

Mykhaylo Shumko

Johns Hopkins University Applied Physics Laboratory

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EDUCATION

Montana State University

August 2014 - December 2019

Ph.D. in Physics

Dissertation title: Connecting Microburst Precipitation to Its Scattering Mechanism

University of California, Santa Cruz

September 2010 - June 2014

B.S. in Astrophysics.

Thesis title: Dynamic studies of punch thorough protection of silicon strip detectors with laser-based charge injection system

RESEARCH INTERESTS

I am a space physicist with a diverse research agenda spanning the ionosphere, inner magnetosphere and magnetotail environments. I push the space physics frontier with data analysis using a wide range of in-situ and remote sensing observatories. By combining these observatories in novel ways can we begin to understand the magnetosphere as a coupled system. Specifically, my current research interests includes characterizing wave-particle interactions in the inner magnetosphere using in-situ satellites and auroral imagers, and characterizing particle acceleration and scattering in the magnetotail. Beyond data analysis, I have a passion for software engineering and I am currently leading the LAMPsat CubeSat mission concept.

TEACHING EXPERIENCE

- **Instructor**, Physics 68, Plasma Physics, Fall 2022
- **Teaching Assistant**, Physics 220, Intro to Physics I (w/ calculus), Spring 2016
- **Instructor**, Physics 201, Physics by Inquiry, Fall 2015
- **Teaching Assistant**, Physics 207, Intro to Physics II, Spring 2015, Summer 2015
- **Teaching Assistant**, Physics 205, Intro to Physics I, Fall 2014

AWARDS

- NASA Goddard Diversity and Inclusion Award, 2021
- NASA Postdoctoral Program Fellowship, 2020-2022
- NASA Earth and Space Sciences Fellowship, 2018-2020
- Vela Fellowship, 2018
- The Best Inner Magnetosphere Poster, GEM Workshop, 2016
- Montana Space Grant Consortium Fellowship, 2015 - 2016

- NASA EPSCoR Travel Grant, 2015

FUNDED GRANTS

- Co-I, **NASA Living With a Star**, “Revealing Cross-Scale Geospace Coupling: The Nightside Transition Region and its Auroral Manifestations”, PI: Kareem Sorathia (2024-2028)
- PI, **NASA Heliophysics Tools and Methods**, “Refactor aurora-asi-lib to support THEMIS, REGO, and TREx all-sky imagers”, PI: Mykhaylo Shumko, (2023-2024)
- PI, **NASA Heliophysics Flight Opportunities Studies**, “The Loss Through Auroral Microburst Pulsations Satellite (LAMPsat) Flight Opportunity Study”, PI: Mykhaylo Shumko, (2023-2024)
- PI, **NASA Postdoctoral Program Fellowship**, “The Connection Between the Inner Magnetosphere Waves and Energetic Particle Precipitation Into Earth’s Atmosphere”, PI: Mykhaylo Shumko, (2020-2022)
- Collaborator, **Heliophysics Supporting Research**, “Investigating the generation and properties of relativistic electron microbursts”, PI: Lauren Blum (2021-2024)
- Co-I, **Internal Scientist Funding Model Grant at GSFC**, “Particle Precipitation: a comprehensive investigation of the drivers and impacts of precipitation across species and energy, PI: Alexa Halford, (2021-2025)
- PI, **NASA Earth and Space Sciences Fellowship**, “Multi-Spacecraft Observations and Modeling of Electron Microburst Precipitation And Its Scattering Mechanism”, PI: Mykhaylo Shumko, (2018-2020)
- PI, **Montana Space Grant Consortium Fellowship**, PI: Mykhaylo Shumko, (2015-2016)

PROFESSIONAL EXPERIENCE

Johns Hopkins University Applied Physics Laboratory

May 2023 - present

Post-Doctoral Fellow

Laurel, MD

- Using a novel combination of LEO and high-altitude satellites such as ELFIN, THEMIS, and MMS to characterize magnetotail particle acceleration and scattering
- Developing the asilib library (<https://aurora-asi-lib.readthedocs.io/en/latest/>) that I created for processing ground-based auroral all-sky imager (ASI) data. I’ve developed a flexible data analysis architecture that allows the inclusion of a diverse set of ASI data. The library currently supports three imaging systems: THEMIS, REGO, and TREx. Furthermore, two more imaging systems—PsA Project, and MANGO—will be added in the coming months.
- Leading the LAMPsat CubeSat mission concept. In this role I’ve gained experience with defining the science goals, mission- and instrument-level requirements, and managing a team of scientists and engineers. My work focuses on trade studies that aim to constrain requirements, and identify solutions that will lead to science closure considering constraining hardware and a limited budget.
- Contributing precipitation data analysis expertise as part of the CINEMA SMEX science team.

University of Maryland

May 2022 - April 2023

Post-Doctoral Associate

College Park, MD

- Discovered and published results on a relativistic electron microburst with a inverse time-of-flight energy dispersion
- Identified the wave drivers of pulsating aurora and relativistic electron precipitation using the THEMIS ASIs, THEMIS satellites, and the SAMPEX satellite.
- Advised a graduate student
- Developed the sampex python package to download, load, and plot the SAMPEX satellite data. This package includes a simple user interface, through documentation with examples, automatic tests, and minimal dependencies.

Dartmouth College
Visiting Scholar

September 2022 - March 2023
Hanover, NH

- Taught the P68 Plasma Physics Course
- Advising a graduate student
- Co-Investigator on a NASA SMEX proposal, submitted in December 2022

NASA's Goddard Space Flight Center
NASA Postdoctoral Program (NPP) Fellow

May 2020 - May 2022
Greenbelt, MD

- Provided microburst physics expertise and now analyzing all-sky imager data for the Loss through Auroral Microburst Pulsations (LAMP) sounding rocket mission
- Interviewed for the Relatively Cosmic podcast.
- Wrote the data processing pipeline for the upcoming Geostationary Transfer Orbit Satellite (GTOsat) mission
- Published studies to understand under what conditions is the low-energy auroral precipitation observed by the THEMIS imagers was associated with relativistic electrons observed by the SAMPEX satellite
- Published studies on multi-point observations of electron curtain and microburst precipitation observed by the AeroCube-6 CubeSats
- Published a study on the duration of electron microbursts observed by NASA's SAMPEX mission
- Advised a summer student

Space Sciences and Engineering Laboratory
Graduate Research Assistant and Postdoctoral researcher

September 2014 - April 2020
Bozeman, MT

- Assisted with the launch of a BARREL high altitude balloon out of McMurdo, Antarctica in December 2019
- Operated the FIREBIRD-II CubeSats and developed the data pipeline to automatically process the data from satellite to the internet within a day
- Generated ephemeris and magnetic ephemeris for FIREBIRD-II using Two Line Elements and IRBEM-Lib
- Created a detection algorithm to identify transient and spatial features observed by the AeroCube-6 multi-spacecraft CubeSat mission
- Developed and maintain a Python wrapper for IRBEM-Lib
- Created a database of microbursts observed with the FIREBIRD-II CubeSats, detected using a wavelet filtering and reconstruction
- Advised REU and undergraduate students
- Co-directed the Rocky Mountain Data Science Club

Los Alamos National Laboratory
Graduate Researcher

June - July 2018
Los Alamos, NM

- Performed an uncertainty quantification of the Magnetic Electron Ion Spectrometer onboard the Van Allen Probes
- Developed a forward model to convert a flux energy spectra to count rates observed by the Magnetic Electron Ion Spectrometer and optimized the model parameters using a Markov chain Monte Carlo sampler

The Aerospace Corporation
Graduate Researcher

May - August 2017
El Segundo, CA

- Analyzed a microburst observed by the Van Allen Probes and used resonant diffusion theory to conclude that the electron transport is inconsistent with particle transport along single-wave characteristics (diffusion curves for monochromatic waves)

- Estimated the magnetic field model footprint error for a variety of magnetic field models using IRBEM-Lib

Santa Cruz Institute for Particle Physics

Undergraduate Researcher

September 2012 - August 2014

Santa Cruz, CA

- Tested Punch-Through Protection resistance and safe operating voltage of low resistance silicon strip detectors using DC voltage sweeps and laser injection
- Carefully transported, cooled, biased, and probed the ATLAS detector's strip silicon detectors under a microscope
- Captured charge pulses on an oscilloscope and analyzed the waveforms using ROOT, a C++ interpreter

INVITED TALKS

- LASP Friends of Magnetospheres seminar, "Localized Burst of Relativistic Electrons in Earth's Plasma Sheet: Low- and High-Altitude Signatures During a Substorm", 2024.
- Center for Geospace Storms (CGS) Seminar, "aurora-asi-lib: an open source package providing data access and analysis tools for the world's all-sky imager (ASI) data", 2024
- Division of Atmospheric and Space Physics of the Canadian Association of Physicists, "Auroral all-sky imager analysis techniques using aurora-asi-lib", 2024
- Magnetosphere Online Seminar Series, "On the Coupling Between Radiation Belt Precipitation and The Aurora: Conjunctive Observations Using aurora-asi-lib", 2023.
- UCLA, "The Association of Relativistic Electron Microbursts with the Aurora", 2022.
- Dartmouth College, "The Association of Relativistic Electron Microbursts with the Aurora", 2022.
- CEDAR workshop, "aurora-asi-lib: Easily download, plot, animate, and analyze auroral all sky imager (ASI) data", 2021.
- GEM workshop, "Precipitation Conjunction Events: an Overview of the Precipitation Workshop", 2019.
- UC Berkeley, "Radiation Belt Electron Precipitation: Decoupling the Spatial and Temporal Properties via Multi-Spacecraft CubeSat Missions", 2017.

CONFERENCES, MEETINGS, AND WORKSHOPS

- Gave a talk at the Canadian Division of Atmospheric and Space Physics meeting
- Member of an ISSI team, "Dynamics of Electromagnetic Ion Cyclotron Wave Activity in the Earth's Magnetosphere", 2021-2024
- Co-chaired the "Space Precipitation: Drivers, Dynamics, and Impacts" oral and poster sessions at 2023 AGU Fall Meeting,
- Co-chaired the Particle Acceleration session at the Fall 2023 MMS SWT meeting,
- Co-convener for oral sessions at 2021 AGU Fall Meeting
- Organized and led a Particle Precipitation Workshop at University of New Hampshire, 2019
- Gave talks at: 2024 GEM Workshop, 2022 GEM Workshop, 2021 AGU Fall meeting, 2021 GEM workshop, 2020 AGU Fall meeting, 2020 GSFC Early Career Scientist Forum, 2020 GSFC Director's Seminar, 2020 GEM workshop, 2019 GEM workshop, 2018 GEM workshop, 2017 AGU Fall meeting, 2017 GEM workshop, 2017 MSU Relativity and Astrophysics Seminar, 2016 Montana Space Grant Symposium

SERVICE

- Organized a DEI session at GEM on work-life balance (2024)
- GEM At Large Steering Committee Member (2024-2028)
- Led and submitted a white paper for the Decadal Survey titled "Recommendations on Funding Mission Operations and Historical Datasets"
- Served on NASA review panels as a Panel Chair, Reviewer, and Executive Secretary
- Reviewed manuscripts for AGU's JGR and GRL journals, AGU Books, and Elsevier's Advances in Space Research journal

PUBLICATIONS

- **Shumko, M.** et al., (2025). Strong relativistic electron precipitation associated with substorm expansion: drivers and energy balance (in-progress).
- **Shumko, M.** et al., (2024). A Localized Burst of Relativistic Electrons in Earth's Plasma Sheet: Low- and High-Altitude Signatures During a Substorm" JGR (submitted).
- Raptis, S. et al., **Shumko, M.** (2024).. Multi-Mission Observations of Relativistic Electrons and High-Speed Jets Linked to Shock Generated Transients (submitted) ApJL.
- Zhang, X., et al., **Shumko, M** (2024). Relativistic and Ultra-Relativistic Electron Bursts in the Earth's Magnetotail (submitted) GRL
- He, J., et al., **Shumko, M** (2024). Association of Relativistic Microbursts Duration with Chorus Wave Properties (submitted)
- Sorathia, K. A., **Shumko, M.**, et al. (2024). Identifying the magnetospheric drivers of giant undulations: Global modeling of the evolving inner magnetosphere and its auroral manifestations. Geophysical Research Letters, 51, e2024GL110772. <https://doi.org/10.1029/2024GL110772>.
- Feinland, M., et al., **Shumko, M.** (2024). Lightning-induced relativistic electron precipitation from the inner radiation belt. Nat Commun 15, 8721. <https://doi.org/10.1038/s41467-024-53036-4>.
- Householder, I., et al., **Shumko, M.** (2024). Comparisons of Energetic Electron Observations between FIREBIRD-II CubeSats and POES/MetOp Satellites from 2018-2020 (accepted) AGU-JGR
- Kurien, L. et al., **Shumko, M.** (2024). Outer zone relativistic electron response to mesoscale periodic density structures in the solar wind: Van Allen probes measurements. Journal of Geophysical Research: Space Physics, 129, e2024JA032614. <https://doi.org/10.1029/2024JA032614>.
- Hasokawa, K, et al., **Shumko, M.** (2024). Variation of the Altitude of Auroral Emission during a Substorm Cycle: Stereoscopic optical observations during the LAMP Rocket Experiment. Journal of Geophysical Research: Space Physics 129.11. <https://doi.org/10.1029/2024JA033036>
- Nosé, et al., **Shumko, M** (2024). Field-aligned currents associated with pulsating auroral patches: Observation with magneto-impedance magnetometer (MIM) onboard loss through auroral microburst pulsations (LAMP) sounding rocket. Journal of Geophysical Research: Space Physics, 129, e2023JA032232. <https://doi.org/10.1029/2023JA032232>
- Wetzel, W., et al., **Shumko, M.** (2024). Properties of relativistic bouncing microbursts. Journal of Geophysical Research: Space Physics, 129, e2023JA032344. <https://doi.org/10.1029/2023JA032344>
- **Shumko M.**, Miyoshi, Y., Blum, L. W., Halford, A. J., Breneman, A. W., Johnson, A. T., et al. (2023). Observation of an electron microburst with an inverse time-of-flight energy dispersion. Geophysical Research Letters, 50, e2023GL104804. <https://doi.org/10.1029/2023GL104804>
- Kandar H., Blum L., **Shumko M.**, et al. (2023). The properties of MeV electron microbursts and their repetition periods compared to chorus waves. Geophysical Research Letters. <https://doi.org/10.1029/2023GL104666>
- Namekawa T., et al., **Shumko M.** (2023). Simultaneous Precipitation of Sub-Relativistic Electron Microburst and Pulsating Aurora Electrons. Geophysical Research Letters. <https://doi.org/10.1029/2023GL104001>.

- Meyer-Reed, C., Blum, L., and **Shumko M.** (2022). Pitch Angle Isotropy of Relativistic Electron Microbursts as Observed by SAMPEX/HILT: Statistical and Storm-time Properties. *Journal of Geophysical Research: Space Physics*, 128, e2022JA030926. <https://doi.org/10.1029/2022JA030926>
- Elliott S, et al., **Shumko M** (2022). Understanding the properties, wave drivers, and impacts of electron microburst precipitation: Current understanding and critical knowledge gaps. *Front. Astron. Space Sci.* 9:1062422. doi: 10.3389/fspas.2022.1062422
- Narock A, et al., **Shumko M** (2022). Supporting responsible machine learning in heliophysics. *Front. Astron. Space Sci.* 9:1064233. doi: 10.3389/fspas.2022.1064233
- **Shumko M.**, et al. (2022). Proton aurora and relativistic electron microbursts scattered by electromagnetic ion cyclotron waves. *Front. Astron. Space Sci.* 9:975123. doi: 10.3389/fspas.2022.975123
- **Shumko M.**, et al. (2022). AuroraX, PyAuroraX, and aurora-asi-lib: A user-friendly auroral all-sky imager analysis framework. *Front. Astron. Space Sci.* 9:100945. doi: 10.3389/fspas.2022.1009450
- Elliott, S., et al., **Shumko M.** (2022). Quantifying the size and duration of a microburst-producing chorus region on 5 December 2017. *Geophysical Research Letters*, 49, e2022GL099655. <https://doi.org/10.1029/2022GL099655>
- **Shumko M.**, et al., (2021). Duration of individual relativistic electron microbursts: A probe into their scattering mechanism. *Geophysical Research Letters*, 48, e2021GL093879. <https://doi.org/10.1029/2021GL093879>
- **Shumko M.**, et al., (2021). A strong correlation between relativistic electron microbursts and patchy aurora. *Geophysical Research Letters*, 48, e2021GL094696. <https://doi.org/10.1029/2021GL094696>
- Johnson, A. T., **Shumko M.**, et al., (2021). The energy spectra of electron microbursts between 200 keV and 1 MeV. *Journal of Geophysical Research: Space Physics*, 126, e2021JA029709. <https://doi.org/10.1029/2021JA029709>
- Capannolo, L., et al., **Shumko, M.** (2021). Energetic electron precipitation observed by FIREBIRD-II potentially driven by EMIC waves: Location, extent, and energy range from a multievent analysis. *Geophysical Research Letters*, 48(5), e2020GL091564.
- Duderstadt, et al., **Shumko, M.** (2021). Estimating the impacts of radiation belt electrons on atmospheric chemistry using FIREBIRD II and Van Allen Probes observations. *Journal of Geophysical Research: Atmospheres*, 126(7), e2020JD033098.
- **Shumko, M.**, et al., (2020). Statistical Properties of Electron Curtain Precipitation Estimated With AeroCube-6. *Journal of Geophysical Research: Space Physics*, 125(12), e2020JA028462.
- **Shumko, M.**, et al., (2020). Electron microburst size distribution derived with AeroCube-6. *Journal of Geophysical Research: Space Physics*, 125(3), e2019JA027651.
- Johnson, A. T., **Shumko, M.**, et al., (2020). The FIREBIRD-II CubeSat mission: Focused investigations of relativistic electron burst intensity, range, and dynamics. *Review of Scientific Instruments*, 91(3), 034503.
- Capannolo, L., et al., **Shumko, M.** (2019). Direct observation of subrelativistic electron precipitation potentially driven by EMIC waves.” *Geophysical Research Letters* 46.22. <https://doi.org/10.1029/2019GL084202>
- **Shumko, M.**, et al., (2018). Evidence of microbursts observed near the equatorial plane in the outer Van Allen radiation belt. *Geophysical Research Letters*, 45(16), 8044-8053.
- **Shumko, M.**, et al., (2018). Microburst scale size derived from multiple bounces of a microburst simultaneously observed with the FIREBIRD-II CubeSats. *Geophysical Research Letters*, 45(17), 8811-8818.
- Breneman, et al., **Shumko, M.** (2017). Observations directly linking relativistic electron microbursts to whistler mode chorus: Van Allen Probes and FIREBIRD II. *Geophysical Research Letters*, 44(22), 11-265.
- Ullán, M., et al., **Shumko, M.**, (2014). Low-resistance strip sensors for beam-loss event protection. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 765, 252-257.