Critical Parameters of Photospheric Magnetic Field to Produce Eruptive Solar Flares and CMEs in Active Regions

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Solar flares and coronal mass ejections (CMEs) are eruptive phenomena caused by magnetic field in the solar corona. In particular, large eruptive events originate in active regions (AR) on the solar surface. However, it is still unclear what determines the capability of an AR to produce eruptive flares and CMEs, and it hinders our ability to predict CMEs. In this study, we propose a new parameter r_m to measure the possibility that a flare on an AR can be eruptive and produce a CME. The parameter r_m is defined by the ratio of the magnetic flux of twist higher than a threshold T_c to the overlying magnetic flux. The value of rm for each AR can be estimated using the nonlinear force-free field (NLFFF) extrapolation. Based on the data obtained by the Solar Dynamics Observatory (SDO)/Helioseismic and Magnetic Imager (HMI), we calculated the values of r_m for 29 ARs at 51 times before to flares larger than M5.0 class. We find that the foot-point of field lines with twist larger than 0.2 can well represent the flare ribbons, and we thus evaluated r_m for T_c=0.2 as a critical parameter for producing eruptive flares and CMEs using discriminant analysis. The result shows that r_m is moderately able to discriminate ARs which have capability to produce CME-accompanied flares.

Keywords: solar physics, coronal magnetic field, coronal mass ejection, solar flare

