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Alfvénic wave packets collision in a kinetic plasma

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The problem of two colliding and counter-propagating Alfvénic wave packets has been investigated in detail since the late Seventies. In particular Moffatt [1] and Parker [2] showed that, in the framework of the incompressible magnetohydrodynamics (MHD), nonlinear interactions can develop only during the overlapping of the two packets.

Here we describe a similar problem in the framework of the kinetic physics. The collision of two quasi-Alfvénic packets has been analyzed by means of MHD, Hall-MHD and kinetic simulations performed with two different hybrid codes: a PIC code [3] and a Vlasov-Maxwell code [4]. Due to the huge computational cost, only a 2D-3V phase space is allowed (two dimensions in the physical space, three dimensions in the velocity space).

Preliminary results suggest that, as well as in the MHD case, the most relevant nonlinear effects occur during the overlapping of the two packets. For both the PIC and Vlasov cases, strong temperature anisotropies are present during the evolution of the wave packets. Moreover, due to the absence of numerical noise, Vlasov simulations show that the collision of the counter-propagating solitary waves produces a significant beam in the velocity distribution functions [5], which, instead, cannot be appreciated in PIC simulations.

We remark that, beyond the interest of studying a well-known MHD problem in the realm of the kinetic physics, our results allows also to compare different numerical codes.

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