Development of Two-Fluid MHD Code with CIP Method

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To understand various plasma phenomena in which micro-scale physical processes are important, the standard MHD model cannot be used for plasma dynamic simulations because it cannot treat the characteristic scale of ion or electron. Of course full particle model or Vlasov model are essentially more accurate, but such simulations need vast amount of computational resources. Recently, several enhancements to MHD model also become used, though, basically they can neither resolve electron inertial scale nor treat the effect of displacement current.

In this study we developed two-fluid MHD code which treats ion and electron fluids independently and Maxwell equations entirely. Therefore this model doesn't need assumptions sometimes thought to be invalid and is adequate on length scale comparable to inertial length. But such simulations based on two-fluid model have not yet examined a lot. We use CIP scheme which can calculate advection term with high resolution and aim for establishment of standard algorithm for solving the two-fluid system. In addition, we are developing relativistic extension to this model. Because displacement current is included as-is, our code can easily be applied to relativistic cases without assumptions such as charge neutrality. We will discuss initial results of our code: dispersion relations of plasma waves and numerical accuracy, in comparison with other models.