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TH/P4-25: Spatiotemporal Oscillations in Tokamak Edge Layer and Their Generation by Various Mechanisms

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Toroidal and poloidal rotations of plasma at the edge region of tokamak devices have long been known to play an important role, such as enhancing the confinement properties by suppressing turbulent behaviour, improving tolerance to error fields and increasing stability to neoclassical tearing modes. Hence, understanding of creation and evolution of rotation is important, since external momentum would not be enough or could not even be realized especially for future large fusion devices. In addition to the externally applied momentum, several mechanisms have been suggested to explain the reasons for spontaneous toroidal rotation of plasmas. For a tokamak edge region as found, for example, within the operational boundaries of the ASDEX upgrade, relevance of the collisional neoclassical theory was recently emphasized. In this regime gyrostresses play a considerable role in modifying the coupled flux surface averaged continuity, energy and momentum equations. Examination of the terms in these equations that are responsible for diffusion or reaction and acting as sources, can show the share of the neoclassical mechanisms to terms like intrinsic rotation, etc. Using similarities of our equations to the nonlinear reaction-diffusion equations with a susceptibility to the Turing instability and applying some robust numerical methods, we present here an approach based on the spatiotemporal simulation of the oscillations in plasma temperature, density, toroidal and poloidal rotation velocities under various perturbative effects. Present study considers a subsonic, collisional plasma in front of the magnetic separatrix. Study indicates a nonlinear, three-time-scales-coupling between the evolutions of the density, temperature and poloidal and toroidal rotation velocities. Numerical solutions of the coupled system for the vector W=[T, N, U_phi, U_theta] were studied under various given sources such as a periodic pellet injection or loop voltage variation with chosen initial and Dirichlet or Neumann-boundary-conditions at the both ends of the radial boundary layers. Some of these effects were seen, to lead to a chaotic spatiotemporal behaviour of W, or to lead to rapidly diverging rotation velocity profiles. Steep gradients in assumed initial profiles were found in most cases, to enhance such effects.

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