Project Details

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Project Title:
Novel Magnetic Models: Development and Application to CME prediction

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Summary:
We propose to develop detailed physical models of erupting active regions and filaments from the rich existing SOHO datasets, laying a foundation for practical, predictive modeling of coronal mass ejections (CMEs). Our approach combines archival SOHO data with a promising new technique, field line modeling. By applying a field line model to observed active regions and prominences, we will characterize pre-eruptive MHD equilibria. By following the evolution of the system with a quasi-static model, we will determine the reasons for loss of equilibrium and subsequent eruption.
Despite over 25 years of study, CMEs remain poorly understood. Theories of CME onset have emphasized, variously, flare blast waves, magnetic buoyancy, instabilities in the streamer belt, loss of magnetic equilibrium in filaments, and flux emergence. Existing MHD models of CMEs are limited by numerical diffusion terms that are several orders of magnitude higher than coronal values, limiting the models' usefulness. Modeling field lines rather than the field itself eliminates numerical resistivity, both enabling studies that could be accomplished in no other way and also greatly reducing computational cost. We have already prototyped a simple force-free field line model. We will extend it to support more complex, data-driven systems and to include gravity, gas presure, and reconnection. our semi-empirical approach both addresses the problem of CME origin and yields a natural bridge between future LWS missions and predictive models that could run in quasi-real-time.
The scope of this proposal is limited to quasi-stationary simulations of the buildup and onset of CMEs. However, field-line based models are both extensible to full, time-dependent ideal MHD simulations, and useful for many other physical systems. The tools which we will develop have the potential to geneate breakthroghs in many other solar, heliospheric, and magnetospheric contexts relevant to LWS.

Publication References:

no references