STEM education and research in

Palestine



Sultana N. Nahar

Dept of Astronomy, The Ohio State University, Columbus, OH 43210, USA

My connection with STEM education and research in Gaza, Palestine started in 2015. I wrote a news article on them in APS (American Physical Society) newsletter in 2017. It reported the flourishing research and devotion beating the suppressing condition and limited resources. However, in December 2023 An-Nisa I reported about the set-backs in STEM programs caused by the Israeli genocide. After a year, in December 2024 the horrible genocide continues killing Palestinians where about 13 thousands are only ystudents, too many teachers and faculty members, and destroying all research labs, libraries, and universities by Israeli bombs.

Palestinians are a nation of pioneering courage, steadfastness, tolerance, and inspiration. Even with their most downgraded inhuman conditions, they don't curse, file law-suits for extortion of money, make sharp remarks insulting the sentiment, do not make selfish demands. The other novel quality they have is the passion for seeking knowledge, explore creative ideas. I will give a few examples of Palestinians to demonstrate their resilience..

RESEARCHER

I will quote a few statements of a person whom I will call Researcher to avoid the risk of target killing. In an extreme inhuman condition of crowded tent and with a traumatic mind by deaths around including over 50 from the Researcher's families by heavy bombings, the Researcher sought to respite some by engaging mind in scientific research and admirably made advance fast. I was not able to cope with the progress the Researcher made due to my other commitments. Gaza is just a land of destruction. Managing research, Researcher made statements some of which are given below:

" ... the laptop is not charged and all the time I am looking and thinking about a place to charge the laptop, so returning to our original In addition, I woke up to the news that my co-worker was killed as a result of an air strike on her and her family, so I cannot speak a word now. I apologize to you, Professor. Because we live in a despicable world...a world that deserves from God the most severe types of torment...because it stands by and watches our suffering and does not lift a finger. We sleep under bombing and wake up to painful news of the killing of our friends... We live in a waterfall of blood,"

"I am tired and I cannot bear any more. I cannot hear anyone and I cannot think of anything. I feel hopeless and I feel extreme fatigue taking over myself. I feel restrictions imprisoning my thoughts and ambition. There is no hope and no benefit to my existence in life. I want to return to northern Gaza through the Netsarim checkpoint. If the army fires bullets, I will be a martyr before God, better than the life we live, and this is what I am thinking...because our life and its absence are the same. A life without pride and dignity is not considered a life that is tired, and by God, by God, it is tire"

"When the soul can no longer bear the weight of pain, and the heart is burdened with what cannot be spoken, writing to friends like you becomes a relief for my suffering. I write because in words, there is refuge, and in letters, a solace for a wound that does not heal. I write when the eyes can no longer cry, and words erupt from the volcano of pain. Connecting with you is the thread of light I follow in the darkness of sorrow; it is the lifeboat in a sea of turbulent waves and pain, hoping to find in you what eases the burden of suffering or pours a touch of tranquility over my wounds. I apologize for disturbing you."

"Please do not write that I am suffering from psychological shock. I am fine, thank God, but I do not have the circumstances that enable me to search because there is no electrical source to charge the laptop and I am not in my home. I am displaced due to the war."

I do intend to go back to Researcher's project.

TENT CLASS FOR GIRLS

Dr. Salem Abumusleh, a physicist, high school teacher and coordinator for Astrophysics Program of the Ministry of Education in Gaza, has introduced Hope and Inspiration Intuitive, Activity for the female students in tents where they learn the vast realm of stars and galaxies, and draw pictures of the sky to relax and take the minds away from the trauma of genocide.



Figure 1: Palestinians female students draw the sky for relaxation



Figure 1: Astronomy class for tent female student

ONLINE CLASSES OF ISLAMIC UNIVERSITY OF GAZA

Israel started bombing IUG in October 2023.The faculty member who build a lab for cancer research in cancer cell watched with deep pain how his yearrs of of effort and devotion to carry on the research jut got vanished in moments. then he wrote he was going to build it up again after the war and that I should help in it. Israeli soldiers kep part of f IU to live theirwhile carrying out operations of destructions in the area. When they were done, they were happyly destroyed this rest of the structures with bobms and posted video of happiness at thecomplete demoliktion of the buildings. So there is nothing left for IUG members to continue on campus. However, their passion did not stop the education. For the 2024 sessions, IUG engaged students to take online classes . Students with laptops and source to charge the laoptops signed up. Classes are going on..



Picture (above): A female student is accepting her award at the Recognition ceremony at Islamic University in Gaza where best students and faculty members in STEM disciplines are awarded for their academic excellence and research.

Recent research carried out by Palestinian Scientists

1.Prof. Suleiman M. Baraka

Al Aqsa University, Gaza (currently at NASA-USA and Calgary, Canada) Below are his recent important research findings published in a series of 3 papers

i) Modeling the Sun-Earth-Moon plasma environment: I- Particle-In-Cell Simulations of the Magnetopause during Active Solar Conditions

Context:

Understanding the plasma environment of the Sun-Earth-Moon system is vital for assessing space weather impacts on the Lunar surface and unlocking the mysteries of the Moon's water cycle. This series of papers investigates the transport of solar wind and Earth's ionospheric ions to the Moon and the charging of its surface by the plasma sheet, in the full moon phase as a reference.

Significance:

Paper 1 marks a major milestone by presenting the first-ever simulation to include the Earth and Moon in the same simulation box. This innovative approach provides unprecedented insight into ion dynamics and velocities before and after reaching the Lunar surface while also revealing the distinct presence, size, and shape of key features such as the bow shock, foreshock, and magnetopause along the Sun-Earth line (Figure on the right).



Figure (left): A 2D X-Z slice of the simulation box illustrates the presence of a foreshock (left arrow), a bow shock (middle arrow), and the magnetopause along the Sun-Earth line - the linear plot on top is shown for clarity and reference.

ii) Modeling the Sun-Earth-Moon plasma environment: II – Tracking Escaped Cold Ionospheric H+ & O+

Context:

Understanding plasma transport from Earth to the Moon is essential to determine how space weather affects the Lunar surface. The objective is to characterize and track Earth's cold ionospheric ions, understand their influence on magnetospheric dynamics, and assess their impact on the Lunar surface.

Significance:

In Paper II, for the first time, we have coupled Earth's magnetosphere and ionosphere with the Moon in a single simulation box. This provides an transformative framework to



Figure (Left): Ionospheric H⁺ and O⁺ ion energies overlaid on XZ (left) and XY (right) plane magnetosphere contours confined to the polar caps and dayside cusps show that thermal velocities don't drive ion escape. Despite no initial acceleration, ions reach ± 15 R_e with average energies of 2.9 keV (H⁺) and 3.5 keV (O⁺).

study the transport of O⁺ and H⁺ ions from Earth to the Moon, which could contribute to additional water formation and influence volatile cycles in the Lunar environment.

iii) Modeling the Sun-Earth-Moon plasma environment: III – Kinetic Simulations of Plasma Sheet Interaction with Lunar Surface

Context:

Plasma-lunar surface interactions are vital for understanding lunar exploration and water formation. While the Moon spends 27% of its orbit in Earth's magnetotail, it was unclear if this shields the surface from solar wind and impacts H₂O generation.



Figure (above): Ion and electron build-up shows the process generates non-gyrotropic plasma at the lunar surface, disrupting quasi-neutrality. This leads to charge separation —positive on the day side and negative on the night side—inducing an electric field

Significance:

The results in Paper III shows the magnetotail does not shield the Moon, allowing plasma to impact the surface, enabling wake formation, ion acceleration, and surface charging. The Moon generates electric fields from plasma interaction and

Significance: photoionization and backstreams about 10% of the plasma.



Figure (above): The solar wind distribution, having Earth and the Moon in the same simulation box, is based on results from Paper I. Ion escapes from Earth's ionosphere into the magnetosphere and beyond are used from Paper II results. Lunar surface charges and lunar wake dynamics are from the findings in Paper III.

2. Dr. Hala Jarallah El- Khozondar Distinguished Professor, Fellow: TWAS-UNESCO, IAS Electrical Engineering and Smart Systems Departments Islamic University of Gaza, P.O.Box 108 Gaza, Palestine



M.S. and Ph.D. New Mexico State University, USA Post-doc and collaboration: Max Planck Institute, Germany

Her research covers a broad spectrum and is aimed at developing technical solutions for the world of tomorrow. For example, she is working on innovative solar system problems, developing optical fibres for faster data transmission, and on optical sensors for more precise diagnosis of diseases. Moreover, she has made major contributions to studying wireless communication, optical communication, nonlinear optics, optical fibre sensors, magneto-optical isolators, optical filters, MTMs devices, biophysics, electro-optical waveguides, and numerical simulation of microstructural evolution of polycrystalline materials.

3. Prof. Sufiyan Tayeh Islamic University in Gaza, Palestine President (killed with his family by Israel in 2023)

He was recognised among the top 2 percent of researchers globally in a study conducted by Elsevier and Stanford University.



Tayeh earned his bachelor's, master's and PhD degrees in physics from the Islamic University. He was the head of that university's physics department from 2008 to 2011, and was appointed president of the university in August 2023. His research had earned him international recognition: Tayeh was winner of the Palestine Islamic Bank Award for Scientific Research for the years 2019 and 2020, recipient of the Abdul Hameed Shoman Award for Young Arab Scientists and the Islamic University Award for Scientific Research for the year 2021. He had recently been appointed the UNESCO Chair for Physical, Astrophysical and Space Sciences in Palestine. Tayeh's research interests included optical waveguides, optical waveguide sensing, ellipsometry, dye-sensitized solar cells, and OLEDs.

• The Indo-US STEM Center plans for STEM teaching and research training for Palestinian students and researchers.





Sir Syed (founder of AMU) Mosque of Aligarh Muslim University. The Indo-US STEM Education and Research Center of the Ohio State University in the USA and Aligarh Muslim University(AMU) in India, founded in 2013, is located at AMU.