Coronal mass ejection as a result of magnetic helicity accumulation

Mei Zhang

National Astronomical Observatory of China

Abstract. In this talk, I will present our understandings that coronal mass ejections (CMEs) are unavoidable products of magnetic helicity accumulation in the corona. (1) We first show that in an open atmosphere such as the solar corona the total magnetic helicity of a force-free field must be bounded. The accumulation of magnetic helicity in excess of its upper bound would initiate a non-equilibrium situation, resulting in an expulsion such as a coronal mass ejection. (2) We then show that the magnitude of the helicity upper bound of the force-free fields is non-trivially dependent on the boundary condition. This suggests that a coronal magnetic field may erupt into a CME when the applicable helicity bound falls below the already accumulated helicity as the result of a slowly changing boundary condition. (3) We also show that a monotonic accumulation of magnetic helicity can lead to the formation of a magnetic flux rope applicable to kink instability. This suggests that CME initiations by exceeding helicity bound and by kink instability can both be the consequences of helicity accumulation in the corona. (4) Finally I will address practical problems on applying our theory for space weather prediction. Preliminary approaches to solve these practical problems will also be briefly mentioned.