The projection operation in the fully kinetic, semi-implicit, adaptive Multi-Level Multi-Domain method

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The Multi-Level Multi-Domain (MLMD) method is a fully kinetic semi-implicit adaptive method for Particle In Cell simulations which allows to reduce the computational cost of simulations by increasing the temporal and spatial resolution only locally, where needed [6]. It is used for simulations of magnetic reconnection [1, 5] and turbulence generated by kinetic instabilities [2] at realistic mass ratios. Different grid levels are simulated at different resolution and coupled through information exchange operations, field and particle boundary conditions from the less (Coarse Grid, CG) to the more resolved (Refined Grid, RG) grid and projection (restriction) of the electric field information from the RG to the CG. Electric field projection consists in combining the native electric field CG solution and the RG solution interpolated to the local CG gridding. The result of this operation is the "mixed grid" electric field.

We focus here in particular on this last operation and on its consequence on the MLMD system in terms of momentum conservation and grid coupling strategy.

The variation of momentum $\Delta P$ on the CG and on the RG is calculated. The projection operation introduces an extra term in the formulation of the $\Delta P$ for the CG. The magnitude of this term can be controlled by preferring a particular form for the projection operator [4]. We also investigate the details of the projection operation by calculating the evolution law for the mixed grid electric field in terms of CG and RG moments [3].

References