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Study of fast magnetic reconnection by using newly high resolution MHD scheme

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Magnetic reconnection is an important process to drive explosive release of magnetic energy by reconnecting anti-parallel magnetic lines in space plasma, such as particle acceleration in solar flares and large-scale convection in the Earth's magnetosphere. Magnetohydrodynamics (MHD) simulation where plasmas are treated as fluid is one of the useful methods to learn macroscopic effects of magnetic reconnection. However, kinetic effects of plasma particles around an X-line are significant to drive fast reconnection, since the MHD approximation is broken in the vicinity of the X-line. Consequently, reconnection rate which means energy release efficiency is low ,the so called slow reconnection. Previous researches have shown that particle simulations including kinetic effects achieve fast reconnection, while MHD simulations do not[e.g., J. Birn et al., 2001].

In this study,we attempt to simulate the fast magnetic reconnection by using a newly high order MHD scheme proposed by S. Kawai[2013]. The results show reconnection rate is higher than previous results by MHD simulations.In addition, we confirm the dependence on spatial resolution of reconnection rate. As the resolution is higher, the reconnection rate is expected to be higher, since current sheet becomes thinner. As a result, global reconnection rate increases in proportion to the resolution. Note that simulations with high resolution allow secondary magnetic islands. That is, the increase of global reconnection rate is due to the multiple X-lines. We confirm, however, local reconnection rate at one of the X-lines, and the rate is equivalent to that from previous particle simulations. Consequently, these results show that the newly scheme enables us to perform fast magnetic reconnection and is useful to study magnetic reconnection in the MHD-scale phenomenon.

Keywords: magnetic reconnection, magnetohydrodynamics