Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
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PEM07-09 Room:302 Time:May 25 09:45-10:00

X5.4/X1.3 flares on 7 March 2012: Exploring the energy storage, trigger and release of solar flares

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Solar flares abruptly release the free energy stored as a non-potential magnetic field in the corona and may be accompanied by eruptions of the coronal plasma. This presentation will focus on active region NOAA 11429, which appeared on the solar disk in March 2012. This active region produced X5.4 and X1.3 flares on 7 March 2012. They are a candidate of case studies examined by ISEST working group in the VarSITI project. The coronal mass ejection (CME) associated with them propagated in the interplanetary space and caused a large magnetic storm on the earth on 9 March. The active region contains delta-type sunspots, showing a strong shear in the entire system. One of important aspects relevant to space weather prediction is to understand physical processes of flare triggers. For a sheared magnetic field structure, the inclusion of a small-scale trigger field near the magnetic neutral line has been considered as one of key magnetic configurations leading to the occurrence of large flares. The Hinode Solar Optical Telescope provided a high accuracy measurement of vector magnetic field at the solar surface, allowing us to identify the trigger field on the neutral line responsible for the X5.4 flare. Moreover, the Doppler velocity measurements revealed that high-speed material flow exists in the horizontally oriented magnetic field formed nearly in parallel to the polarity inversion line and it existed at least from 6 hours before the onset of the flare, and that the high-speed material flow gradually develops the bipole structure, pushing the trigger field located at the destination of the flow and evolving the magnetic structure favorable for the onset of the eruptive fare. The observations suggest that gas dynamics at the solar surface play a vital role of leading to the onset of flares. The further observations show that another large flare (X1.3 flare) was triggered about one hour later at the west part of the neutral line, Why was the entire sheared magnetic structure not erupted at one time and were two steps taken for energy release? How does the gas dynamics on the solar surface contribute the trigger of the X1.3 flare? The non-linear force free field extrapolation from the observed vector magnetic field at the solar surface inferred the magnetic field configuration in the corona and the twistness of the magnetic field. The location of chromospheric flare ribbons as a function of time tells which twisted field is involved in the temporal evolution of the energy release.The talk will show the magnetic field configuration and dynamics of the active region and discuss the energy storage and trigger of the solar flares.

Keywords: Solar flare, Hinode, Photospheric magnetic field, corona, coronal field, space weather