Project Details

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Topic: Fast Reconnection Onset

Project Title:
Magnetic Reconnection Rate and its Implications for Fast Reconnection Onset in Solar Flares and Magnetopause

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Summary:
The science objectives of this investigation are to characterize, quantitatively, the magnetic reconnection rate in various plasma regimes at the reconnection sites, i.e., current sheets. Specifically these reconnection processes are usually preceded by fast onset in the solar corona and at the Earth s magnetopause, where the primary current sheets form and evolve, as manifested by energetic solar flares on the Sun and significant energy transfer at the magnetopause due to magnetic reconnection. The associated evolution of magnetic topology and plasma dynamics will be investigated. The goal is to elucidate the relation between reconnection rate and fast reconnection onset across disciplines.

The methodology to be employed is a combined approach of observational analysis and numerical simulations. For the magnetic reconnection rate in the solar corona, we will utilize the well-established quantitative analysis based on remote-sensing observations of flare-associated energy release processes. Specifically, the separation of flare ribbons seen in the low solar atmosphere manifests the magnetic reconnection progressively higher in the corona, as two regions are magnetically connected. This enables a quantification of the magnetic reconnection rate by combining flare ribbon motion seen in H-alpha/UV wavelengths with longitudinal photospheric magnetic field measurement. For the Earth s magnetopause, we will measure the reconnection rate using ground-based radars, which involves identifying the ionospheric projection of the reconnection X-line and measuring the electric field tangential to it in its rest frame. By performing the measurement at a longitude conjugate to spacecraft that are positioned at the magnetopause, we can obtain the relation between the reconnection rate and the current sheet. All these measurements are readily available for our investigations. The numerical simulations involve both large-scale MHD and fully kinetic Particle-in-Cell simulations. The former aims at the formation and disruption of current sheets, leading to large-scale topological change, which can be compared with flare ribbon evolutions. The latter simulation at kinetic scales is more tailored toward fundamental reconnection physics in terms of the roles of guide field, the plasma asymmetry across the current sheet and the amount of magnetic shear and flow shear in fast reconnection onset, with implications for the aforementioned studies in the different space plasma regimes.

The proposed study is highly relevant to the FST #2: Fast Reconnection Onset . This investigation addresses the identified primary goals by examining the reconnection rate in various regimes relevant for heliophysics in order to understand the global- and local-scale processes . Specifically, we aim to address one of the listed Measures of success : Determining the reconnection rate, and in particular the criteria for fast reconnection to occur in various physical environments within the heliosphere and across size scales . We will contribute to the FST team effort by providing the expertise and necessary tools in the observational analysis of flare-ribbon morphology and probing the reconnection processes at the magnetopause via multiple observations and simulation runs. In anticipation of the development and utilization of large event sets from multiple observations, the detailed analysis results will be made available to the whole team. In addition, numerical simulation runs will be performed in coordination with the entire team to optimize the pursuit of common goals and allocation of resources.

Publication References:

no references