

Current status and prospects of Vlasov code

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In recent days, MHD simulations are widely used for numerical modeling of the solar wind, solar flares, global planetary magnetospheres, and other global and macroscopic phenomena. However, the MHD simulations need artificial resistivity, conductivity, adiabatic index, and diffusion coefficients. These quantities are essentially due to first-principle kinetic processes that are eliminated in the framework of conventional MHD approximation. Recently it has been suggested that the macroscopic, mesoscopic and microscopic processes in space plasma are strongly coupled with each other, which is called cross-scale coupling. To go toward the cross-scale coupling in the solar-terrestrial system, it is important to include full-kinetic dynamics of plasma particles in the global and macro-scale simulations.

In the present study, we regard the Vlasov model as a potential candidate for the first-principle simulation of all space plasma processes, which will be a final goal of the computational space plasma science. We are now developing a new Vlasov simulation code to go beyond the conventional MHD framework toward the cross-scale plasma science. Our new two-and-half dimensional (2.5D) full-electromagnetic Vlasov code is successfully applied to macro-scale phenomena such magnetic reconnection or Kelvin-Helmholtz instability. Here we discuss the current status of the Vlasov model and future prospects of their application to scale coupling in the plasma universe.