Project Details

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Selection Year: 2012
Program Element: Focused Science Topic

Topic: Flare Dynamics in the Lower Solar Atmosphere

Project Title:
Characterization of Sunquake Signatures in Terms of Energy and Momentum, and Their Relationship with the Flare Impulsive Phase

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Summary:
The sunquakes, observed in the form of expanding wave ripples, in the solar photosphere represent packets of acoustic waves that are excited by flare impacts and travel through the solar interior. The excitation impacts strongly correlate with the impulsive flare phase and are caused by the energy and momentum transport from the flare magnetic energy released sites. However, the exact mechanism of the energy and momentum transport are not known. Solving the problem of the sunquake mechanism will substantially improve our understanding of the flare energy release in the form of energetic particles, wave and mass motions, and radiation. We propose a comprehensive investigation of the sunquake properties and their relationship to the physical processes of the impulsive phase, using observational data from the SDO, RHESSI, Hinode, SOHO, GONG, and numerical modeling. The problem of the flare dynamics in the lower solar atmosphere is very complex and involves a wide range of topics from the particle acceleration in specific magnetic configurations, MHD instabilities and CME initiation to the impacts in the solar photosphere and helioseismic response.

Our main goal and contribution to the LWS TR&T Focused Topic Team "Flare Dynamics in the Lower Solar Atmosphere" will be analysis, characterization and interpretation of the photospheric and helioseismic response ("sunquakes") and associated localized impacts in terms of the energy and momentum transport, and relationship to the flare impulsive phase. The data analysis will be supported by 3D MHD simulations and comparison with X-ray and coronal data.

More specifically, we will contribute:

1) Data sets of the flare observations from SOHO/MDI and SDO/HMI, including dynamic and energetic characteristics of sunquakes (by two different techniques: time-distance analysis and holography), magnetic field characteristics, variations of magnetic field, Doppler shift, white-light emission, Stokes profiles and line profiles by implementing a special processing of the HMI level-1 data for M- and X-class flares and specific targets selected by the Focused Teams;

2) Simulation results of the energy and momentum impacts in the lower atmosphere for various theoretical models (including the thick-target model, localized heating, magnetic field variation (so-called "McClymont jerk"), CME eruptions and others) by using numerical simulations of two types: non-linear realistic 3D radiative MHD simulations, and 3D MHD simulations of the helioseismic response; these simulations will be coupled with computations of the HMI and MDI/GONG spectral lines, Stokes parameters and observables, and take into account instrumental characteristics;

3) Understanding of the physical mechanisms of the flare impacts, energy and momentum transport in the low chromosphere

and photosphere, and "sunquakes" through comparison of the observational characteristics with the simulation models and with the characteristics of the X-ray emission and coronal dynamics, in close cooperation with other Focused Topic Teams.

Publication References:

Summary: no summary

Reference: Kosovichev, Alexander G.; (2014), Sunquakes and starquakes, Precision Asteroseismology, Proceedings of the International Astronomical Union, IAU Symposium, Volume 301, pp. 349-352, doi: 10.1017/S1743921313014579

Summary: no summary

Reference: Sharykin, I. N.; Kosovichev, A. G.; Zimovets, I. V.; (2015), Energy Release and Initiation of a Sunquake in a C-class Flare, The Astrophysical Journal, Volume 807, Issue 1, article id. 102, 9 pp, doi: 10.1088/0004-637X/807/1/102

Summary: no summary

Reference: Sharykin, I. N.; Kosovichev, A. G.; (2015), Dynamics of Electric Currents, Magnetic Field Topology, and Helioseismic Response of a Solar Flare, The Astrophysical Journal, Volume 808, Issue 1, article id. 72, 9 pp, doi: 10.1088/0004-637X/808/1/72

Summary: no summary

Reference: Sharykin, I. N.; Kosovichev, A. G.; Sadykov, V. M.; Zimovets, I. V.; Myshyakov, I. I.; (2017), Investigation of Relationship between High-energy X-Ray Sources and Photospheric and Helioseismic Impacts of X1.8 Solar Flare of 2012 October 23, The Astrophysical Journal, Volume 843, Issue 1, article id. 67, 8 pp, doi: 10.3847/1538-4357/aa77f1