The Impact of Magnetic Shear on Edge Harmonic Oscillation Driven by Parallel Velocity Shear In Slab Model

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Since the initial discovery of the high-confinement mode (H-Mode) in 1982, it has become a prominent area of fusion energy research due to the improved confinement time and reduction in edge fluctuation [1]. It is believed to be an operating regime for future generation steady-state tokamak reactors. The major problem with the H-mode operating regime is Edge Localized Modes (ELMs), which are associated with a large amount of energy and particle flux to PFCs due to the bursty nature. Which is beneficial for impurity control but also responsible for high peak heat loads on divertor and other PFCs. There are robust research efforts both theoretical and experimentally focused on developing sustained high confinement regimes that suppress or mitigate ELMs.

The ELMs mitigation and suppression accompanied by the Coherent Modes (CMs) are often observed in many tokamaks systems [2]. In DIII-D, regime known as QDB which has similar edge profile as H-Mode, The Edge Localized Modes are replaced by low amplitude edge instability known as Edge Harmonic Oscillations or EHO [3]. The main characteristic of EHOs are characterized by well-defined periodic toroidal structure of density and magnetic fluctuations that are just outside the separatrix and peak at region of strongest gradient of parallel velocity. D. McCarthy suggested that the actual source of EHO is instability driven by radial shear in toroidal velocity(Parallel velocity shear instability or $V_{||}$ mode) [4].

The code for solving Nonlinear three dimensional coupled fluid equations that describe electrostatic parallel velocity shear instability in 3-D slab corresponding to radial, poloidal and toroidal directions has been developed using the Finite-Difference Method for spatial derivatives and the Adams-Bashforth Method for time Evolution, with the Periodic Boundary condition in Y and Z directions and Dirichlet Boundary condition in X direction. Finite and constant Ion(T_i) and Electron temperature(T_e) are taken into account in the model. The background equilibrium normalized density and parallel velocity radial profiles used for simulation are shown in Figure-1, where the density normalized to $n_0 = 10^{13}$ cm^3 and parallel velocity normalized to $c_s = 7\times10^6$ cm/s and x scale length normalized to 7 cm.

The further investigation of a magnetic shear on an electrostatic two-fluid model of EHO driven by parallel velocity shear has been carried out and corresponding results and analysis presented.

References

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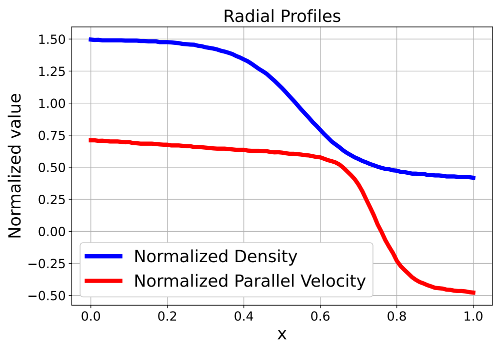

Figure 1 : The normalized radial density and parallel velocity profiles.