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Fast magnetic reconnection in Hall-MHD and Hybrid-PIC simulations of the tearing instability

Simone Landi (1,2), Emanuele Papini (1), Luca Del Zanna (1,2,5), Luca Franci (3,2), and Petr Hellinger (4)

(1) Dipartimento di Fisica e Astronomia, Università di Firenze, Firenze, Italy , (2) Osservatorio Astrofisico di Arcetri, INAF, Firenze, Italy , (3) Queen Mary, University of London, London, United Kingdom, (4) Astronomical Institute, CAS, Prague, Czech Republic, (5) INFN, Sezione di Firenze, Sesto Fiorentino, Italy

Magnetic reconnection provides the primary source for explosive energy release, plasma heating and particle acceleration in many astrophysical turbulent environments, for instance solar and stellar coronae, planetary magnetospheres, accretion disks around compact objects, magnetars, pulsar winds and their nebulae. The last years have witnessed a revival of interest in the MHD tearing instability as a driver for efficient reconnection, since it has been clearly established that, provided the current sheet aspect ratio becomes small enough ($a/L \sim S^{-1/3}$ for a given Lundquist number $S \gg 1$), reconnection occurs on the rapid ideal Alfvén timescales and becomes independent on S. Here we investigate, by means of high-resolution two-dimensional Hall-MHD and Hybrid-kinetic simulations, the *ideal* tearing instability of thin current sheets in the Hall-MHD regime, which is appropriate when the width of the resistive layer δ, in general smaller than the sheet thickness a, becomes comparable to the ion inertial length d_i. Numerical results and differences with respect to the MHD case, due to the Hall term and to ion-kinetic effects, will be discussed, especially in the nonlinear regime where secondary tearing instabilities naturally leads to an explosive disruption of the reconnecting site and to energy release on super-Alfvénic timescales, as required to explain space and astrophysical observations of plasma phenomena in turbulent environments.