NSF Award Abstract — #0447354

Integrated Research and Education in Solar Physics, Space Weather, and Energetic Charged Particles

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Abstract

The Sun occasionally becomes extremely active and produces the largest flux of high-energy charged particles in our solar system. The physical characteristics of these solar-energetic particles (SEP) vary considerably. The solar physics community currently has a useful paradigm to help categorize these events; however, we lack a detailed understanding of the important physical processes involved in their acceleration and propagation to Earth. It is now clear that, in order to arrive at a fundamental physics-based picture, we need to take a cross-disciplinary approach that combines solar physics, particle transport theory (acceleration and propagation), space-plasma physics, and space weather. A deeper understanding of the physics of solar-energetic particles will enable a better predictive capability for space weather and all that that entails. The PI proposes to integrate basic research and education to help understand various aspects of the connected Sun-Earth system as a whole. The PI intends to develop a graduate-level solar physics course in the Department of Planetary Sciences at the University of Arizona. The course will present an introduction to the physics of the Sun, including a detailed description of solar magnetic fields and extreme solar activity, some of which is responsible for the acceleration of high-energy particles, and the relation between solar activity and Earth's climate. Second, the PI will partner with the National Solar Observatory to develop a series of summer schools for graduate students and researchers that teach a cross-disciplinary approach to studying the Sun-Earth connection. Third, a public outreach component to the project is targeted to spark public interest in solar physics and space weather, and to provide new subject material for science teachers and students at public schools. LPL's Public Outreach Program and the University of Arizona's SAMEC (Science & Math Education Center) program will direct public outreach activities. The research plan focuses on studying the origin of energetic charged particles (up to a few tens of GeV) near Earth and beyond, using analytic theory and numerical modeling (including data analysis when needed). The long-term goals are to determine the mechanism(s) responsible for SEP acceleration, to identify probable sources, understand how they propagate in the fluctuating electric and magnetic fields of the space near Earth (and Mars), to determine the causes of the observed variability in particle fluxes, energy spectra, and composition, and to determine the structure of solar, coronal, and heliospheric magnetic fields.