

Project Details

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Project Title:

Evolution of Magnetic Fields and Flows Associated with Flares and CMEs

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Summary:

Recent advances in observations revealed new results on the relationship between evolution of magnetic fields and onset of solar flares and Coronal Mass Ejections (CMEs). The most remarkable finding of our group is that of rapid penumbral decay in the outer part of delta sunspots, and the enhancement of transverse fields at the flaring neutral lines. It is timely that the problems can be studied further, as the unprecedented data are obtained from newly launched Hinode mission that is complementary to more than 8 years archive of vector magnetograph observations at the Big Bear Solar Observatory (BBSO), and the tools for coronal magnetic field extrapolation have been matured. We assemble a team consisting of researchers from BBSO, National Astronomical Observatory of Japan (Dr. Suematus, Hinode observations), and Max-Planck-Institute for Solar System Research (Dr. Wiegmann, coronal field extrapolation). Our objective is to advance the study of evolution of surface magnetic structures and flows in the flare productive active regions and to understand the energy release process and magnetic reconfiguration associated with flares and CMEs. Our research will focus on the following two related topics:

(1) With the aid of high-cadence, high-resolution, and high-sensitivity vector magnetograms from Hinode, as well as the rich archive of data from vector magnetograph systems at BBSO, we propose a comprehensive study of rapid changes of photospheric magnetic fields associated with flares. More specifically, we will study the evolution of 3-D magnetic topology by analyzing new data and carrying out non-linear force-free extrapolation. Although our primary task is to explain the observed photospheric magnetic field evolution related to flares, analysis of the same data set will also advance our understanding of 3-D pre-flare magnetic condition.

(2) We will study photospheric flow fields, including shear and converging flows, of flare productive regions. With Adaptive Optics (AO) equipped ground-based observations, we have found solid evidence of strong shear flows along flaring neutral lines. From a limited number of events using Center-of-Mass techniques, we have detected sudden variation of mean converging and shear flows associated with flares. Continuous sub-arcsecond observations from Hinode will allow us to analyze the spatial distribution and temporal evolution of the flows, and their association with flares and CMEs. We will also compare our observational findings with theoretical models of flares to find if the observational signatures match the predictions of specific models.

The proposed research is clearly related to the NASA's strategic goal 3A: to understand the sun and its effects on Earth. This proposal has a strong education component. Continuation of this grant is crucial in supporting the very productive Ph.D. program in Solar-Terrestrial Physics at NJIT.

Publication References:

Summary: no summary

Reference: Wang, Haimin; Liu, Chang; Wang, Shuo; Deng, Na; Xu, Yan; Jing, Ju; Cao, Wenda; (2013), Study of Rapid Formation of a ? Sunspot Associated with the 2012 July 2 C7.4 Flare Using High-resolution Observations of the New Solar Telescope, The Astrophysical Journal Letters, Volume 774, Issue 2, article id. L24, 5 pp, doi: 10.1088/2041-8205/774/2/L24