Determining Critical Condition for a Solar Flare from the Nonlinear Force-Free Field Based on the Double-Arc Instability Analysis

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Large solar flare usually occurs from an active region (AR) that has large free energy and strongly sheared horizontal field near the PIL. If two magnetic arcades in this field reconnect, a double-arc current loop system can be developed. Ishiguro & Kusano (2017) showed that the double-arc instability (DAI) can be analyzed by evaluating a parameter, so called kappa, which is the product of the twist and the fraction of reconnected flux and the total flux in a double-arc structure. Here, we use the theory of DAI to find a proxy parameter of kappa (kappa*) in a real AR. First, we extrapolate coronal magnetic field of an AR from the photospheric magnetogram data by using nonlinear force-free field (NLFFF) extrapolation. Next, we calculate and analyze the distribution of the twist in the AR. We approximate the reconnected flux by using high-twist flux in the NLFFF model. By evaluating several thresholds of high-twist field, we calculate and analyze the evolution of kappa* during flaring period. We find that kappa* increased significantly before the flares and decreased abruptly after the flares. We demonstrate that the profile of kappa* evolution for different flares are similar. We suggest that kappa* can be used as a parameter that can serve as an indicator of the DAI in an AR.

Keywords: Sun, Solar Flare, NLFFF

