Plasmoid fast reconnection with transient small-scale Petschek-type structures

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Magnetic reconnection is thought to play a core role in explosive energy conversion in the solar corona. According to the Sweet-Parker model, however, it is difficult to conduct magnetic reconnection efficiently in highly conductive plasma because the current sheet is elongated too much. Recent understanding of fast reconnection is that, plasmoids will separate the current sheet into shorter Sweet-Parker current sheets and these shorter current sheets can explain fast reconnection of reconnection rate M~0.01. We propose another new mechanism to get fast reconnection of M~0.01, which include transient Petschek-type structure to accelerate reconnection. Petschek model is proposed against Sweet-Parker model to explain fast reconnection. However, numerical simulations and theories suggest that static Petschek reconnection doesn't realize in a system with spatially uniform resistivity. Some mechanism is needed to sustain the localized diffusion region. We perform resistive 2D MHD simulation in a large system with a high spatial resolution, and find that small-scale slow mode MHD shocks predicted by Petschek spontaneously form even under a uniform resistivity. In this process, growth of plasmoids in the current sheet play a role of localizing the diffusion region, and slow mode shocks form next to plasmoids. These plasmoids enhance magnetic reconnection intermittently and repeatedly. As a result, the reconnection rate increases up to 0.02. Furthermore, our simulation suggests that the obtained reconnection rate doesn't depend on the Lundquist number. This is due to a similarity in the evolution of plasmoid in different scale. (Shibayama et al. (2015), Physics of Plasmas, 22, 10, 100706).