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Hybrid Particle-In-Cell model with Adaptive Mesh Refinement

Nicolas Aunai[1], Roch Smets[1], Philip Deegan[1], Andrea Ciardi[2], and Alexis Jeandet[1]
[1]CNRS / Laboratoire de Physique des Plasmas, Palaiseau Cedex, France (nicolas.aunai@lpp.polytechnique.fr)
[2]Sorbonne Université, Observatoire de Paris, PSL Research University, LERMA, CNRS UMR 8112, Paris, France

Collisionless magentized plasmas a priori need to be evolved using Vlasov-Maxwell kinetic formalism.
However the tremendous number of spatial and temporal scales involved in phenomena of interest makes it prohibitive, from a computational standpoint.
Fully kinetic particle in cell and single fluid MHD codes are commonly used at very small or very large scales.
The hybrid formalism, treating ions kinetically and electrons as a fluid, is in principle advantageous to fill the gap between these two extremities.
However, a correct treatment of critical regions such as reconnection X-lines require a good resolution of sub-ion dissipative scales, which
still constitute a major challenge if aiming at simulating meso/macro scale systems.
This work presents a new code, named PHARE, which successfully implements the adaptive mesh refinement mechanism in a hybrid particle-in-cell code.
Such a code is able to dynamically focus the resolution in critical regions while others not only have a coarser spatial resolution, but are also
evolved much less often thanks to a recursive time stepping procedure.
Adopting a patch based AMR mechanism, the code architecture is made so that the specific solver/physical model that is solved at a given refined level
is abstracted, thus giving the opportunity to handling multi-formalisms AMR patch hierarchies, where, for instance, coarsest levels are solved in MHD while
dynamicall created refined levels are solved within the Hybrid framework.