Study of double arc instability causing the onset of solar eruption

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The stability of magnetic flux rope in the solar corona is an important issue for the understanding what causes solar eruptions, such as solar flares and coronal mass ejections (CMEs). Although various scenario has been suggested for this problem, the tether-cutting reconnection scenario suggested by Moore et al. (2001) is widely accepted. However the stability of double arc loop, which can be formed by tether-cutting reconnection of sheared magnetic field before eruption, has not been analyzed yet.
To explain such a solar eruption based on the tether-cutting reconnection model, recently we suggested Double Arc Instability (DAI). In this theory, we numerically analyzed the stability of double arc electric current loop in the same method as the axisymmetric torus instability developed by Demoulin & Aulanier (2010). As a result, we found that the double arc loop is more easily destabilized than the axisymmetric torus, and that it becomes unstable even if the external field is not decayed with altitude in contrast to the axisymmetric torus instability. It suggests that the tether-cutting reconnection can efficiently work as the onset mechanism of solar eruption, and that the decay index does not necessarily need to be larger than a criteria to trigger solar eruptions, while the torus instability can play a role in the full eruption of the flux rope to inter-planetary space. We discuss the critical conditions for the DAI to grow in the force-free magnetic field and derive that the critical parameter , which is defined as the product of the magnetic twist and the normalized tether-cutting reconnecting flux, must be larger than a certain threshold to destabilize DAI. Finally, we develop three-dimensional MHD simulation of the DAI to analyze the onset process of solar eruption in more realistic configuration of magnetic field.

Keywords: Sun, flares, instability

