3D warm effects for low-frequency wave propagation in magnetically confined plasmas

N. Mellet, W.A. Cooper, L. Villard, P. Popovich, S. Brunner and T.M. Tran

Ecole Polytechnique Fédérale de Lausanne (EPFL)
Centre de Recherches en Physique des Plasmas
Association Euratom-Confédération Suisse, CH-1015 Lausanne, Switzerland.

The study of wave propagation is an important topic in plasma physics as it can play a considerable role in heating or instability processes. The LEMan [1] code is designed to treat low-frequency waves e.g. in the Alfvén and ion-cyclotron domain. In this range of frequencies, the main points of interest are heating in the ion-cyclotron domain (ICRH) and the global Alfvén modes that can be driven unstable [2] by the fast ions resulting either from fusion reactions or from neutral beam injection (NBI).

A warm model has been implemented in the LEMan code. To determine the corresponding dielectric tensor, the linearised Vlasov equation is solved by the same method used in [3], but retaining only the lowest order terms in the finite Larmor radius expansion. In order to compute the parallel gradient of the perturbed distribution function, the latter is decomposed in term of Fourier harmonics. A linear system is thus obtained and leads to a dielectric tensor whose form corresponds to a convolution connecting together the components of the Fourier series of the electric current density and field. Such a method permits to take into account the poloidal upshift of the parallel wave vector and to avoid using approximations that are quite delicate in stellarator geometries.

In the Alfvén range, the main kinetic effects that can be modelled with this formulation are the Kinetic Alfvén Wave (KAW) and the electron Landau damping. Lack of symmetry in stellarator systems gives rise to a larger variety of global modes (TAE, HEA, MAE, etc...). These modes already exist in the cold model but can also be influenced by kinetic effects. Investigation will be done to see how the different methods act on the results. The computation of a straight helix has been done and points out the presence of a helicity-induced Alfvén eigenmode (HAE). Adding other effects like toroidicity to the previous geometry will influence the spectrum and may modify the characteristics of the HAE.

References

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