Project Details

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Project Title:
Modeling Coronal Structures and Dynamics

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Summary:
Coronal mass ejections (CMEs) are a principal link in the chain of events that affect space weather and the Earth s plasma environment and hence play a central part in pursuing the objectives of NASA s Living With a Star (LWS) program. A crucial goal in the study of CMEs is understanding the evolution of the coronal magnetic field prior to an eruption. This goal requires the determination of the initial and boundary conditions that lead to an eruption and the identification of observable features associated with these conditions. Our proposed work consists of three major tasks. Task 1 is the derivation of suitable initial states. Since the pre-eruption state or states are not well known, a number of states need to be developed and tested. Here we propose to use an established analytical method, as well as a numerical method, to derive both force-free and non-force-free states and to determine their equilibrium properties. Some of these models will contain a twisted flux rope, connected to the photosphere and anchored in the corona by an overlying arcade, and others will include a helmet streamer configuration above the flux rope. These models will also be supplemented by several loop-type models previously suggested in the literature. Task 2 is the test of the stability and of the subsequent dynamic evolution of the various equilibrium configurations, using MHD simulations. Of particular interest are the potential development of current sheets, their breakup by magnetic reconnection, the development of flare loops and flare ribbons, and the identification of observable signatures that characterize the unstable configurations. Again, this requires the possible existence or formation of non-force-free configurations. The final task, 3, is to determine the energetic particles spectrum produced by reconnection as a function of space and time during the course of an eruption . In this work we will trace both ions and electrons as they propagate within the electric and magnetic field generated in the various MHD simulations. This test-particle approach will provide specific predictions for each model as to the type and distribution of energetic particles that it should produce. Such predictions can then be compared with energetic particle distributions that are inferred from the hard X-ray and g-ray emissions now being observed by the RHESSI spacecraft. Tasks 2 and 3 will also be supplemented by an investigation into kinetic aspects of magnetic reconnection, which might affect reconnection rates and particle acceleration.

Publication References:

Summary: ''

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Reference: Birn, Joachim; Forbes, Terry G.; Hesse, Michael; (2006), Stability and Dynamic Evolution of Three-dimensional Flux Ropes, The Astrophysical Journal, Volume 645, Issue 1, pp. 732-74, doi: 10.1086/504280