

The background of the book cover is a complex, multi-colored simulation of a cosmic environment. It features a central, bright yellow and orange star-like structure with several long, thin arms extending outwards. The surrounding space is filled with dark blue and black regions, interspersed with patches of orange and red, suggesting a high-density environment with various physical processes occurring. The overall appearance is that of a hydrodynamic simulation of a galaxy or a cluster of galaxies.

Probing Cosmic Monsters

Confronting Hydrodynamic Simulations
with New Observations of
High-density Environments

Syeda Lammim Ahad

সৈয়দা লামমীম আহাদ

Ph.D. Thesis

Probing Cosmic Monsters

Confronting Hydrodynamic Simulations with
New Observations of High-density Environments

Proefschrift

ter verkrijging van
de graad van doctor aan de Universiteit Leiden,
op gezag van rector magnificus prof.dr.ir. H. Bijl,
volgens besluit van het college voor promoties
te verdedigen op dinsdag 21 november 2023
klokke 11:15 uur

door

Syeda Lammim Ahad

geboren te Madaripur, Bangladesh
in 1992

Acknowledgements

My PhD journey has been challenging and transformational in many ways, and approaching the finish line has been possible thanks to the remarkable and kind people who helped along the way.

First, I want to express my deepest gratitude to my supervisors, Henk Hoekstra and Yannick Bahé. Thank you for giving me the opportunity and freedom to follow my curiosity through the PhD projects. I am very grateful for sharing your insights that helped me improve my understanding of astronomy, academia, science, outreach, and more. I look up to your passion for science and pursuit of excellence, and how you guided me with kindness and patience throughout difficult times is what I want to internalize the most in my future career. I hope our paths will cross again in future and allow me to further learn from your wisdom. Also, I am grateful for the kind guidance of Adam Muzzin through several of my PhD projects. I have learned a lot from you and thoroughly enjoyed our discussions about exciting science. I look forward to more opportunities to work together in future!

I want to thank the past and current admin and support staff of the Observatory - Evelijn, Marjan, Monica, Alexandra, Robin, Nancy, Somayeh, Châtelaine, Alina, Hafize, and others for their constant support from the beginning till the end of my PhD experience. I am incredibly grateful for the support from the SCIS team with the residence permit, and the IT Helpdesk team, especially during the 'work from home' era. Also, I want to thank the Graduate School Office staff for their support throughout. All of your efforts not only kept things going smoothly but also helped me stay sane whenever things went wrong.

I would also like to thank the observatory social committee for keeping up the social and fun energy at the institute. The yearly social events are some of the best memories I have of my time here. Also, I highly appreciate the information and support the Observatory Wellbeing committee provided through the difficult pandemic and post-pandemic era.

I extend my thanks to the past and present members of the weak lensing and cos-

Acknowledgements

Anna and Mantas - it was a joy having you two as office neighbours! Nastasha, thank you very much for your help during my job application time! Thanks to all the PhDs, postdocs, and master students of the Observatory who made the past five years in Leiden an engaging, and enjoyable experience - Maria Cristina, Christos, Andrej, Jit, Gabriella, Omar, Danna, Valeriya, Tomasso, Eleonora, Santiago, Olivier, Martijn, Martijn, Stijn, Turgay, Shun-Sheng, Jeger, Dirk, Xiaoyuan, Sander, Shravya, Jeroen, Rens, Naadiyah, Sarah, Ashley, Willeke, Dora, Zephyr, Luna, Dario, Alessandro, MJ, Pooneh, Roland, Chloe, Erik, Evgenii, Roi, Zorry, Andrés, Joey, Fraser, Dilovan, Bas, Kirsty, Hiddo, Pranjali, Morgan, Katie, Brian, Wil, Xuechen, Zhenlin, Patrick, Danial, Alex, and everyone else I had the pleasure to interact with.

My biggest thanks to my husband Ruslan, my family in Bangladesh and my family-in-law from Ukraine for being constant sources of support and strength during my PhD journey, even when they themselves were going through very challenging times. Ruslan, I can never express my gratitude enough for all your support throughout these years, all on top of working on your PhD yourself. Thank you for all the packed lunches, the discussions about work whenever I needed to think out loud, and for restoring my belief in my capacity to finish the work whenever I felt lost. I am grateful for all the ups and downs we have been through together across Europe, and I am excited to see what awaits us in Canada!

I want to thank my undergraduate besties — Manira, Maitraye, Sunandita, who are more like sisters and have been the best work-from-home buddies and support system whenever I needed. It was curious how the pandemic made our PhD journeys way more connected than it would have been otherwise. I cannot wait to finally live closer to you girls and hopefully meet more than once every five years!

Last but not least, I want to thank my mentors from Bangladesh. As there is still no way to pursue astronomy as a career there, the path I walked is a rarely chosen one. I am grateful to Mrityunjoy Saha, Asrafuzzaman Akhunji, Farseem Mannan Mohammedy, Md. Zahurul Islam, Arshad Momen, and Munir Hasan, who supported and encouraged me on my journey to pursue astronomy. Also, my thanks to the astronomers from Bangladesh who showed that this is possible and shared their experiences whenever I asked for direction - Sultana N. Nahar, Khan Md. Bin Asad, and Syed Ashraf Uddin.