Project Details

ROSES ID: NNH17ZDA001N
Selection Year: 2017
Program Element: Focused Science Topic

Topic: Understanding The Onset of Major Solar Eruptions

Project Title:
The Role of Magnetic Reconnection in the Onset of Solar Eruptions

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Summary:
Objectives: NASA space-based missions have revealed that magnetic reconnection is the dominant process for explosive energy release from the Sun to the magnetosphere and throughout the heliosphere. Reconnection is well known to be the driver of the largest explosions in the solar system, giant eruptive solar flares. Observations and theory have suggested that reconnection is also the critical process underlying the energy buildup leading to CMEs/eruptive flares, and may well be responsible for eruption onset, but this hypothesis needs definitive testing. We propose a research program designed to attack this fundamental question in Heliophysics: What is the role of magnetic reconnection in the onset of major solar eruptions? Answering this question is critical for achieving the Focused Science Topic (FST) objective of "Understanding the Onset of Major Solar Eruptions" and for achieving NASA's goals of understanding the Sun and solar system.

Methodology: The proposed work builds on our extensive studies of magnetic reconnection as the initiation mechanism and the driver for solar eruptions ranging from small coronal-hole jets to large active-region CMEs/eruptive flares. The proposed research also builds on our pioneering theoretical and numerical studies of how magnetic reconnection leads to the free-energy buildup required for explosive eruption. The work consists of a balance of theoretical and numerical studies using our 3D adaptively refined MHD solver (ARMS), which is uniquely powerful for simulating magnetic reconnection in the solar corona. We will employ the methodology that we have used to attack successfully many fundamental Heliophysics problems: first develop insight by investigating idealized models that isolate the key physics of the problem, then apply the understanding gained to calculate predictive signatures that can be tested with observations from NASA missions and incorporated into space-weather models.

Proposed Contribution to the FST Team Effort: We will contribute to the FST Team our unique physical insight and understanding of solar eruptions as demonstrated by our pioneering theoretical models, such as breakout, that are widely used by the world-wide Heliophysics community for interpreting observations. We will also contribute our numerical technology, ARMS, that has been developed over the past two decades exactly for the problem of reconnection-driven coronal activity. We will make definitive calculations of reconnection-driven eruption for comparison with observations and with other onset mechanisms. Our proposed research program is essential for understanding the fundamental processes leading to solar eruptions. We look forward to working with the observational groups and with the other modelers in the FST to develop a definitive understanding of eruption onset and useful predictive signatures.

The Principal Investigator directing this project is Dr. Spiro K. Antiochos of NASA/GSFC. Dr. Antiochos is a world-recognized expert in both theories and observations of solar eruptions. He will be assisted by Drs. C. Richard DeVore and Judith T. Karpen from GSFC, Joel T. Dahlin from the University of Maryland, and Peter F. Wyper from Durham University.

Publication References:

no references