

Statistical Relation between Solar Flares and Coronal Mass Ejections with Respect to Sigmoidal Structures in Active Regions

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We will report statistical dependences among features of coronal mass ejections (CMEs), solar flares, and sigmoidal structures in soft-X-ray images (Kawabata et al. 2018). We applied analysis methods to all the features in the same way in order to investigate the reproducibility of the correlations among them, which may be found from previous statistical studies. Samples of 211 M-class and X-class flares, observed between 2006 and 2015 by the Hinode/X-ray telescope, Solar and Heliospheric Observatory/Large Angle and Spectrometric Coronagraph, and Geostationary Operational Environmental Satellite, were examined statistically. Five kinds of analysis were performed: Occurrence rate analysis, linear-correlation analysis, association analysis, the Kolmogorov–Smirnov test, and the Anderson–Darling test. These give three main results. First, the sigmoidal structure and long-duration events (LDEs) have a stronger dependence on CME occurrence than large X-ray-class events in on-disk events. Second, for the limb events, a significant dependence exists between LDEs and CME occurrence, and between X-ray-class events and CME occurrence. Third, 32.4% of on-disk flare events have sigmoidal structure and are not accompanied by CMEs. However, the occurrence probability of CMEs without sigmoidal structure is very small, 8.8%, in on-disk events. While the first and second results are consistent with previous studies, we provide for the first time a difference between the on-disk and limb events. The third result, that non-sigmoidal regions produce fewer eruptive events, is also different from previous results. We suggest that sigmoidal structures in soft X-ray images will be a helpful feature for CME prediction in on-disk flare events.

Keywords: Sun, Solar flares, Coronal mass ejections, Sigmoid