A scaling model for plasmoid-dominated turbulent reconnection

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In resistive magnetohydrodynamics (MHD), two magnetic reconnection models have long been discussed: The Petschek reconnection model requires some assumptions in the electric resistivity, whereas the Sweet--Parker model is too slow to explain reconnection events in the universe. In late- 2000s, it was found that Sweet--Parker reconnection switches to plasmoid-dominated reconnection in larger systems at a high Lundquist number. Plasmoid-dominated reconnection features multiple secondary islands, due to the tearing instability in the reconnecting current sheet. Importantly, the reconnection rate of the plasmoid-dominated reconnection is moderately fast (R ~ 0.01), which is insensitive to the Lundquist number. Owing to this, plasmoid-dominated reconnection has been extensively studied over the past decade.
Traditionally, theories on Sweet--Parker and plasmoid-dominated reconnections assume the incompressibility for simplicity. Meanwhile, much less attention has been paid to the compressible fluid effects. In a compressible plasma, the typical Alfven speed approaches or exceeds the local sound speed, and then various characteristic features appear. In addition, we expect a highly compressible plasma in solar coronal environments. Thus, it is very important to explore the role of the plasma compressibility in plasmoid-dominated reconnection.
In our previous contribution in the JpGU 2016 meeting, we presented several MHD simulations on plasmoid-dominated reconnection. We found that the reconnection rate increases for compressible parameters. In this contribution, we will propose a simple scaling model for the reconnection rate. Carrying out MHD runs in the 2-D parameter space, we will validate our prediction. New features on the onset of plasmoid-dominated reconnection will also be presented.

Keywords: Magnetic reconnection, Magnetohydrodynamics, Turbulence, Compressible fluid