. During her first year, she and about a dozen fellow graduate students went to an all-you-can-eat sushi restaurant. At the end, a white male colleague handed her a pile of his dirty plates: "Here, now go and do what you're really here to do." She felt devastated, but did not know what to say. "If I get really mad, then I'm the angry black woman," she thought. "But if I give too much concession, then I'm sort of too conciliatory."[108] It

[102] John Johnson (2013).
[103] John Johnson (2013).
[104] Jenkins (2016).
[105] Mayol (2016).
[106] Jenkins (2016).
[107] Jenkins (2016).
[108] Haruch (2014).

took her years to get past this experience. Most of this time was spent ruminating about very different kinds of circular objects than the dishes she was told to wash, however. In 2014, she completed a dissertation about the connection between accretion disks and jets in blazars, a class of active galactic nuclei. She thus became the first black woman to earn a doctorate in astrophysics from Yale. Her co-director was Meg Urry. In addition to her, Isler thanked Keivan Stassun and others she had left behind in Nashville. "I count it an honor to be called your protégé," she wrote about her mentor. "Special, giddy acknowledgements to the rest my Bridge family. Love ya'll!"[109]

Having teachers like Stassun and Urry, Isler connected with other activists already as a student. In 2012, she participated in a conference in Washington on "Maximizing American Talent by Advancing Women of Color in Academia." Together with Hakeem Oluseyi and others, she co-authored a paper about astronomers like herself. "Women of color (WoC) are at the intersection of race and gender," the researchers noted. "While they experience issues that arise for both women and minority groups, they are often overlooked in efforts on behalf of either category." Isler and her peers complained that women of color were frequently excluded from committees and informal networking opportunities, such as social gatherings at professors' homes. As they applied for jobs, the special barriers they had to overcome were not recognized. When they persisted in their careers despite racism and sexism, they were often told that they had gained a certain position or award on account of being women or minority representatives. Such comments themselves were intended to diminish achievements and could be "cumulatively devastating over time."[110]

Isler, Oluseyi and their colleagues were not content with merely identifying barriers faced by women of color in astrophysics; they were also keen to put forward recommendations for overcoming them. In their view, deans, department heads, and search committee chairs should all be required to participate in diversity and cultural awareness training. "Fair hiring practices" that minimized implicit bias needed to be encouraged. The activists further suggested special rewards for mentors of women of color, the development of support groups, and statistical tracking. Although Isler herself had left the Fisk-Vanderbilt Master's-to-PhD Bridge Program, she also cited it as a resource for building "strong cohorts" of female graduate students of color.[111]

Even though the blazars Isler researched were far away from Earth, Isler used her science to make sense of her social position. In 2014, she published an essay in *Status* on "Planck's Law, Blackbodies and the Physics of Diversity." She explained that "persons with intersectional identities (e.g. Black women, Latina women, and those of mixed heritage) may not be sufficiently well-represented by a single parameter." A person like herself was "neither just Black or just a woman," in other words.

[109] Isler (2014a), iv–v.

[110] Norman et al. (2013), 160–61.

[111] Norman et al. (2013), 162–63.

"She is Black + woman, and the concerns, prejudices, stereotypes, disadvantages and advantages she faces are unique." In the framework of "sociophysics," multiple identity groups were therefore "analogous to multi-temperature blackbodies, like accretion disks, which require more parameters to characterize fully."[112]

Isler not only brought the social and physical sciences together, but also learned to explain both in layman's terms. Her dissertation itself bore the title "In Like a Lamb, Out Like a Lion." In 2015, a TED Fellowship provided her with an opportunity to explain blazars and intersectionality to broad audiences. One of her presentations was entitled "How I fell in love with quasars, blazars and our incredible universe." She described blazars, or blazing quasars, as supermassive black holes that were transporting "incredible amounts of energy throughout a galaxy."[113] She started another TED talk with the statement that "great things happen at intersections." Places like Times Square in New York were "bustling with the excitement of a seemingly endless stream of people." She further considered STEM an "intersectional term," in between science, technology, engineering, and mathematics. Women of color in STEM, she concluded, were "uniquely positioned" to drive conversations in ways that were more "inclusive of a wider variety of lived experience." They were thus the "untapped genius that could change science for the better."[114]

The online distribution of Isler's TED talks gave her a large following on social networking services, like Twitter. Yet, she still struggled to convince powerful conservatives. During a US Supreme Court case about a race-conscious university admissions program in 2015, Chief Justice John Roberts asked: "What unique perspective does a minority student bring to a physics class?" This was followed by: "I'm just wondering what the benefits of diversity are in that situation." Isler responded to the judge's questions in an opinion piece in the *New York Times*. "If we limit the physics classroom to white students," she argued, "we also limit the production of new information about the world." Yet, she rejected the idea that black students had to justify their presence at all. They could simply bring love and interest to the subject. They did not carry a responsibility for enriching the learning experience of their white peers.[115]

Isler continued her activism alongside her astrophysical research. She returned to Nashville in 2015 on a fellowship from the National Science Foundation. Four years later, she became an assistant professor at Dartmouth College in New Hampshire. Besides her work on blazars, she established the STEM en Route to Change (SeRCH) Foundation, an organization dedicated to social justice. Its signature program was "Vanguard: Conversations with Women of Color in STEM." Isler promoted it on social media using the hashtag #VanguardSTEM. Her vision behind this

[112] Isler (2014b), 17.

[113] Isler (2015a).

[114] Isler (2015b).

[115] Isler (2015c).

series of panel discussions was to "cultivate an empowered community" of scientists like herself who were advocating for their identities and interests.[116]

The impact of alumni of the Fisk-Vanderbilt Master's-to-PhD Bridge Program also elevated Keivan Stassun to national prominence. In 2014, he co-authored an article in *Nature* describing the success of his initiative. He noted that on average only about half the doctoral students at American universities successfully completed their degree programs. At Fisk-Vanderbilt, in contrast, more than 80% did. Simultaneously, participation by women and minorities was boosted. He thus called upon his colleagues to assess candidates' maturity, perseverance and adaptability through interviews. Too often, he argued again, admissions committees eliminated applicants based on standardized test results. Yet, he emphasized that "diversity, in the form of individuals with different perspectives, backgrounds and experiences, is a key component of innovation and problem solving." The lack of variety in most graduate programs therefore meant "slower progress in tackling today's scientific and technical challenges."[117]

Gaining further recognition from his work, Stassun was appointed to a Task Force on Diversity and Inclusion in Astronomy Graduate Education in 2017. Co-chaired by Stassun's former supervisor at Berkeley, Gibor Basri, the group was charged with identifying practices that would promote variety in numerous areas. They included "race and ethnicity, gender, LGBTIQA* status, disability status, neurodiversity, socioeconomic status." In its final report in 2019, the taskforce endorsed Fisk-Vanderbilt's "well-developed, proven system of holistic review" for applicants. "Leadership" could be demonstrated in interviews not just through experiences in academia, but also in one's family, community, religious group or athletics.[118]

The Task Force on Diversity and Inclusion in Astronomy Graduate Education thus called for the Fisk-Vanderbilt Master's-to-PhD Bridge Program to be replicated at other institutions. Basri's group recommended that astronomy departments should "partner with and recruit from undergraduate programs that produce large numbers of graduates from underrepresented groups." These were typically found at minority-serving institutions, including historically black and tribal colleges. Another goal was to design admissions criteria in a way to "broaden the definitions of excellence and merit." This involved the adoption of "holistic approaches."[119]

The Fisk-Vanderbilt partnership, indeed, quickly inspired similar programs. One of them was led by Alexander Rudolph, Basri's co-chair of the Task Force on Diversity and Inclusion in Astronomy Graduate Education. Rudolph was an astronomer at the California State Polytechnic University, Pomona. Located within Los Angeles County, Cal Poly Pomona had a large proportion of Hispanic students. Moreover, it was within a short distance of community colleges as well as major research universities in Southern California. This geography facilitated Cal-Bridge,

[116] Eddy (2017).

[117] Miller and Stassun (2014).

[118] Rudolph et al. (2019), 4, 14–15.

[119] Rudolph et al. (2019), 5.

a network led by Rudolph and funded by the National Science Foundation. In 2019, the astronomer reported in *Physics Today* that his "program has selected 59 scholars over the past 5 years. They include 34 Latinx, 7 African American, and 25 women students, with 15 of the women coming from underrepresented minority groups. Thus over 25% of Cal-Bridge scholars are women of color."[120]

As daunting as the establishment of partnerships with a historically black or Hispanic-serving college could be, such institutions were at least plentiful. Rudolph was hopeful that similar initiatives to the Nashville and California bridge programs would spring up elsewhere. He wrote that "numerous regions of the US have high concentrations of minority-serving and Hispanic-serving institutions." Those regions included the states of Texas, Florida and New York. He added, "Cal-Bridge leadership is prepared to help any such regional partnership get off the ground with technical and other support, including sharing materials we developed and lessons learned."[121]

If minority-serving colleges were readily available in some of the most populous regions of the United States, finding an equivalent university with a strong focus on disabled students was more challenging. Dedicated schools for blind or deaf students existed, but rarely at the tertiary level. Exceptions included Gallaudet University, an institution in Washington for the deaf and hard of hearing. In the late 1950s, then called Gallaudet College, it had provided eleven men with damaged inner ears to NASA for a study of the effects of weightlessness on the human body. It thereby contributed to the country's human spaceflight program.[122] In addition, Gallaudet was a center for deaf activists. In 1988, students organized a protest that led to the hiring of the first deaf president in the university's history.[123]

Nonetheless, institutions of higher education that were specifically devoted to people with disabilities were few and far between. Only a limited number of colleges comparable to Gallaudet existed in the United States and other countries. One of them was the National Technical Institute for the Deaf in Rochester, New York. It housed Jason Nordhaus, an astrophysicist fluent in American Sign Language. Among other initiatives, he led "AstroDance," a project that sought to teach hard-of-hearing students about black holes and neutron stars through multimedia performances.[124] Nonetheless, such work at the college level was still exceptional. Those interested in making astronomy accessible for the handicapped thus often had to go outside the realm of universities. A key site for engaging them were museums and planetariums. Many employees of such institutions saw diversity work as core elements of their job. For some of them, it was only a small step from education and outreach to activism.

[120] Rudolph (2019), 56.

[121] Rudolph (2019), 57.

[122] Hotovy (2017).

[123] Lang (1994), 137–38.

[124] Nordhaus et al. (2020).

References

Abraham, Curtis. 2005. "Under African Skies." *New Scientist* 185, no. 2482: 46–49.

Allotey, Francis K.A. 1990. "Banquet Address." In *Proceedings of the 17th Annual Day of Scientific Lectures and 13th Annual Meeting of the National Society of Black Physicists*, edited by Kennedy J. Reed, 177–84. Lawrence Livermore National Laboratory.

American Astronomical Society. 1998. "1997–1998 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 30: 947–74.

American Astronomical Society. 2000. "1999–2000 Annual Report of the American Astronomical Society." *Bulletin of the American Astronomical Society* 32: 887–916.

Basri, Gibor. 2011. Interview by Larry Crowe. The HistoryMakers Digital Archive.

Basri, Gibor. 2014. "The Discovery of the First Lithium Brown Dwarf: PPl 15." In *50 Years of Brown Dwarfs: From Prediction to Discovery to Forefront of Research*, edited by Viki Joergens, 51–79. Cham: Springer.

Bastien, Fabienne A., Keivan G. Stassun, Gibor Basri, and Joshua Pepper. 2013. "An Observational Correlation between Stellar Brightness Variations and Surface Gravity." *Nature* 500, no. 7463: 427–30.

Bellovary, Jillian. 2016. "Faculty Highlight: Fabienne Bastien." Astronomy in Color. http://astronomyincolor.blogspot.com/2016/08/faculty-highlight-fabienne-bastien.html.

Bishop, J. E. 2002. "Pre-College Astronomy Education in the United States in the Twentieth Century." In *Information Handling in Astronomy – Historical Vistas*, edited by André Heck, 207–231. Dordrecht: Kluwer Academic Publishers.

Bohannon, John. 2004. "South Africa's Own Shooting Star." *Science.* https://www.sciencemag.org/careers/2004/04/south-africa-s-own-shooting-star.

Bok, Bart J. 1973. "The State of Astronomy." *The Planetarian* 2, no. 1: 3–8.

Burbidge, E. Margaret. 1978. Oral history interview by David DeVorkin. Niels Bohr Library & Archives, American Institute of Physics, College Park.

Cahalan, Rose. 2012. "Star Power." The Alcalde. https://alcalde.texasexes.org/2012/02/star-power/.

Christensen-Dalsgaard, Jørgen. 2013. "Twinkling Stars." *Nature* 500, no. 7463: 405–6.

Committee for Sexual-Orientation & Gender Minorities in Astronomy. 2020. "SGMA Interviews: Jane Rigby." American Astronomical Society. https://aas.org/comms/sgma/sgma-interviews-jane-rigby.

Dave, Romeel, and Jarita Holbrook. 2012. "Black Sun, A Documentary Film on the 2012 Solar Eclipses." National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=1256995&HistoricalAwards=false.

Davenport, James C. 1999. "The National Society of Black Physicists: Reflections on Its Beginning." In *The African American Presence in Physics*, edited by Ronald E. Mickens, 6–12. Atlanta.

Dinolfo, Adrianna. 2014. "1st Vice Chancellor for Equity and Inclusion Reflects on Time in Position." *The Daily Californian*. https://www.dailycal.org/2014/11/05/1st-vice-chancellor-equity-inclusion-reflects-time-position/.

Eddy, Camille. 2017. "#VanguardSTEM Empowers Women of Color." *Tech Diversity Magazine*. https://techdiversitymagazine.org/2017/06/28/vanguardstem-empowers-women-of-color/.

Elmegreen, Debra. 1995. "A Note from the Chair's Corner." *Status: The Committee on the Status of Women in Astronomy*, January 1995.

Evans, Karin. 2015. "Unconscious Bias." *Mindful*, August 2015, 45–52.

Fermi National Accelerator Laboratory. 1974a. "Science Students Finish Fourth Summer Program." *The Village Crier* 6, no. 31: 1–3.

Fermi National Accelerator Laboratory. 1974b. "Fermilab Hosts Minority Physics Conference." *The Village Crier* 6, no. 45: 2.

Fermi National Accelerator Laboratory. 1981. "National Society of Black Physicists to Meet Here." *Ferminews* 4, no. 16: 1.

Ghorayshi, Azeen. 2018. "Nobody Believed Neil DeGrasse Tyson's First Accuser. Now There Are Three More." BuzzFeed News. https://www.buzzfeednews.com/article/azeenghorayshi/neil-degrasse-tyson-sexual-allegations-four-women.

Glanz, James. 2001. "Arthur Walker, 64, Scientist and Mentor, Dies." *New York Times*, May 9, 2001.

Holbrook, Jarita. 1998. "African Astronomy." In *National Society of Black Physicists XXV Annual Day of Scientific Lectures and 21st Annual Meeting; 12th Annual National Conference of Black Physics Students*, edited by Alan D. MacKellar, 79–81. University of Kentucky.

Harris, Elizabeth A. 2019. "After Investigation, Neil DeGrasse Tyson Will Keep His Job." *New York Times*. https://www.nytimes.com/2019/07/26/arts/design/neil-degrasse-tyson-keeps-job.html.

Haruch, Steve. 2014. "A Graduate Program Works To Diversify The Science World." NPR. https://www.npr.org/sections/codeswitch/2013/12/17/251957062/a-graduate-program-works-to-diversify-the-science-world.

Holbrook, Jarita, and Charles Brown. 2004. "US-Africa Planning Visit: Collaborations in Cultural Astronomy." National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=0438245.

Holbrook, J. C. 2008. "Ethnoastronomy: Pondering Celestial Diversity." *Spectrum: A Report on Underrepresented Minorities in Astronomy*, January 2008, 4–5, 8–9, 12, 17–18.

Holbrook, Jarita. 2009. "US-Africa Workshop on the Identification and Analysis of Arabic Astronomy Documents Found in Africa." National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=0941871.

Holbrook, Jarita C. 2010. "Life in the Margins." Vector. http://vector.nsbp.org/2010/11/19/life-in-the-margins/.

Holbrook, Jarita, Hakeem Oluseyi, and Arletha Williams-Livingston. 2012. "Total Solar Eclipse Coverage in Africa: Boundary Maintenance and the Control of 'Image' within the African-American Scientific Community." *Critical Arts* 26, no. 5: 762–87.

Holbrook, Jarita Charmian, Diane Gu, and Sharon Traweek. 2018. "Reaching for the Stars Without an Invitation." American Scientist. https://www.americanscientist.org/article/reaching-for-the-stars-without-an-invitation.

Horsthemke, Kai. 2004. "'Indigenous Knowledge' – Conceptions and Misconceptions." *Journal of Education* 32: 31–48.

Horsthemke, K. 2008. "Scientific Knowledge and Higher Education in the 21st Century: The Case against 'Indigenous Science'." *South African Journal of Higher Education* 22, no. 2: 333–47.

Horsthemke, Kai. 2017. "'Epistemological Diversity' in Education: Philosophical and Didactic Considerations." *Forum Pedagogiczne* 7, no. 1: 261–78.

Hotovy, Hannah. 2017. "How 11 Deaf Men Helped Shape NASA's Human Spaceflight Program." National Aeronautics and Space Administration. http://www.nasa.gov/feature/how-11-deaf-men-helped-shape-nasas-human-spaceflight-program.

Humphreys, Roberta. 2018. "The award rejection that shook astronomy." *Physics Today*.

Isler, Jedidah C. 2014a. "In Like a Lamb, Out Like a Lion: Probing the Disk-Jet Connection in Fermi Gamma-Ray Bright Blazars." Doctor of Philosophy dissertation, Yale University.

Isler, Jedidah C. 2014b. "On Planck's Law, Blackbodies and the Physics of Diversity." *Status: A Report on Women in Astronomy*, June 2014, 16–18.

Isler, Jedidah. 2015a. "How I Fell in Love with Quasars, Blazars and Our Incredible Universe." TED. https://www.ted.com/talks/jedidah_isler_how_i_fell_in_love_with_quasars_blazars_and_our_incredible_universe.

Isler, Jedidah. 2015b. "The Untapped Genius That Could Change Science for the Better." TED. https://www.ted.com/talks/jedidah_isler_the_untapped_genius_that_could_change_science_for_the_better.

Isler, Jedidah C. 2015c. "The 'Benefits' of Black Physics Students." *New York Times*, December 17, 2015.

Jenkins, Elizabeth Cook. 2016. "Rising Star." *Vanderbilt*. http://stories.vanderbilt.edu/rising-star.

Johnson, John. 2013. "A Young Black Scientist Making History!" Mahalo.ne.Trash. http://mahalo-nottrash.blogspot.com/2013/09/a-young-black-scientist-making-history.html.

Jones, Maya A. 2016. “Astrophysicist and HBCU Grad Hakeem Oluseyi Is Making Waves.” The Undefeated. https://theundefeated.com/features/astrophysicist-and-hbcu-grad-hakeem-oluseyi-is-making-waves/.

Jones, Nicola. 2018. “Whose Physics Is It Anyway? Q&A with Chanda Prescod-Weinstein.” FQXi. https://fqxi.org/community/articles/display/227.

Lang, Harry G. 1994. *Silence of the Spheres: The Deaf Experience in the History of Science*. Westport: Bergin & Garvey.

Lincoln, Mia. 2012. “Free Speech vs. Political Correctness.” *California Patriot*. http://www.californiapatriot.org/magazine/2012/09/free-speech-vs-political-correctness/.

Mac Donald, Heather. 2011. “Pepper-Spraying Taxpayers.” *National Review*. https://www.nationalreview.com/2011/11/pepper-spraying-taxpayers-heather-mac-donald/.

MacKellar, Alan D., ed. 1998. *National Society of Black Physicists XXV Annual Day of Scientific Lectures and 21st Annual Meeting; 12th Annual National Conference of Black Physics Students*. University of Kentucky.

Mayol, Taylor. 2016. “The Astrophysicist at the Cutting Edge of Black Holes.” OZY. http://www.ozy.com/rising-stars/the-astrophysicist-at-the-cutting-edge-of-black-holes/71552.

McGruder, Charles. 1992. “Notes on the Session ‘Funding the Bouchet-ICTP Institute.’” In *Proceedings of a Meeting of an American Sub-Group of the Council of Edward A. Bouchet-ICTP Institute*, 73. Atlanta: Clark Atlanta University.

McGruder, Charles. 2001. “US-South Africa Planning Visit in Astronomy.” National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=0125413.

McGruder, Charles H., and Chidi E. Akujor. 1990. “Is the Jet in Quasar 1038+064 Precessing?” In *Proceedings of the 17th Annual Day of Scientific Lectures and 13th Annual Meeting of the National Society of Black Physicists*, edited by Kennedy J. Reed, 49–57. Lawrence Livermore National Laboratory.

McGruder, Charles, Hakeem Oluseyi, Lawrence Norris, and Pius Okeke. 2011. “The African Astronomical Society Arrives.” *Spectrum: A Report on Underrepresented Minorities in Astronomy*, January 2011, 1–2, 12–13.

Mickens, Ronald E. 2002. “The Genesis of the National Society of Black Physicists.” In *Edward Bouchet: The First African-American Doctorate*, edited by Ronald E. Mickens, 109–14. Singapore: World Scientific.

Miller, Casey, and Keivan Stassun. 2014. “A Test That Fails.” *Nature* 510, no. 7504: 303–4.

Nordhaus, Jason, Manuela Campanelli, Joe Bochner, Thomas Warfield, Hans-Peter Bischof, and Jake Noel-Storr. 2020. “AstroDance: Engaging Deaf and Hard-of-Hearing Students in Astrophysics via Multimedia Performances.” *Journal of Science Education for Students with Disabilities* 23, no. 1.

Norman, Dara, Jedidah Isler, Hakeem Oluseyia, Nancy Morrison, Caroline Simpson, and Laura Trouille. 2013. “Women of Color in Astronomy and Astrophysics.” In *Seeking Solutions: Maximizing American Talent by Advancing Women of Color in Academia*, edited by Karin Matchett, 160–150. Washington: National Academies Press.

Oluseyi, Hakeem, and Joshua Horwitz. 2021. *A Quantum Life: My Unlikely Journey from the Street to the Stars*. New York: Ballatine.

Peery, Benjamin. 1977. Oral history interview by David DeVorkin. Niels Bohr Library & Archives, American Institute of Physics, College Park.

Physics Today. 1982. “National Society of Black Physicists Meets.” *Physics Today* 35, no. 1: 54.

Powell, Kendall. 2013. “On the Lookout for True Grit.” *Nature* 504, no. 7480: 471–73.

Prescod-Weinstein, Chanda. 2014. “Ain’t I a Woman? At the Intersection of Gender, Race and Sexuality.” Women In Astronomy. http://womeninastronomy.blogspot.com/2014/05/aint-i-woman-at-intersection-of-gender.html.

Prescod-Weinstein, Chanda. 2015. “Hold Fast to Blackness.” Medium. https://medium.com/@chanda/hold-fast-to-blackness-3e4fa529917d.

Prescod-Weinstein, Chanda. 2016. “Being Black Means We Have to Be 200% Better.” Medium. https://medium.com/@chanda/being-black-means-we-have-to-be-200-better-c724a974c908.

Prescod-Weinstein, Chanda. 2018. "Sexual Misconduct Allegations against Neil DeGrasse Tyson Reveal the Complexity of Academic Inequality." *Scientific American*. https://blogs.scientificamerican.com/observations/sexual-misconduct-allegations-against-neil-degrasse-tyson-reveal-the-complexity-of-academic-inequality/.

Reed, Elizabeth. 1977. "Behind the Green Door." *Black Enterprise* 7, no. 7: 27–32.

Reed, Kennedy J. 1990. "Foreword." In *Proceedings of the 17th Annual Day of Scientific Lectures and 13th Annual Meeting of the National Society of Black Physicists*, edited by Kennedy J. Reed, iv–v. Lawrence Livermore National Laboratory.

Roberts, Michelle. 2005. "75 Years after Discovery, Pluto Still Puzzles." NBC News. https://www.nbcnews.com/id/wbna6968617.

Rudolph, Alexander L. 2019. "Cal-Bridge: Creating Pathways to the PhD for Underrepresented Students in Physics and Astronomy." *Physics Today* 72, no. 10: 50–57.

Rudolph, Alexander, Gibor Basri, Marcel Agüeros, Ed Bertschinger, Kim Coble, Megan Donahue, Jackie Monkiewicz, Angela Speck, and Keivan Stassun. 2019. "Final Report of the 2018 AAS Task Force on Diversity and Inclusion in Astronomy Graduate Education." *Bulletin of the American Astronomical Society*.

Sanders, Robert. 2003. "An Orb by Any Other Name: Debate over What Constitutes a Planet Is Far from Settled." UC Berkeley News. https://www.berkeley.edu/news/media/releases/2003/02/26_planet.shtml.

Schmelz, Joan. 2015. "Woman Astronomer of the Month: Joan Schmelz." Women In Astronomy. http://womeninastronomy.blogspot.com/2015/10/woman-astronomer-of-month-joan-schmelz.html.

Shipman, H. 1981. "Task Group on Education in Astronomy (TGEA): Annual Report for 1981." *Bulletin of the American Astronomical Society* 13: 929–30.

Shipman, Harry. 1983. "Task Group on Education in Astronomy: Annual Report for 1983." *Bulletin of the American Astronomical Society* 15: 1018–19.

Space Telescope Science Institute. 1993. "The Baltimore Charter for Women in Astronomy." *Space Telescope Science Institute Newsletter* 10, no. 2: 39–40.

Sobel, Dava. 2016. *The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars*. New York: Penguin.

Stassun, Keivan Guadalupe. 2000. "A Test of Star Formation Theory: The Connection between Rotation, Accretion, and Circumstellar Disks Among Low-Mass Pre-Main Sequence Stars." Doctor of Philosophy dissertation, University of Wisconsin – Madison.

Stassun, Keivan Guadalupe. 2002a. "Introducing the CSMA Website: Diversity Resources for the Astronomy Community." *Spectrum: A Report on Underrepresented Minorities in Astronomy*, January 2002, 1–2.

Stassun, Keivan Guadalupe. 2002b. "Diversifying Our Profession: The Role of Minority Serving Institutions." *Spectrum: A Report on Underrepresented Minorities in Astronomy*, June 2002, 1, 3.

Stassun, Keivan G. 2005. "Building Bridges to Diversity in Physics and Astronomy." *Mercury* 34, no. 3: 20–27.

Stassun, Keivan. 2013. "GRE Scores Are an Obstacle to Diversity in Graduate Admissions." AstroBetter. https://www.astrobetter.com/blog/2013/04/22/gres-and-diversity-in-graduate-admissions/.

Stassun, Keivan G. 2020a. "About Me." Vanderbilt University. http://astro.phy.vanderbilt.edu/~stassuk/about.htm.

Stassun, Keivan. 2020b. "Vanderbilt Initiative in Data-Intensive Astrophysics (VIDA): About." Vanderbilt University. http://astro.phy.vanderbilt.edu/~vida/about.htm.

Stassun, Keivan G., Susan Sturm, Kelly Holley-Bockelmann, Arnold Burger, David J. Ernst, and Donna Webb. 2011. "The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program: Recognizing, Enlisting, and Cultivating Unrealized or Unrecognized Potential in Underrepresented Minority Students." *American Journal of Physics* 79, no. 4: 374–79.

Szrom, Madeline. 2015. "Master's-to-PhD Program Paves Smooth Path for Underrepresented Students." INSIGHT Into Diversity. https://www.insightintodiversity.com/masters-to-phd-program-paves-smooth-path-for-underrepresented-students/.

Tyson, Neil deGrasse. 2019. *Letters from an Astrophysicist*. New York: W. W. Norton.

Tyson, Neil deGrasse 2020. "Reflections on the Color of My Skin." Hayden Planetarium. https://www.haydenplanetarium.org/tyson/commentary/2020-06-03-reflections-on-color-of-my-skin.php.

Urry, C. Megan. 1993. "Introduction to WIA Meeting." In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 5–9. Baltimore: Space Telescope Science Institute.

Vanderbilt University. 2007. "Vanderbilt-Cape Town Partnership." Vanderbilt University. https://www.vanderbilt.edu/AnS/physics/uct/meeting07.htm.

Vincennes Sun-Commercial. 1973. "Something In Your Sky? Maybe It's Merely UFOria." *Vincennes Sun-Commercial*, October 21, 1973.

W.K. Kellogg Foundation. 2007. *2007 Annual Report: Philanthropy in the Spirit of Our Times*. Battle Creek: W.K. Kellogg Foundation.

Whitelock, P. A. 2004. "Optical Astronomy in Post-Apartheid South Africa: 1994 to 2004." In *Organizations and Strategies in Astronomy*, edited by André Heck, 5:39–60. Dordrecht: Kluwer Academic Publishers.

Whitelock, Patricia Ann. 2009. "Astronomy and Development in Southern Africa." In *Accelerating the Rate of Astronomical Discovery*. Sissa Medialab.

Whitelock, Patricia. 2020. "The National Astrophysics and Space Science Programe (NASSP)." Presentation at the SAAO 200 Symposium: Beyond 200 Years of Astronomy, South African Astronomical Observatory.

Whitelock, Patricia Ann. 2022. "The Southern Half of the Sky." In *The Sky Is for Everyone: Women Astronomers in Their Own Words*, edited by Virginia Trimble and David A. Weintraub, 161–70. Princeton: Princeton University Press.

Williams, Joseph. 2015. "UC Berkeley Has a Plan to Boost Black Student Numbers After Affirmative Action Ban." TakePart. http://www.takepart.com/article/2015/09/11/berkeley-plan-boost-black-students-after-affirmative-action-ban.

Zirker, Jack B. 1978. "Sacramento Peak Observatory." *Bulletin of the American Astronomical Society* 10: 309–11.

Chapter 5
Stairway to Heaven

Astronomers experienced disability throughout history. Many who were lucky to live long enough lost some of their senses or mobility at some point. Take some of the most famous men from the early modern Scientific Revolution, for example. Smallpox scarred Johannes Kepler's eyes when he was just 3-year-old, leaving him badly near-sighted. In order to prevent him from scratching, his grandmother further bound his hands so tightly that they never regained their full function.[1] As for his contemporary Galileo, he became blind at 72, perhaps due to glaucoma, although his left eye had always had less than perfect vision.[2] Before these two tragedies, the young Tycho Brahe had lost part of his nose in a sword duel with another student in 1566.[3]

Scientists compensated for such impairments through technologies or through their use of assistants. Disability was thus also frequently a source of innovation. After his hands had almost been maimed, Kepler's described his writing as "knotty" or "tricky."[4] Fortunately, he was able to distribute his books in clear print. Until complete blindness set in, Galileo was to make the most of the lenses in his possession. In fact, both Kepler and Galileo became famous for the telescopes they built. These instruments overcame not only the limits of their own bodies, but also those of their better-sighted peers. As for Brahe, a metal prosthesis may not have returned his complete sense of smell, but at least made his face appear less disfigured.[5]

Men like Kepler and Galileo may have been exceptional geniuses. However, sufficient resources and technological innovations also allowed many other disabled astronomers to make contributions. Eighteenth-century John Goodricke, for

[1] Gilder and Gilder (2005), 14.

[2] Watson (2009).

[3] Greenlees (2015).

[4] Gilder and Gilder (2005),.

[5] Greenlees (2015).

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*,
Space and Society, https://doi.org/10.1007/978-3-031-46113-2_5

instance, was deaf, but benefitted from an excellent education paid for by his wealthy family. His father, a baronet and diplomat, sent him to a pioneering school for the deaf in Edinburgh. Goodricke disseminated his research in another invention of the age: the scientific journal. A letter of his on the light variation of the star Algol appeared in the *Philosophical Transactions of the Royal Society of London*.[6] A century later, another deaf astronomer, Frederick Barnard, used a large mechanical "amplifier" in his office at Columbia College in New York. Although this device may not have helped much, he was successful as a scientist and administrator. He worked as president of Columbia for an unprecedented 25 years. During this tenure, he also served as president of the American Association for the Advancement of Science in 1866.[7]

For many astronomers, their disability was hard to hide. Indeed, any visitor to Barnard's office would have needed to speak directly into his mechanical contraption for a chance to be heard. Nevertheless, few scientists would have identified primarily as disabled people. Although Annie Jump Cannon, for instance, was deaf from an early age,[8] her sex was more defining. For her long-time work as a computer at the Harvard College Observatory, she received the last award given by the Association to Aid Scientific Research by Women in 1933. When she used the money to endow the prize that would be named after her, she intended it as a recognition for "distinguished contributions to astronomy by a woman."[9]

Even if scientists like Cannon saw disability as secondary to their identity, they still suffered from discrimination because of it. In 1923, for instance, the Harvard astronomer was considered for membership in the United States National Academy of Sciences (NAS). Cannon's university colleague Edmund Beecher Wilson, a zoologist, wrote to Raymond Pearl, an NAS council member, that she had made "real contributions to astronomy by the intelligence and intuition with which she has classified the Harvard spectral photographs." Pearl, however, objected to Cannon on the grounds that she was deaf. In the spirit of the eugenics movement at the time, he added: "It seems to me that in the passage of time as the Academy gets larger and near its limits, we might well introduce some statement about the undesirability of electing physical defectives."[10]

In Cannon's case, it was probably her combined condition of being both deaf and female that precluded her membership in the National Academy of Sciences. Pearl, a biologist at Johns Hopkins Hospital, further confided to Wilson: "The astronomers seem to me to be a particularly bad lot. They are either deaf, blind, or spit, or something." Yet, at the time, the NAS had at least one male deaf member in its astronomy section: Robert Grant Aitken of the Lick Observatory in California. Aitken was still affected by the wider eugenics movement. On a "Record of Family Traits"

[6] Goodricke (1783).

[7] Lang (1994), 28.

[8] Mack (1990), 98.

[9] Rossiter (1995), 352.

[10] Lang (1994), 85.

developed by the Eugenics Record Office in 1925, Aitken was expected to describe his deafness.[11] However, at least, he did not face the sexism that Cannon had to endure. When the latter was nominated in the early 1920s, the NAS was still an exclusively male body.

Perhaps because many astronomers did not identify primarily as disabled people, they were slow to form dedicated groups akin to the committees for women and racial or ethnic minorities. This also meant that scientists who suddenly lost some of their faculties did not know where to turn for support. As late as 1985, the International Astronomical Union's *Information Bulletin* contained the following call for help: "One of the IAU members recently lost his eyesight. Who can give him advice so that he can continue to work in his field?" Gerard Stevens, a 45-year-old member of the Laboratory for Space Research in Utrecht in the Netherlands, had become completely blind. The Information Bulletin continued: "Unfortunately, little is known about which possibilities exist for blind scientists in different countries and even less information is available about any opportunity for blind astrophysicists. Dr. Stevens is most eager to continue to contribute to our science and it is clearly our moral duty to do our best to help him."[12]

Lacking a strong support network, Gerard Stevens soon stopped publishing. Before losing his eyesight, he had worked on data about energetic particles in space as collected by the International Sun-Earth Explorer-3 (ISEE-3). He then shifted his interest to infrared spectroscopy, seeking to measure radiation that is not visible to the human eye anyway.[13] However, he was apparently unsuccessful. The last paper by him that I was able to trace was an article from 1987 about cosmic ray transport.[14] Thereafter, Stevens disappeared into obscurity, around the same time as the laboratory in Utrecht was losing its independent identity and was becoming fully part of the Space Research Organization of the Netherlands (SRON).

Stevens's case was tragic. However, a disabled British astrophysicist was reaching celebrity status just as the Dutch researcher's star was fading. During the 1980s, Stephen Hawking received the Gold Medal of the Royal Astronomical Society among other prizes. Moreover, he became one of the best-known scientists for whom disability was also an inescapable part of his public image. Diagnosed with a motor neuron disease in 1963, he occupied the Lucasian Chair of Mathematics at the University of Cambridge from 1979. This professorship had been previously held by Isaac Newton. In 1985, an oil painting of Hawking in a wheelchair was displayed at the National Portrait Gallery in London (Fig. 5.1). The artwork had an impact not just on museum visitors in the British capital, but – through reproductions – also on scientists elsewhere. "The portrait is an inspiring source of encouragement to those who, like myself, are handicapped," wrote Petar Grujić from the Institute of Physics in Belgrade. "For we experience black-hole confinement, not

[11] Lang (1994), 84–85.

[12] West (1985), 5, 56.

[13] West (1985), 56.

[14] Hick and Stevens (1987).

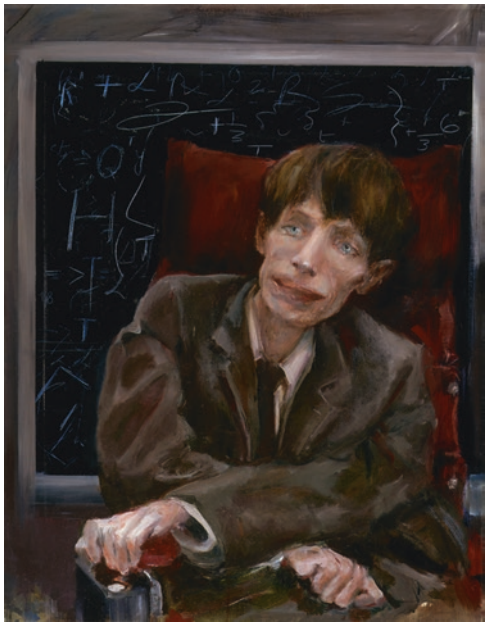

Fig. 5.1 Stephen Hawking, by Yolanda Sonnabend, oil on canvas, 1985. (National Portrait Gallery, used under license)

only as an intellectual adventure (to which Professor Hawking has contributed so much) but also in attempting to transcend the psychological horizon often imposed by the environment."[15]

Seen as a role model for disabled people, Hawking exerted great efforts to make science more inclusive. In 1988, he became well-known through his bestselling book *A Brief History of Time*, which presented cosmological theories in non-technical terms. Around the same time, he started participating in outreach and fundraising activities to make scientific buildings broadly accessible. In 1990, he spoke at the launch of a campaign to convert a disused hospital into a hostel for disabled students in Cambridge. He said that he had to wait years for his department to install a wheelchair ramp. This was all the institution had initially been committed to, citing low demand. "This is a self-fulfilling prophecy," Hawking commented through his voice synthesizer. "If they don't provide facilities for the disabled, there won't be any disabled for whom they have to provide facilities."[16]

Hawking's activism coincided with, and contributed to, a wave of new legislation in different countries in around the turn of the millennium. The Americans with Disabilities Act (ADA) became effective in 1990. It complemented the Civil Rights Act of 1964, which had made discrimination based on race, religion, sex or national origin illegal. The ADA required reasonable accommodations for employees with disabilities. In the United Kingdom, the Disability Discrimination Act 1995 served

[15] Grujic (1986).

[16] Science (1990).

a similar purpose and added to acts on sex discrimination and race relations from the mid-1970s. The United Nations Convention on the Rights of Persons with Disabilities further globalized this effort. Signed in 2007, this international human rights treaty was followed by a *World Report on Disability*. The latter was published by the World Health Organization and the World Bank in 2011. Hawking wrote in his foreword: "Governments throughout the world can no longer overlook the hundreds of millions of people with disabilities who are denied access to health, rehabilitation, support, education and employment, and never get the chance to shine." He expressed the hope that the twenty-first century would "mark a turning point for inclusion of people with disabilities in the lives of their societies."[17]

Hawking not just championed rights of disabled people on Earth, but also promoted their place in outer space. In 1993, he briefly appeared in *Star Trek: The Next Generation*. In this television series, the blind character Geordi La Forge rises to the position of chief engineer of the *Enterprise*. In a scene set on the starship's holodeck, Hawking (played by himself) wins a poker game against Isaac Newton, Albert Einstein and Data. The latter is a fictional android who would become Lucasian Professor at Cambridge in the late twenty-fourth century. Outside the virtual realm, Hawking came closest to experiencing space travel in 2007. The Zero Gravity Corporation, an operator of weightless flights, allowed him to float freely inside a specially modified jet.[18]

As much as Hawking's paralyzing illness was unfortunate, he was also privileged. "I have benefitted from access to first class medical care," he wrote in the *World Report on Disability*. "I rely on a team of personal assistants who make it possible for me to live and work in comfort and dignity." He added "the majority of people with disabilities in the world have an extremely difficult time with everyday survival, let alone productive employment and personal fulfilment."[19] Hawking was arguably unique in the amount of human, financial and technological resources that he received from academic institutions, governments and corporate sponsors.

While Hawking attracted an exceptional level of attention and support, many other astrophysicists also dedicated years of their lives to disability activism. They were not always disabled themselves, but nonetheless committed to making their profession more diverse and inclusive. Like Hawking, they employed new technologies to broaden access. For blind people, for instance, sonification and 3D printing made celestial objects audible and tactile. Passionate for outreach, these astronomers targeted people on a spectrum of ages as well as abilities. They sought to inspire others not just in universities and observatories, but also in museums, planetariums and schools. Dispersed across different countries and institutions, they only came together in the form of dedicated committees relatively late. The American Astronomical Society's Working Group on Accessibility and Disability was established in 2016, for instance. However, by this point, activist

[17] Hawking (2011).

[18] New Scientist (2007).

[19] Hawking (2011).

astrophysicists had long made a difference to numerous disabled people, even without counting Hawking's popular impact.

Touch the Sky

Although significant disability legislation was passed only in the 1990s and thereafter, efforts to make astronomy accessible for blind people had already begun decades earlier. At the height of the Cold War Space Race, popular fascination for the Moon and the planets had reached a height. This was true not just in the space faring superpowers of the United States and the Soviet Union, but also in smaller countries without their own launch vehicles. East German leaders were especially keen to link their future to spaceflight. Between 1954 to 1975, all participants in the *Jugendweihe*, the secular confirmation ceremony for adolescents, received a book entitled *Weltall Erde Mensch* (Outer Space, Earth, Man). Offering scientific explanations of the universe and human evolution, it was supposed to replace Christian creationism. Celebrating Soviet achievements like the launch of *Sputnik-1* in 1957, state propaganda presented space travel as the next step of socialist development.[20]

Committed to space education as part of its utopian socialism, the East German government introduced astronomy as a separate mandatory subject for high-school students regardless of ability. Gerhard Henschel taught it at a school for the blind in Königs Wusterhausen near Berlin beginning in 1963. Trained as a geography teacher, he found the task daunting at first. However, he was reminded of the relief globe developed by August Zeune during the early nineteenth century. Inspired by Zeune, a pioneer in the education of the blind in Germany, Henschel was determined to create tactile models of the sky as well. He thus visited the Archenhold Observatory in Berlin and met its director Diedrich Wattenberg, a popularizer who had written the astronomy chapter of *Outer Space, Earth, Man.* Encouraged by their conversation, Henschel adapted a celestial globe for use by the blind. Dome head nails connected by glued thread made the constellations touchable.[21]

As the space age progressed, Henschel added to his collection of teaching aids. By 1967, the astronomical cabinet at Königs Wusterhausen included a lunar relief and models of rockets featuring cross-sections with tactile interiors. Like for his celestial globe, he often used cheap materials. His students simulated the formation of craters on the lunar surface by dropping a marble into a bowl of salt. Spots on the surface of a miniature Sun were represented through sandpaper. Henschel also created a model of the solar system with a ratio of 1:1 billion. A ball with a diameter of 1.4 meters served as the Sun, and different fruits and vegetables as planets: peas as Mercury and Mars, cherries as Earth and Venus, coconuts as Jupiter and Saturn, and apples as Uranus and Neptune. To get a sense the distance between Earth and the

[20] Anderson (2020).

[21] Henschel (1965).

sun of over 150 million kilometers, one student walked 150 meters away from a peer in an open space.[22]

Although Henschel taught numerous blind high-school students over the years, he had little direct impact on the astronomical profession. None of his students became a notable astrophysicist, let alone an astronaut. East Germany's only space traveler, Sigmund Jähn, was a fully sighted air force pilot. Henschel published his work in German. At the request of Diedrich Wattenberg, he wrote an article about his work for *Blick in das Weltall* (Look into Space), a regular publication of the Archenhold Observatory. He also contributed to *Die Gegenwart* (The Presence), a magazine for blind people. However, the circulation of these periodicals was limited. The only citations of his articles I found were in a German doctoral dissertation completed in 2015.[23] Around that time, the only active blind member of the Astronomische Gesellschaft, was apparently still unaware of Henschel's work, despite sharing his first name: Gerhard Jaworek. Instead of Henschel, Jaworek had drawn inspiration from Stephen Hawking, although the latter was marked by a very different kind of disability. Rather than touching Henschel's three-dimensional models, Jaworek had learned more from listening to the audio version of *Spektrum der Wissenschaft*, the German edition of *Scientific American*. Growing up, he had also been intrigued by the technical content and the futuristic sounds of *Star Trek*, *Star Wars* and *Space Patrol*.[24]

Even in a country like Germany with strong scientific institutions and traditions, efforts to make astronomy more accessible for disabled people thus remained fairly isolated until the 1980s. During that decade, Noreen Grice in the United States began a long career of making the stars knowable through touch. Most probably unaware of Henschel's work, she had to start almost from scratch. She was not blind herself either, but she did experience forms of social and economic exclusion. Growing up in public housing projects outside Boston, she endured bullying. Although she was interested in astronomy from an early age, she was too afraid to go outside at night to look at the stars.[25] In more affluent neighborhoods, she did not find much warmth either. "You're a project kid, you're not welcome here," people would say.[26] Yet, she realized that education was a way out of poverty. In the ninth grade, she won a prize for the best science fair project for her entire junior high school. She thus received a family membership to the Boston Museum of Science, which she considered "a perfect gift."[27]

Although Grice was interested in science education, she had little awareness of the special needs of blind people. In 1984, while studying astronomy at Boston University, she worked part-time at the city's Museum of Science. One Saturday,

[22] Henschel (1967).

[23] Kraus (2015).

[24] Jaworek (2015)..

[25] Grice (2011).

[26] Greenfieldboyce (2008).

[27] Grice (2011).

while taking tickets at the planetarium, she noticed a group of blind people in line. Her supervisor told her that all she needed to do was help them to their chairs. The particular show was pre-recorded. Wondering what the group thought of the presentation, she asked them afterwards. "It stunk," they responded and walked away. Feeling very bad, she sought expert advice. Within a few days, she visited the library of the Perkins School for the Blind in Watertown, Massachusetts. The staff showed her braille books about astronomy by Isaac Asimov. Pulling some from the shelf, she asked "Where are the pictures?" The librarian explained that raised pictures were rare because their production was expensive and time-consuming. Like the planetarium visitors, the pupils thus had little access to astronomical images. For her senior project in college, Grice thus envisioned an astronomy book for the blind with illustrations of the constellations, planets, the Moon and galaxies. She experimented with different methods of embossing, such as gluing string to cardboard and molding shapes with clay. However, she was dissatisfied with the results.[28]

By the late 1980s, Grice had new technology to reproduce images for blind people. After earning a master's degree in astronomy from San Diego State University, she was rehired by the Boston Museum of Science. In 1988, she received a grant to purchase an Apple IIe computer and a VersaPoint braille embosser. The latter punched paper into series of dots to create images. With this equipment, she produced tactile brochures and floor maps for the museum. Blind students and museum visitors helped her optimize the material. She initially used dots for stars in pictures, which caused confusion. "What are all these As?" asked her testers, as a single dot was also the braille symbol for the letter A.[29]

While many of Grice's initial images stayed within the walls of her museum, the astronomer championed accessible education globally. In 1988 as well, she published an article on "Astronomy for Special People" in *Planetarian*, the journal of the International Planetarium Society. She urged her peers to believe in the potential of visually impaired people. "Whether or not they *ever* could see a star or a color is not important," she wrote. "What is important is to give them the chance to understand *more* about the world around *them*, so that they can better live in it and contribute to it."[30]

By "special people," Grice meant not just those with visual impairments, but with any disability. "The science and art of astronomy can be made accessible to persons regardless of any handicap they may have," she wrote. Those with hearing loss could benefit from closed captioning or scripts during planetarium shows. On designated days, sign-language interpreters were available at her museum. Elevators could bring wheelchair users to the different levels of any large building. In smaller spaces like the domes of observatories, devices attached to metal handrails could lift people up a flight of steps. Alternatively, small telescopes and special programs could be made available on the ground level. They could even be brought to

[28] Grice (2004), 219–20.

[29] Grice (2004), 220.

[30] Grice (1988), 19.

hospitals and nursing homes for those unable to travel at all. In any case, she concluded: "These special people need our attention, respect, and concern."[31]

Having spent the previous 6 years trying to make astronomy more accessible, Grice embraced the Americans with Disability Act of 1990. In another piece in *Planetarian*, she reminded readers that the law mandated "reasonable accommodations." For planetariums, she explained, "ADA compliance can include Braille star maps, removable seats, empty spaces for wheelchairs, or providing scripts to hearing-impaired visitors."[32] However, she also urged her peers to go beyond what was merely required. "Invite people with disabilities to your facility to get feedback on what you offer and what you might include in the future," she told a symposium audience in 1995. "Be pro-active rather than reactive in making an all-inclusive environment!"[33]

Although Grice's main concern was for disabled people, she also supported the cause of able-bodied female astronomers like herself. In 1992, she participated in the meeting organized by Meg Urry and others at the Space Telescope Science Institute. She presented the results of a survey of forty-eight planetariums in the United States. Thirty-five of them had never had a female director. Most women worked as secretaries, cashiers or part-time presenters and earned less than $10,000 per year. She cited another study according to which the few female directors earned about $36,000 on average, compared with $46,000 for their male peers. In order to help overcome the inequalities within her profession, she joined Urry and others in signing the Baltimore Charter.[34]

While Grice was interested in the status of various groups, the focus of her career remained on blind people. After she had gained the technology for desktop braille publishing, she returned to the book manuscript from her time as an undergraduate student. With funding from the museum and in collaboration with the National Braille Press, she brought out *Touch the Stars* in 1990. Between its covers were forty-four pages with text in large print and braille plus eleven tactile illustrations. Because the National Braille Press did not have a graphics printer at the time, she used her embosser to produce every image. With no marketing other than word of mouth, the first edition of 400 copies quickly sold out. She thus issued a revised version with nineteen illustrations in 1993, this time with 800 copies. A third edition came with twenty-three pictures. On some days, she was printing images from dawn to midnight.[35]

Touch the Stars soon attracted the attention of sighted scientists as well. Bernhard Beck-Winchatz, a German astronomer at DePaul University in Chicago, spotted a copy at the gift shop of the Adler Planetarium. As he also served as associate director of a NASA-funded center for education and outreach, he was immediately

[31] Grice (1988),

[32] Grice (1996b), 8.

[33] Grice (1996a), 211.

[34] Grice (1993).

[35] Grice (2004), 220–21.

attracted to the book. He contacted Grice, asking for suggestions on how to make the colorful images from the Hubble Space Telescope accessible. The two astronomers explored the idea together with Ben Wentworth, a science teacher at the Colorado School for the Deaf and Blind. The latter and his students evaluated the prototypes produced by Grice. Initially, she drew boundaries to distinguish between different regions of brightness and color in the Ring Nebula. However, based on the pupils' feedback, she chose textures, such as dotted areas and parallel lines, instead. Another challenge was the Hubble Deep Field with its thousands of objects. When she raised too many galaxies in the picture, her readers' fingers were lost. Greatly reducing the number of surface features worked much better for them.[36]

Like *Touch the Stars*, the book coming out of the collaboration with Winchatz and Wentworth was an immediate success. Their work was called *Touch the Universe: A NASA Braille Book of Astronomy*. It thus also benefited from the brand of the American space agency. The three educators presented a prototype at a press conference during the meeting of the American Astronomical Society in Pasadena in June 2001. Within five minutes, they received the first order via email, which was soon followed by hundreds more.[37] In November, the Walt Disney Company honored Wentworth as Outstanding Teacher of the Year at a televised gala event in Los Angeles. The award included $25,000 for him personally and $5000 for his school.

Encouraged by the impact of their work, Grice, Winchatz and Wentworth embarked on a follow-up venture: the Space Exploration Experience (SEE) Project for the Blind and Visually Impaired. Originally sponsored by NASA too, it included among its partners the Yerkes Observatory and the Wisconsin School for the Blind and Visually Impaired. Rather than writing another book, the team sought to enable students to make practical observations. Grice created tactile star wheels and diagrams of asteroid orbits to help with locating celestial objects. During summer workshops in the mid-2000s, pupils used these tools as well as accessible software to operate telescopes. Swell form machines then turned their astronomical images into tactile objects.[38]

Although mostly US organizations participated in the SEE Project, the collaboration with the Yerkes Observatory led to international connections as well. Since the 1990s, Vivian Hoette, who worked at the Adler Planetarium and later at Yerkes, had been involved in Hands-On Universe (HOU). Despite its name, this program was less about touch. Instead, it enabled high school students to analyze date acquired from remote telescopes via the internet. Started by the Lawrence Berkeley National Laboratory in California, it had participants from as far away as Japan. Hoette herself also ran a live show between Yerkes and the Tokyo Science Museum. In the latter, an afternoon audience could see the night sky over Wisconsin. For her

[36] Grice (2004), 222–24.

[37] Grice (2004), 224.

[38] Grice (2007).

efforts, an asteroid discovered by Japanese astronomers in 1991 was named after her.[39]

It was through Hoette then that Masayuki Nakamura of Tokiwa University in Mito north of Tokyo was introduced to the SEE Project. A young friend had told him about a blind relative: "I want to show my uncle the beautiful images of a comet and some nebulae that I took through the telescope presented by him." The friend lamented, "I can never let him feel the wonder of the universe." In the autumn of 2005, he learned about Hoette's project and emailed her about how to make tactile images. The following summer, he participated in a camp at the Yerkes Observatory, bringing samples of his work from Japan. Later in 2006, he was tasked with creating the main concept of the new Otawara City Astro-Museum. Together with municipal staff, he decided that it should be "universally designed." Blind and sighted people were meant to enjoy the displays equally through tactile and colorful images.[40]

Nakamura used some of the same techniques as Grice and Hoette (Fig. 5.2) had developed for the new museum. In 2006, he brought swell paper and a thermal expansion machine to Tokiwa University. During the same year, he developed a booklet on the sun with tactile spots and prominences. Subsequently, he created images of the planets and the Pleiades, known in Japanese as Subaru. Because no uniform standard existed, Nakamura reflected, "trial and error went on day after

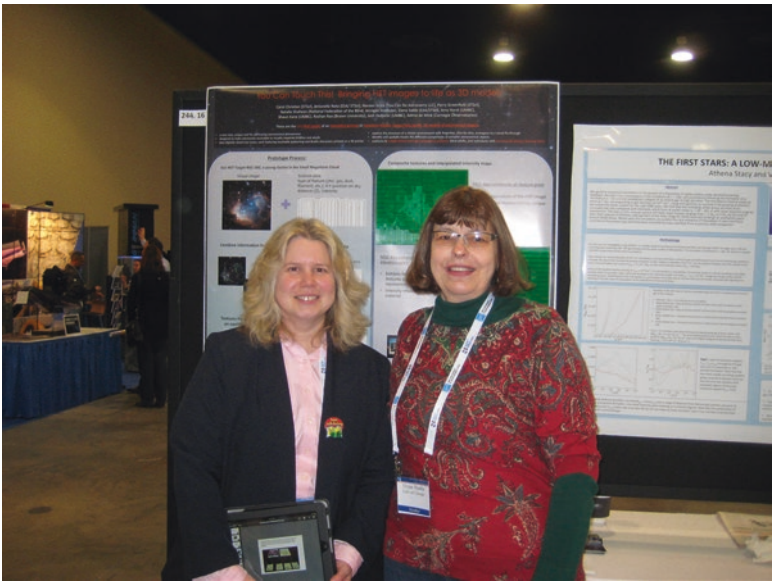

Fig. 5.2 Noreen Grice and Vivian Hoette at the 223rd Meeting of the American Astronomical Society in Washington, DC, in 2014. (Courtesy of Noreen Grice)

[39] Schmadel (2003).

[40] Nakamura and Kikuchi (2013), 3, 5.

day." The first exhibition of "Tactile Universe" generated a sensation in the whole country, he claimed. In 2008, the Otawara City Astro-Museum opened and soon received its first groups of blind visitors.[41]

Most of those who led initiatives to create tactile models of celestial objects, whether based in Germany, Japan or the United States, were sighted people. They also focused on making the knowledge created by others more accessible rather than chasing new discoveries of nature themselves. Yet, inclusive astronomy was not just practiced and promoted by specialists in education and public outreach. Several blind scientists engaged in research as well. They did so not only in theoretical fields, like Stephen Hawking, but also in observation. Observing meant using other senses for visually impaired people, of course. The main ones were touching and hearing.

Music of the Spheres

While many twentieth-century astronomers experienced a reduction in their vision at some point in their life, an especially prominent one named Kent Cullers was blind from the beginning. He was born in 1949 as a premature baby. A common medical intervention that was meant to save his life also stole his sight. At the time, doctors regularly immersed newborns like him in oxygen in order to compensate for their weak lungs. As a result, blood vessels swelled and destroyed his retinas.[42] Because this damaging treatment was so widespread, the education system had to adapt to the surge in blind children. Schools integrated them into regular classes and provided them with tactile aids and special help in braille. "I learned to type when I was 8," Cullers said.[43] The German astronomer Gerhard Jaworek likewise attributed his blindness to a treatment with pure oxygen after a premature birth. He later commented that it was the "most common cause" for loss of sight in industrialized nations at the time.[44]

Although it had been a medical intervention that had disabled Cullers, the American did not shy away from science and technology. When he was five, his father, a geophysicist, read to him *The Golden Book of Astronomy* by Rose Wyler and Gerald Ames. "I literally could imagine reaching out and touching those cold, or hot, or whatever, objects," he said about the planets and stars his father described. "In my mind, I was right out there."[45] The young Kent listened to other material as well, such as the legend of King Arthur. Ultimately, however, he stuck with the natural world rather than the supernatural. "I got better at science. I never got better at

[41] Nakamura and Kikuchi (2013), 6–7.

[42] Airhart (1997).

[43] Softky (2003).

[44] Jaworek (2015), 9.

[45] Airhart (1997).

magic." At the age of eleven, he received an amateur radio license, enabling him to talk with people all over the world.[46]

Communication across great distances subsequently turned from being a hobby into a career. Stimulated by his father's readings, Cullers dreamt of other worlds, such as icy planets. As he grew up, he gained access to more tools to help his investigations. "When I graduated from college, I could read a book on a computer screen with vibrating pins under my fingers," he said. Taking advanced physics classes while pursuing his doctorate at Berkeley was still challenging. Professors often did not talk as much as they were writing. "All I heard was the scritch-scritch-scritch of chalk on the blackboard." Luckily, he had friends who would explain the steps and draw the illustrations on his hand. Recorders and increasingly powerful computers further supported his studies.[47] His graduate research was on radar measurements of the electrical field in the auroral zone above Alaska. At the same time, he became fascinated by the search for extraterrestrial intelligence (SETI). He read the report of NASA's Project Cyclops, which proposed the coordination of numerous radio telescopes to detect signals from up to a thousand light years away. He also got to know scientists at the Ames Research Center working on this still esoteric area of astronomy. He joined them after completing his dissertation in 1980.

Although Cullers was a rarity as a blind astrophysicist, he did not achieve anything close to Stephen Hawking's fame. While his employer, NASA, was a mainstream organization, SETI itself remained at the fringe. He was content with the absence of major breakthroughs. He spent much of his effort at the Ames Research Center on signal processing. He found that distinguishing an extraterrestrial message from the various interferences in Earth's atmosphere required the analysis of enormous amounts of data with special computers. "I don't mind laying the groundwork," he said, while resigning himself to the possibility of not contacting an alien civilization during his lifetime.[48] American politicians were less patient, however. Tired of waiting for conclusive results, they criticized NASA's SETI program for wasting public money. Senator William Proxmire from Wisconsin once gave the agency his tongue-in-cheek Golden Fleece Award. In 1993, Congress forced NASA to cut the program altogether.

At this point, private money from Silicon Valley, in which the Ames Research Center was located, secured the continuation of SETI and Cullers's employment. A $20 million bequest from the estate of a Hewlett-Packard executive resurrected the quest to find patterns in radio signals under the name Project Phoenix. This program was run by the non-governmental SETI Institute, which became Culler's new employer. Hollywood too provided a significant boost through Robert Zemeckis's film *Contact* starring Jodie Foster in 1997. Based on a novel by Carl Sagan, the movie included the character Kent Clarke, who was derived from Cullers. The astrophysicist failed a screen-test, however, and was replaced by the actor William

[46] Softky (2003).

[47] Softky (2003).

[48] Broad (1985).

Fichtner instead. “Most days I have enough trouble playing myself,” Cullers laughed.[49]

The success of *Contact* suddenly gave Cullers and his SETI colleagues much more attention and credibility. “The movie has generated enthusiasm in the public,” said Frank Drake, one of the founders of the field, in 1997. “We believe that given a few more years, the groundswell will be so great that NASA will feel it’s safe to engage in SETI again.” The Project Phoenix website registered an increasing number of visitors and soon began accepting donations via credit card. Cullers too felt that it became easier to defend the importance of his work. “It’s nice to have a movie say it for me rather than me having to rant and rave,” Cullers laughed. “We are proud of this movie. We’ve been understood a little better as human beings.” Even a checkout clerk at the local supermarket got a feeling of what his work was like: “Gosh, what you do is sure harder than I thought.”[50]

Part of a well-funded institution in Silicon Valley, Cullers benefited from much human and technological support. Computer software converted two-dimensional graphs of data points into series of rising and falling tones. Other programs allowed him to write code by transforming his speech into text. In addition, he relied on “good old human slave labor,” as he put it. Students and friends made tactile drawings of graphs and simple images by means of a pen and a rubber mat. As they ran the pen over an image, they made raised lines on a sheet of paper.[51] All of these tools removed many obstacles in his research. “My blindness isn’t a disability for me. It is an annoyance,” he claimed. “I may not be able to drive a car, but that’s insignificant.”[52]

While Cullers made ample use of new technologies, he appreciated the older braille writing system that had originated in the 1820s. Moreover, he used the publicity he had gained to campaign for the tactile alphabet. “We would never let society become illiterate, but for blind people, that could happen in another generation.” So he said during a keynote speech at a benefit luncheon for the Braille Institute Auxiliary of Orange County in 1998. He worried that braille was no longer taught to many blind children, as reliance on speech and hearing was more convenient. “But you can’t have precision in math and science without Braille,” he argued.[53] When reading letters and symbols, one could slow down, speed up and repeat in a way that listening did not allow.

Dedicated to the promotion of tactile alongside aural material, Cullers welcomed and supported Noreen Grice’s work. “She was good at imagining the difficulties that a blind person might have, without, as typically happens with Sighted people, becoming overwhelmed,” he said. “She had enough empathy to get it, but not so

[49] Schrieberg (1997).

[50] Schrieberg (1997).

[51] Airhart (1997).

[52] Williams (2001).

[53] Chavez (1998).

much that she couldn't deal with it."[54] He contributed a foreword to her book *Touch the Stars*, writing: "I can calculate the temperature of a star, but, before reading this book, I knew nothing about the appearance of the constellations."[55] He also endorsed her subsequent NASA-supported book, *Touch the Universe*, with a statement on the cover: "As a radio astronomer (and the world's only blind one, at that), I feel a powerful intuitive connection with the astonishing exotic objects in the distant universe," he explained. "When I touch the tactile image of the Hubble Northern Deep Field of galaxies in *Touch the Universe*, I am overwhelmed by the same astonishment, a sensory connection with the distant cosmos. It has oft been said that a picture is worth a thousand words. Well, for the first time in my career, I get the picture."[56]

Throughout his career, Cullers benefitted from well-funded institutions in California to access the assistive technology he needed. This privilege, combined with the support of his middle-class family, partly explains his extraordinary success. However, as computers became more widespread, blind people far away from Silicon Valley gained more pathways to an astronomical career as well. One of them was Wanda Díaz-Merced, who grew up in the remote town of Gurabo in Puerto Rico. "I am very proud that I don't come from an economically privileged family," she said. "My little sister has a severe physical impediment and sometimes we did not have what to eat at home." However, what the two girls lacked in terms of means, they made up for in their imagination. They dreamed of flying a space shuttle and spent hours in a room pretending to visit distant galaxies. Just as important as leisurely games was a dedication to studying. "My parents gave me the example of humility and hard work," Díaz-Merced recounted.[57]

Díaz-Merced's interest in space led her to study physics at the University of Puerto Rico. Yet, as she progressed in her degree program, her eyesight receded. Diabetes slowly destroyed the blood vessels in her retinas. A failed laser surgery further contributed to blinding her.[58] Around the same time, she lost her job as an undergraduate research assistant. However, this setback was temporary. At a conference, she learned about the NASA program Achieving Competence in Computing, Engineering, and Space Science (ACCESS). Managed by the American Association for the Advancement of Science, ACCESS offered paid internships to students with disabilities. This enabled her to join the Goddard Space Flight Center in Maryland in 2005. Under Robert Candey, she contributed to the development of xSonify, a computer application that turned numerical data into sounds. It used pitch, volume and rhythm to distinguish between different values.[59]

What began as a summer internship ultimately led to the completion of a doctorate in computer science. Díaz-Merced continued working on xSonify with her

[54] Chandler (2003).."

[55] Cullers (2002), xii.

[56] Grice (2004), 224.

[57] Amde et al. (2013), 86–87.

[58] Koren (2017).

[59] Diaz Merced (2011), 42.

Goddard supervisor and peers at the Harvard–Smithsonian Center for Astrophysics among other institutions. They explored the use of sonification in both radio and X-ray astronomy, analyzing plasma bubbles in the ionosphere and identifying frequencies in observations of the variable star EX Hydrae. In 2013, Díaz-Merced submitted a thesis to the University of Glasgow in Scotland on "Sound for the Exploration of Space Physics Data." The core of her dissertation consisted of experiments in which volunteers searched for patterns in either audio or visual representation or both. She concluded that using sound as an adjunct to visualization helped her participants identify signals masked by noise.[60]

While Díaz-Merced (Fig. 5.3) promoted the use of sonification in research, she was equally interested in education and public outreach. Already during her student days at the University of Puerto Rico, she had been involved in activities of the Society of Amateur Radio Astronomers and NASA's Radio JOVE project. The latter allowed non-professional scientists to observe natural radio emissions from bodies like Jupiter with their own telescopes or remotely controlled instruments. She also taught astrophysics through a variety of art forms, including dance, acting, writing and drawing, in an attempt to make research "inclusive for all." Sonification was thus another tool to enhance learning.[61] "XSonify opens a world of possibilities for

Fig. 5.3 Wanda Díaz-Merced laying her hand on Noreen Grice's shoulder at a conference of the Astronomical Society of the Pacific in Tucson, Arizona, in 2005. (Courtesy of Noreen Grice)

[60] Diaz Merced (2013a).

[61] Diaz-Merced et al. (2007).

mathematics/science/physics teachers of sighted and visually impaired students and for amateur radio astronomers," Díaz-Merced stated in an article from 2008.[62]

Even though Díaz-Merced's initial efforts in education and outreach were focused on Puerto Rico, they had connections reaching as far away as Japan. Among the people she found especially inspirational were Jōsei Toda and Daisaku Ikeda, the second and third president of the Buddhist organization Soka Gakkai. When her students were struggling with experiments, she would tell them words by Ikeda: "Life is a marathon, as is faith, and even if we lose the advantage in the middle of the race, victory or defeat are decided at the finish line."[63] Soka Gakkai International and Soka University supported the Díaz-Merced's work in Puerto Rico, which was named the Shirohisa Ikeda Project in honor of Daisaku's son.[64]

While pursuing her doctorate at the University of Glasgow, Díaz-Merced further expanded her network. In 2008, as part of the International Heliophysical Year, she presented at a United Nations workshop on basic space science in Bulgaria. There she met Abebe Kebede of North Carolina A&T State University, a historically black institution. The two subsequently collaborated on bringing Radio Jove to Ethiopia. Groups at Mekelle University and other institutions thus became able to collect data about phenomena such as solar radio bursts and share them with others around the world via the internet.[65] In 2012, Díaz-Merced and Kebede participated at the Gondar School of Science and Technology held in collaboration with the Ethiopian Space Science Society. The blind astrophysicist gave a presentation on the "Many Ways of Seeing Things."[66]

After earning her doctorate, Díaz-Merced moved further south on the African continent. In 2014, she joined the Office of Astronomy for Development (OAD) directed by Kevin Govender in Cape Town. There, she worked with institutions like the Athlone School for the Blind to inspire pupils and develop sonification techniques and analysis methods. "I would like to see people with disabilities realise the power they have in their other senses," she said. Michael Masutha, South Africa's deputy minister of science and technology, was supportive. "The visual sense is not the only sense you can use to become a scientist," he said. "The only thing that can limit your horizons is your imagination." Govender was equally enthusiastic. "Wanda has opened our eyes to many possibilities for involving all sectors of society in scientific studies and research," he commented. "We intend to support and develop her ideas so that they can be spread throughout the world."[67]

Díaz-Merced, indeed, used her new base in South Africa to reach audiences not just locally, but globally. In 2014, she installed an antenna at the Athlone School so that the students could experience an operational Radio Jove system. The following

[62] Diaz-Merced et al. (2008), 42.

[63] Amde et al. (2013), 90.

[64] Garcia (2005).

[65] Ebuy (2011).

[66] Diaz-Merced (2013b).

[67] Department of Science and Technology (2014).

year, she facilitated a teleconference between members of the institution and the NASA project based elsewhere.[68] She gathered many more listeners by giving a talk at a TED conference in 2016. She explained the usefulness of sonification for the study of gamma-ray bursts. Such explosions were gigantic, but nonetheless invisible to the naked eye. Turning data into sounds provided sighted and blind astronomers with equal opportunities to make contributions to these and other phenomena. "If people with disabilities are allowed into the scientific field, an explosion, a huge titanic burst of knowledge will take place," she promised.[69]

Overall, Díaz-Merced's talk was well-received. A recording on the TED website was played hundreds of thousands of times over the next few years. The main criticism was that she had not cited an important predecessor in the area of sonification. "Interesting stuff, but why no mention of the seminal work on acoustic astronomy by Dr. Fiorella Terenzi of FIU?" asked a technology lawyer from Maryland. "She pioneered the field." Terenzi, an Italian-born astrophysicist at Florida International University, congratulated Díaz-Merced. However, she reminded her younger peer that back in the 1980s, she had developed a way to convert radio waves from galaxies into sound. "I called it 'radio computer music astronomy' or simply 'acoustic astronomy' because for the very first time astronomical data were processed via a sound synthesis language called cmusic." She acknowledged that "Things in 2016 for sure are different, audio-fication of celestial data can now be done on every home computer." However, she still wished "to be credited once in a while."[70]

Short TED talks like Díaz-Merced's hardly allowed for abundant references to previous literature. However, Díaz-Merced did not claim to be the first to turn astronomical data into sound. She was well aware that in the history of radio astronomy, electromagnetic radiation from outside Earth had first been picked up as noise, before it was visualized. In her doctoral thesis at the University of Glasgow, she referenced the work of Donald Gurnett who had sonified data from NASA missions like *Voyager 2* for decades.[71] Díaz-Merced's supervisor at the Goddard Space Flight Center, Robert Candey, had also conceived of sonification as a means for outreach prior to working with the Puerto Rican. In a conference paper in 1998, he had written: "Besides improving data exploration and analysis for most researchers, the use of sound is especially valuable as an assistive technology for visually impaired people and can make science and math more exciting for high school and college students."[72]

If Robert Candey had already considered outreach possibilities during the 1990s, Fiorella Terenzi had made greater efforts to popularize astronomy through sonification during the same period. While she did not publish many journal articles, she was successful in other types of media. Before working at the Computer Audio

[68] Donson (2015).

[69] Diaz Merced (2016).

[70] Diaz Merced (2016).

[71] Diaz Merced (2013a, b).

[72] Candey et al. (1998).

Research Laboratory at the University of California, San Diego, she had studied opera and composition as well as physics in her hometown of Milan. Her combined expertise then gave rise to the compact disc *Music from the Galaxies*, which Island Records released in 1991. She told her listeners that many astronomical phenomena such as various forms of radiation were hidden from the human eye. She promised that by transforming observations into sound and comparing visual and acoustic interpretations, new physical and chemical information could be gained. If that sounded rather dry, Terenzi did her best to make her data exciting. She performed on a television show hosted by the comedian Dennis Miller, who introduced her as a "a cross between Carl Sagan and Madonna." Assisted by laser effects, she further enlightened and entertained audiences in planetariums and concert halls. In 1994, the science and fantasy magazine *Omni* praised her for "uncovering the celebrated music of the spheres." She also added her own voice and image to the CD-ROM *Invisible Universe*.[73]

Although not blind like Díaz-Merced, Terenzi believed as much into the power of the acoustic domain. "Eyes get tired," but ears do not, she told me. "You can watch *Star Wars* 50 times and then you get tired because visual data are redundant." In contrast, you can listen to a "song hundreds of times," she claimed. "You listen to *Stairway to Heaven* of Led Zeppelin and you still remember where you were the first time you heard the song. You still remember your first encounter on the beach in the summertime with the first kiss." Powerful computers could turn almost any astronomical data into sound, ready for comparison. She was thus proposing an acoustic catalog of planets, stars and even black holes. "Way back in 1987, my audification took a year," she said to me in 2022. "These days, you can do audification on your iPhone."

As much as Terenzi championed acoustics, she also mastered optics. She put her own body as well as celestial ones at the center of her performances. One reviewer praised *Invisible Universe* as "entertaining, informative, aesthetic achievement: Call it science with sex appeal."[74] Around the same time, she was planning a television series in which she would teach astronomy as a "a Barbarellalike character."[75] In 1998, she published an autobiography entitled *Heavenly Knowledge*, which described a sensual universe. Chapters like "The Sex Life of the Cosmos" drew lessons from systems like binary stars for human relationships. "I want us all to hear how the music of the spheres resonates with the music of our hearts," she wrote.[76]

Consciously bringing her own physical attractiveness to astrophysics made Terenzi stand out among, and apart from, many in her discipline. "In America there is this idea of a scientist which I do not fit," she admitted to *People* magazine in 1996.[77] This is not to say that images of beautiful female astrophysicists did not

[73] Meola (1994).

[74] Sun Sentinel (1996).

[75] Meola (1994).

[76] Terenzi (1998), 5.

[77] People (1996).

exist in popular culture. One of them was Charlie Blackwood, instructor and love interest of the navy pilot Pete "Maverick" Mitchell (played by Tom Cruise) in *Top Gun*. In fact, seeing the actress Kelly McGillis play Charlie in the film had "ignited" Terenzi's own aspirations, as she shared with me. However, the astrophysicist in *Top Gun* appeared serious and modest compared with Terenzi's publicity pictures. The Italian astronomy popularizer liked to dress in tight and revealing outfits. As a result, *Omni* described her as "sultry."[78] The English musician Thomas Dolby, who recorded some songs with her, noted her "blond pinup looks."[79]

Terenzi had not always emphasized her femininity. When she had first studied physics in Italy, she found many men to be condescending toward her. "I overcame that by undermining my physical presence, always keeping my hair up, wearing no makeup, trying to behave like a boy." However, having to hide her female body in an overwhelmingly male environment was "very painful." "Sometimes I wanted to really show up at a classroom with a nice dress and lipstick."[80] Over time, she came to resent the stereotypical looks ascribed to physicists. "If I look like an Albert Einstein caricature, I'm a great genius," she commented to me. "If I come out with my hair down and nail polish and I speak in a romantic language like Italian is, I'm not a good scientist." She wished that there could be a female equivalent to Brian May of the British rock band Queen who was both a famous musician and an astrophysicist.

Seeking to make science sexy, Terenzi (Fig. 5.4) perhaps would not have objected to posters of seductive women in observatories. When she had been the only female

Fig. 5.4 Fiorella Terenzi in 2019. (Courtesy of Fiorella Terenzi)

[78] Meola (1994).

[79] Dolby (2016), 158.

[80] Woodmansee (2003), 163.

physics graduate in a class of 400 at the University of Milan,[81] she might have benefitted from a women's support group. However, as she subsequently sought a career in American show business alongside academia, her outfits were seen as inappropriate by other feminists. In the 1990s, just as the Baltimore Chapter was being written and circulated, she thus came to avoid scientific conferences that were women-oriented. "I was going through the same issue such as being judged by the way you look." In her interview with me, she remembered a "strong strike of jealousy, resentment, non-acceptance."

Although Terenzi stayed away from the Committee on the Status of Women in Astronomy, her book *Heavenly Knowledge* did promote a form of feminism. She dedicated it to "all women, cast into silence and shadow throughout these centuries of scientific and astronomical discovery." The first chapter was entitled "The Universe Is a Beautiful Woman." In it, she noted that "there is a growing campaign among my female colleagues in all of the sciences to give a human perspective to our work, to create a science that aspires to cooperate with Nature rather than to only quantify it." She quoted the philosopher Mary Tiles that we should pursue a science that learns more by conversing "with Nature than by putting it on the rack to force it to reveal its secrets." This was "a science of Venus rather than a science of Mars."[82]

Although both Terenzi and Díaz-Merced shared a commitment to astronomical outreach and education, the latter was distinct in her disability activism. The Italian astrophysicist did have a strong sense of gender justice. She wrote in *Heavenly Knowledge* that she wished she could "repaint the celestial vault with an equal number of female and male constellations."[83] However, she celebrated the image of an able-bodied woman, if not that of a goddess. This is not to say that disabled people were absent from her audiences. However, unlike her Puerto Rican peer, she hardly employed "disability" as a category in her work. When I spoke to Terenzi, she did consider her way of pronouncing English a "disability," however. "Even having an accent is a disability," she told me. Speaking with an Italian accent might make her seem more charming, but also less "intelligent" compared with scientists with a British accent. Because of her linguistic background, she claimed to have suffered from "discrimination." She once gave the following career advice to younger women: "If you want to do space journalism for a newscast, it's better not to have an accent. And an Italian accent is not very appropriate for the American market."[84]

[81] People (1996).

[82] Terenzi (1998), 9.

[83] Terenzi (1998),

[84] Woodmansee (2003), 163.

Spectra

While Fiorella Terenzi sought a broader stardom, Wanda Díaz-Merced was more content with working within professional associations. In 2015, she and eleven other scientists proposed to the Council of the American Astronomical Society the formation of a Working Group on Disability and Accessibility (WGAD). The co-authors of the proposal included Jason Nordhaus of the National Technical Institute for the Deaf and Alicia Aarnio, a former student of Keivan Stassun's, among others. "There have always been astronomers with disabilities," they wrote, mentioning the example of the deaf Annie Jump Cannon. "When we focus on accessibility, we are honoring a tradition of our field," they thus claimed. Nevertheless, they complained that their field still suffered from ableism or stigmatization and discrimination based on disability. They cited a survey of AAS members from 2013, in which fewer than 2% of respondents identified as disabled. Compared with almost 20% of the American population overall, this meant that persons with disabilities were "dramatically underrepresented."[85]

Being part of a diverse group of activists made Díaz-Merced go beyond visual impairment. Aarnio described herself as "a mental health advocate, striving to promote awareness and de-stigmatization of mental health issues."[86] The proposal to the AAS Council thus read: "Mental illness and other 'invisible' disabilities are especially stigmatized and often ignored in conversations about access." Aarnio, Díaz-Merced and their co-authors acknowledged that the physical sciences had long "celebrated scientists who were non-neurotypical in particular ways." However, they added that "there is a broad spectrum of neurodiversity and current classroom and professional environments rarely recognize this." They further noted that "disability is an axis across which anyone can move throughout their lives." As this included people of various "intersectional identities," the group hoped to liaise with the existing AAS committees on women and minorities.[87]

Other diversity promoters within the astronomical profession welcomed Díaz-Merced and her fellow disability activists. In 2015, the Puerto Rican participated in a conference on Inclusive Astronomy at Vanderbilt University. Organized by Stassun, Jedidah Isler and others, this event built on the Women in Astronomy meetings and was sponsored by the National Science Foundation. It sought to advocate for inclusion of astronomers who identified with more than one underrepresented category in the areas of gender, race or disability. The blind scientist was part of a panel on "Inclusive Environments." This session presented tools for visually and hearing impaired people, flexible workplaces and climate surveys alongside an Impostor Syndrome Bingo.

Through the contributions of people like Díaz-Merced, disability made it into a strategic document resulting from the Inclusive Astronomy conference.

[85] Aarnio et al. (2015), 2.

[86] Aarnio et al. (2015), 7.

[87] Aarnio et al. (2015), 2–3.

Complementing the Baltimore Charter and the Pasadena Recommendations, participants compiled a set of guidelines called the Nashville Recommendations. They complained that "most astronomers who are some combination of female, LGBTIQA*, disabled, or a person of color, can tell stories of overt discrimination, microaggressions, and hostile climate." The recommendations therefore stressed that "Astronomy must become more inclusive." The whole profession stood to benefit as "diversity leads to greater innovation, more creative thinking, and higher quality science." The guidelines argued that the knowledge and experience of "traditionally marginalized individuals" were in particular need for future discoveries. Their inclusion was also necessary for maintaining appreciation and support by diverse publics.[88]

Unlike the guidelines coming out of the earlier Women in Astronomy conferences, the Nashville Recommendations included points specifically about disabled people. The document noted that significant barriers existed for them in "building infrastructure, educational practices, limitations in technology, institutional apathy, and culture within the astronomical community." As accessibility was a human right, these obstacles constituted discrimination. The participants in the Inclusive Astronomy conference therefore called for wheelchair-accessible observatories and the use of dyslexic-friendly fonts in publications as well as palettes for colorblind readers. Congresses were supposed to follow "principles of universal design and disability justice." Presenters were urged to speak slowly and use microphones and simple language.[89] Ironically, the Nashville Recommendations themselves were hardly free of jargon. An appendix explained such acronyms as "LGBTIQA*": "Lesbian, Gay, Bisexual, Transgender, Intersex, Questioning, Agender, and other gender identities."[90]

Díaz-Merced was perhaps able to gain Keivan Stassun as an ally especially easily, because he had a son who was on the autism spectrum. This family experience inspired the Vanderbilt professor to shift the focus of his own advocacy from racial and ethnic minorities to neurodiversity. As his offspring became older, Stassun noticed his "incredible capabilities for math, pattern recognition, and data visualization." He thus became determined to see autism not as a mental deficit, but to ask instead: "What can we learn from the autistic mind to help us advance?"[91] With funding from local philanthropists, he launched a Center for Autism and Innovation at Vanderbilt University.

The Inclusive Astronomy conference coincided with Meg Urry's presidency at the American Astronomical Society. In this capacity and as a key figure behind the earlier Baltimore Declaration, she attended the gathering in Nashville and endorsed its recommendations. She wrote later in 2015: "The AAS supported this meeting because we believe deeply in equity and inclusion, and in making sure that qualities

[88] American Astronomical Society (2015), 6–8.

[89] American Astronomical Society (2015), 21–22.

[90] American Astronomical Society (2015), 39.

[91] Hamilton (2018).

that aren't relevant to the practice of astronomy not be used in determining one's suitability for it."[92] At a subsequent AAS conference in January 2016, the Council unanimously approved the formation of the Working Group on Accessibility and Disability with Wanda Díaz-Merced as co-chair. Ironically, Urry herself injured her knee during the first day of the event and was thus bound to an electric cart. This accident was eye-opening. "It's hard to read posters from below, it's difficult to get lunch quickly when it means at least two elevator rides," she found out. "All conversations center on the disability (what happened? are you all right? and lots of extremely kind concern expressed by colleagues)." She thus made her own list of desired modifications for congresses. They included lap desks for buffet meals, ramps for speaking platforms, and chairs for people who cannot stand for long.[93]

Urry's knee injury was related to arthritis, from which she had been suffering in secret for 25 years. Despite her sympathies for disabled colleagues, Urry only revealed her condition after having completed her term as AAS president in 2016. She cherished an image of herself as a "high-energy person," even though recurring inflammations drained her. "I chose not to mention my physical challenges openly because I thought it might allow others to decide for me what I could or could not do," she admitted. "Would they think, 'Meg is slowing down, we'd better not think of her'?" she worried. However, a member of the newly created WGAD convinced her that when leading scientists like herself disclose their disabilities, they could become role models for others and push back against discrimination.[94]

The newly created Working Group on Accessibility and Disability quickly reciprocated the support it had received from other activists. Díaz-Merced served on a multimodal access committee of the National Society of Black Physicists.[95] She and her colleagues also joined members of the Committee on the Status of Minorities in Astronomy in expressing support for the Black Lives Matter movement. In response to killings of African Americans by police, John Johnson of Harvard University and others signed a statement in 2016 affirming their commitment to "inclusion, support, and safety of every Black person in astronomy." WGAD expressed solidarity and urged the AAS Council to produce a resolution that "Black lives do matter, in language as strong and unambiguous as possible." A letter signed by Díaz-Merced, Alicia Aarnio and others warned that "failing to publicly denounce recent racist events that strongly affect Black scientists constitutes an abdication of the Society's responsibility to actively create a supportive community for its members of color."[96]

The leadership of the American Astronomical Society, indeed, responded to the calls by its diversity committees. Although Urry's successor as president, Christine Jones, had much less of an activist profile, she adopted similar stances. "I am very pleased that the AAS Council has endorsed the Nashville vision statement for

[92] Conover (2015), 9.

[93] Urry (2016).

[94] Urry (2016).

[95] Aarnio et al. (2015), 7.

[96] Aarnio (2016).

making astronomy more inclusive," Jones said in July 2016. "Offering equal opportunities for people of all races, genders, sexual orientations, and physical abilities to participate in astronomy will benefit both our science and our nation."[97] In September of that year, the president again expressed support for scientists who were suffering under racism. "Together with the Council, I affirm our complete and unwavering support for all our colleagues whose experiences in the workplace often differ significantly from those of the majority." Jones added that the "painful events that gave birth to and sustain the Black Lives Matter movement remind us that considerable work still needs to be done to ensure that the climate within our profession is welcoming for everyone."[98]

Getting the American Astronomical Society to make official statements on such divisive topics as race was the result from pressure by numerous constituents. Even within the young Working Group on Accessibility and Disability, Díaz-Merced was only one of several loud voices. Similarly active was Jesse Shanahan, a younger woman with an unusual path to science. In 2013, she completed a bachelor's degree in Arabic linguistics and philosophy at the University of Virginia. Only in her last semester had she taken a course in astrobiology. This was thus too late for her to change her major. When she presented her senior thesis at a linguistics conference, she wandered over to the department of physics and astronomy in search of advice. A professor suggested that she work as a research assistant at George Mason University back in her home state. For more than a year, she helped analyze data about dwarf galaxies collected by the Spitzer Space Telescope while auditing classes in physics. From there she enrolled in a master's degree program in astronomy at Wesleyan University that was designed for unconventional students. "She was about as nontraditional as we've ever gotten," said her department head. "She displayed tremendous enthusiasm and passion."[99]

Shanahan's inner drive was needed, as she encountered numerous obstacles on her path to the heavens. Ehlers–Danlos syndrome, a rare connective-tissue disorder, hindered her mobility, requiring her to often use a cane.[100] During her first year of graduate school, she could not use any of the telescopes in the observatory, as she was unable to climb the stairs to reach them. Major national facilities like the Arecibo Observatory in Puerto Rico and the Green Bank Telescope in West Virginia posed similar challenges. "Everything required the ability to walk distances, climb hills, or climb stairs," Shanahan said.[101] On top of that, she carried an extra financial burden. "Between medications, doctors' appointments, specialist appointments, testing, imaging, physical therapy, and mobility aids, my disability costs my partner and I almost 1/3 of our total income," she calculated. With her geneticist being an eight-hour drive away, travel and incidental expenses brought the cost of her

[97] Fienberg and Marvel (2016).

[98] Christine Jones (2016).

[99] Wilson (2015).

[100] Wilson (2015).

[101] Shanahan (2015a).

treatment up to half of what the couple was making. "Unreasonably," as she saw it, Wesleyan University was offering supplemental stipends for dependents, but not for a disability.[102]

Along the way, Shanahan endured harassment based on disability as well as her gender. Several professors met her requests for accommodations under the Americans with Disabilities Act with disbelief. "My need for rest or flexible deadlines was consistently interpreted as laziness rather than an actual physical need," she wrote. She had similar experiences at the first AAS meeting she attended. "I had to sit in front of my poster rather than stand, and I was harassed for it."[103] At her university, she filed a complaint against a fellow graduate student who subsequently came out as a transwoman. Her colleague belittled her abilities as a scientist, Shanahan claimed. The transwoman also started unwelcome discussions about sex and sent her explicit poems. The institution found the abuser guilty of harassment, but allowed her to remain a student under the condition that she underwent training and avoided such behavior.[104] Shanahan herself, in contrast, left Wesleyan University without completing her master's degree.

For her own benefit as well as to serve others, Shanahan engaged in diversity work while a student. In response to her concerns, Wesleyan University partnered with an architect to make at least parts of its century-old observatory building wheelchair-accessible. A plan drafted in 2015 contained a ramp leading to the ground floor, but not to the dome with its twenty-inch telescope. A camera attached to the instrument would allow for remote observation.[105] During the same year, Shanahan participated in the Inclusive Astronomy conference in Nashville and expressed support for its vision. "Talent is not restricted to one group, so when you limit yourself to one group, you're necessarily excluding a lot of talent, a lot of genius," she explained. "A lot of people in science like to claim that this is a true meritocracy, and that's not true." Unlike at previous gatherings, she felt valued at Vanderbilt. "The organizers worked incredibly hard to create a space where people would be respected, listened to."[106]

Although Shanahan's studies at Wesleyan did not culminate in a graduate degree, she was very dedicated to advancing her profession. She was one of the co-founders of the Working Group on Accessibility and Disability and served on the society's Early Career Advisory Board. Together with Sarah Tuttle of the McDonald Observatory in Texas, among others, she also formed an Astronomy Anti-Racism Group (AARG!) in 2015.[107] The following year, she published an article in *Science* magazine under the title "Disability is not a disqualification." She narrated how she overcame various barriers, including flights of stairs and pressure by professors to

[102] Shanahan (2015b).

[103] Shanahan (2015a).

[104] Wilson (2015).

[105] Lee (2015).

[106] Conover (2015).

[107] Aarnio et al. (2015), 10.

sacrifice her health for success. Yet, she still encountered what she called the "erroneous assumption that ableness is a prerequisite for scientific achievement." She wrote, "I hope to be a conspicuous example of a disabled astronomer so that future students with disabilities do not feel as isolated as I did."[108] To spread her message on social media, she created the hashtag #disabledandSTEM.

Despite her best efforts, Shanahan still found academic career opportunities difficult to access after having dropped out of her master's degree program. In 2016, she tweeted, "The AAS should make an accessibility officer position and hire me. #dreamjob." This aspiration remained unrealized, notwithstanding some public support from fellow activist John Johnson at Harvard University.[109] Between 2018 and 2019, the disabled astronomer worked as research assistant at the University of California, San Diego, undertaking statistical analyses of galaxies. Thereafter, she offered her skills as a data scientist to private industry. At Booz Allen Hamilton in Washington, DC, and at Peltarion in Sweden, she applied artificial intelligence to much more terrestrial matters, including cybersecurity and health.

Despite her challenges with physical mobility, Shanahan was able to travel both inside and outside the United States of America. Other members of the Working Group on Accessibility and Disability too overcame national borders alongside other kinds of barriers. This was the case with the Puerto Rican Wanda Díaz-Merced. While being an employee of the IAU's Office of Astronomy for Development in South Africa, she remained on the move. In 2016, she co-organized a workshop on Astronomy beyond the Common Senses for Accessibility and Inclusion. This was part of the Latin American Regional IAU Meeting in Cartagena, Colombia. For the event, she teamed up with members of a recently established IAU Working Group on Astronomy for Equity and Inclusion.

As a Puerto Rican, Díaz-Merced found it especially easy to liaise with fellow Spanish speakers. The founding chair and vice-chair of the new IAU working group were both Hispanophones: Beatriz García of Argentina's Institute of Technology in Detection and Astroparticles, and Amelia Ortiz-Gil of the University of Valencia in Spain. When forming the committee in 2013, they formulated the following mission statement: "Create strategies, tools, resources to provide people with special educational needs or people with visual, hearing and / or motor disabilities, a learning and participative space, accessible, interesting and educational, without neglecting the basics of scientific dissemination, ensuring interaction in a playful context." Accordingly, the group's first goal was to bring together "educators and disability specialists to develop new teaching and learning strategies."[110]

In order to realize their vision, García and her associates relied on a global network. The disability efforts by Amelia Ortiz-Gil and colleagues in Spain had been sparked by the International Year of Astronomy. "We felt that it was a once in a lifetime opportunity to reach to social groups which are not usually so well attended

[108] Shanahan (2016).

[109] John Johnson (2016).

[110] Greve (2013), 6.

by the regular astronomy outreach and popularization efforts," they wrote about the worldwide celebration. The Spanish researchers thus translated an Italian online course for blind people and printed its contents as a braille book. Based on work done in Argentina, they further developed a planetarium show for visually impaired people. Particular sounds were associated with each celestial object in the script.[111]

The Spanish astronomers were aware of the work by Noreen Grice and Vivian Hoette in the United States and sought to go beyond it. As Ortiz-Gil put it, images by her American peers were tactile, but still portrayed objects like the Moon as essentially "flat." In contrast, she used 3D printers to produce round models of Earth's natural satellite (Fig. 5.5). For clarity, the objects had simplified surface features and braille letters on top of smooth rectangles for descriptions. First testing of prototypes occurred at the universities of Valencia and Puerto Rico. Subsequently, blind users in Portugal, Italy, Ireland, Argentina, Brazil and India gave their input. The final design allowed for a "full Moon feeling," in Ortiz-Gil's words.[112] Subsequently, funding by the Office of Astronomy for Development enabled her group to create a similar representation of Venus for "a tactile voyage through the solar system."[113]

After Ortiz-Gil had involved colleagues from several countries in the development of the planetary models, another major global event for the astronomical profession enabled her to distribute the pieces even further. Her touchable Moon and Venus were on display at a new exhibition called Inspiring Star. This show was part of the centenary celebrations of the International Astronomical Union. It was launched at the organization's General Assembly in Vienna, Austria, in 2018. From there, the exhibit toured Europe and other parts of the world. In January 2019, Kotebe Metropolitan University in Addis Ababa, Ethiopia, hosted both the Inspiring

Fig. 5.5 Models of Mercury, Venus, Earth, the Moon and Mars at the Astronomical Observatory of the University of Valencia in 2021. (Courtesy of Amelia Ortiz-Gil)

[111] Ortiz-Gil et al. (2011), 839–42.

[112] Ortiz Gil (2012).

[113] Ortiz-Gil et al. (2019).

Stars Exhibition and an inclusion workshop. Around 200 people attended, and Abebe Kebede from North Carolina A&T State University gave a keynote speech.[114] In October, as part of World Space Week, a similar event was held in in the Iranian capital Tehran.[115]

In November 2019, Inspiring Stars came to Japan for one of the biggest international events of the inclusive astronomy movement thus far. The exhibition formed part of an IAU symposium on Astronomy for Equity, Diversity and Inclusion. This conference was hosted by the National Astronomical Observatory of Japan (NAOJ) in Mitaka, Tokyo. It was thus in a part of the metropolis that also hosted animation studies producing science fiction. The event's scientific organizing committee comprised Beatriz García, Amelia Ortiz-Gil and Wanda Díaz-Merced, among others. Locally, they were supported by Japanese outreach professionals, among them Kumiko Usuda-Sato of the NAOJ and Shin Mineshige of Kyoto University. Eliminating barriers for disabled people was again one of the main goals of this group. Ortiz-Gil and her colleagues proposed such topics as "Data Accessibility for Blind and Visually Impaired Astronomers and Citizen Scientists."[116]

Díaz-Merced's Japanese peers were sighted, but likewise had years of experience working with disabled people. Mineshige had led a Universal Design Working Group as part of the Japanese Society of Education and Popularization of Astronomy. A decade before the IAU symposium, Mineshige had already produced a multimodal astronomy textbook. Aware of Noreen Grice's work, he had gone beyond making another braille text about the universe. His book offered four different versions of the same content: normal print, braille, audio and electronic forms. The digital version allowed for the magnification of letters and the change in background colors. The different modalities were meant to appeal not just to totally blind people, but also those with low vision or dyslexia.[117] In the 2010s, Mineshige and Usuda-Sato had organized several symposia on universal design at the NAOJ. Proceedings were published on a voice browser–friendly website. Moreover, the NAOJ printed touchable, three-dimensional models of its Subaru Telescope in Hawaii.

Although key organizers of the IAU symposium on Astronomy for Equity, Diversity and Inclusion had their main expertise in disability, the coverage of their event was broader. The identities they addressed included gender, ethnicity and culture as well. Besides the universal design conferences, the organizers took note of wider diversity efforts in Japan. Internationalization policies, for instance, "have steadily grown since the 1980s." The NAOJ specifically had also promoted a "gender balanced workplace." The 2019 event was meant to contribute to inclusiveness further, "making astronomy truly accessible to all." As the host, the National

[114] Yacob (2019).

[115] Sharbaf (2019).

[116] Ortiz-Gil (2017).

[117] Mineshige et al. (2009).

Astronomical Observatory promised "to be an agent of change hand-in-hand with the IAU."[118]

The Mitaka symposium then facilitated a global conversation not just about disability, but also about gender and other topics. Yuko Motizuki from Japan's Institute of Physical and Chemical Research (RIKEN) complained in a keynote speech that women represented only about 18% of astronomers worldwide. Her own country was even more "gender-imbalanced," as she put it. Female astronomers in Japan made up 12%. Among associate and full professors, it was 1.5%. She asked, "How can we solve these problems?" Jarita Holbrook, then at the University of the Western Cape in South Africa, gave some suggestions in her own lecture: "class meeting times 10am – 2pm or evenings to allow mothers to schedule around child pickup and drop-offs, the same for colloquia/departmental events, childcare grants for conferences across the field, cross-cultural training, training in active listening, anti-bias training, and cohort building."[119]

Holbrook partly expected the Mitaka symposium to produce some practical guidelines for combining work with parental responsibilities. Beyond that, she argued for a more profound transformation of her discipline. Her keynote address was entitled "Using Cultural Astronomy to Create a More Inclusive Astronomy." She saw the latter as either part of, or adjacent too, a worldwide movement to "decolonize" the curriculum and the wider academy. The goal was to "better attract and retain people embodying all types of diversity."[120] If childcare support for specific events had become relatively uncontroversial, "decolonization" – like any broad change – required new battles to be fought. Stakes were high, as large astronomical instruments became ever more expensive. This was no more evident in the struggles over the Thirty Meter Telescope in Hawaii.

References

Aarnio, Alicia. 2016. "Black Lives Matter -- In Solidarity." Access: Astronomy. http://accessastronomy.blogspot.com/2016/07/black-lives-matter-in-solidarity.html.

Aarnio, Alicia, Wanda Díaz-Merced, Lauren Gilbert, Jennifer L. Hoffman, Jessica Kirkpatrick, Karen Knierman, Elisabeth A.C. Mills, et al. 2015. "Proposal to Form the AAS Working Group on Disability and Accessibility." American Astronomical Society. https://aas.org/sites/default/files/2019-09/Proposal-Working-Group-on-Disability-and-Accessibility.pdf.

Airhart, Marc G. 1997. "The Universe in Your Hands." *Mercury* 26: 14–17.

Amde, Amdeselassie Atske, Abebe Kebede, and Dawit Lebenie, eds. 2013. "Listening to the Stars; A Biography of Dr. Wanda Díaz Merced." In *The 3rd Gondar School of Science & Technology (GSST – 2012)*, 86–90. Gondar: University of Gondar.

[118] Ortiz-Gil (2017).

[119] Canas and Usuda-Sato (2019).

[120] Canas and Usuda-Sato (2019).

American Astronomical Society. 2015. "Inclusive Astronomy 2015 Recommendations (or the 'Nashville Recommendations'): Final Version for AAS Council Endorsement of Vision Statement." American Astronomical Society.

Anderson, Colleen. 2020. "Youth Space Education and the Future of the GDR." *Central European History* 53, no. 1: 146–67.

Broad, William J. 1985. "Luminaries Scan Heavens for Sign of Cosmic Aliens." *Chicago Tribune*, April 16, 1985.

Canas, Lina, and Kumiko Usuda-Sato. 2019. "Keynote Speakers." Astronomy for Equity, Diversity and Inclusion. https://iau-oao.nao.ac.jp/iaus358/keynote/.

Candey, Robert M., Ramona L. Kessel, and Justin R. Plue. 1998. "Web-Based Sonification of Space Science Data." In *SIGGRAPH 98: Conference Abstracts and Applications*, 290. New York: Association for Computing Machinery.

Chandler, David L. 2003. "To Touch the Heavens." *Smithsonian* 34, no. 5: 103–6.

Chavez, Erika. 1998. "Blind Physicist's Quest: Save Braille From Extinction." *Los Angeles Times*. https://www.latimes.com/archives/la-xpm-1998-apr-21-me-41495-story.html.

Conover, Emily. 2015. "Inclusive Astronomy Conference Confronts Diversity Issues in Science." *CSWP & COM Gazette* 34, no. 2: 7, 9.

Cullers, Kent. 2002. "Foreword." In *Touch the Stars*, by Noreen Grice, viii–xiii, fourth edition. Boston: National Braille Press.

Department of Science and Technology. 2014. "Blind Astronomer Inspires Pupils to Reach for the Moon and the Stars." Department of Science and Technology. https://www.dst.gov.za/old-site-backup/index.php/media-room/communiques/912-blind-astronomer-inspires-pupils-to-reach-for-the-moon-and-the-stars.

Diaz-Merced, Wanda. 2011. "The Sounds of Science." *Physics World* 24, no. 6: 42–43.

Diaz-Merced, Wanda L. 2013a. "Sound for the Exploration of Space Physics Data." PhD thesis, University of Glasgow.

Diaz-Merced, Wanda L. 2013b. "Many Ways of Seeing Things." In *The 3rd Gondar School of Science & Technology (GSST – 2012)*, edited by Amdeselassie Atske Amde, Abebe Kebede, and Dawit Lebenie, 91–99. University of Gondar.

Diaz Merced, Wanda. 2016. "How a Blind Astronomer Found a Way to Hear the Stars." TED. https://www.ted.com/talks/wanda_diaz_merced_how_a_blind_astronomer_found_a_way_to_hear_the_stars/transcript.

Diaz-Merced, Wanda L., Alina Marrero-Hernandez, John C. Mannone, and Robert M. Candey. 2007. "Artistic Expression of Sonified Data." In *EPO and a Changing World: Creating Linkages and Expanding Partnerships*, 46. Astronomical Society of the Pacific.

Diaz-Merced, Wanda L., Robert M. Candey, John C. Mannone, Fields David, and Emilio Rodriguez. 2008. "Sonification for the Analysis of Plasma Bubbles at 21 MHz." *Sun and Geosphere* 3, no. 1: 42–45.

Dolby, Thomas. 2016. *The Speed of Sound: Breaking the Barriers Between Music and Technology*. New York: Flatiron Books.

Donson, Billy. 2015. "A Radio Jove Telecon with South African Students." *The JOVE Bulletin*. https://radiojove.gsfc.nasa.gov/library/newsletters/2015Jul/.

Ebuy, Kibrom. 2011. "Ethio-Jove: A Progess Report from the Radio Jove Ethiopia Teams." *The JOVE Bulletin*. https://radiojove.gsfc.nasa.gov/library/newsletters/2011Nov/.

Fienberg, Rick, and Kevin B. Marvel. 2016. "AAS Endorses Vision Statement for Inclusive Astronomy." American Astronomical Society. https://aas.org/media/press-releases/aas-endorses-vision-statement-inclusive-astronomy.

Garcia, Leonard. 2005. "Radio Jove Participants from Puerto Rico Participate in the Shirohisa Ikeda Education Project." *The JOVE Bulletin*. https://radiojove.gsfc.nasa.gov/library/newsletters/2005Jun/.

Gilder, Joshua, and Anne-Lee Gilder. 2005. *Heavenly Intrigue: Johannes Kepler, Tycho Brahe, and the Murder Behind One of History's Greatest Scientific Discoveries*. New York: Anchor Books.

Goodricke, John. 1783. "A Series of Observations on, and a Discovery of, the Period of the Variation of the Light of the Bright Star in the Head of Medusa, Called Algol." *Philosophical Transactions of the Royal Society of London* 73: 474–82.

Greenfieldboyce, Nell. 2008. "An Astronomy Book the Blind Can Appreciate." NPR. https://www.npr.org/templates/story/story.php?storyId=18137734.
Greenlees, George. 2015. "The Astronomer's Nose: Tycho Brahe's Controversial Prosthesis." *ENT and Audiology News* 24, no. 4.
Greve, Jean-Pierre de. 2013. "Message from the President." *IAU Commission 46: Astronomy Education and Development: Newsletter* 78: 4–10.
Grice, Noreen A. 1988. "Astronomy for Special People." *The Planetarian* 17, no. 3: 18–20.
Grice, Noreen. 1993. "Women's Roles in America's Planetariums." In *Women in Astronomy*, edited by C. Megan Urry, Laura Danly, Lisa E. Sherbert, and Shireen Gonzaga, 143–44. Baltimore: Space Telescope Science Institute.
Grice, Noreen. 1996a. "Making Planetariums and Science Museums More Accessible for People with Disabilities." In *Astronomy Education: Current Developments, Future Coordination*, edited by John A. Percy, 210–11. San Francisco: Astronomical Society of the Pacific.
Grice, Noreen. 1996b. "A New Planetarium Captioning System for the Hearing-Impaired." *Planetarian* 25, no. 4: 8–9, 64.
Grice, N. A. 2004. "Astronomy for Blind and Visually-Impaired People." In *Organizations and Strategies in Astronomy*, edited by André Heck, 5:217–31. Dordrecht: Kluwer Academic Publishers.
Grice, Noreen. 2007. "The Touch of Astronomy." *Mercury* 36, no. 3: 18–23.
Grice, Noreen. 2011. "Students' Learning and Employment: Stories from the Field." *Physics Today* 64, no. 4: 8.
Grujic, P. 1986. "Portrait of a Physicist." *Physics Bulletin* 37, no. 1: 3.
Hamilton, Stephanie. 2018. "Meet the AAS Keynote Speakers: Keivan Stassun." *Astrobites*. https://astrobites.org/2018/06/05/meet-the-aas-keynote-speakers-keivan-stassun/.
Hawking, Stephen W. 2011. "Foreword." In *World Report on Disability*, ix. World Health Organization.
Henschel, Gerhard. 1965. "Astronomie in der Oberschule für Sehgeschädigte." *Blick in das Weltall* 9: 80–87.
Henschel, Gerhard. 1967. "Neue astronomische Lehrmittel für Sehgeschädigte." *Die Gegenwart: Magazin für blinde und sehbehinderte Menschen und ihre Freunde* 6: 9–11.
Hick, P., and G. Stevens. 1987. "Approximate Solutions to the Cosmic Ray Transport Equation: The Maximum Entropy Method." *Astronomy and Astrophysics* 172: 350–58.
Jaworek, Gerhard. 2015. *Blind zu den Sternen: Mein Weg als Astronom*. Baden-Baden: Aquensis.
Johnson, John. 2016. "(Un)Accessible Astronomy: Ableism in Science." Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2016/01/unaccessible-astronomy-ableism-in.html.
Jones, Christine. 2016. "President's Column: Making Astronomy Welcoming & Safe for All." American Astronomical Society. https://aas.org/posts/news/2016/09/president%E2%80%99s-column-making-astronomy-welcoming-safe-all.
Koren, Marina. 2017. "How Blind Astronomers Will Observe the Solar Eclipse." *The Atlantic*. https://www.theatlantic.com/science/archive/2017/08/experiencing-eclipses-without-seeing/535551/.
Kraus, Simon Friedrich. 2015. "Astronomie für Blinde und Sehbehinderte: Legitimation – Konzepte – Modelle – Materialien." Dissertation, Universität Siegen.
Lang, Harry G. 1994. *Silence of the Spheres: The Deaf Experience in the History of Science*. Westport: Bergin & Garvey.
Lee, Max. 2015. "Observatory Builds a Ramp to the Cosmos." *The Wesleyan Argus*. http://wesleyanargus.com/2015/10/22/ada-disability-van-vleck-observatory/.
Mack, Pamela E. 1990. "Straying from Their Orbits: Women in Astronomy in America." In *Women of Science: Righting the Record*, edited by G. Kass-Simon and Patricia Farnes, 72–116. Bloomington: Indiana University Press.
Meola, Denise. 1994. "Ode for a Soundless Universe: Uncovering the Celebrated Music of the Spheres." *Omni* 17, no. 2: 22.
Mineshige, Shin, Jun Takahashi, and Hideji Nagaoka. 2009. "Multi-Modal Textbook on Astronomy." *Astronomical Herald* 102, no. 9: 543–51.

Nakamura, Masayuki, and Shuichi Kikuchi. 2013. "A New Perspective of Art Expression for the Blind and Visually Impaired: Plural Images by Component Orders on Swell Paper." *Community Development Studies* 17: 1–24.

New Scientist. 2007. "Stephen Hawking Gets Taste of Zero Gravity." *New Scientist*. https://www.newscientist.com/article/dn11730-stephen-hawking-gets-taste-of-zero-gravity/.

Ortiz Gil, Amelia. 2012. "Full Moon Feeling." Presentation at the European Planetary Science Congress, Madrid.

Ortiz-Gil, Amelia. 2017. "LoI 2019–2000: Astronomy for Equity, Diversity and Inclusion -- a Roadmap to Action within the Framework of IAU Centennial Anniversary." International Astronomical Union. https://www.iau.org/science/meetings/proposals/loi/2019/2000/.

Ortiz-Gil, A., P. Blay, A. T. Gallego Calvente, M. Gómez Collado, J. C. Guirado, M. Lanzara, and S. Martínez Núñez. 2011. "A Fascinating Adventure: Astronomical Activities for People with Disabilities during IYA 2009." In *Highlights of Spanish Astrophysics VI*, edited by M. R. Zapatero Osorio, J. Gorgas, J. Maíz Apellániz, and J. R. Pardo, 839–44. Barcelona: Spanish Astronomical Society.

Ortiz-Gil, Amelia, Jordi Burguet-Castell, Enrique Pérez-Montero, Fernando Ballesteros, Lina Canas, Alberto Fernández-Soto, Andrés Gálvez, et al. 2019. "A Tactile Voyage Through the Solar System: Venus." *EPSC Abstracts* 13.

People. 1996. "From the Vastness of Space, a Little Traveling Music." *People* 46, no. 14: 98.

Rossiter, Margaret W. 1995. *Women Scientists in America: Before Affirmative Action, 1940–1972*. Baltimore: Johns Hopkins University Press.

Schmadel, Lutz D., ed. 2003. "(27748) Vivianhoette." In *Dictionary of Minor Planet Names*, Fifth Revised and Enlarged Edition., 882. Berlin: Springer.

Schrieberg, David. 1997. "Hollywood Gives SETI Its Big Break." *Christian Science Monitor*, August 6, 1997.

Science. 1990. "Hawking Appeals for Handicapped." *Science* 249, no. 4966: 245.

Shanahan, Jesse. 2015a. "Accessible Astronomy." *Women In Astronomy*. http://womeninastronomy.blogspot.com/2015/11/accessible-astronomy.html.

Shanahan, Jesse. 2015b. "Part I: Being Disabled Is Damn Expensive!" Medium. https://medium.com/@enceladosaurus/part-i-being-disabled-is-damn-expensive-fc34393849ba.

Shanahan, Jesse. 2016. "Disability Is Not a Disqualification." *Science* 351, no. 6271: 418.

Sharbaf, Sepideh. 2019. "Inspiring Stars in Tehran." Inspiring Stars. https://sites.google.com/oao.iau.org/inspiringstars/istehran.

Softky, Marion. 2003. "Blind -- and Looking for ET." The Almanac. https://www.almanacnews.com/morgue/2003/2003_07_30.blind.html.

Sun Sentinel. 1996. "Star-Trek Guide with Sex Appeal." *Sun Sentinel*. https://www.sun-sentinel.com/news/fl-xpm-1996-07-21-9607160250-story.html.

Terenzi, Fiorella. 1998. *Heavenly Knowledge: An Astrophysicist Seeks Wisdom in the Stars*. New York: Avon.

Urry, C. 2016. "Past President's Column: A Day in the Life of a Disabled Astronomer." American Astronomical Society. https://aas.org/posts/letter/2016/07/past-presidents-column-day-life-disabled.

Watson, Peter G. 2009. "The Enigma of Galileo's Eyesight: Some Novel Observations on Galileo Galilei's Vision and His Progression to Blindness." *Survey of Ophthalmology* 54, no. 5: 630–40.

West, Richard M., ed. 1985. *International Astronomical Union Information Bulletin* 53. Dordrecht: D. Reidel.

Williams, John M. 2001. "The Blind Physicist Who May Find E.T." *Braille Monitor* 44, no. 10.

Wilson, Robin. 2015. "Female Astronomers: Outsiders in Their Field." *Chronicle of Higher Education*. https://www.chronicle.com/article/Female-Astronomers-Outsiders/234298.

Woodmansee, Laura S. 2003. "Women of Space: Cool Careers on the Final Frontier." Burlington: Apogee.

Yacob, Alemiye Mamo. 2019. "Inspiring Stars Exhibition and Inclusion Workshop Gather More than 200 Participants." Inspiring Stars. https://sites.google.com/oao.iau.org/inspiringstars/january2019ethiopia.

Chapter 6
Decolonizing Space

"The Thirty-Meter Telescope is in trouble," wrote Sandra Faber of the University of California, Santa Cruz, in an email to friends in April 2015. She warned that the billion-dollar project was being "attacked by a horde of native Hawaiians who are lying about the impact of the project on the mountain and who are threatening the safety of TMT personnel." She complained that local police were refusing to arrest the protestors who were blocking the roads for construction vehicles. She thus urged her circles to add their names to a petition in support of the enormous instrument.[1] The request promised that the new telescope would "greatly benefit the local communities of Hawaii Island, the State of Hawaii, and the world with its anticipated scientific contribution." The appeal also sought to reassure that "after a seven-year public and agency review," the TMT had received all required state and county permits.[2]

The original petition shared by Faber was not created by an employee of the TMT corporation. Instead, the author, Mailani Neal, identified herself as "an 18 year-old, Native Hawaiian girl in high school with loving passion for astronomy and my culture." Neal further emphasized commonalities between indigenous islanders and professional scientists from elsewhere. "The Ancient Hawaiians were astronomers by nature," she explained. "They used the stars and other celestial objects to expertly navigate the Pacific Ocean to the Hawaiian Islands as well for many aspects of the culture such as fishing." The nineteenth-century king Kalākaua had supported modern astronomical observations as well.[3]

Neal's petition "We Support TMT" drew over 9000 signatures. However, Faber's email added to the troubles of the observatory. Alex Filippenko of the University of California, Berkeley, forwarded his colleague's email to his entire department with

[1] Solomon (2015).

[2] Neal (2015).

[3] Neal (2015).

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*,
Space and Society, https://doi.org/10.1007/978-3-031-46113-2_6

the words "I support what she says." Unlike him, many people found the description of native Hawaiians as a lying "horde" offensive. Faber herself quickly apologized for having used "inflammatory and insensitive language." She added, "I regret that I sent it in a hurry, without thinking through how the message was written or how it would be interpreted." Filippenko himself echoes this apology: "because at that moment I was attending (and trying to pay close attention to) an important administrative meeting, I sent the message before carefully reading Prof. Faber's specific wording." He acknowledged to have shown a "lack of respect for the views of the demonstrators."[4]

Faber and Filippenko's apologies hardly satisfied those outraged by the emails. Among those pushing back were not just many native Hawaiians, but also other astronomers who had long engaged in activism. Chanda Prescod-Weinstein, then at the Massachusetts Institute of Technology, and Sarah Tuttle of the McDonald Observatory collected their own list of signatures under a "short statement about the use of racist language in astronomy and physics." Prescod-Weinstein and Tuttle wrote that such language was "100% unacceptable, 24 hours a day, 7 days a week, 365 days a year. There is never an excuse for it." Both activists told offenders that "An apology cannot fix the harm caused by your use of racist language. Only education, reflection, and ultimately anti-racist action can. Be sorry that you were racist, not that you accidentally let it out in front of other people." The signatories that she was able to gather included fellow champions of minorities Jedidah Isler and John Johnson. LGBT activists Jane Rigby and Jessica Mink also added their names, as did disability rights campaigner Jesse Shanahan, among many others.[5]

Within a few weeks, the email row had escalated to a point that Meg Urry issued an official response as president of the American Astronomical Society. She acknowledged that most people in her discipline had discussed the Thirty Meter Telescope "in a respectful and fair manner." Yet, "a few remarks disrespectful to indigenous groups have tarnished the debate and greatly offended members of our community." She thus sought to express "very clearly, that racism is unacceptable, that referring to groups as monolithic is not acceptable, and that the AAS is firmly committed to an inclusive, welcoming, professional environment." The AAS president concluded that "only when all astronomers feel welcome and supported in the profession will our discipline realize its full potential for excellence."[6]

Even such an explicit statement by a leader of the astronomical profession failed to calm the storm that had arisen over Mauna Kea. For activists like Prescod-Weinstein and Johnson, Faber's email was one more proof that science itself needed to be changed. "There have been native students who have been saying privately, I'm not sure science is for me. I'm not sure astronomy is for me," commented Prescod-Weinstein. For her and Johnson, the solution to racism lay in a deep transformation of their field. "We're really looking to basically tear down the

[4] Stemwedel (2015).

[5] Prescod-Weinstein (2015).

[6] Urry (2015).

current structure that's in place in academia," explained Johnson.[7] In a *Women in Astronomy* blog post, he further wrote that "we'll only get to diversity by attacking the power structures that hold us back and stand in the way." He specified, "For gender diversity, the roadblock is sexism. For racial diversity, the roadblock is racism."[8]

It was in this context that Tuttle, Shanahan and others formed their Astronomy Anti-Racism Group (AARG!) in 2015. It was inspired by Young Mormon Feminists, another group that sought to end white supremacy. "Astronomy has a racism problem," Tuttle wrote on her *WordPress* site. "In fact, our society has a racism problem." She thus challenged her colleagues to undo the system that benefitted her and other white academics. For a period of 6 months, she laid strict ground rules. "To join this group you recognize that white supremacy and racism exists, and you want to do active work to dismantle it. You will be removed from the group if you demonstrate otherwise." Members had to create an action plan for themselves and report progress in a closed Facebook group every week. "If you fail to report for 2 weeks in a row, or 3 weeks total you will be removed from the group," Tuttle warned.[9]

In their anti-racism, younger astronomers like Prescod-Weinstein, Tuttle and Johnson were arguably more aggressive than many members of previous generations. Hakeem Oluseyi noted in an interview with me that older and earlier black scientists like Art Walker, George Carruthers, Charles McGruder or Shirley Jackson had "fought with letters" and "maintained a particular poise." In contrast, Johnson and Prescod-Weinstein's call was more like "Burn it down!" Oluseyi saw them as a "new group," calling them the "woke crowd." However, he appreciated the pursuit of a variety of strategies to advance people of color. "I think different approaches are great, like Malcolm X versus Martin Luther King."

In a departure from earlier generations, younger activists employed a new vocabulary. One of the most important terms was "decolonization." In using this word, astronomers referred less to the independence movements in colonies of European empires during the twentieth century. Instead, they meant an ongoing critique of Western worldviews, including those of mainstream science. In response to the controversy over the Thirty Meter Telescope, Prescod-Weinstein published a "Decolonising Science Reading List." She argued that "we must understand that Hawai'i is not the first or only place where astronomers used and benefited from colonialism." However, she emphasized that "science need not be inextricably tied to commodification and colonialism."[10]

By pursuing ideas like decolonization, astrophysicists like Prescod-Weinstein also sought to create an identity for themselves that was radically different from famous white and Western figures in the history of physics. "I don't have to end up like Newton, who served as warden of The Royal Mint in the late 1600s and was

[7] Solomon (2015).

[8] John Johnson (2014).

[9] Tuttle (2015a).

[10] Prescod-Weinstein (2019).

said to enjoy his ability to burn at the stake, hang, and torture coin counterfeiters," Prescod-Weinstein wrote in a book entitled *The Disordered Cosmos* in 2021 "I don't have to end up like J. Robert Oppenheimer, the brilliant and tragic theoretical physicist who oversaw the creation of the first nuclear weapons and spent the rest of his life trying to undo the damage." The black scientist dreamed of rescuing physics from "its historical place in the hands of violently colonial nation-states."[11]

Just Science

Chanda Prescod-Weinstein did not mince words. In her volume on *The Disordered Cosmos*, she even called Isaac Newton "a complete asshole."[12] No surprise then that she also became a target of attacks herself. Unlike some older astronomers like Charles McGruder, she attracted a large following on Twitter and soon many haters too. At the height of the controversy over the Thirty Meter Telescope in 2015, tweets of hers about white supremacy and systematic racism drew the attention of conservatives. Campus Reform, a website dedicated to exposing "liberal bias and abuses at universities," aggregated comments by her and channeled much anger at her.[13] Fortunately for Prescod-Weinstein, she had equally loud defenders such as Sarah Tuttle. She encouraged her colleagues to tweet with the hashtag #StandWithChanda and sign a "Statement of Solidarity." The latter went: "We support her and affirm our desire for a day when academics of color can work without being constantly harrassed, attacked, marginalized, and erased."[14]

While Prescod-Weinstein was particularly visible and vulnerable, she survived and thrived in part due to a strong network of young activists such as Tuttle. Another figure with a significant public persona was Lucianne Walkowicz, a fellow queer astronomer who preferred the pronoun "they." Based at the Adler Planetarium in Chicago, Walkowicz dedicated much time to outreach as well as research. In 2015, they signed Prescod-Weinstein's "short statement about the use of racist language in astronomy and physics." They also added their name under the "Statement of Solidarity" with her.

Very interested in decolonization, Walkowicz applied the concept even to places beyond Earth. In 2018, while holding a NASA chair in astrobiology, they organized a meeting at the Library of Congress under the title Decolonizing Mars. The event website explained: "Many people are used to hearing about 'colonizing Mars' to talk about humanity living in space; here, we examine how using a colonialist framework in space reproduces past harm from humanity's history on Earth." The intention was therefore to envision "fresh pathways for thinking about space

[11] Prescod-Weinstein (2021), 7.

[12] Prescod-Weinstein (2021), 134.

[13] Tuttle (2015b).

[14] Tuttle (2015c).

exploration by stepping away from the ways we usually talk about space, which by definition is 'decolonizing' the topic."[15]

With the idea of decolonizing Mars, Walkowicz also sought to move beyond the tropes of much science fiction. Besides space colonies, the astronomer problematized the notion of the frontier, which was used in *Star Trek* and other works of fiction. They feared that the cowboy mythology that had promoted the murder and displacement of indigenous people in the American West would be used to justify missions to space. Those particularly invested in space expansionism included heads of technology companies like Elon Musk and Jeff Bezos. "The people for whom the American frontier myth were constructed, who were primarily white men, also now have the narrative of space," Walkowicz warned. "And because tech is so incredibly non-diverse, and has been so slow to change even in those small ways in which it has, I think a lot of those narratives go unquestioned."[16]

Despite Walkowicz's best efforts, many commentators still did not take Decolonizing Mars seriously. As the event was held in Washington, its website recognized the Piscataway and Pamunkey Peoples as traditional owners of the area. The organizer further stated: "We acknowledge the grave harm that colonialism brought to these lands, in particular the erasure of both indigenous and African identities not under only slavery, but via racist laws that segregated all peoples into binary classification of 'white' and 'black'."[17] One critic was unimpressed. "Mars is not populated and there are no indigenous people there. We aren't colonizing by taking away a thing from anyone." Using the pronoun "she" instead of Walkowicz's preferred "they," the commentator added: "She brings up indigenous people as if it matters in any way at all. We aren't even at the point of developing a planet and she wants to limit it to be inclusive."[18]

Other critics went beyond merely ridiculing Walkowicz and warned about what they considered the politicization of science. An article in the *American Conservative* had the ironic title "Mars Needs Social Justice Warriors!" However, rather than simply making fun of the queer astronomer, the essay denounced them as a "hardcore ideologue." The author worried that like communists, Walkowicz and others were policing language in a way to control people. Holding on the frontier narrative of space exploration, the writer lamented, "There is nothing that Social Justice Warriors won't attempt to take over, and ruin."[19] Another opponent, David Randall of the National Association of Scholars, cited the Decolonizing Mars event as evidence that "actual science has begun to bow to social justice." He cautioned that "If things go on, the quality of American scientists is likely to decrease sharply."

[15] Wall (2019).

[16] Haskins (2018).

[17] Walkowicz (2018a).

[18] Dowling (2018).

[19] Dreher (2018).

Ultimately, he worried about the "departure of world scientific leadership from America to countries less constrained by ideological rigidity."[20]

Walkowicz certainly tried to control the discourse in some of the spaces they were creating. Although the astronomer claimed inclusiveness, they restricted the participants of the Decolonizing Mars gathering. "Please note that attendance is by nomination/invitation only," said the code of conduct. On the list were Jarita Holbrook, Hakeem Oluseyi and Jesse Shanahan, among others. Behavior was regulated in an effort to create an "inclusive, collaborative environment." The rules stated: "We explicitly ban racism, sexism, homophobia, transphobia, and other kinds of bias – whether these behaviors are overt or subtle." Feigning surprise was forbidden, like "What?! I can't believe you don't know what X is!" Participants were also reminded not to correct other speakers by interrupting them with the words "well, actually…" Distinguishing the meeting from others, Walkowicz called it an "unconference."[21]

Unsurprisingly, the unusual character of Walkowicz's event raised further suspicions. Keith Cowing, a former NASA employee and journalist, referred to it as "yet another stealthy space meeting in Washington." Challenging the claim of inclusivity, he commented on his website NASA Watch that "they only seem to want like-minded attendees." Despite public tweets with the hashtag #decolonizemars, Cowing found that the attendee list was password-protected. "No media seem to have been allowed. No webcast. Nothing," the journalist commented. "This is just more DC choir practice in an echo chamber by a subset of the usual suspects." Given that the gathering was publicly funded, he criticized that the "remaining 99.9% of the people who pay for this party get left out."[22]

Despite criticism of Decolonizing Mars as a shady event, Walkowicz's outreach work as a whole also put them into the limelight. During the 2010s, they gave TED talks that garnered millions of views. One from 2011 was entitled "Finding planets around other stars."[23] Two subsequent presentations were more political. "The sky is inherently democratic. It's accessible, in principle, anyway, by anyone, everywhere, just simply by the act of looking up," they said at TEDxPhoenix. However, light pollution was ruining the view.[24] In their third lecture, Walkowicz told the audiences not to use Mars as a "backup planet." Rather than dreaming of the red planets as a future home for humanity, the astronomer urged their listeners to preserve Earth in the face of climate change. "It is hubris to believe that interplanetary colonization alone will save us from ourselves."[25]

Lucianne Walkowicz's lectures turned the astronomer into a celebrity. However, the scientist did not appreciate all the manifestations of this stardom. In 2018, the

[20] Randall (2019), 221.

[21] Walkowicz (2018b).

[22] Cowing (2018).

[23] Walkowicz (2011a).

[24] Walkowicz (2011b).

[25] Walkowicz (2015).

American toy company Mattel released a doll named Luciana Vega as a special edition of its American Girl series. The figure and the real-life researcher bore many resemblances, from interests in Martian exploration to hair and clothes. "The doll comes with a pink dress that I own a blue version of, that is a dress with a space print on it," the scientist commented. "The doll also has a pair of hologram shoes that resemble multiple pairs of shoes that I have." Walkowicz found none of this pleasing, however. "I don't think it's flattering for a company to take your life's work and identity and monetize it for their own purposes." Rather than embracing their look-alike, they sued the toy maker.[26]

Walkowicz used their prominence in support of a series of protests that erupted after the killing of George Floyd, an African American man, by a police officer in May 2020. Together with Chanda Prescod-Weinstein, Jedidah Isler, and others, they called for an academic strike in solidarity with all blacks. Using hashtags like #ShutDownSTEM and #ShutDownAcademia on social media, they urged their colleagues to pause their usual work for one day. Instead of studying the natural world, scientists were told to learn about racism and how to eradicate it. Various organizations, including the American Astronomical Society, endorsed the strike. The AAS Executive Office cancelled meetings on June 10. It further gave its staff the "option of using the day to find time and space for individual reflection, learning, and action."[27]

The organizers counted the names of over 5000 people who pledged to participate in the academic Strike for Black Lives.[28] Nevertheless, occurring during the coronavirus pandemic, their action arguably had little impact on the operations of scientific institutions. By June 2020, many university buildings across the world had already been closed for a few months. There would have been little point in picketing an astronomy department whose members had been used to remote work. Nonetheless, the organizers did their best to turn a lockdown into a shutdown. When I sent an email to Jedidah Isler's Dartmouth College address on the day of the strike, I received an automatic reply: "If you are a reporter, please email me at my non-work email or ping me via social media. However, I will not be responding to media requests on June 10, 2020."

Despite the reluctance of the organizers to speak to journalists on the day of the strike itself, the event earned coverage in the *New York Times*, on CNBC, and in other outlets. While many publications were sympathetic, a few also gave a platform to critics. The *Wall Street Journal* published a commentary by Lawrence Krauss, a well-known cosmologist and author of books like *The Physics of Star Trek* and *Beyond Star Trek: Physics from Alien Invasions to the End of Time*. Krauss's piece in the newspaper was entitled "The Ideological Corruption of Science." He argued that "while racism in our society is real, no data were given to support this claim of systemic racism in science." He thus accused the strike organizers of

[26] Steve Johnson (2020).

[27] American Astronomical Society (2020).

[28] Nord et al. (2020).

imposing an ideology from cultural studies on investigations of the natural world. They include a language of dominance and oppression, arguments against the existence of objective truth, and demands for scientists to become actively anti-racist and anti-sexist. Moreover, Krauss feared censorship and purges of dissenting scholars similar to those that had occurred under dictatorships like Nazi Germany or the Soviet Union. He thus urged academic leaders to "publicly stand up not only for free speech in science, but for quality, independent of political doctrine and divorced from the demands of political factions."[29]

Although a theoretical physicist rather than an observational astronomer, Krauss defended the Thirty Meter Telescope too. During the same month as his op-ed appeared in the *Wall Street Journal*, he gave an interview to the online magazine *Quillette* about "Why Identity Politics Should be Kept Out of Science." He acknowledged that "some indigenous people in Hawaii" were complaining about the construction of too many telescopes on their sacred mountain. Yet, he claimed that the planners of the TMT had recognized the "great sensitivity" of the project. Because "a group of young scientists" had bought into the idea that the observatory was racist, it might not be built. "That's a huge setback for science," he warned.[30]

An even better observing location than Mauna Kea would be outer space, beyond the interference of Earth's atmosphere. However, this realm did not remain out of reach for identity politics either. In the late 2010s, controversy arose over the James Webb Space Telescope (JWST), an even more ambitious and expensive project than the TMT. It was deployed about 1.5 million kilometers away from Earth. Technical challenges aside, the name rather than the place was the problem this time. The instrument was supposed to commemorate an official who had served as NASA administrator during the 1960s. While his record in overseeing the early astronaut programs was widely praised, other aspects of his career were questionable. Accusations centered on a stint as an undersecretary of state between 1949 and 1952. During this time, the moral panic known as the Lavender scare about homosexuals in the US government had begun. At the beginning of the Cold War, the Department of State established security principles that denied employment to people known for "sexual perversion" alongside communists and others. Recovering this history, two articles alleged that Webb had played a major role in the persecution of gay people. One of the essays, published in *Forbes*, was in part based on information by Chanda Prescod-Weinstein. It argued that "If we value inclusion in science, we should avoid naming our observatories for people who built their careers by tearing down others."[31]

Not all diversity activists were convinced by the allegations against James Webb. Hakeem Oluseyi, who had admired NASA's efforts at racial integration during the 1960s, found them disturbing. The scientist thus undertook his own research on the topic. He read that in 2011, a quote had been added to the Wikipedia page about

[29] Krauss (2020).

[30] Kay (2020).

[31] Francis (2015).

James Webb: "It is generally believed that those who engage in overt acts of perversion lack the emotional stability of normal persons." However, digging into the historical records, Oluseyi discovered that this sentence had been misattributed. He also came across "zero evidence" of other homophobic statements. He thus concluded that the articles from 2015 and related rumors "wrongly accused an innocent man who was, among more well-known achievements, a hero of diversity and inclusion in American government."[32]

Although Oluseyi had previously been on friendly terms with queer activists Prescod-Weinstein and Walkowicz, his attempt to exonerate Webb upset them. They argued that by holding a high position in the State Department, Webb bore responsibility for the dismissal of gay employees. "After 1950 he knew about it, was in charge, did nothing," tweeted Prescod-Weinstein. Walkowicz blogged that she was "extremely tired of straight people incorrectly explaining gay history." Moreover, she argued that "the scrubbing of Webb's historical record does active harm to LGBTQIA+ astronomers in the field today." Even if Webb had never publicly stated anything bigoted, he was still part of a discriminatory machinery. Oppression often worked as "a slow, bureaucratic death march of policy that leaves us with little to quote except the number of people whose lives it altered or ended."[33]

Countering Oluseyi's attempt to exonerate Webb, Prescod-Weinstein and Walkowicz teamed up with Sarah Tuttle to write an opinion essay in *Scientific American*. Their demand was clear from the title: "NASA Needs to Rename the James Webb Space Telescope." They claimed that the administrator's legacy was "best complicated and, at worst, complicit." Even if no homophobic quote could be attributed to him, he was still responsible for policies enacted under his leadership. Rather than honoring a senior official of a discriminatory administration, the new instrument should commemorate somebody who had "worked tirelessly to liberate others." Their choice was the abolitionist and former slave Harriet Tubman. She had used a network of safe houses known as the Underground Railroad to rescue enslaved people in the mid-nineteenth century. Previously, she had "likely used the North Star" to navigate to freedom herself.[34]

After opposing the academic Strike for Black Lives, the cosmologist Lawrence Krauss also criticized the attempt to rename the James Webb Telescope. To him, the former NASA administrator was being incriminated not because he had been a bigot himself, but because he had served a discriminatory government. "If encouraging diversity is the issue," Krauss wondered, there would be much better choices than Tubman who had not made "any contributions to astronomy." One suggestion of his was the Vera Rubin Space Telescope, after the astronomer who had uncovered evidence for the existence of dark matter. Another proposal would be the Jocelyn

[32] Oluseyi (2021).

[33] Walkowicz (2021a).

[34] Prescod-Weinstein et al. (2021).

Bell Burnell Space Telescope, after the discoverer of pulsars.[35] Both Rubin and Bell Burnell had also advocated strongly for women in science.

Krauss's recommendations of alternative names remained unrealized, however. Vera Rubin, who had died in 2016, already had a major facility named after her. In 2020, the Large Synoptic Survey Telescope (LSST) in Chile, while still under construction, had been renamed the Vera C. Rubin Observatory.[36] As for Bell Burnell, she was still alive and not American, but British. Naming a flagship mission after her would have thus broken with a tradition that had shaped the Compton, Hubble and Chandra spacecraft. Nonetheless, in 2020 as well, another large strategic science mission came to commemorate an American woman. The Wide-Field Infrared Survey Telescope was renamed the Nancy Grace Roman Space Telescope in recognition of a recently deceased former NASA Chief of Astronomy.

Discussions about the name of the JWST did not remain limited to a few voices, however loud. Hoping to gain strength in numbers, Walkowicz and the other authors of the *Scientific American* piece circulated a petition to rename the instrument. "This new mission reflects the rainbow of possible universes that our community imagines, dreams about, and works for, and its name should reflect its future legacy," the astronomers wrote. They cited a court case from the 1960s, in which a former NASA employee had sued for "review of his discharge for 'immoral conduct'." The scientists argued that if Webb deserved credit for the success of the Apollo program, he must also bear responsibility for the homophobic climate at the agency. Therefore, "Webb's legacy of leadership is complicated at best, and at worst, complicit with persecution." Putting forward again the abolitionist Harriet Tubman, the activist academics demanded that the next-generation "telescope be given a name worthy of its remarkable discoveries, a name that stands for a future in which we are all free."[37]

Posted online in May 2021, the petition had amassed over a thousand signatories by July. They included NASA employees and external scientists who had applied for observing time with the JWST. This was enough pressure for the leadership of NASA to start an investigation involving its acting chief historian, Brian Odom. "It's time for NASA to stand up and be on the right side of history," Walkowicz and the other co-authors urged the agency. "We believe the known historical record speaks clearly in favour of renaming the telescope." Some other activists still wanted to wait for the outcome of the inquiry. One of them was Rolf Danner, the chair Committee for Sexual-Orientation and Gender Minorities in Astronomy. "It's important to look at what happened and what the facts are," he said and refrained from signing the document. Unlike for the launch of the space telescope itself, NASA gave no timeline for the completion of the investigation. Odom noted that the COVID-19 pandemic was limiting historians' access to archives.[38]

---

[35] Krauss (2021).

[36] Mitton and Mitton (2021), 1.

[37] Walkowicz et al. (2021).

[38] Witze (2021a).

NASA's investigation concluded in September 2021 with a one-sentence statement. "We have found no evidence at this time that warrants changing the name of the James Webb Space Telescope," NASA Administrator Bill Nelson told the media. Odom explained further: "That doesn't mean there isn't evidence. It means that we found no evidence in this investigation."[39] No further details were given, and Walkowicz was furious. In October, the nonbinary scientist resigned from the NASA Astrophysics Advisory Committee. "People ask me to serve on advisory committees because I don't traffic in bullshit, and they will always get a real answer from me," they claimed in an open letter. "I don't play along when I think grave mistakes or poor choices are being made. And I don't participate in things that I find farcical." To them, NASA leadership seemed to prefer "a committee of Yes Men." It boggled their mind that the agency apparently had "so little insight into its own participation in systematic oppression."[40]

On Christmas Day 2021, the James Webb Space Telescope finally launched, having overcome the controversy over its name in addition to numerous technical obstacles. The event thus also refocused many activist astronomers on the research enabled by the instrument. Walkowicz acknowledged that the debate had been tiring. "I want to get excited about the new data that this telescope will produce. All of us just want to be excited about the data." Oluseyi also appeared tired of the divisions within the discipline. "Just like with all politics, the loud extremists are the ones who get the attention," he said. "They define the opposition, but I'm not the opposition. I want justice [like them]. I grew up under so much injustice."[41] As for Prescod-Weinstein, she had already indicated back in late September that she might boycott the name, but not the findings of the mission. "I am personally thrilled about the Just Wonderful Space Telescope (JWST)," she tweeted.[42]

Science Must Fall?

Although some of the loudest voices in the debate about the legacy of the NASA Administrator James Webb were American, they resonated beyond the United States. The petition to rename the JWST had signatories from Australia, Canada, Germany, Mexico, the Netherlands, South Africa and the United Kingdom as well. At least one of them was employed by the European Space Agency (ESA), a major funder of the space telescope alongside NASA and the Canadian Space Agency. Officially, ESA declared that "inclusion" was one of its fundamental values and promised to discuss the issue with its American counterpart. Even scientists at much smaller institutions without major stakes in the instrument expressed opinions about

[39] Foust (2021).

[40] Walkowicz (2021b).

[41] Abbany (2021).

[42] Witze (2021b).

the controversy. One of them was Javier Armentia, director of the Pamplona Planetarium in northern Spain. He was sufficiently aware of the history of gay rights in America to know the case of Frank Kameny as another homosexual scientist persecuted during the Lavender Scare. Armentia told the Spanish newspaper *El País* that Kameny "would be a good name" for the telescope.[43]

The governing council of the Royal Astronomical Society (RAS) was also dissatisfied with the affair. At a meeting in July, it decided to write to the UK Space Agency, ESA and NASA to express its concerns about the original JWST naming process and the dismissal of requests for renaming. In a press release, it acknowledged that these three organizations were "all strong public advocates of equity, diversity and inclusion in recruitment and retention of employees, ideas central to the mission of the RAS." The RAS leadership thus expressed its "disappointment" over a lack of a thorough investigation by NASA. It declared: "Until that investigation takes place and the results are made public, the RAS now expects authors submitting scientific papers to its journals to use the JWST acronym rather than the full name of the observatory."[44]

If the debate surrounding the James Webb Space Telescope attracted contributors from different parts of the world, the broader decolonization discourse did so even more. Some of the most active participants came from South Africa, another country with significant investments in astronomy and a history of European settlement and racial segregation. The lingering legacies of colonial education, coupled with the persistence of inequality, fueled protest movements even decades after the end of apartheid. A statue of the British imperialist Cecil Rhodes at the University of Cape Town was one of their first targets. After the monument was removed in April 2015, demonstrations began against rising costs of tuition. The hashtag #FeesMustFall thus became the next rallying cry after "Rhodes Must Fall."[45]

The demand to decolonize education in South Africa soon came to encompass the disciplines concerned with the natural world. In 2016, a video of a meeting between "fallists" and members of the Faculty of Science at the University of Cape Town went viral. "Science as a whole is a product of western modernity, and the whole thing should be scratched off. Especially in Africa," said one of the discussants. Undisturbed by laughter in the room, she continued, "Western modernity is the direct antagonistic factor to decolonization, because Western knowledge is totalizing." The fallist especially criticized the idea of physical laws as purely European discoveries. "It is saying that it was Newton and only Newton who knew or saw an apple falling and then out of nowhere decided that gravity existed and created an equation." In order to decolonize science, it should be restarted from "an African perspective."[46]

[43] Barone (2021).

[44] Kahlon (2022).

[45] Kamanzi (2016).

[46] UCT Scientist (2016).

Surprisingly, the campus video from Cape Town quickly gained more than million views on YouTube. However, many of those paying attention to the fallist failed to take her seriously. Using the trending hashtag #ScienceMustFall on Twitter, numerous responses were ironic. One tweet asked, "Why stop with just Science? Modern art must fall! We don't need your white canvasses."[47] Another comment challenged the call to decolonize classical mechanics in fundamental terms: "the only reason we understand the word 'fall' is science."[48] Some social media users supported the fallist by pointing out that science had been used to justify oppression in the past. Nevertheless, probably a majority did not want to see the theory of gravity rejected over concerns about social justice.

The fallist on YouTube was not a scientist herself. "See! That very response is the reason why I am not in the Science Faculty," she told those that laughed at her during the meeting.[49] Yet, despite the ridicule that this particular speaker faced, some professional astronomers joined her in her call for decolonization. One of them was Tana Joseph, a South African who was classified as colored but identified as black. In 2021, then a postdoctoral researcher, she was among the signatories of the petition to rename the James Webb Space Telescope. However, she was also well-placed to contribute to other debates about the past and future of her discipline.

Joseph had been born in 1984, a decade before the first general election with universal suffrage in South Africa. Yet, despite her experience of apartheid as a child, she acknowledged having had a "tremendous amount of privilege." She had university-educated parents, spoke English as well as Afrikaans and belonged to the middle class. She was thus well-prepared for the new opportunities that had arisen with democracy. Inspired by images from the Hubble Space Telescope that were printed in the *Cape Times*, she decided to become an astronomer. She studied the subject at the University of Cape Town before earning a doctorate in physics in Southampton in 2013. As part of her graduate research, she discovered a new black hole binary system.[50]

As a native South African with excellent credentials, Joseph was in a good position to make use of the new instruments that were set up in her home country. After her return from England, she worked as a postdoctoral fellow on the Square Kilometre Array, searching for more black holes and neutron stars. She also organized open days of the University of Cape Town's astronomy department and arranged for visits by high-school students. These activities gave her practical experience for a subsequent role as outreach astronomer at the South African Astronomical Observatory. Besides pursuing her research in high-energy astrophysics, she dedicated herself to public engagement and science communication.

As much as Joseph was excited about the new equipment available to South African astronomers, she became disillusioned by the organizations managing

[47] Henderson (2016).

[48] Lindeque (2016).

[49] UCT Scientist (2016).

[50] Visibility STEM Africa (2021).

them. She described the South African Astronomical Observatory as a "literal colonial institution." It was set up by the British in 1820 to support navigation across their empire. The astronomy department at the University of Cape Town had only ever been headed by either a British or a Dutch scientist. It thus formed a "perfect microcosm of the colonial history of South Africa," in which the Dutch and the English had taken turns ruling the country. The foreigners came to observe the southern skies, but "didn't care" about the racial oppression under apartheid. Even after the transition to democracy, the ranks of powerful senior academics were mostly filled with white males. The Square Kilometre Array as the world's biggest radio telescope was "helping to dispel Afro-pessimism," she acknowledged. Still, she complained that the project had "inherited the same colonial/oppressive power structures that plague older institutions."[51]

In order to overcome the established hierarchies in South African astronomy, Joseph turned to the concept of decolonization. Like many others, she went beyond what she called the "textbook definition" of the term, that is, "becoming independent from a former colonial power." To her, decolonization was "not just about erasing colonial structures & culture, but about acknowledging, centering and supporting African science for and by Africans." This involved engaging with scholars of the humanities and looking at history. Although she did not go as far as to call for a restart of research on gravity altogether, she was critical of the broader institutional legacy of the Scientific Revolution. Joseph argued that many key figures of seventeenth-century science came "from rich, influential families, so they were at leisure to study." She added, "Today's academic system is still set up for men who don't have to worry about money."[52]

Joseph's critique met much sympathy, but also some caution by more established astronomers in South Africa. One of them was British-born Patricia Whitelock, who had long promoted the black students through the National Astrophysics and Space Science Programme. "I'm not sure exactly what the decolonization means," she told me. "There's a lot of discussion about it, and people, including black people, have very different ideas what they mean." She recounted that one of her black colleagues at the South African Astronomical Observatory, Shazrene Mohamed, had been unhappy about the great number of pictures of old white men on the walls. Whitelock thus wondered whether decolonization included "getting rid of those pictures of white people on the walls of the observatory and putting up pictures of black people." The British-born astronomer added, "That's okay with me as long as it doesn't involve no longer working with people from very different cultures from our own." She explained that South Africa already had "a lot of problems with xenophobia." Not just white people, but also black migrants from other countries had become victims of violence. "Because the unemployment is so high in this country, people think that people are coming from elsewhere in Africa and taking their jobs." Yet, Whitelock stressed that "astronomy works as an international endeavor." People

[51] Centre For Civil Society UKZN (2020).

[52] Centre For Civil Society UKZN (2020).

from different national, cultural and religious backgrounds could come together and "work on the stars, if nothing else."

Removing photographs of white astronomers from observatory walls was perhaps a rather symbolic exercise. "Maybe some symbolism is important," Whitelock conceded in her conversation with me. However, the institutional structures of modern astronomy in South Africa and elsewhere were much harder to change or dismantle. Tana Joseph's talk about decolonization was considered "radical" by many. To her, this view itself was an "indication of how social justice issues are perceived and dealt with in the sciences." In order to protect high-profile projects like the Square Kilometre Array from criticism, many astronomers preferred to be silent about racism and sexism among their ranks. Nevertheless, the activist urged her colleagues to take such topics seriously. "We must also be prepared to reflect on, and have conversations about, things that make us uncomfortable."[53]

Discussing oppression could only be a starting point, however. In fact, Joseph found that many senior academics were "good at talking the talk," but had no idea, intention or incentive to "walk the walk." Joseph thus offered recommendations for both individuals and organizations. She asked the foreigners who were coming to South Africa not just to further their own career, but to support the development of astronomy locally. This involved doing more than science. "You can't come to Africa and not understand our cultures, how to say our names, etc." She demanded from institutions that they acknowledge and compensate academics from underrepresented groups for their labor toward equity, diversity and inclusion. "We could be writing papers, but instead we're on EDI committees." Joseph warned that there were "no quick fixes," however. Decolonization was "a lengthy process" with timescales of decades rather than years.[54]

Patricia Whitelock agreed with Tana Joseph on a slower pace of change. "You have to be a bit careful about not throwing the baby out with the bathwater," she cautioned in her exchange with me. "It's very easy to destroy things. It's extremely difficult to build them up." The white astronomer also believed that positions should be earned rather than be given on the basis of identity alone. Making somebody director of an observatory simply because she is a black woman was "not going to do anyone any good," Whitelock argued. "There are people who feel, because they are what they are, they should get everything handed to them. It's not reasonable." In the long run, however, she was hopeful that demographic and cultural shifts would occur. As a woman who had started her career in the 1970s, she had witnessed big changes herself over the decades. "I used to walk into a workshop at an observatory and the wall would be covered in pictures of nude women," she remembered. "That would be totally unacceptable anywhere civilized these days." Whereas astronomical meetings had been overwhelmingly male decades ago, they were now often "approaching 50% women." The number of black astronomers was still far

[53] Centre For Civil Society UKZN (2020).

[54] Centre For Civil Society UKZN (2020).

from parity with white ones, she acknowledged. However, compared with the situation under apartheid, they had much greater opportunities.

Planetary Identity Politics

For better or worse, Tana Joseph's attempts to change institutions like the University of Cape Town and the South African Astronomical Observatory were, indeed, slow. In 2018, she took a break from her work to transform her country's astronomical landscape from the inside. Ironically, she came to be hosted by the same countries whose colonial influences she had criticized for so long. In 2018, she moved to the University of Manchester in Britain as Royal Society Newton International Fellow. There, she used data from precursor telescopes to the Square Kilometre Array to study black hole and neutron star binary systems. In 2020, she continued her work as a postdoctoral research fellow at the University Amsterdam in the Netherlands. Two years later, she was also appointed coordinator of the Netherlands Astronomy Equity and Inclusion Committee (NAEIC), which advised the country's Astronomy Council. She commented: "I look forward to working with my colleagues to make astronomy in the Netherlands a safer, more equitable and inclusive place, in which all our researchers can thrive."[55]

With a new generation of activists like Chanda Prescod-Weinstein or Tana Joseph establishing themselves in the astronomical profession, it is unlikely that calls for decolonization will fall silent in the near future. Circulating between former colonies and metropoles, such demands resonated with increasingly global audiences. Inspired by Twitter feeds of Prescod-Weinstein and Charee Peters, a Native American astronomer who used the @SiouxperNova, John Johnson of Harvard wrote a blog post entitled "Decolonizing Astronomy." In it, he reminded proponents of the Thirty Meter Telescope that the "simple historical fact about Hawai'i is that white America took it from the native Hawaiians in much the same way they took the mainland from indigenous people who had previously lived there for 14,000 years."[56] Michael Rich, a fellow astrophysicist at the University of California, Los Angeles, responded that such a history of colonialism was not restricted to the United States. He pointed out that "Chile has a gulf between rich and poor more vast than the US, and it, too, like nearly all modern nations, has issues with its treatment of indigenous peoples. Therefore the other giant telescope projects must face these issues."[57] On Facebook, a heated discussion of Johnson's blog post then also involved a postdoc at the Pontifical Catholic University of Chile in Santiago named Joshua Tan.[58]

[55] Astronomie.nl (2022).

[56] John Johnson (2015a).

[57] John Johnson (2015b).

[58] Tan (2015).

On Facebook then, Johnson was encouraged to write a blog post about injustices related to the Giant Magellan Telescope (GMT) in Chile,[59] which also formed part of the US Extremely Large Telescope Program. Johnson was reluctant to do so. In his earlier "Decolonizing Astronomy" post, he also acknowledged that he was employed by an GMT partner institution, namely Harvard.[60] However, he did allow Joshua Tan to use his blog for a post "On Chilean Astronomy and Observatory Conflicts." The postdoctoral researcher in Santiago noted that the "issues with indigenous rights in Chile have a long and sordid history stretching back to the invasion of the Spanish in the sixteenth century." Tan further claimed that the telescope consortiums "act as de facto (and in some cases de jure) mining companies -- the corporations who are arguably most guilty of exacerbating worker problems and trampling on the rights of the indigenous." He mentioned a 17-day strike of workers on the Atacama Large Millimeter/sub-millimeter Array (ALMA), another billion-dollar telescope, back in 2013.[61]

With giant telescope corporations operating according to long-standing colonialist and capitalist logics, John Johnson believed that a large cultural shift was required. In his "Decolonizing Astronomy" post, he stated that a colleague had pointed out to him that the TMT board had "a large fraction of non-white members." The black astrophysicist was unimpressed. "This misses the forest for the trees since the US astronomy community is 91% white, by construction. Diversifying the board does nothing to change the culture of astronomy, which is to say the culture of white astronomy."[62] Johnson further linked to an earlier post of his on the *Women in Astronomy* blog. There, he contended that "we'll only get to diversity by attacking the power structures that hold us back." Such a "direct attack on power structures" contrasted in his view with merely striving for respect and multiculturalism.[63]

When I interviewed Johnson in 2022, he saw these power structures still as largely intact. The Harvard astronomer explained that "colonization was part of the long project of extending and expanding markets that was demanded by the early forms of mercantilism and capitalism." Yet, he noted that "the injustice experienced by indigenous people is just one form of many injustices." To him, "the larger framework of those injustices is the existence of a rigid hierarchy and an unequal distribution of resources at all levels and all institutions." He acknowledged that nowadays, more women could be found at the top than before. However, across society, and across the world, there was still the "same inequitable and grossly unequal distribution of resources."

Johnson was also pessimistic about the potential of many diversity programs at universities to remove global inequities. He claimed in his conversation with me

[59] Tan (2015).

[60] John Johnson (2015b).

[61] Tan (2015).

[62] John Johnson (2015b).

[63] John Johnson (2014).

that the "unique thing that happens on a university campus is the training of the next generation of individuals who will rigidly maintain that unequal distribution, who will maintain the status quo." In his experience, academics who are good at upholding the capitalist status quo were promoted, even if their research was not very original or thought-provoking. When university administrators ostensibly embraced social justice ideas, they also tended to take away "the spirit of true radical activism." They caused "infighting" and diverted energies into "fruitless endeavors." Also in 2022, Johnson wrote in *Physics Today*: "One of the ways universities and other institutions maintain their existence is to align themselves with the power structures in broader society." He explained, "As a result, the priorities of institutions tend to be conservative – they are resistant to changes that would threaten their continued access to power and resources."[64]

If many academic institutions were invested in capitalist inequalities, the same was true for large private companies. Although Johnson had used Twitter and Facebook to connect with fellow activists, he had also become disillusioned with these platforms over time. Twitter, in particular, seemed to be "antithetical to community building," he said to me. The identity politics that he had seen play out on social media appeared increasingly destructive to him. It often devolved "into finding out who's the most oppressed person in the room, and basically telling everyone else to shut up." The lockdowns imposed by governments during the COVID-19 pandemic contributed to further isolation and atomization of individuals. Protest movements advocating economic justice like that of the yellow vests in France thus fragmented.

In order to challenge global capitalism, Johnson thus envisioned solidarity built through strong personal relationships. In 2015 already, he had thus founded the Banneker Institute, a summer program at Harvard University. Named after the pioneering African-American naturalist Benjamin Banneker, it sought to prepare underrepresented students for graduate school. However, rather than helping them fit into the dominant culture of professional astronomy, it sought to create new norms. One of them was to listen to one another "to understand, not just to respond." The institute also aimed to "foster a collaborative learning environment by offering information rather than imposing direction." The participants further declared: "We are teammates not competitors; we have learned something once we all understand it." Johnson commented on his blog: "These are radical notions in our individualistic society and even more so in let-me-demonstrate-how-I-am-better-than-you halls of academic science."[65]

Besides teaching astrophysical topics, Harvard's Banneker Institute sought to foster critical views of society. "Students also participate in the Social Science Seminar, where we cover topics such as the history of race and racism in the U.S., colonialism, capitalism and modern-day imperialism," Johnson explained. "We connect these topics to science and use these topics to provide context for the

[64] Johnson (2022).

[65] Johnson and Cofer-Shabica (2019).

structure and practice of modern scientific research."[66] One week was especially dedicated to the history of colonialism in Latin America. Students were asked to discuss questions like the following: "What is at stake for the US Government and US business interests, if the Puerto Rican people were to win their independence?"[67]

Being located at Harvard University as one of the world's wealthiest institutions of higher education, the Banner Institute was hardly removed from the capitalist interests it sought to critique. "The field of astronomy and the social structures upon which it is built are extensions of the structures of US society at large," Johnson acknowledged. "And building off of those structures, solidarity is not a natural outcome."[68] Nonetheless, the summer program was able to provide its students with important lessons. Kevin Ortiz Ceballos, a participant from Puerto Rico, found learning to be "more effective for the entire group, especially because our progress is not measured by traditional (and arbitrary) metrics nor by competing against our peers."[69] Carissa Avina-Beltran from California noted: "Having experienced an overall welcoming and positive learning environment this summer, at arguably one of the most competitive and 'elite' institutions, assures me that similar practices can be implemented in classrooms and learning spaces outside of Cambridge."[70]

While stressing the collective, the Banneker Institute also benefitted its participants as individuals. Each student received a $5000 stipend plus on-campus housing and a reimbursement of travel expenses. The summer program further paid for a junior membership in the American Astronomical Society and a trip to an AAS meeting.[71] More valuable, however, was access to well-funded and prestigious graduate programs. Kevin Ortiz Ceballos, for instance, participated in the Banneker Institute in 2019, while he was still an undergraduate student at the University of Puerto Rico. This experience undoubtedly helped him gain admittance to the doctoral program in astronomy and astrophysics at Harvard University in 2021.

After running well for about 5 years, Harvard's Banneker Institute also went into a hiatus during the coronavirus pandemic. An announcement in 2020 said that the program was taking a break "until we can meet safely again in person."[72] Almost 2 years later, the website still said: "While we hoped to resume in 2022, the COVID policies over Harvard and the Smithsonian are incompatible with the immersive community environment we hope to foster with our summer program."[73] John Johnson explained to me that he had hoped that his "efforts to build community could take place in an actual natural human setting, rather than on Zoom."

---

[66] Lada (2022).

[67] Banneker Institute (2018).

[68] Johnson and Cofer-Shabica (2019).

[69] Banneker Institute (2019d).

[70] Banneker Institute (2019a).

[71] Banneker Institute (2022b).

[72] Banneker Institute (2020).

[73] Banneker Institute (2022a).

To what extent Harvard University will continue to produce revolutionaries in science and society remains to be seen. However, some Banneker alumni from before the COVID-19 pandemic already expressed an interest in pursuing new planetary politics. One of them was Dorsa Majidi, another member of the 2019 cohort, who was originally from Tehran in Iran. She said: "The program has also taught me about the importance of social justice awareness and development of a global solidarity in shaping the future of our world."[74] Another student, Suchitra Narayanan from Coimbatore in India, also sought to connect her science to a global view. "Astronomy can bring people together in a way no other field does," she stated. "Great things have come from nations working together, like the International Space Station (ISS) with its 20-year history of international cooperation or even the Event Horizon Telescope (EHT), which captured the first image of a black hole."[75]

In Narayanan's view, "Collaboration in astronomy is essential because of the sheer magnitude of the Universe."[76] However, an inclusion of all countries in the astrophysical enterprise was still no natural outcome, but rather a matter of contention. In 2022, the Russian invasion of Ukraine put the lives of astronomers there in immediate danger. At the same time, international sanctions affected science in Russia. The European Space Agency decided to suspend a joint Mars mission with Roscosmos. The European Astronomical Society (EAS) announced that it would "not provide grants or support to scientists at Russian institutions," although it promised to "allow their participation as individuals" at its meeting that year.[77] Around the same time, the heads of the EAS, the American Astronomical Society, the African Astronomical Society, the Astronomical Society of Australia, the Korean Astronomical Society, the Royal Netherlands Astronomical Society, and the Italian Astronomical Society issued a joint statement. They declared that "the current events jeopardise the scientific cooperation within our European community and with the rest of the world."[78]

As a new war started to divide Europe in particular, many scientists still refused to cut ties. The editors of *Nature Astronomy* condemned the "attack on Ukraine without blocking scientific communication through a boycott of Russian research." They added, "As our space race history teaches us, maintaining some bridges in divided times may help rekindle cooperation when happier times will come, for everyone's benefit."[79] The International Astronomical Union also rejected a petition from Ukrainian astronomers to ban their Russian colleagues from scientific activities. "That would definitely be making a political statement, which the IAU cannot do," IAU President Debra Elmegreen wrote in an email to Yaroslav Yatskiv, president of the Ukrainian Astronomy Association. "The IAU was founded right after

[74] Banneker Institute (2019b).

[75] Banneker Institute (2019c).

[76] Banneker Institute (2019c).

[77] Davies (2022).

[78] Davies et al. (2022).

[79] Nature Astronomy (2022).

WWI [World War I] in order to bring colleagues together, so we do not wish to drive them apart by deciding whom to support based on what their governments are doing."[80]

Many astronomers also sought to counter the new division by emphasizing their commitment to reaching across borders. In March 2022, dozens of South African scientists including Patricia Whitelock signed an open letter reminding readers that their country had "benefitted significantly from international solidarity, which contributed to the peaceful transition from apartheid." They therefore stressed, "Now it is our time to show solidarity in the fight for fundamental values." They thus called upon their government "to provide support through offering temporary positions for fleeing Ukrainian scientists and possibilities for Ukraine-based students to finish their studies." They added, "This especially concerns African students where the South African government is obliged to take vigorous action to ensure the safety, possibility of repatriation, and availability of alternative educational opportunities."[81]

While the Russo-Ukrainian War marked new tensions between nations, many astronomers pursued a comprehensive planetary identity. One of them was Mike Simmons, the founder of Astronomers Without Borders (AWB). After stepping down as president of AWB, he established a new organization called Astronomy for Equity in 2021. In a conference presentation that year, he asserted that "Astronomy is universal, accessible, and ubiquitous" and that it "provides a global perspective." The key to justice for him was planetary unity. "A more equitable world requires an inclusive worldview in which our family or community includes all of Earth's inhabitants as fellow passengers on Spaceship Earth," he claimed. Astronomy provided a paradigm shift called the Overview Effect. "We gaze skyward from different windows on Spaceship Earth, marveling at the Universe our small planet is part of, recognizing that we really are all in this together."[82]

Simmons thus saw great potential for his new initiative. "Astronomy has volunteer activists worldwide," he stressed. Even in developing countries that had only few professional observatories, amateur clubs could easily be found. "Astronomy for Equity will provide a hub where developed world resources can be shared through vetted crowdfunding campaigns, expert advice, club pairing, and other means," he announced. The main obstacle was a lack of communication. Yet, through centralized online spaces, the American astronomer promised to facilitate sharing, mentoring, and support. This would benefit especially isolated and marginalized communities across the world. He wanted to help create science labs for girls in Nigerian refugee camps, for instance, and to bring tactile and sound materials to blind people in many places.[83]

In spearheading Astronomy for Equity, Simmons was in the company of many like-minded space scientists. His initiative was part of the Blue Marble Space, a

[80] Stone (2022).

[81] Sushch et al. (2022).

[82] Simmons (2021).

[83] Simmons (2021).

charity that promoted international unity and awareness. He also associated with other people who promoted the Overview Effect, a view of Earth without national borders and a sense of connection with all of humanity. They included Frank White, who had written extensively about the phenomenon and what it meant for the evolution of humanity. He envisioned that humans turned "Terranauts" would eventually colonize the solar system and the entire galaxy.[84] Already in 2008, Simmons and White were part of a group of astronauts and other scientists who established an Overview Institute.[85] In 2021, Simmons also came to sit on the Advisory Board of the Center for Planetary Identity.[86]

Promoters of the "overview effect" also had their critics, of course. The historian Jordan Bimm argued that Frank White, who was educated at Harvard University, viewed "spaceflight through a lens that is eerily similar to American manifest destiny." Bimm added, "But rather than America being destined to colonize the West, White argues that humanity is *supposed* to colonize space." He further stated: "Even as White tries to get readers to visualize humanity and the Earth as a total system devoid of cultural barriers like political boarders, his ethnocentric assumption of cultural superiority and colonial-style expansionist destiny permeates just below the surface of the entire overview philosophy."[87]

Organizations like the Overview Institute or the Center for Planetary Identity thus certainly had to grapple with major challenges to their projects. Even if these particular institutions fail in the future, other astronomers found fertile ground for planetary identifications. Banneker Institute alumna Suchitra Narayanan went on to pursue a doctorate at the University of Hawai'i. However, while studying other places in the universe, she also expressed deep concern about the "pale blue dot" that is Earth. In 2021, she reminded her fellow astrophysicists that "All of the groundbreaking research we are privileged to do and are surrounded by does not matter unless we have a planet to live on." She thus encouraged others to sign an open letter about the climate crisis written by Astronomers for Planet Earth, another volunteer network.[88] Like Astronomy for Equity, Astronomers for Planet Earth aimed for unity as well as justice. The latter group noted that "the astronomical perspective allows us to see how small our planet is and how we must work together so that all of humanity can thrive." Astronomers for Planet Earth further described themselves as a global organization that encompasses many walks of life, including black lives." It also warned that black, indigenous, and people of color as historically exploited communities were suffering the most under climate change.[89]

With different initiatives by young and old people underway, the broader movement for equity in astronomy, indeed, had the potential to bring about a much more

[84] White (1998).

[85] Beaver (2008).

[86] Center for Planetary Identity (2021).

[87] Bimm (2014), 43.

[88] Narayanan (2021).

[89] Astronomers for Planet Earth (2022a).

comprehensive form of inclusion than before. More than the diversity efforts in many other sciences, those in astronomy could achieve a planetary identity and a planet-wide solidarity. Astronomers for Planet Earth sought to promote an "astronomical perspective" exemplified by Carl Sagan's comments on Earth as a "pale blue dot": "On it, everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives," Astronomers for Planet Earth quoted Sagan on their website. "Every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every 'superstar', every 'supreme leader', every saint and sinner in the history of our species lived there – on a mote of dust, suspended in a sunbeam."[90]

Astronomers for Planet Earth hoped that their perspective could nurture humanity's stewardship for Earth as a tiny and fragile place.[91] At the same time, comments like Sagan's also make the differences between people of different genders, races, ethnicities and abilities seem miniscule compared to the vastness of the cosmos. Capitalist inequities and competition over resources could also appear petty, or at the very least surmountable. The disappearance of colonial logics from human minds would perhaps also be the most effective form of decolonization.

References

Abbany, Zulfikar. 2021. "James Webb: How a Space Telescope Tore American Scientists Apart." Deutsche Welle. https://www.dw.com/en/james-webb-how-a-space-telescope-tore-american-scientists-apart/a-60216754.

American Astronomical Society. 2020. "AAS Endorses #ShutDownSTEM, #ShutDownAcademia & #Strike4BlackLives." American Astronomical Society. https://aas.org/posts/news/2020/06/aas-endorses-shutdownstem-shutdownacademia-strike4blacklives.

Astronomers for Planet Earth. 2022a. "Statement on Social Justice." Astronomers for Planet Earth. https://astronomersforplanet.earth/statement-on-social-justice-and-racial-equity/.

Astronomers for Planet Earth. 2022b. "The Astronomical Perspective." Astronomers for Planet Earth. https://astronomersforplanet.earth/the-astronomical-perspective/.

Astronomie.nl. 2022. "Tana Joseph Appointed Equity, Diversity & Inclusion Coordinator for Dutch Astronomy." Astronomie.nl. https://www.astronomie.nl/nieuws/en/tana-joseph-appointed-equity-diversity-inclusion-coordinator-for-dutch-astronomy-3157.

Banneker Institute. 2018. "Social Justice Fridays." Harvard University. https://bannekerinstitute.fas.harvard.edu/files/bannekerinstitute/files/sjf_study_guides.pdf.

Banneker Institute. 2019a. "Student Profile: Carissa Avina-Beltran." Harvard University. https://bannekerinstitute.fas.harvard.edu/news/2019-student-profile-carissa-avina-beltran.

Banneker Institute. 2019b. "Student Profile: Dorsa Majidi." Harvard University. https://bannekerinstitute.fas.harvard.edu/news/student-profile-dorsa-majidi.

Banneker Institute. 2019c. "Student Profile: Suchitra Narayanan." Harvard University. https://bannekerinstitute.fas.harvard.edu/news/student-profile-suchitra-narayanan.

[90] Astronomers for Planet Earth (2022b).

[91] Astronomers for Planet Earth (2022b).

Banneker Institute. 2019d. "Student Profile: Kevin Ortiz Ceballos." Harvard University. https://bannekerinstitute.fas.harvard.edu/news/student-profile-kevin-ortiz-ceballos.
Banneker Institute. 2020. "Program Hiatus." Harvard University. https://bannekerinstitute.fas.harvard.edu/news/program-hiatus.
Banneker Institute. 2022a. "Program Hiatus for 2022." Harvard University. https://bannekerinstitute.fas.harvard.edu/news/program-hiatus-0.
Banneker Institute. 2022b. "Sponsorship Opportunities." Harvard University. https://bannekerinstitute.fas.harvard.edu/sponsorship.
Barone, Luca Tancredi. 2021. "Dimisión en la NASA por el rechazo al cambio de nombre del telescopio James Webb, un exdirectivo acusado de homofobia." *El País*. https://elpais.com/ciencia/2021-10-13/una-astrofisica-de-la-nasa-dimite-por-el-rechazo-al-cambio-de-nombre-del-telescopio-james-webb-un-exdirectivo-acusado-de-homofobia.html.
Beaver, David. 2008. "Astronauts, Scientists, Cultural Thought Leaders to Announce Formation of the Overview Institute." SpaceRef. https://spaceref.com/press-release/astronauts-scientists-cultural-thought-leaders-to-announce-formation-of-the-overview-institute/.
Bimm, Jordan. 2014. "Rethinking the Overview Effect." *Quest: The History of Spaceflight Quarterly* 21, no. 1: 39–47.
Centre For Civil Society UKZN. 2020. "Tana Joseph Decolonising the Sciences Part Of The Decolonisation Webinar Series." YouTube. https://www.youtube.com/watch?v=90Wo11LxNS4.
Center for Planetary Identity. 2021. "Who We Are." The Center for Planetary Identity. http://planetaryidentity.org/who-we-are.
Cowing, Keith. 2018. "Yet Another Stealthy Space Meeting In Washington, DC." NASA Watch. http://nasawatch.com/archives/2018/06/yet-another-ste-5.html.
Davies, Roger. 2022. "A Statement and EAS 2022 Policy Regarding the War in Ukraine: A Word from the President." *European Astronomical Society E-Newsletter* 16. https://eas.unige.ch/e--newsletter.jsp?nb=16.
Davies, Roger, Debra Elmegreen, Paula Szkody, Jamal Mimouni, John Lattanzio, Myeong-Gu Park, Peter Barthel, and Roberto Buonanno. 2022. "Message about the Scientific Community in Ukraine." European Astronomical Society. https://eas.unige.ch/statement_ukraine.jsp.
Dowling, M. 2018. "NASA Official Fears Colonizing Mars Harms Indigenous Rights -- REALLY!" Independent Sentinel. https://www.independentsentinel.com/nasa-official-fears-colonizing-mars-harms-indigenous-rights-really/.
Dreher, Rod. 2018. "Mars Needs Social Justice Warriors!" *The American Conservative*. https://www.theamericanconservative.com/dreher/mars-needs-social-justice-warriors/.
Foust, Jeff. 2021. "NASA Defends Decision to Retain JWST Name." *SpaceNews*. https://spacenews.com/nasa-defends-decision-to-retain-jwst-name/.
Francis, Matthew. 2015. "The Problem With Naming Observatories For Bigots." *Forbes*. https://www.forbes.com/sites/matthewfrancis/2015/06/11/the-problem-with-naming-observatories-for-bigots/.
Haskins, Caroline. 2018. "The Racist Language of Space Exploration." The Outline. https://theoutline.com/post/5809/the-racist-language-of-space-exploration.
Henderson, Roxanne. 2016. "UCT Student Upsets Newton's Apple Cart with Her Demand That #ScienceMustFall." TimesLIVE. https://www.timeslive.co.za/news/south-africa/2016-10-14-uct-student-upsets-newtons-apple-cart-with-her-demand-that-sciencemustfall/.
Johnson, John. 2014. "Why I Think Diversity Is Good, but the Wrong Target." Women in Astronomy. http://womeninastronomy.blogspot.com/2014/11/why-i-think-diversity-is-good-but-wrong.html.
Johnson, John. 2015a. "Decolonizing Astronomy: Or Why Debt Should Enter Your Net-Worth Calculation." Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2015/05/decolonizing-astronomy-or-why-debt.html.
Johnson, John. 2015b. "Part 2 of My Responses to Reader Comments on 'Decolonizing Astronomy.'" Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2015/05/part-2-of-my-responses-to-reader.html.

Johnson, John. 2022. “Finding Joy in Academia: A Delicate Balancing Act.” *Physics Today*. https://doi.org/10.1063/PT.6.4.20221025a.

Johnson, John, and Vale Cofer-Shabica. 2019. “Banneker 5 Report 1: Building Community.” Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2019/06/banneker-5-report-1-building-community.html.

Johnson, Steve. 2020. “‘Far Too Many Resemblances to Me:’ Adler Astronomer Alleges an American Girl Doll Stole Their Likeness.” *Chicago Tribune*. https://www.chicagotribune.com/entertainment/museums/ct-ent-astronomer-walkowicz-american-girl-vega-doll-0507-20200506-v4iggq7izvcifmsr3edkgjuj6u-story.html.

Kahlon, Gurjeet. 2022. “The RAS and JWST.” The Royal Astronomical Society. https://ras.ac.uk/news-and-press/news/ras-and-jwst.

Kamanzi, Brian. 2016. “#FeesMustFall: Decolonising Education.” Al Jazeera. https://www.aljazeera.com/opinions/2016/11/3/feesmustfall-decolonising-education.

Kay, Jonathan. 2020. “PODCAST 98: Physicist Lawrence Krauss on Why Identity Politics Should Be Kept Out of Science.” *Quillette*. https://quillette.com/2020/07/04/podcast-98-physicist-lawrence-krauss-on-why-identity-politics-should-be-kept-out-of-science/.

Krauss, Lawrence. 2020. “The Ideological Corruption of Science.” *Wall Street Journal*. https://www.wsj.com/articles/the-ideological-corruption-of-science-11594572501.

Krauss, Lawrence M. 2021. “Science Goes Rogue.” Quillette. https://quillette.com/2021/03/14/science-goes-rogue/.

Lada, Brian. 2022. “Banneker Institute Teaches Astronomy to Historically Marginalized Students.” AccuWeather. https://www.accuweather.com/en/space-news/banneker-institute-teaches-astronomy-to-marginalized/1146360.

Lindeque, Brent. 2016. “Student Wants Science to Fall. Internet Responds Perfectly.” Good Things Guy. https://www.goodthingsguy.com/opinion/science-must-fall/.

Mitton, Jacqueline, and Simon Mitton. 2021. *Vera Rubin: A Life*. Cambridge: Belknap Press of Harvard University Press.

Narayanan, Suchitra. 2021. “The ‘Pale Blue Dot’ Blues.” *Astrobites*. https://astrobites.org/2021/06/04/astro-and-eco-anxiety/.

Nature Astronomy. 2022. “Cooperation in Astronomy under Strains of War.” *Nature Astronomy* 6, no. 4: 404.

Neal, Mailani. 2015. “We Support TMT.” GoPetition. https://www.gopetition.com/petitions/we-support-tmt.html.

Nord, Brian, Chanda Prescod-Weinstein, Matthew Buckley, Kyle Cranmer, Djuna Croon, Daniel Harlow, Seyda Ipek, et al. 2020. “A Strike For Black Lives.” Particles for Justice. https://www.particlesforjustice.org.

Oluseyi, Hakeem. 2021. “Was NASA’s Historic Leader James Webb a Bigot?” Medium. https://hmoluseyi.medium.com/was-nasas-historic-leader-james-webb-a-bigot-131c821d5f12.

Prescod-Weinstein, Chanda. 2015. “Short Statement about the Use of Racist Language in Astronomy and Physics.” Medium. https://medium.com/@chanda/short-statement-about-the-use-of-racist-language-in-astronomy-and-physics-d586c44a406f.

Prescod-Weinstein, Chanda. 2019. “Decolonising Science Reading List.” https://medium.com/@chanda/decolonising-science-reading-list-339fb773d51f.

Prescod-Weinstein, Chanda. 2021. *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred*. New York: Bold Type Books.

Prescod-Weinstein, Chanda, Sarah Tuttle, Lucianne Walkowicz, and Brian Nord. 2021. “NASA Needs to Rename the James Webb Space Telescope.” *Scientific American*. https://www.scientificamerican.com/article/nasa-needs-to-rename-the-james-webb-space-telescope/.

Randall, David. 2019. “Politicized Science.” *Academic Questions* 32, no. 2: 215–22.

Simmons, Mike. 2021. “Astronomy for Equity: A New Set of Global Initiatives.” Presentation at the Communicating Astronomy with the Public (CAP) conference.

Solomon, Molly. 2015. “How The Debate Over TMT Prompted a Problematic Email.” Hawaii Public Radio. https://www.hpr2.org/post/how-debate-over-tmt-prompted-problematic-email.

Stemwedel, Janet D. 2015. "The Thirty Meter Telescope Reveals Ethical Challenges For The Astronomy Community." *Forbes*. https://www.forbes.com/sites/janetstemwedel/2015/06/12/the-thirty-meter-telescope-reveals-ethical-challenges-for-the-astronomy-community/.

Stone, Richard. 2022. "Western Nations Cut Ties with Russian Science, Even as Some Projects Try to Remain Neutral." *Science*. https://www.science.org/content/article/western-nations-cut-ties-russian-science-even-some-projects-try-remain-neutral.

Sushch, Iurii, Markus Böttcher, Hartmut Winkler, Martin Bucher, Andrew Chen, Robert Warmbier, Soebur Razzaque, et al. 2022. "Open Letter: South Africa-Based Scientists Condemn Russia's War in Ukraine." Eyewitness News. https://ewn.co.za/2022/03/19/open-letter-south-africa-based-scientists-condemn-russia-s-war-in-ukraine.

Tan, Joshua. 2015. "On Chilean Astronomy and Observatory Conflicts." Mahalo.ne.Trash. http://mahalonottrash.blogspot.com/2015/05/on-chilean-astronomy-and-observatory.html.

Tuttle, Sarah. 2015a. "Anti-Racism Pro-Astronomy 6 Month Challenge." Sarah Tuttle. https://astrotuttle.wordpress.com/2015/05/11/anti-racism-pro-astronomy-6-month-challenge/.

Tuttle, Sarah. 2015b. "#StandWithChanda." Women In Astronomy. http://womeninastronomy.blogspot.com/2015/07/standwithchanda.html.

Tuttle, Sarah. 2015c. "A Statement of Solidarity." Medium. https://medium.com/@niais/we-standwithchanda-to-do-her-work-and-speak-her-mind-without-fear-of-retribution-1acb7e9dfcb8.

UCT Scientist. 2016. "Science Must Fall?" YouTube. https://www.youtube.com/watch?v=C9SiRNibD14.

Urry, C. 2015. "A Response to Community Concerns About Our Professional Climate." American Astronomical Society. https://aas.org/posts/news/2015/05/response-community-concerns-about-our-professional-climate.

Visibility STEM Africa. 2021. "'My Journey To Astronomy and Beyond!' – Dr Tana Joseph." YouTube. https://www.youtube.com/watch?v=1XM2vadO_f8.

Walkowicz, Lucianne. 2011a. "Finding Planets around Other Stars." TED. https://www.ted.com/talks/lucianne_walkowicz_finding_planets_around_other_stars.

Walkowicz, Lucianne. 2011b. "Look up for a Change." TED. https://www.ted.com/talks/lucianne_walkowicz_look_up_for_a_change.

Walkowicz, Lucianne. 2015. "Let's Not Use Mars as a Backup Planet." TED. https://www.ted.com/talks/lucianne_walkowicz_let_s_not_use_mars_as_a_backup_planet.

Walkowicz, Lucianne. 2018a. "Territorial Acknowledgement." Decolonizing Mars. https://www.decolonizemars.org/blog/2018/6/27/territorial-acknowledgement.

Walkowicz, Lucianne. 2018b. "Code of Conduct." Decolonizing Mars. https://www.decolonize-mars.org/meeting-code-of-conduct.

Walkowicz, Lucianne. 2021a. "The Straights Are Here To Save Us." Not Not Rocket Science. https://notnotrocketscience.substack.com/p/the-straights-are-here-to-save-us.

Walkowicz, Lucianne. 2021b. "Why I'm Resigning from Advising NASA." Patreon. https://www.patreon.com/posts/why-im-resigning-57248140.

Walkowicz, Lucianne, Chanda Prescod-Weinstein, Brian Nord, and Sarah Tuttle. 2021. "Rename the James Webb Space Telescope." Google Docs. https://docs.google.com/document/d/1PS_rtSOzaH40q1r_jQkhJhXmW97DOw-S6dqGA0jDKzM/.

Wall, Mike. 2019. "Bill Nye: It's Space Settlement, Not Colonization." Space.com. https://www.space.com/bill-nye-space-settlement-not-colonization.html.

White, Frank. 1998. *The Overview Effect: Space Exploration and Human Evolution*. Second Edition. Reston: American Institute of Aeronautics and Astronautics.

Witze, Alexandra. 2021a. "NASA Investigates Renaming James Webb Telescope after Anti-LGBT+ Claims." *Nature* 596, no. 7870: 15–16.

Witze, Alexandra. 2021b. "NASA Won't Rename James Webb Telescope." *Nature* 598, no. 7880: 249–249.

Appendix: List of Interviews

Gibor Saul Basri, via email, May to June 2020.
Lina Canas, via Zoom, January 8, 2021.
Lydia Cidale, via email, May 2020.
Rolf Danner, via Zoom, April 15, 2021.
Wanda Díaz-Merced, via Zoom, February 17, 2021.
Beatriz García, via Zoom, December 16, 2020.
Kevin Govender, via Zoom, August 4, 2021.
Noreen Grice, via email, July 2020.
John Asher Johnson, via Zoom, May 26, 2022.
Tana Dale Joseph, via Zoom, May 20, 2022.
Nana Ama Browne Klutse, via Zoom, September 22 and 27, 2021.
Lawrence M. Krauss, via Zoom, April 6, 2021.
Geoffrey Marcy, via email, January 2021 and March 2023.
Charles McGruder, via Zoom, March 2, 2021.
Ronald E. Mickens, via email, June to July 2020.
George Kildare Miley, via Zoom, August 9, 2021.
Jessica Mink, via Zoom, January 20, 2021.
Priscilla Muheki, via Zoom, September 24, 2021.
Sultana Nahar, via email, May 2020.
Carolina J. Ödman-Govender, via Zoom, August 12, 2021.
Hakeem Muata Oluseyi, via Zoom, February 8, 2021.
Amelia Ortiz-Gil, via Zoom, December 14, 2020.
Charee Peters, via Zoom, February 16, 2021.
Mirjana Pović, via Zoom, September 20, 2021.
Chanda Prescod-Weinstein, via Zoom, June 8, 2021.
Francesca Primas, via Zoom, March 4, 2021.
Enrico Ramirez-Ruiz, via Zoom, April 21, 2021.
Somaya Saad, via email and LinkedIn, April to June 2020.
Joan Schmelz, via Zoom, February 2, 2021.

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*, Space and Society, https://doi.org/10.1007/978-3-031-46113-2

Jesse Shanahan, via Zoom, October 4, 2021.
Frank H. Shu, via email, May 2020.
Susan Simkin, via email, March 2020.
Mike Simmons, via Zoom, May 18, 2021.
Keivan Stassun, via Zoom, December 18, 2020.
Babak Tafreshi, via email, April 2022.
Fiorella Terenzi, via Zoom, May 17, 2022.
Silvia Torres-Peimbert, via Zoom, March 5, 2021.
Sarah Tuttle, via Zoom, September 25, 2021.
Claudia Megan Urry, via email, March to May 2020.
Kumiko Usuda-Sato, via Zoom, December 14, 2020.
Gerrit L. Verschuur, via Zoom, November 15, 2022.
Ashley Walker, via Zoom, February 19, 2021.
Lucianne Walkowicz, via Zoom, June 6, 2022.
Patricia Whitelock, via Zoom, October 12, 2022.
Shahinaz Yousef (Om Musa), via email and WhatsApp, May 2020.

Index

J. M. Determann, *Diversity, Equity, and Inclusion in Astronomy*, Space and Society, https://doi.org/10.1007/978-3-031-46113-2