

Magnetohydrodynamic Simulation of the Solar Active Region 12673 and eruption accompanied with a Great Solar Flare

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The solar active region (AR) 12673 came out on September 2017 and exhibited rapid evolution during few days. Consequently, the AR12673 produced 4 X-class flares and 27 M-class flares from 2017 September 4 to 10, including a great solar flare (X9.3 flare) which is ranked as largest in the solar cycle 24. In order to reveal a dynamics of the great solar flare, we performed a Magnetohydrodynamic (MHD) simulation. We first reconstructed a three-dimensional magnetic field based on the photospheric magnetic field, which is obtained prior to the flare, through the MHD relaxation method and then put it in the MHD simulation as the initial condition.

The MHD simulation exhibited a drastic eruption, in particular, we found that a highly twisted flux tube is formed during the eruption through a reconnection of multiple twisted lines formed prior to the flare, and it eventually exhibited a writhe motion. The writhe motion is due to the kink instability because the eruptive flux tube is ultimately composed of highly twisted lines with more than required threshold of the kink instability. Because the reconstructed magnetic field prior to the flare has no such highly twisted lines leading the instability, this writhe motion would come from the nonlinear evolution of the eruptive flux tube. Furthermore, this writhe motion might explain the southward magnetic fields observed in vicinity of Earth whereas the northward magnetic fields were expected from solar observations. We will discuss more detailed dynamics and compare with solar observations and results obtained from solar wind simulation (SUSANOO).

Keywords: Solar Flare, Coronal Mass Ejection, Magnetohydrodynamics