Dr. Suleiman M Baraka Resume

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Research Experiences
Senior Astrophysicist | Space Plasma Kinetic Modeling Specialist

20+ years of astrophysics and space research experience

- I have extensive expertise in modeling the interactions between the solar wind, Earth's magnetosphere, and ionosphere, with particular emphasis on their impact on the Moon. My research focuses on the intricate dynamics of the dayside magnetosphere, including the ionospheric escape of H^+ and O^+ ions, the mechanisms driving lunar surface charging, and the behavior of ions and electrons within the lunar wake.

- I am highly skilled in utilizing the advanced global 3D particle-in-Cell electrodynamics model, IAPIC (Institut d'Astrophysique de Paris particle-in-Cell code), which has undergone extensive development and enhancement within the research community (Baraka et al., 2021). My expertise spans a range of software tools critical to this work, including IDL, Python, and Fortran, as well as specialized software like PySPEDAS for efficient data analysis and visualization.

Key Achievenments:

- The kinetic derivation of the magnetopause's shape, size, and location for magnetized planets in our solar system and the magnetopause of exoplanets that orbit within the corona of their parent stars. Utilizing advanced 3D particle-in-Cell (PIC) simulations (Baraka et al., 2021).These kinds of accomplishments are necessary when looking at the imaging data from the SMILE mission.

- Simulating the dynamics of cold ions within the plasmasphere and magnetotail lobes is a challenging task, as these ions are difficult to detect with spacecraft missions. However, our kinetic simulations provide a detailed analysis of their behavior, offering crucial insights into their energies, charging mechanisms, and interactions with larger magnetospheric processes.

Objective:

- Through advanced simulations and collaborative research, we are dedicated to advancing our understanding of space plasma phenomena and their effects on planetary and lunar environments. I am committed to driving significant breakthroughs in the field.

Education

- **Ph.D. in Astrophysics and Space Physics**

- Université Pierre et Marie Curie, Paris, France, 2007
- **Ph.D. Thesis Title**: Study of the Interaction Between the Solar Wind and the Earth Magnetosphere: Theoretical Model and Application on Data Analysis of the Halloween Event of October 2003.
- Advisor: Lotfi Ben Jaffel, Institut d'Astrophysique de Paris, UPMC-CNRS, France
- Contact: bjaffel@iap.fr

- **M.Sc. in Theoretical Physics**
  - Islamic University, Gaza, Palestine, 2003
  - **M.Sc. Thesis Title:** Study of the Onset of the Earth Magnetosphere Under the Influence of the Solar Wind.
- **B.Sc. in Physics**
  - Al-Quds University, East Jerusalem, 1983-1987

Recent Appointments

- **Part-Time Research**
  - University of Alberta, Edmonton, AB
  - 2021 - June 2023
- **National Institute of Aerospace, VA, USA**
  - 2019 - Present (on unpaid absence)
- **Fulbright Visiting Scholar**
  - Department of Electrical and Computer Engineering, vt@space, Virginia Tech, VA, USA
  - 2018 - 2019

Professional Collaborators

- **Wayne Scales**
  - Virginia Tech, Bradley Department of Electrical and Computer Engineering.(Space@VT)
- **Bob Clauer**
  - Virginia Polytechnic University, Blacksburg, VA, USA
- **William Moore**
  - Hampton University, VA, USA
- **Sona Hosseini**
  - JPL, Caltech, M/S 183–401, 4800 Oak Grove Drive, Pasadena, CA
- **Lotfi Ben Jaffel**
  - Institut d'Astrophysique de Paris, Paris, France
- **Olivier Le Contel**
  - Laboratoire de Physique des Plasmas, Paris, France

- **Iannis Dandouras**
  - Institut de Research Astrophysique et Planétologie, Toulouse, France
- **Guillaume Gronofff**
  - NASA-LRC, Hampton, Virginia, USA
- **David G Sibeck**
  - NASA Goddard Flight Center, MD, USA
- **Andrey Samsonov**
  - Holmbury St. Mary, Dorking, Surrey, RH5 6NT, England
- **Eric Donovan**
  - University of Calgary, Calgary, Alberta, T2N 1N4, Canada
- **Robert Rankin**
  - The University of Alberta, Edmonton, Alberta, T6G 2G7, Canada

Publications

- **Baraka, S.**, Hosseini, S., Gronoff, G. and Alqeeq, S., 2024. Modeling the Sun-Earth-Moon plasma environment: I- Particle-In-Cell Simulations of the Magnetopause during Active Solar Conditions. Annales Geophysicae (in preparation for submission).
- **Baraka, S**., Hosseini, S., Alqeeq, S. and Gronoff, G., 2024. Cold Ionospheric H^+ & O^+ Ions Escape Tracked in Magnetosphere: PIC Code Simulation. Annales Geophysicae (in preparation for submission).
- **Baraka, S**., Hosseini, S., Gronoff, G. and Alqeeq, S., 2024. Modeling the Sun-Earth-Moon plasma environment: III - Kinetic Simulations of Plasma Sheet Interaction with Lunar Surface. Annales Geophysicae (in preparation for submission).
- **Baraka, S**, Hosseini, S.; Gronoff, G.; Rankin, R., Ben-Jaffel, L. (2023) The Sun-Earth-Moon Connection: I–3D Global Kinetic Simulation, *arXiv preprint arXiv:2309.15851*
- **Baraka, S**, Hosseini, S.; Gronoff, G.; Rankin, R., Ben-Jaffel, L. (2023) The Sun-Earth-Moon Connection: II–Solar Wind and Lunar Surface Interaction, *arXiv preprint arXiv:2309.15852*
- **Baraka, S**, Hosseini, S.; Gronoff, G.; Rankin, R., Ben-Jaffel, L. (2022). The First Kinetic Simulation of Solar Wind-Magnetosphere-Moon Coupling. Study of Lunar Wake and Migration of Oxygen and Hydrogen from Ionosphere to the Lunar Surface, AGUFM Abstract # **SM55B-1451**
- **Baraka, S.**, Donovan, E., Ben-Jaffel., L., (2023). The Impact of North and South IMF on the Dynamics of the Earth's Magnetopause, size and shape and Dawn-Dusk Asymmetry From Global 3D Kinetic Code(in preparation).
- **Baraka, S. M**., Le Contel, O., Ben-Jaffel, L., & Moore, W. B. (2021). The impact of radial IMF tilt angle on the cusps and the global dynamic structure of Earth Magnetosphere. Comparison study(in preparation). To be submitted to JGR-Space Physics

- **Baraka, S. M.**, Le Contel, O., Ben-Jaffel, L., & Moore, W. B. (2021). The impact of radial and non-radial IMF on the Earth's magnetopause size, shape, and dawn-dusk asymmetry from global 3D kinetic simulations. Journal of Geophysical Research: Space Physics, 126, e2021JA029528. https://doi. org/10.1029/2021JA029528
- Alqeeq, S., Le Contel, O., Canu, P., Retino, A., Chust, T., Alexandrova, A., Mirioni, L., **Baraka, S**, et. al., Investigation of the homogeneity of energy conversion processes at dipolarization fronts from MMS measurements,Physics of Plasmas 29.1 (2022): 012906.)
- Investigation of energy conversion processes and wave activity related to dipolarization fronts observed by MMS Alqeeq, S., Le Contel, O., Canu, P., Retino, A., Chust, T., Alexandrova, A., Mirioni, L., **Baraka, S.**, Richard, L., Khotyaintsev, Y., Nakamura, R., Wilder, F., Ahmadi, N., Wei, H., Argall, M., Fischer, D., Gershman, D., Burch, J., Torbert, R., and Giles, B. and the MMS Team Conference Paper EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-11118 (2021)
- **S. Baraka,** O. Le Contel, L. Ben Jaffel, Magnetosphere Dynamical and Morphological Response to Multi-species Plasma Supply From the Ionosphere: New Comprehensive 3D PIC Simulation. (In preparation: JGR-Space Physics).
- Gronoff, G., Arras, P., **Baraka, S.,** Bell, J. M., Cessateur, G., Cohen, O., ... & Garcia-Sage, K. (2020). Atmospheric Escape Processes and Planetary Atmospheric Evolution. Journal of Geophysical Research: Space Physics, e2019JA027639.
- **S. Baraka,** Large Scale Earth's Bow Shock with Northern IMF as Simulated by PIC Code in Parallel with MHD Model, J. Astrophys. Astron., vol. 37, no. 2, pp. 1–16, 2016.
- **S. Baraka** and L. Ben-Jaffel, Earth's Magnetosphere 3D Simulation by Coupling Particle-In-Cell and Magnetohydrodynamics Models: Parametric Study, AGU Fall Meet. Abstr., vol. 1, p. 4222, 2014.
- **S. M. Baraka**, L. B. Jaffel, and I. S. Dandouras, The unusual event of Jan 21st 2005 observed by Cluster spacecracts is considered for comparison by PIC EM Relativistic code simulation, AGU Fall Meet. Abstr., p. B2236, Dec. 2013.
- **S. Baraka** and L. Ben-Jaffel, Particle-In-Cell PIC 3D and MHD simulations of the Earth's Bow shock in EGU General Assembly Conference Abstracts, vol. 14, p. 6477, 2012.
- **S. Baraka** and L. Ben-Jaffel, Sensitivity of the Earth's magnetosphere to solar wind activity: Three-dimensional macroparticle model, J. Geophys. Res. Space Phys. 1978–2012, vol. 112, no. A6, 2007.
- **S. Baraka** and L. Ben-Jaffel, Impact of solar wind depression on the dayside magnetosphere under northward interplanetary magnetic field, Ann. Geophys., vol. 29, pp. 31–46, Jan. 2011.
- **S. Baraka** and L. Ben-Jaffel, PIC EM Relativistic code is used to simulate the Earth bow shock," in AGU Fall Meeting Abstracts, vol. 1, p. 2032, 2011.

Invited Talks

- **March 2023**
  - **Title**: The Sun-Earth-Ionosphere-Moon Coupling: Large-Scale Kinetic Simulation in a Singular Setting
  - **Venue**: University of Purdue, West Lafayette, Indiana, US

- **April 2022**
  - **Title**: Advanced Visualization Techniques in Magnetospheric Physics
  - **Venue**: University of Calgary, AB, Canada
- **January 2020**
  - **Title**: Kinetic Simulations of Space and Astrophysical Plasmas
  - **Venue**: Royal Military College, Kingston, ON, Canada
- **October 2015**
  - **Title**: 3D Magnetosphere-Ionosphere Coupling Simulation using IAP Code
  - **Venue**: European Southern Observatory, ESO, Garching, Germany
- **February 2012**
  - **Title**: Advocating Space Weather Education in the Arab World
  - **Venue**: 10th meeting of the Arab Union for Astronomy and Space Sciences, Muscat, Oman
- **November 2011**
  - **Title**: Examples of PIC EM Relativistic Global Code Simulation for Bow Shock
  - **Venue**: Instituto de Astrofisica de Andaluciá, Granada, Spain
- **April 2007**
  - **Title**: Introduction to Space Weather
  - **Venue**: Cairo University, Egypt
- **January 2007**
  - **Title**: Impact of Solar Wind Depression on Dayside Magnetosphere
  - **Venue**: Centre d'Etude Environment Terrestres et Planetaires, Velizy, France
- **November 2006**
  - **Title**: Simulated Depression of Solar Wind Inflow in the Dayside Magnetopause
  - **Venue**: Conference Magnetospheric Physics, Centre d'Etude Spatiale des Rayonnements, Toulouse, France
- **May 2006**
  - **Title**: Impact of 2D Plasma Density Depression on Magnetopause Standoff Distance
  - **Venue**: AGU Joint Assembly, Baltimore, USA

Poster Presentations

- **The First Kinetic Simulation of Solar Wind-Magnetosphere-Moon Coupling. Study of Lunar Wake and Migration of Oxygen and Hydrogen from Ionosphere to the Lunar Surface**
  - Authors Baraka, S., Hosseini, S., Gronoff, G., Rankin, R., Ben-Jaffel, L. (2022)
  - Event AGUFM Abstract #SM55B-1451
  - Location Chicago, Illinois, US
  - Date December 2022

- **3D Study of the Impact of the Radial IMF on the Earth's Magnetopause Size and Shape and the Dawn-Dusk Asymmetry. IAPIC 3D Simulations**
  - Event AGUFM Abstract ID SM51C-3199
  - Location San Francisco, USA
  - Date December 2019
- **Global Comparison of Cluster and Themis Data on July 16th, 2007 with PIC EM Code in the Vicinity of the Earth's Magnetosphere During Radial IMF Conditions**
  - Event AGUFM Abstract ID SA41C-3501
  - Location Washington, DC, USA
  - Date December 2018
- **Magnetospheric Dynamical and Morphological Response to Multi-Species Plasma Supply From the Ionosphere: New Comprehensive 3D PIC Simulation**
  - Event AGUFM Abstract ID SM23B-2552
  - Location San Francisco, USA
  - Date December 2015
- **3D Simulation of the Earth's Magnetosphere by Particle-In-Cell and Magnetohydrodynamics Models: Parametric Study**
  - Event AGUFM Abstract ID SM41A-4222
  - Location San Francisco, USA
  - Date December 2014
- **Unusual Event of Jan 21, 2005 Observed by Cluster Spacecraft is Considered for Comparison by PIC EM Relativistic Code Simulation**
  - Event AGUFM Abstract ID SM41B-2236
  - Location San Francisco, USA
  - Date December 2013
- **Particle-In-Cell PIC 3D and MHD Simulations of the Earth's Bow Shock**
  - Authors Baraka, S. and L. Ben Jaffel
  - Event EGU2012 Abstract ID EGU2012-6477
  - Location Vienna, Austria
  - Date April 2012
- **Kinetic Modeling of the Earth's Bow Shock and Magnetopause**
  - Event GEM Annual Meeting
  - Location Snowmass, Aspen, Colorado, USA
  - Date June 2009
- **PIC EM Relativistic Simulation of Solar Wind-Magnetospheric Interaction, Space Weather Application**
  - Event First European Week on Space Weather
  - Location ESTEC Noordwijg, Holland
  - Date November 2004

Conference Talks

- **MENA Countries Strategic Need for Space Weather Research**
  - Beirut, Lebanon
  - September 2015
- **Kinetic Modeling: Difficulties, Challenges, and Aspiration**
  - AGUFM 2013, GEM Focus Group
  - San Francisco, USA
  - December 2013
- **Comparison Between MHD and PIC Codes to Simulate the Jump Condition in the Dayside Magnetosphere**
  - Snowmass, Aspen, Colorado, USA
  - June 2009
- **Introduction to Numerical Simulation of the Dayside Magnetosphere**
  - Lunar and Planetary Lab, Arizona University, USA
  - September 2005
- **Space Simulation and Solar Wind-Earth Magnetosphere Interaction**
  - Université Pierre et Marie Curie, Paris, France
  - January 2005
- **Space Weather Simulation**
  - Al Akhawayn University, Ifrane, Morocco
  - July 2004

Awards (Total of 65,000 Euros)

- **Winner of 2018 International Award**
  - Renata Borlone, Loppiano, Florence, Italy
  - Award Video
  - February 2018
- **Joint Franco Palestinian Research Grant**
  - 2016-2018
  - Grant Total: 20,000 Euros
- **Invited Professor Grant**
  - UPMC, LPP, Paris, France
  - October 2015
  - Grant Amount: 5,000 Euros

- **Erasmus Mundus IRFU**
  - Uppsala University, Sweden
  - September 2015
  - Grant Amount: 4,000 Euros
- **Bank of Palestine Grant**
  - Four months support to work at NIA Hampton VA-NASA
  - June 2015
  - Grant Amount: 16,000 Euros
- **Joint Franco Palestinian Research Grant**
  - 2011-2013
  - Grant Total: 20,000 Euros

Professional Memberships

- **CAP** (Canadian Association of Physics)
  - Since 2022
- **APS** (American Physical Society)
  - Since 2017
- **IAU** (International Astronomical Union)
  - Since 2015
- **EGU** (European Geophysical Union)
  - Since 2011
- **AUASS** (Arab Union for Astronomy and Space Science)
  - Since 2007
- **AGU** (American Geophysical Union)
  - Since 2005

Computer Skills

- Proficient in:
  - **Programming Languages**: IDL, Python, MATLAB, gnuplot
  - **Data Processing**: pyspedas
  - **Scientific Computing**: Fortran 77
- Experienced with:
  - **Document Preparation**: LaTeX-BibTeX, JabRef, Zotero, Microsoft tools
  - **Visualization Tools**: Vapor, VisIt, CISM, R software
- Operating Systems:
  - **Professional** in Mac, Linux, and Windows platforms

Outreach and Media

- **Feature Story by NIA**
  - Unlocking the Universe in Gaza
  - NIA Feature Storyt
- **ARTE TV report on astronomical activities in Gaza.**
  - ARTE TV report
- **Academic and social consulting.**
  - Consultant for undergraduate and graduate students across disciplines
  - Consulting Example
- **Revitalization of Astronomy initiative.**
  - Initiative Example
- **Promoting Astronomy for Peace**
- **Motivational Speaking for Youth**
  - Motivional Example
- **Media Presence on Astronomical Phenomena**
  - Active engagement to discuss astronomical phenomena and address public inquiries

References

- **David G. Sibeck**
  - NASA Goddard Flight Center, Org Code: 674 NASA/GSFC Mail Code: 674
  - Greenbelt, MD 20771, Greenbelt, MD
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- **Olivier Le Contel**
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