Modelling Ohmic Intrinsic Rotation in JET Plasmas

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The lack of effective momentum injection in ITER has driven a worldwide research effort to predict its intrinsic rotation levels. The main objective of this work is to determine if measured features of rotation profiles in JET Ohmic plasmas could be explained by the turbulent transport model developed in [Parra 10, Parra 11]. The typical JET rotation profile in Ohmic plasmas is observed to change sign from co-current rotation in the edge to counter-current rotation in the core [Nave 10]. Thus one would like to determine if turbulent transport could explain this mid radius reversal of the rotation sign. In the model considered here, turbulent momentum redistribution is based on the low-flow ordering and self-consistently includes higher order contributions for tokamaks with small poloidal magnetic field. New drive terms for rotation appear that depend on the gradients of the background profiles of density and temperature. The new gyrokinetic equations have been implemented in the multi-scale gyrokinetic codes GS2 [Dorland 00]. The modified GS2 [Barnes 13] now models the effect on turbulence of neoclassical parallel velocity and heat flow, and neoclassical poloidal electric field. For the first explorations of the effect of individual higher order terms on the momentum flux, GS2 was run in simplified tokamak geometry. These have shown that changing collisionality [Barnes 13] as well as magnetic shear [Lee 14] can change the direction of rotation in quantitative agreement with observations in some tokamaks. The modified GS2 has recently become ready for simulations with experimental data as input. Here, we will show the first simulations of momentum flux using as input, data from a JET discharge with Ohmic heating. Results are very encouraging since calculations of the intrinsic momentum flux, $\Pi_{intrinsic}=\Pi\,[V=0,\ \partial V/\partial r=0]$, shows co-current momentum expelled, thus indicating that core hollow profiles as observed in the data can be obtained. Moreover, the intrinsic momentum flux is the right order of magnitude to explain the experimentally observed rotation gradient.

References

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