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Structural Growth of Magnetic Flux Systems and Solar Eruption
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Erupting magnetic structures seen in coronal mass ejections are of grand scales. There have been speculations that such structures are formed in the solar interior before their emergence out of the solar surface. However, the structures observed to emerge into the solar photosphere are usually of a much smaller scale than the coronal structures observed before eruption. In this paper, we examine the evolution of a group of small scale flux tubes into stepwisely larger scale flux systems while magnetic helicity is continuously injected into the corona. As magnetic helicity increases, individual flux tubes expand and reconnect with each other to create new field line connections between magnetic patches separated farther than the footpoint distance of the original connection. Thus created are new flux systems of larger scales, which are entwined with mutual magnetic helicity. When the system reaches a critical state, in which it can no more increase the footpoint distances by magnetic reconnection, the system must eject excessive magnetic helicity and energy away from the boundary. This process arises as an eruptive phenomenon in the solar corona. A relevant observation is presented and compared with the simulation. It is also found that a localized eruptive behavior may take place with a smaller helicity input through a ballooning instability when the plasma beta is relatively high (though still lower than unity).

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