Towards the Prediction of Solar Flare by Analysing Magnetic Twist Based on the Nonlinear Force Free Field

*Johan Muhamad[1], Kanya Kusano[1], Satoshi Inoue[1]

1. ISEE, Nagoya University

As the largest eruption in the solar system, solar flare can release enormous amount of energy to the interplanetary space, including the Earth. It is essentially important to study the solar flare mechanism in order to be able to anticipate severe impacts of flare to the near-Earth space environment. Since the flare releases magnetic energy during its process, the distribution of the accumulated magnetic energy before the onset of flare must be informative for predicting flares. Active region that contains large amount of excess magnetic energy shows non-potential configuration of magnetic fields in the region around the polarity inversion line (PIL). This non-potential magnetic field manifests as a highly-twisted magnetic field line. It is well-known that the highly-twisted field is subject to kink instability. However, it is still not clear how to extract the information of magnetic twist from the observation for the flare prediction. Here, we propose a non-dimensional parameter that contains information of twist distribution and magnetic flux of an active region to predict the occurrence of a solar flare. We use SDO/HMI (SHARP) data to evaluate the evolution of this parameter for the active region (AR) NOAA 11158. Non-linear Force-Free Field (NLFF) modelling is used to reconstruct the coronal structure from the vector magnetogram data. We then calculated a new parameter which is the averaged twist of magnetic field lines normalised by the total magnetic flux within AR from the NLFF model. We found that our proposed parameter increased before large flares and dramatically decreased after the onset of the flares. Our study shows that this parameter can be used as a proxy of the stability of an active region. It suggests that the combination of this new parameter and the magnetic free energy is usable to estimate the probability of large flares, and we will devise a new scheme of solar flare prediction using them.

Keywords: Solar Flare, Magnetic Twist, NLFFF, Prediction

