Electromagnetic effects in the stabilization of turbulence by sheared flow

S.L. Newton[1], M.D.J. Cole[2], S.C. Cowley[1] and N.F. Loureiro[3]

[1]*EURATOM/CCFE Fusion Association, Culham Science Centre, UK*
[2]*Max-Planck-Institut für Plasmaphysik, EURATOM Association, Greifswald, Germany*
[3]*Associação EURATOM/IST, Instituto Superior Técnico, Lisboa, Portugal*

What impact do sheared flows have on tokamak confinement?

Their stabilising effect has been studied, but it is also known that strong toroidal plasma flows necessarily introduce potentially destabilising parallel velocity shear.

Working in a sheared slab geometry, we have identified a coordinate transformation which cleanly separates aspects of flow shear. The parallel component appears simply as a drive, analogous to the ion temperature gradient (ITG). The perpendicular component appears as a convective term, sweeping any perturbations along field lines, into regions of high shear and ultimately dissipation. This representation allows a critical flow shear to be identified, which is related to the propagation speed of the fastest wave in the system. Beyond this value, no unstable eigenmodes can form, and only transient perturbations may grow - which can potentially ignite subcritical turbulence.

Applying the transformation to a dissipative fluid model developed rigorously from the gyrokinetic equation, we previously investigated the effect of flow shear on the ITG instability in the electrostatic limit. We have extended the model to retain finite, but small, β and consider here the changes introduced by the electromagnetic effects. The rapidly propagating shear Alfvén wave now formally allows for a much larger region of potential eigenmode growth, which is investigated numerically. It is also seen that sufficiently strong parallel flow shear can destabilise the Alfvén wave itself.

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