An arbitrary-wavelength solver for the gyrokinetic quasi-neutrality equation.

J. Dominski[1], S. Brunner[1], B.F. McMillan[2], T-M. Tran[1] and L. Villard[1]

1) École Polytechnique Fédérale de Lausanne (EPFL), Centre de Recherches en Physique des Plasmas (CRPP), CH-1015 Lausanne, Switzerland.

2) Centre for Fusion, Space and Astrophysics, Department of Physics, University of Warwick, Coventry CV4 7AL, United Kingdom.

ORB5 is a gyrokinetic code [1, 2] simulating turbulence in tokamak plasmas. It accounts for multi-species dynamics, collisions, realistic magnetic equilibrium profiles, and includes electromagnetic perturbations. Nonetheless, when studying microinstabilities and associated turbulence at the ion time scale, as in the case of the ion temperature gradient (ITG) and trapped electron modes (TEMs), the present version of ORB5 assumes that the dominant modes in the turbulent spectra have long wavelengths in the direction perpendicular to the magnetic field lines compared to the ion Larmor scale ($k_\perp \rho_i \ll 1$). The electric potential is then currently obtained from the quasi-neutrality equation where the polarization density contribution from the ions is estimated within this long wavelength approximation. But when including the non-adiabatic response of electrons, shorter scale modes ($k_\perp \rho_i \gtrsim 1$) are destabilized and contribute to the turbulence spectra. These modes can be of the TEM or electron temperature gradient (ETG) types. Moreover, even for formally ion scale modes such as the ITG, the non-adiabatic response of passing electrons results in the development of fine radial structures near mode rational surfaces [3, 4, 5].

We are thus currently implementing a new electric potential solver which includes the linear polarization drift contribution to the quasi-neutrality equation for all wavelengths of the turbulent spectra, following an approach similar to Ref. [6, 7]. We shall present preliminary results of this new electrostatic field solver based on the integral form of the linearized polarization drift term, in different geometries in view of its integration to the global ORB5 code.

References

[1] T.M. Tran., et al., *Theory of Fusion Plasmas, International Workshop* (Editrice Compositori, Società Italiana di Fisica, Bologna, 1999), p.45.

[2] S. Jolliet, et al., *Comp. Phys. Comm.* **177**, p.409 (2007).

[3] G. L. Falchetto, et al., *Phys. Plasmas* **10**, p. 1424 (2003).

[4] R. E. Waltz, et al., *Phys. Plasmas* **13**, 052301 (2006).

[5] J. Dominski, et al., *J. Phys.: Conf. Ser.* **401**, 012006 (2012).

[6] A. Mishchenko, et al., *Phys. Plasmas* **12**, 062305 (2005).

[7] A. Mishchenko, et al., *AIP Conference Proceedings* **871** 394-399 (2006).