Numerical degenerate elliptic problems and their applications to magnetized plasma simulations.

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Abstract

This work is devoted to the numerical approximation of the isothermal Euler-Lorentz system for charged particles in the gyro-fluid limit. The starting point is a paper of P.Degond, F.Deluzet, A.Samgam and M.H.Vignal published the "Journal of computational Physics" for a uniform magnetic field and directed along a coordinate axis. In this article, they derive a well posed elliptic equation for the component of the velocity parallel to the magnetic field and an Asymptotic preserving scheme for the Euler-Lorentz system. In the present situation we consider instead a variable magnetic field. In that case the component of the velocity parallel to the magnetic field is solution to an anisotropic elliptic problem. This problem is solved by using a variational formulation and a decomposition of the parallel velocity into a part constant along the magnetic field lines and another which represents a fluctuation. At the end, we get an Asymptotic Preserving scheme. I will finsh by presenting how this approach can be generalized to the situation of the full Euler equation ([Brull-Mouton-Degond-Deluzet]).