Study of flare prediction based on the critical condition of eruptive instability in the solar corona

*草野 完也[1]、伊集 朝哉[1]
*Kanya Kusano[1], Tomoya Iju[1]

1. 名古屋大学宇宙地球環境研究所
1. Institute for Space-Earth Environmental Research, Nagoya University

Solar eruptions, e.g. flares and CMEs, are believed to be the explosive liberation of magnetic energy contained in the solar corona. However, the onset mechanism of solar eruptions is not yet clearly explained. We have proposed that the feedback interaction between an ideal magnetohydrodynamic (MHD) instability driven by the electric current flowing in the solar corona and magnetic reconnection plays a crucial role to drive solar eruptions. However, the mode of instability and the critical condition of instability are not yet well understood. On the other hand, Moore et al. (2001) proposed that the tether-cutting reconnection between sheared magnetic fields may cause the solar eruptions. Recently, Ishiguro and Kusano (submitted to ApJ) clarifies that the double-arc electric current loop, which can be formed by the tether-cutting reconnection, can produce a new type of instability called double-arc instability (DAI). The objective of this study is to clarify the critical condition of the DAI using the three-dimensional MHD simulation and to apply the result to the prediction of solar eruptions. For these purposes, we have analyzed the correlation of a new parameter kappa, which is defined as the averaged magnetic twist of magnetic flux subject of tether-cutting reconnection, with the onset of eruption using the simulation data. Also, we analyzed the statistical property of magnetic twist of various active regions using SDO/HMI data and the nonlinear force-free field extrapolation technique to devise a new way to evaluate the criticality of active region for the DAI. We will discuss the prospects of physics-based new flare prediction based on those results.

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