Gyrokinetic turbulence in the presence of strong rotation

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Tokamak experiments often operate with a rotating plasma, which can be driven externally but can also arise spontaneously. This rotation is advantageous in the stabilisation of resistive wall modes and in producing enhanced energy confinement through turbulence suppression. In the co-rotating frame of the plasma, the effects of rotation are felt as a Coriolis force [1] and centrifugal force [2]. Using the assumption of low toroidal Mach number, the centrifugal force has in the past been neglected, but can become important in the case of strong rotation, as is common in spherical devices. The centrifugal effects are also important for heavy impurity ions even at small toroidal velocities. The centrifugal force is felt through a centrifugal drift and an enhanced mirror force. In this work, the first nonlinear gyrokinetic simulations including the centrifugal force in a strongly rotating plasma are presented. The enhanced mirror force leads to a redistribution of density with the flux surface, and the enhanced particle trapping lowers the threshold for trapped electron modes. At intermediate scales this can result in promotion of the trapped electron mode over the ion temperature gradient mode as the dominant instability, resulting in an enhanced electron heat flux. The centrifugal drift causes a particle pinch for trapped electron modes which could have important consequences for fusion devices.

References