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Magnetic double gradient instability in a compressible plasma current sheet

Daniil Korovinskiy (1), Viktoria Ivanova (2), Nikolay Erkaev (3,4), Vladimir Semenov (5), Ivan Ivanov (6), Helfried Biernat (1,7)

(1) Space Research Institute, Austrian Academy of Sciences, 8042, Graz, Austria (daniil.korovinskiy@gmail.com), (2) Orel State Technical University, 302020, Orel, Russia (biglion@inbox.ru), (3) Institute of Computational Modeling, Russian Academy of Sciences, Siberian Branch, 660036, Krasnoyarsk, Russia (erkaev@rambler.ru), (4) Siberian Federal University, 660041, Krasnoyarsk, Russia, (5) State University of St. Petersburg, 198504, St. Petersburg, Russia (sem@geo.phys.spbu.ru), (6) Theoretical Physics Division, Petersburg Nuclear Physics Institute, 188300, Gatchina, Leningrad Region, Russia (navi.vonavi@mail.ru), (7) Institute of Physics, University of Graz, 8010, Graz, Austria (helfried.biernat@oeaw.ac.at)

A linear MHD instability of the electric current sheet, characterized by a small normal magnetic field component, varying along the sheet, is investigated. The tangential magnetic field component is modeled by a hyperbolic function, describing Harris-like variations of the field across the sheet. For this problem, which is formulated in a 3D domain, the conventional compressible ideal MHD equations are applied. By assuming Fourier harmonics along the electric current, the linearized 3D equations are reduced to 2D ones. A finite difference numerical scheme is applied to examine the time evolution of small initial perturbations of the plasma parameters. This work is an extended numerical study of the so called "double gradient instability", – a possible candidate for the explanation of flapping oscillations in the magnetotail current sheet, which has been analyzed previously in the framework of a simplified analytical approach for an incompressible plasma. The dispersion curve is obtained for the kink-like mode of the instability. It is shown that this curve demonstrates a quantitative agreement with the previous analytical result. The development of the instability is investigated also for various enhanced values of the normal magnetic field component. It is found that the characteristic values of the growth rate of the instability shows a linear dependence on the square root of the parameter, which scales uniformly the normal component of the magnetic field in the current sheet.