Single particle orbits in anisotropic fully shaped plasmas

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Present day devices employ sufficiently high power auxiliary heating such that the pressure associated with the corresponding energetic particles is of the order of the thermal pressure. In particular, for NBI and ICRH, the fast ions are distributed anisotropically, and this has been shown to influence the equilibrium and MHD stability. In the present contribution, we aim to explore the influence of anisotropy on single particle orbits, and ultimately kinetic corrections to perturbations of MHD-like origin. New 3D single particle orbit equations have been derived[1] and introduced into the guiding centre orbit code VENUS. These new equations of motion allow for a treatment of the pressure anisotropy and electromagnetic perturbations. VENUS uses the well established equilibrium and stability codes VMEC and TERPSICHORE as inputs, and follows a single particle on its orbit around 2D or 3D configurations. As a first application, the magnetic drift precession frequency is studied for both trapped and passing particles in a tokamak. The effects of parallel ($P_{\parallel} > P_{\perp}$) and perpendicular ($P_{\perp} > P_{\parallel}$) anisotropy are shown, including poloidal dependence of the perpendicular pressure due to anisotropy. Also, an analytical expression of the toroidal drift frequency for trapped particles including magnetic shear, plasma elongation and radial pressure gradients is derived. Thus a comparison with already existing expressions is possible and all of them can be compared to independent orbit simulations. The VENUS code is also used for elucidating the effects of the different parameters on the toroidal drift frequency. Another application is the modification of fast particle orbits due to pressure anisotropy, especially for large orbit widths and small inverse aspect ratio ϵ. Finally, the inclusion of electromagnetic perturbations allows for an investigation of MHD-like perturbations and their impact on particle orbits as well as resonance phenomena.

References

[1] W. A. Cooper *et al.*, Phys. Plasmas, **13** (2006) 092501.