[구SS-09] An MHD Simulation of the X2.2 Solar Flare on 2011 February 15

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We perform an MHD simulation combined with observed vector field data to clarify an eruptive dynamics in the solar flare. We first extrapolate a 3D coronal magnetic field under a Nonlinear Force-Free Field (NLFFF) approximation based on the vector field, and then we perform an MHD simulation where the NLFFF prior to the flare is set as an initial condition. Vector field was obtained by the Soar Dynamics Observatory (SDO) at 00:00 UT on February 15, which is about 90 minutes before the X2.2-class flare. As a result, the MHD simulation successfully shows an eruption of strongly twisted lines whose values are over one-turn twist, which are produced through the tether-cut magnetic reconnection in strongly twisted lines of the NLFFF. Eventually, we found that they exceed a critical height at which the flux tube becomes unstable to the torus instability determining the condition that whether a flux tube might escape from the overlying field lines or not. In addition to these, we found that the distribution of the observed two-ribbon flares is similar to the spatial variance of the footpoints caused by the reconnection of the twisted lines being resided above the polarity inversion line. Furthermore, because the post flare loops obtained from MHD simulation well capture that in EUV image taken by SDO, these results support the reliability of our simulation.

[구SS-10] Prediction of free magnetic energy stored in a solar active region via a power-law relation between free magnetic energy and emerged magnetic flux

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To estimate free magnetic energy stored in an active region is a key to the quantitative prediction of activity observed on the Sun. This energy is defined as an excess over the potential energy that is the lowest energy taken by a magnetic structure formed in the solar atmosphere including the solar corona. It is, however still difficult to derive the configuration of a coronal magnetic field only by observations, so we have to use some observable quantity to estimate free magnetic energy. Recently, by performing a coordinated series of three-dimensional magnetohydrodynamic simulations of an emerging flux tube that transfers intense magnetic flux to the solar atmosphere we have found an universal power-law relation between free magnetic energy and emerged magnetic flux, the latter of which is a possibly observed quantity. We further investigate what causes this relation through a comparison with a model of linear force-free field.