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Plasma simulation with a multi-scale numerical method LONG YANG, KUN LIU, SHUCHAO DUAN, Institute of Fluid Physics, CAEP, COMPUTATIONAL PHYSICS TEAM — Multi-scale effect is widely existed in plasma. Plasma will be deviated from ideal plasma assumption when it meets external field, in which parts of electrons will gain energy from the field and become runaway electrons. Ideal MHD method can't deal with the physical problems if the problems are closed related to those runaway electrons effect. To solve those problems, PIC (particle in cell simulation) method and hybrid fluid method were used traditionally. But those methods have their own limitations, PIC method needs a very long calculation time which limits time scale it can simulate, and hybrid method introduces some non-physical assumptions and requires dealing complex data exchange between different methods. In this paper, a muti-scale method is described, in which the evolution of plasma is referenced UGKS direct modeling method [1], and finite volume scheme is used to solve the multicomponent plasma BGK equations. And the time-varying Maxwell equations are deduced with the finite difference scheme, the magnetic field divergence is controlled by adopting the CT/CD method. This method does not require different calculation methods in calculation of different time scales. It will be degradation to kinetic scheme if the plasma average collision time is large and degradation to MHD scheme if the average plasma collision time is small automatically. The computational accuracy of this method is quite the same as that of the DSMC method, and the calculation time required is far less than that of the PIC method. The method can be applied to the simulation gas discharge plasma under extreme conditions and complex non-ideal completely ionized plasma.

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