Simulation of the Formation and Structuration of a Diamagnetic Cavity in a Magnetosphere Barium Cloud

B. Bernecker[1,2], Q. Cauvet[1], C. Couillaud[1], M. Salmon, S. J. Pichon[1], J. Darrenougue-Chassagne

[1] *CEA, DAM, DIF, F-91297 Arpajon, France*

[2] *Université Paris-Saclay, CEA, LMCE, 91680 Bruyères-le-Châtel, France*

The 3D multi-fluid magnetohydrodynamic code CLOVIS, is developed to investigate ionospheric natural disturbances like Equatorial Spread F or artificial events like barium cloud experiments. The model is based on Euler equations for the neutral fluid and Euler-Maxwell equations with the ideal MHD assumptions for the charged fluid. CLOVIS uses a Finite Volume method based on the Godunov's scheme with approximate Riemann solvers like ROE or HLLC for Euler equations and 8-wave or HLLD for ideal MHD equations [1].

The active experiments like barium releases, help to improve our understunding of ionospheric physics, magnetosphere-ionosphere coupling, and also cometary physics.The high altitude barium release experiment G-10 from the Combined Release and Radiation Effects (CRRES) mission shows the formation of a diamagnetic cavity and a structuration of the plasma [2]. The expansion of a sub-Alfvenic plasma through the magnetic field lines is known to form a diamagntic cavity where the total magnetic field almost vanishes. At the lower order, the radius evolution of the cavity can be estimated by equating the kinetic energy in the release to the swept-up magnetic energy.

The structuration results from the growth of the large larmor radius instability (LLR) which is similar to the Rayleigh-Taylor instability (RTI) but for unmagnetized ions [3]. The linear theory shows that the LLR instability developps faster than the RTI. Simulations initialized with the G-10 conditions have been performed with CLOVIS. The maximum radii from the experiment and from the simulations are in good agreement. The second order MUSCL-HANCOCK reconstruction associated with the HLLD solver, allows us to describe the evolution of plasma structures in the framework of the ideal MHD.

Références

[1] Miyoshi, T., Terada, N., Matsumoto, Y., Fukazawa, K., Umeda, T., and Kusano, K. The HLLD approximate Riemann solver for magnetospheric simulation, IEEE transactions on plasma science (2010).

[2] Huba, J. D., Bernhardt, P. A., and Lyon, J. G. . Preliminary study of the CRRES magnetospheric barium releases, Journal of Geophysical Research : Space Physics (1992)

[3] Hassam, A. B., and Huba, J. D. . Structuring of the AMPTE magnetotail barium releases. Geophysical research letters (1987)