Geometry-enhanced sheared flow in the L to H transition

F. Spineanu[1], M. Vlad[1], A. Croitoru[1,2]

[1] National Institute of Laser, Plasma and Radiation Physics

[2]Faculty of Physics, University of Bucharest

The sudden increase of the plasma rotation at the transition from L to H confinement in tokamak may have different origins. We draw attention here to a mechanism that is a robust instability and implies the bootstrap current at the edge.

We consider a narrow layer inside plasma, a small radial interval limited by the last closed magnetic surface. During the NBI, the new ions, of high energy, transiently extend their orbit and for many of them the low-field-side of their banana orbit “enters” the radial layer. The density of trapped ions in that layer increases at the rate of the NBI input. Accordingly, the bootstrap current increases. However, the geometry of a banana orbit of this new ion trapped population does not follow the magnetic surface. The largest-r point of any banana is on the equatorial plane, due to symmetry, but the tips are substantially inside the magnetic surface. This modulates the basic collisional transfer of momentum toward the circulating electrons, the origin of the bootstrap current. The parallel current is then a function of the parallel length, which is compensated by radial current to preserve the zero-divergence. The parallel variation of the parallel current drives a time increase of the vorticity (projected on the magnetic line) which is simply the radial derivative of the poloidal velocity. This increase of the velocity-shear enhances the barrier against the turbulent transport. The consequence is the increase of the radial gradient of the pressure (formation of the pedestal). Or, higher pressure gradient means higher bootstrap current and the cycle is closed with positive gain. This instability may contribute to the transition L to H, in the presence of NBI or NBI/ICRH.

The first calculations of this instability will be presented.