BOSTON UNIVERSITY

Boston University College of Arts & Sciences
Center for Space Physics

2023—2024 SPACE PHYSICS SEMINAR SERIES

X-ray and Energetic Electron Imaging of Earth and Planetary Radiation Environments

Radiation belt electron fluxes can be enhanced during geomagnetic storms by two orders of magnitude; during the recovery phase, these fluxes decay back to nominal levels in a few days. Precipitation into the upper atmosphere is a primary loss mechanism for these electrons. Upon impacting the upper atmosphere, these electrons create new ionization, leading to a chemical response that increases NOx and HOx and destroys ozone. Quantifying both radiation belt loss and the impact on the atmosphere requires an accurate estimate of the flux, energy spectrum, and spatial and temporal scales of precipitation.

Measuring energetic electron precipitation has typically relied on in-situ particle detectors; however, these instruments can only provide point measurements, leaving a temporal-spatial ambiguity in space-based measurements and providing no cross-track information. A novel solution to this problem is to measure the impact of energetic electron precipitation through the X-rays produced in the upper atmosphere. The NASA-funded Atmospheric Effects of Precipitation through Energetic X-rays (AEPEX) CubeSat mission will be the first to image radiation belt electron precipitation by measuring the bremsstrahlung X-rays created during the precipitation process, using a new instrument called the Atmospheric X-ray Imaging Spectrometer (AXIS). AXIS uses a coded aperture mask to enable wide field-of-view imaging in a small form factor. With a 1000 x 1000 km field-of-view and ~50-100 km resolution, AXIS will solve the temporal-spatial ambiguity and image a wide cross-track swath with each orbit. AEPEX will launch in late 2024; this talk will provide an overview of the mission goals, instrument and spacecraft design, and current status. AEPEX will be followed in a few years by IMPAX and RADICALS, two new missions that will push the X-ray imaging capabilities further by imaging at higher time resolution and with greater energy range. The development of AEPEX has further led to novel mission concepts for outer planet radiation belt observations, in particular for Jupiter. A variant of the AXIS instrument could image energetic electron precipitation into Jupiter's upper atmosphere, and potentially image soft X-rays produced by the radiation belts themselves through inverse Compton scattering. Finally, we discuss a new instrument concept under development that applies coded aperture imaging to electron detection, enabling the measurement of pitch angle distributions of energetic electrons in a variety of space environments.

Thursday, April 11th

4:00-5:00 p.m.

725 Commonwealth Ave | Room 502

Robert Marshall

University of Colorado Boulder