Two-dimensional structure and particle pinch in a tokamak H-mode

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Steep gradient of the radial electric field is found to suppress turbulence transport, so the structural formation mechanism in toroidal plasmas is crucial to understand improved confinement. Much of researches were devoted to the study of the steep radial electric field structure in the L-H transition physics [1], but poloidal shock has been predicted theoretically when a large poloidal flow exists [2]. In a tokamak H-mode, a large poloidal flow exists in an edge transport barrier, and electrostatic potential and density profiles can be steep both in the radial and poloidal direction. Two-dimensional structures of the potential, density and flow velocity near the edge of tokamak plasma are investigated in the case that the strong radial electric field exists. The analysis is carried out with the momentum conservation law with the shock ordering. A set of equations is derived by considering the nonlinearity in bulk-ion viscosity and turbulence-driven shear viscosity [3]. The two-dimensional structure of the electric field in a transport barrier is obtained, giving a poloidal shock with the solitary radial electric field profile. The poloidal electric field induces convective transport in the radial direction, and poloidal asymmetry generates inward pinch of particles, which has pinch velocity of order of 1[m/s]. Large poloidal flow with radial shear enhances the inward pinch velocity. The jump of this inward flux at the onset of transition explains a rapid establishment of the density pedestal at the L-to-H-mode transition.

[1] e.g., N. Kasuya, K. Itoh and Y. Takase, Nucl. Fusion **43** (2003) 244

[2] K. C. Shaing, R. D. Hazeltine and H. Sanuki, Phys. Fluids B **4** (1992) 404

[3] N. Kasuya and K. Itoh, submitted to Phys. Rev. Lett.