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Investigation of Energetic Particle Hybrid Simulation Model

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Energetic particle populations coexisting with the thermal gas are commonly found in space plasma environments. Although the number density of the energetic particles is usually much lower than the thermal population, the energy density is often substantial. Typical examples include the thermal gas and galactic cosmic rays in the interstellar medium, a cold plasma originating from the ionosphere and the energetic ring-current population in the inner magnetosphere.

The typical scale sizes such as the Larmor radius between the two population are vastly different, making it important to take into account kinetic effect of energetic particles even for the macroscopic dynamics in which the fluid approximation for the thermal population is adequate. The difference in scale size makes it impractical to deal with both the components in a fully kinetic manner.

Here we propose a method that deals with only the energetic particles as a kinetic population whereas the fluid approximation is used for the thermal gas. We will demonstrate that this may be achieved as a natural extension of our recently developed quasi-neutral two-fluid plasma simulation code. Several preliminary simulation results will be discussed to investigate the validity of the model.

Keywords: numerical simulation, plasma, cosmic rays