Project Details

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Topic: Fast Reconnection Onset

Project Title:
!urrent sheet configurations and their control of fast reconnection onset

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Summary:
1. Background
Magnetic reconnection, a process that converts magnetic energy to plasma energy via topological changes in magnetic field lines, occurs in current sheets throughout the universe. Reconnection in the current sheets observed in the heliosphere is usually fast, leading to explosive energy conversion and particle acceleration, such as solar flares, coronal mass ejection, and geomagnetic storms/substorms. Although fast reconnection occurs ubiquitously in these current sheets (solar corona, solar wind, and magnetospheres of Earth and planets), the configurations of these current sheets differ from one heliospheric system to another. Moreover, even in one specific heliospheric system, there are various types of current sheets. Configurations of these current sheets control whether and how reconnection initiates. However, the current sheet configurations are not well documented, and how do they control fast reconnection onset is not well understood.

2. Science Goals
(1) Perform a systematic survey of current sheet configurations for Earth s magnetotail and solar wind.
(2) Investigate how the configurations of these current sheets control fast reconnection onset.

3. Methodology
(1) To achieve science goal 1, we will analyze in-situ current sheet crossings in the solar wind and Earth s magnetosphere by the spacecraft of MMS, THEMIS, ARTEMIS, and Parker Solar Probe. These events will be classified into several different categories based on their structures of magnetic and electric fields and distributions of density and temperature. For each category of the current sheet, we will perform statistical studies to give parameter ranges for a more quantitative description.
(2) To achieve science goal 2, we will perform particle-in-cell (PIC) simulations using different current sheet configurations as initial conditions to see whether and how these quiescent current sheets evolve into fast reconnection. For each current sheet categories, we will perform series of simulations with different parameters that are guided by the aforementioned statistics of spacecraft observations. These PIC simulations will give critical values of these parameters for fast reconnection onset in every current sheet configurations.

4. Proposed Contributions to the Focused Science Team Effort
This proposed research aims to contribute to the Focused Science Team #2, Fast Reconnection Onset in the following four aspects. (1) A systematic survey of current sheet using in-situ spacecraft observations in various heliospheric environments will provide pre-conditions for fast reconnection onset in throughout the heliosphere. (2) The PIC simulations with observation-motivated current sheet configurations will answer how these current sheet configurations control fast reconnection onset in the observed heliospheric environments. (3) Further analyses of the simulation results help better understand the mechanisms and dynamics of fast reconnection onset, which have also been controversial for decades. (4) Although the in-situ observations and the observation-motivated simulations are for the current sheets and reconnection in the solar wind and Earth s magnetosphere, the results of this research can be generalized to other heliospheric systems, such as the solar corona and planetary magnetospheres.

Publication References:

no references