MERGING AND GROWTH OF CELLULAR MAGNETIC STRUCTURES LEADING TO SOLAR ERUPTION

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Magnetic field structures in and below the solar surface are like islands in the ocean of plasma. When the magnetic fields emerge into the corona, plasmas can no more segregate them from each other. The originally separated magnetic structures come into contact and naturally create current sheets between them. Although magnetic reconnection tends to smear out the current sheets, partitional structures cannot be totally destroyed all at once because of the huge Lundquist number of the coronal plasma and strong line-tying conditions. Magnetic field structures rather incrementally grow by merging of smaller scale structures. By numerical simulations, we investigate the merging and growth of cellular magnetic structures in an idealized active region composed of several flux tubes lying along a polarity inversion line. When magnetic helicity is injected, a flux rope tends to find an equilibrium with a lowest possible potential energy by increasing pitches of the field line helix. This process may manifest itself as a kink instability in a single isolated flux tube. However, when magnetic reconnection between flux ropes is possible as in our model active region, the system tends to lower the potential energy by increasing the distance between the field line footpoints. As a result, new flux ropes are formed by stages of increasing footpoint distances. When the system can no more increase the footpoint distances with increasing magnetic helicity, the system must eject excessive magnetic helicity and energy away from the line-tied region of the boundary. This process arises as an eruptive phenomenon in the solar corona. A relevant observation is also presented and compared with the simulation.

coronal magnetic fields, cellular structure merging, solar eruption

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