Project Details

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Project Title:
A Study of White-Light Flares Observed by the Solar Dynamics Observatory

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Summary:
The "white light flare" continuum emission is the most important component of flare luminosity, and arises in a still-mysterious manner within the lower solar atmosphere. With the launch of the Solar Dynamics Observatory, we suddenly have excellent new capabilities for studying the mechanics of white-light flares, in particular the manner in which they launch global waves both into the corona and also into the interior of the Sun.

The most violent solar flares, those that tend to have the greatest impact on modern technological society, usually appear as white-light flares. The intense continuum emission from these flares is known to have a close association with the acceleration of high-energy particles, a fundamental process in flare physics. Helioseismic observations of white-light flares show seismic motions associated with the white-light emission. The coupling has thus far eluded our understanding. We do not know whether chromospheric shocks created by thick-target heating penetrates through the photosphere to produce the seismic signatures, whether backwarming of the photosphere is a major contributor, or whether the newly-discovered magnetic "jerks" are important.

The answers to these questions should give us deep insight into the transient magnetic forces that express themselves in flares and the mechanisms that release them. Because strong white-light flares are sudden and difficult to detect sudden, and their impulsive phases short-lived, they require high-resolution high-cadence imaging spectroscopy at visible wavelengths. This has never previously been available from space. The Solar Dynamics Observatory (SDO) now provides this capablity, along with key Doppler and magnetic measurements from the Helioseismic and Magnetic Imager (HMI), and multiwavelength data from the Atmospheric Imaging Assembly (AIA) and Extreme-ultraviolet Variability Experiement (EVE) instruments. We are fortunate also to have the unique RHESSI hard X-ray and gamma-ray imaging spectroscopy as well. SDO furthermore observes systematically; we therefore expect to extend the statistics to the many flares of GOES M class or above in Cycle 24. With modern computational facilities for modeling flare physics, the SDO is a crucial resource for addressing the seismic waves and many related questions. We propose to develop the basic data-analytical facilities for this task and apply them to the formulation of realistic physical models of flare mechanics in the chromosphere, photosphere and solar interior.

This work seeks to incorporate seismic disturbances into our general understanding of the lower solar atmosphere during a flare, previously characterized best by white-light flare signatures plus model inferences from the hard X-ray and gamma-ray observations. We specifically propose to

* Make systematic multi-wavelength studies of white light flares, with a strong emphasis in the use of the new and powerful capabilities of the Solar Dynamics Observatory;

* Identify which mechanisms for seismic excitation may work, via multi-wavelength observations, and which are feasible via comparisons with simulations;

* Relate our new knowledge to the understanding of the basic physical mechanisms of flares;

* Establish methods for working with future observations, both space- and ground-based, to exploit the seismic signatures for understanding the physics of flares and CMEs.

Publication References:

Summary: no summary

Reference: Martínez Oliveros, J. C.; Couvidat, S.; Schou, J.; Krucker, S.; Lindsey, C.; Hudson, H. S.; Scherrer, P.; (2011), Imaging Spectroscopy of a White-Light Solar Flare, Solar Physics, Volume 269, Issue 2, pp.269-281, doi: 10.1007/s11207-010-9696-z

Summary: no summary

Reference: Martínez Oliveros, Juan-Carlos; Hudson, Hugh S.; Hurford, Gordon J.; Krucker, Säm; Lin, R. P.; Lindsey, Charles; Couvidat, Sebastien; Schou, Jesper; Thompson, W. T.; (2012), The Height of a White-light Flare and Its Hard X-Ray Sources, The Astrophysical Journal Letters, Volume 753, Issue 2, article id. L26, 5 pp, doi: 10.1088/2041-8205/753/2/L26

Summary: no summary

Reference: Martínez Oliveros, Juan-Carlos; Krucker, Säm; Hudson, Hugh S.; Saint-Hilaire, Pascal; Bain, Hazel; Lindsey, Charles; Bogart, Rick; Couvidat, Sebastien; Scherrer, Phil; Schou, Jesper; (2014), Chromospheric and Coronal Observations of Solar Flares with the Helioseismic and Magnetic Imager, The Astrophysical Journal Letters, Volume 780, Issue 2, article id. L28, 6 pp, doi: 10.1088/2041-8205/780/2/L28

Summary: no summary

Reference: Martínez Oliveros, J. C.; Lindsey, C.; Hudson, H. S.; Buitrago Casas, J. C.; (2014), Transient Artifacts in a Flare Observed by the Helioseismic and Magnetic Imager on the Solar Dynamics Observatory, Solar Physics, Volume 289, Issue 3, pp.809-819, doi: 10.1007/s11207-013-0358-9