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Study of magnetic reconnection in large scale magnetic island coalescence via two-way coupling of MHD and PIC

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Magnetic island coalescence is a test case for flux tube merging in solar system plasmas. It is important to study the reconnection dynamics of large, MHD-scale islands which may be present in real physical systems. However, this reconnection is dictated by small scale kinetic physics. We approach this problem with a new technique of coupling large-scale MHD simulations with small embedded regions that are simulated with PIC. We will briefly describe this method which is suitable for such problems where large-scale phenomena are affected by small scale physics. We will describe the setup of magnetic island coalescence and perform a system size scaling study of this process. The coupled MHD-PIC approach allows us to simulate large systems with limited computing power. We find that the kinetic feedback is critical in producing correct reconnection dynamics, which even Hall-MHD is not able to capture. The current sheet structure as well as the reconnection rate are very different in Hall-MHD simulations compared to the kinetic simulations. We show the properties of the reconnecting current sheet and how they change with the system size. We also observe the formation of plasmoids in the kinetic region. We will show various properties of kinetic nature like the pressure anisotropy and agyrotropy in the reconnection zone. We find the scaling of the reconnection rate with system size in MHD, Hall-MHD and the coupled MHD-PIC approach and find important differences between them.