Project Details

ROSES ID: NNH13ZDA001N
Selection Year: 2013
Program Element: Solar Dynamics Observatory

Project Title:
Physical Processes in High-Beta Current Slabs

PI Name: David McKenzie
PI Email: atn@g.ucla.edu
Affiliation: Montana State University-Bozeman
Project Member(s):
- Longcope, Dana W.; Co-I; Montana State University
- Reeves, Katharine K; Co-I; Smithsonian Astrophysical Observatory

Summary:
In the evolution of a coronal mass ejection (CME) and the associated solar flare, a current sheet connecting the CME to the post-eruption flare arcade is important as the location of magnetic reconnection and energy release for the flare. Numerous observations in white light, UV, EUV, and X-rays indicate the presence of heated plasmas surrounding/within the current sheets, while numerical models are beginning to reproduce the temperatures and general appearances in EUV and X-rays. Conditions in this region are key for controlling the reconnection (e.g., length scales, onset, time-varying rate of flux transfer). However, only recently have high-resolution observations become possible with the capability to scrutinize the conditions within the sheet area. The most recent data from space-based telescopes reveal an environment far more complex than the simple laminar current sheet envisioned in two-dimensional and 2.5-D models of reconnection. It is a regime of complicated flows, eddies, and oscillatory bulk motions, likely pervaded by MHD shocks. While some observed oscillations have been treated as magnetosonic waves the presence of vortical flows and eddies is a relatively new discovery and is much harder to understand in the framework of a low-beta magnetized plasma. Indeed, analysis demonstrates that the plasma beta is of order unity, so that gas pressure forces and magnetic tensions have significant, and important, interplay in this crucial region.

The primary objective of this investigation is an empirical characterization of conditions and processes in the observed plasma sheets, including temporally and spatially resolved variations in temperature, density, and velocity. The observational analysis builds upon our recently published initial findings, taking maximum advantage of the high-resolution data returned from SDO/AIA. These measurements are important for understanding heating, thermal conduction, velocity variations, and turbulence within the plasma sheet. The findings are relevant to understanding the conditions that initiate, accelerate, and prolong reconnection (e.g., growth and spatial variation of anomalous resistivity), and directly address Priority Objectives in NASA's Heliophysics Roadmap, such as scale sizes and geometries of reconnection, kinetic processes responsible for reconnection, and the relationship between microphysical processes and large-scale topologies.

The investigation will be augmented by MHD modeling of perturbations moving through magnetized plasma. In our preliminary examination, recently submitted for publication, our model indicates shocks propagating in the un-reconnected field adjacent to current sheets, and density rarefactions suggestive of the plasma voids observed in supra-arcade downflows. The modeling component of the investigation supports and is supported by the observations, through exploration of the relative importance of density and magnetic field gradients, variations in plasma beta, and the effects of sub/supersonic flows.

In addition to the named PI and Co-Is, two graduate students will be supported (names not available at this time).

Publication References:

Summary: no summary

Reference: Reeves, Katharine K.; Freed, Michael S.; McKenzie, David E.; Savage, Sabrina L.; (2017), An Exploration of Heating Mechanisms in a Supra-arcade Plasma Sheet Formed after a Coronal Mass Ejection, The Astrophysical Journal,

Volume 836, Issue 1, article id. 55, 10 pp, 10.3847/1538-4357/836/1/55