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P1.1086 Stability of microtearing modes

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In H-mode plasmas, the modelling of the pedestal dynamics is an important issue to predict temperature and density profiles in the tokamak edge and therefore in the core. The model EPED [1] , based on the stability of large and small scales MagnetoHydroDynamic (MHD) modes, is most commonly used to characterize the pedestal region. The EPED model has been quite successful until now. However some recent analysis of JET plasmas [2] suggest that another class of instabilities, called microtearing modes, may be responsible for electron heat transport in the pedestal, and thereby play some role in determining the pedestal characteristics. Microtearing modes belong to a class of instabilities where a modification of the magnetic field line topology is induced at the ion Larmor radius scale. This leads to the formation of magnetic islands, which can enhance the electron heat transport. The past analytical work predicted peaked growth rate of MTM at a finite value of collisionality and decreases down to negative value in collisionless regime[3]. However, recent gyrokinetic simulations in toroidal geometry found unstable MTMs [4], even at low collisionality. The purpose of our work is to progressively include missing physical mechanisms (magnetic drift, electric potential, collsions,…) in the analytical model and compare it with the numerical simulations to improve the understanding of MTM destabilization mechanisms.
Numerically, the modelling of MTMs is challenging. The width of the current layer and the sensitivity of magnetic reconnection to dissipation imply having a very high numerical resolution and a very weak numerical dissipation, especially at low collisionality. The improvement of the analytical model is crucial, first to better understand the role played by the different physical parameters, but also because it is free of these problems. As a first step, linear theory of a slab microtearing mode using a kinetic approach has been established and compared with linear gyrokinetic simulations [5]. The linear stability of the collisionless MTMs predicted by the theory is found consistent with numerical simulations using the gyrokinetic code GKW [6]. Starting with this simple model the magnetic drift and the electric potential are included progressively in the analytical calculation. The full expression of the current inside the resistive layer is rather complex. Without the electric potential, the magnetic drift has been found to be destabilising, but only in conjunction with a finite collisionality[7]. Then, with both electric potential and magnetic drift, the evaluation of the current inside the resistive layer is obtained from a system of two equations linking the vector potential(as the consequence the current) and the electric potential. This system of equations have been solved numerically using an eigenvalue code. A good agreement between the analytical calculation and GKW simulations has been found. It appears that the magnetic drift velocity and electric field fluctuations are destabilizing when combined with collisions. However, this destabilization effect disappears at low collisionality and no unstable MTM is found so far in collisionless plasmas. The magnetic drift and electric potential cannot explain the destabilization of MTMs at low collisional frequency observed in recent gyrokinetic simulations [4]. The effect of trapped particle is now under investigation. It is found numerically that depending on the collisionality, trapped particles can increase or decrease the MTM growth rate. The next step of this study is investigate the properties of MTM turbulence and evaluate the corresponding electron heat transport in particular in the JET-ILW pedestal.

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