Double Arc Instability in the Solar Corona

N. Ishiguro* and K. Kusano
Institute for Space-Earth Environmental Research, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-8601 Japan
*e-mail: n-ishiguro@isee.nagoya-u.ac.jp

Ejection of twisted flux rope was sometimes observed in solar eruptions. It suggests that the stability of flux rope is related to the onset of solar explosive phenomenon. Kliem and Toeroek (2006) proposed the Torus Instability (TI) to explain the mechanism of solar eruption and that its stability is determined by the decay index. Although TI is often used as the criteria of explosive phenomenon, how the loop becomes unstable is still unclear. Although various scenarios for the onset of solar eruptions have been suggested, the tether-cutting reconnection scenario proposed by Moore et al. (2001) is widely accepted. However, the stability of double-arc loop, which is formed by the tether-cutting reconnection, has not been analyzed yet. So we model a double-arc loop as two circular tori connected each other and analyze the stability. The equations of equilibrium state and the ideal MHD constraint, which is the conservation of magnetic flux below the double arc, are derived, and we solve them numerically. As the result of analysis, we found that double-arc current loop can be destabilized for any type of external field, and the critical height of the instability is much lower than that of TI. We also found that the decay index is not relevant to the double-arc instability (DAI). On the other hand, we found that necessary condition for DAI is that the twist of magnetic field line is larger than one half. In addition, we can show that the DAI can reproduce the observational feature that fast eruption occurs after slow-rise phase. These results show that solar explosive phenomena may occur as a result of destabilization of double-arc loop which is formed by tether-cutting reconnection before flux rope becomes torus shape. Thus, it suggests that the onset of solar explosive phenomena may be determined by the DAI.