Geophysical Research Abstracts
Vol. 20, EGU2018-18672, 2018
EGU General Assembly 2018

Fully kinetic simulations of tangential discontinuities at the Earth magnetopause using the new energy conserving semi-implicit method

Alfredo Micera (1), Elisabetta Boella (2), Diego Gonzalez-Herrero (2), Andrei Zhukov (1), and Giovanni Lapenta (2)

(1) Royal Observatory Brussels, Department of Solar Physics ans Space Weather, Belgium , (2) KU Leuven, Department of Mathematics, Belgium

Despite the great advance in computer power, kinetic modelling of space plasmas is still quite prohibitive. Simulations within the existing numerical techniques are usually computationally very expensive mainly because of numerical constraints, which pose a strict limit on the maximum adopted spatial and temporal resolution.
Very recently we have developed an innovative semi-implicit energy conserving Particle-In-Cell (PIC) algorithm. The new code, called ECSIM [1,2], being stable and accurate over a wide range of temporal and spatial scales, allows for modelling heliospheric macroscopic phenomena retaining a kinetic description for both ions and electrons with a limited computational effort.
In this work, the new approach has been used to investigate the microscopic plasma dynamics in tangential discontinuities at the Earth magnetopause. Multi-dimensional PIC simulations have been carried out over MHD temporal and spatial scales. Numerical results show that, while bulk quantities are consistent with previous fluid or hybrid simulations [3], an intense electron heating/acceleration occurs at the discontinuity interface, which could not be captured with these models. The electron distribution function thus deviates considerably from Maxwellian and develops a highly energetic tail. Accurate analysis of the particle trajectories in order to understand the origin of these particles will also be presented. Finally, we notice that these results are in agreement with recent MMS observations.

[1] G. Lapenta, J. Comput. Phys. 334, 349 (2017).
[2] G. Lapenta, D. Gonzalez-Herrero and E. Boella, J. Plasma Phys. 83, 705830205 (2017).
[3] P. .J. Cargill and T. E. Eastman, J. Geophys. Res. 96, 13763 (1991).