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Gyrokinetic simulation of electrostatic microturbulence in ADITYA-U tokamak

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ADITYA-U is a medium-sized, air-core tokamak, which has been recently upgraded from ADITYA tokamak to incorporate a new set of divertor coils for shaped plasma operation with a new vacuum vessel along with a new toroidal belt limiter. Since its commissioning, several experiments relevant to the operation of future fusion devices such as ITER have been performed, including experiments on generation, transport and control of runaway electrons, plasma disruption, transient transport phenomena such as cold-pulse propagation and plasma detachment. However, there are very few simulation studies on ADITYA-U tokamak and even the global simulation studies of the microturbulence by state-of-the-art codes like GTC are yet to be established. In recent experiments, a broadband fluctuation spectrum is observed in the frequency range of 0 to 50kHz in the measured density fluctuations sampled at 100 kHz. The rack-Langmuir probes are also used for the measurements of the radial profile of density in the edge/Scrape-off-Layer (SOL) regions. The particle diffusivity of ~ 0.2m^2 /sec in the edge/SOL region is derived from these measured density profiles [1], which are further cross-checked with UEDGE code simulations [2].

To validate the experimental observations a first-principles global gyrokinetic simulation of the electrostatic microturbulence driven by the pressure gradients of thermal ions and electrons is carried out for the ADITYA-U tokamak geometry using experimental plasma profiles with collisional effects. The dominant instability is determined to be trapped electron mode (TEM) based on the linear eigenmode structure and its propagation in the electron diamagnetic direction. The turbulent transport level of ion diffusivity determined by the nonlinear simulations is found to match well with the experimentally measured value of ~ 0.2m^2 /sec. The frequency spectrum of the electrostatic fluctuations, with broadband from 0 to ~ 50kHz, is also found to be in good agreement with the experimentally recorded spectrogram in ADITYA-U [3].

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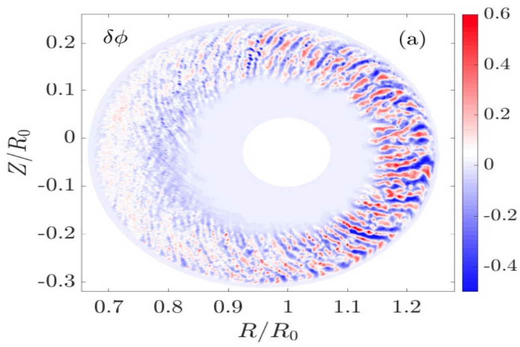

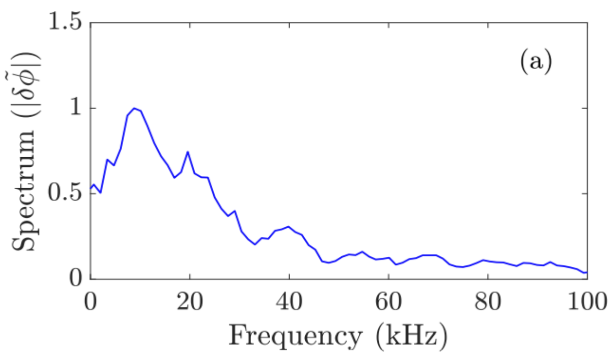

(Left) The contour plot of the electrostatic potential of the microturbulence in the nonlinear phase. (Right) The spectrum of electrostatic fluctuations