Geophysical Research Abstracts
Vol. 19, EGU2017-15103, 2017
EGU General Assembly 2017

Simulations of Hall reconnection in partially ionized plasmas

Maria Elena Innocenti (1), Wei Jiang (2), and Giovanni Lapenta (1)

(1) Center for mathematical Plasma Astrophysics, KULeuven (University of Leuven), 3001 Leuven, Belgium, (2) School of Physics, Huazhong University of Science and Technology, 430074 Wuhan, China

Magnetic reconnection occurs in the Hall, partially ionized regime in environments as diverse as molecular clouds, protostellar disks and regions of the solar chromosphere.
While much is known about Hall reconnection in fully ionized plasmas, Hall reconnection in partially ionized plasmas is, in comparison, still relatively unexplored. This notwithstanding the fact that partial ionization is expected to affect fundamental processes in reconnection such as the transition from the slow, fluid to the fast, kinetic regime, the value of the reconnection rate and the dimensions of the diffusion regions [Malyshkin and Zweibel 2011 , Zweibel et al. 2011].
We present here the first, to our knowledge, fully kinetic simulations of Hall reconnection in partially ionized plasmas. The interaction of electrons and ions with the neutral background is realistically modelled via a Monte Carlo plug-in coded into the semi-implicit, fully kinetic code iPic3D [Markidis 2010].
We simulate a plasma with parameters compatible with the MRX experiments illustrated in Zweibel et al. 2011 and Lawrence et al. 2013, to be able to compare our simulation results with actual experiments. The gas and ion temperature is T=3 eV, the ion to electron temperature ratio is Tr=0.44, ion and electron thermal velocities are calculated accordingly resorting to a reduced mass ratio and a reduced value of the speed of light to reduce the computational costs of the simulations. The initial density of the plasma is set at n= 1.1 10{14} cm-3 and is then left free to change during the simulation as a result of gas-plasma interaction. A set of simulations with initial ionisation percentage IP= 0.01, 0.1, 0.2, 0.6 is presented and compared with a reference simulation where no background gas is present (full ionization). In this first set of simulations, we assume to be able to externally control the initial relative densities of gas and plasma. Within this parameter range, the ion but not the electron population is heavily affected by collisions with the neutrals.
In line with experimental results, we observe reduction of the reconnection rate and no variation of the half-thickness of the ion diffusion region with decreasing IP (increasing gas density). Contrarily to the experiments, we can confidently state that these effects are not influenced by boundary constraints. We then provide an explanation for the behaviour observed.