Project Details

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Project Title:
Probing Coronal EUV Waves and Wave-like Phenomena: SDO/AIA Data Analysis and MHD Modeling

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Summary:
We propose to carry out analysis of SDO/AIA data and complimentary MHD simulation for global EUV disturbances (EIT waves) and fast propagating disturbances (FPDs) discovered by AIA. This work directly addresses the second topic of Targeted Investigation "1.2.3 Science Analysis for SDO" in the 2010 LWS TR&T solicitation, i.e., "Investigate the physics and diagnostic potential of coronal wave-like phenomena made accessible by AIA's high cadence, high signal-to-noise ratio, or large field of view".

We seek answers to the following Compelling Science Questions: (1) What is the physical nature of global EUV disturbances (EIT waves)? Are they real MHD waves or apparent waves caused by CME expulsions? (2) What are the origin and nature of fast (~1000 km/s) propagating disturbances (FPDs) discovered by AIA in EIT wave events? Are they theoretically predicted, but rarely observed propagating fast mode MHD waves? What are their excitation mechanisms? (3) What are the relationships of EIT waves and FPDs with other eruptions, including CMEs and flares? Why do some CMEs lead to EIT waves, while others do not?

Answering these questions will Enable Us to: (1) understand the roles played by EIT waves and FPDs in transport of energy vertically through different layers of the magnetized atmosphere and horizontally across the solar disk; (2) understand their roles in solar eruptions, such as CMEs and flares, which contribute to the dynamic evolution of the corona; and (3) use them as seismological diagnostics to infer otherwise elusive coronal parameters, such as the magnetic field strength.

These foreseen outcomes are highly Relevant to NASA's LWS Program, and in particular, well serve two of the four main goals of LWS's flagship mission SDO: "2. Identify the role of the magnetic field in delivering energy to the solar atmosphere and its many layers", and "3. Study how the outer regions of the Sun's atmosphere evolve over space and time -- ranging from seconds to centuries."

To implement this investigation, we will employ the following Methodology: (1) Analyze SDO/AIA data and complimentary data from SDO/HMI, STEREO, Hinode, and SOHO to study an ensemble of EIT waves for their dynamic evolution, temperature distribution, energy content, and newly discovered duality of diffuse and sharp fronts; (2) Analyze AIA data of FPDs to obtain their statistical properties of propagation, dispersion, damping, and energy flux, and compare the result with predictions from MHD wave theories; (3) Run state-of-the-art 3D MHD simulations of EIT waves and FPDs using the BATS-R-US and NLRAT codes, guided by AIA observations, to distinguish between alternative interpretations and test our analysis algorithms.

The Major Strengths of the proposed work lie in: (1) AIA's unprecedented capabilities are the best suited for these tasks which previous missions were incapable of; (2) this work is timely since the next one to two years will be the best chance to study these coronal wave(-like) phenomena with a double-quadrature formation of SDO and STEREO; (3) the feasibility and promise of the proposed work is demonstrated in our first AIA results published and in preparation (Liu et al. 2010c,a,d); (4) previously

underused Fourier (time-distance) analysis will be applied to the newly discovered FPDs; and (5) this work consists of balanced elements of data analysis and MHD simulation supporting and benefiting from each other.

Publication References:

no references