# Project Details

**ROSES ID:** NNH19ZDA001N
**Selection Year:** 2019
**Program Element:** Focused Science Topic

**Topic:** Fast Reconnection Onset

**Project Title:**
The Onset of Reconnection and Associated Turbulence in Solar Eruptions

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- Matthaeus, William H;Co-I;University Of Delaware

**Summary:**
One of the most important outstanding problems in space science has been to understand the mechanisms responsible for the onset of explosive energy release during magnetic reconnection. Simulations dating back to the GEM Challenge have demonstrated that in an idealized case -- two-dimensional, laminar, symmetric, anti-parallel reconnection in a collisionless electron-proton plasma -- reconnection is mediated by the physics of whistler waves so that onset occurs when the width of the current layer becomes thinner than the ion inertial length. When these constraints are relaxed, however, the criteria for onset become less clear. In the solar corona, for example, collisions can be important during onset (i.e., the reconnection is not super-Dreicer). In addition, turbulence can oftentimes both trigger and disrupt reconnecting current layers to a sufficient degree (particularly when three-dimensional dynamics are allowed) that the two processes cannot be independently considered.

In this proposal we will focus on the onset of reconnection and triggering of flares in the solar corona. The corona represents a particularly challenging case because of the wide disparity in scales -- more than ten orders of magnitude lie between kinetic length scales and the dimensions of flare regions. Moreover, physical processes on these scales are interconnected since, for example, the compression of a coronal current sheet by forcing flows at large scales can lead to turbulence and the onset of reconnection at small scales.

We propose to examine the microscale aspects of this problem through a mixture of theory and simulation studies, but plan as well to take advantage of the expertise offered by a Focused Science Team to connect with the macroscales. We will examine such important questions as: Does the onset of reconnection in coronal environments necessarily involve turbulence? How important is the plasma collisionality? Are there significant differences between two-dimensional and three-dimensional systems with regards to reconnection and the associated turbulence? Our simulations will primarily use particle-in-cell and hybrid codes which will include collisions self-consistently. The reconnection rate will provide a key diagnostic to determine if onset occurs and what factors significantly affect it. The role of turbulence will be studied by analyzing systems with and without turbulence and noting key differences. In addition, the statistical properties of the turbulence generated in the system (e.g., spectra, structure functions) will be determined with an eye for how they vary between systems and how this may affect reconnection onset. In addition, the role of secondary reconnection sites generated by turbulence and how they impact the global process will be

addressed.

This proposal would address a critical portion of the Focused Science Team's effort by providing theoretical and simulation studies of reconnection onset criteria and the associated turbulence in the solar corona. It is anticipated that this proposal will particularly help the Focused Science Team address the primary goal of ``Establish[ing] an understanding of what the critical conditions are for the onset of fast reconnection at a current sheet in the various regimes relevant for heliophysics'', although the work will also contribute to the other primary goals.

The PI of the proposal is Dr. Marc Swisdak, who will be responsible for the overall direction and its integration into a Focused Science Team. Prof. Drake will be a co-Investigator and will collaborate on all aspects of the theoretical analysis and particle-in-cell simulations. Prof. Shay and Prof. Matthaeus will be co-Investigators based at the University of Delaware. They will collaborate on all aspects of the theoretical analysis and will be primarily responsible for the turbulence portions of the proposal.

## Publication References:

no references