Structure of the ISTTOK edge plasma fluctuations

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Transport in magnetically confined plasmas is generally accepted to be driven by plasma turbulence. The dynamics underlying the turbulence processes have been therefore extensively investigated with the aim of understanding and enhancing the confinement in fusion plasmas.

The tokamak ISTTOK ($R = 46$ cm, $a = 8.5$ cm, $B_T = 0.5$ T, $I_p \approx 4$-7 kA) is equipped with several diagnostics that allow the investigation of the edge fluctuations such as: (i) a poloidal and (ii) a radial array of Langmuir probes with 8 pins each; and (iii) a Heavy Ion Beam diagnostic with a multi-cell array detector that allows simultaneous measurements across the plasma column. Data were simultaneously sampled at 2 MHz and the analyses performed during the discharge flat top (~20 ms) using different analysis techniques.

It has been found that the fluctuations have distinct characteristics for $r>a$ (scrape-off layer, SOL) and $r \lesssim a$ (core periphery). SOL fluctuations are characterized by short correlations both in space (poloidal) and time (λ_c~5-10 mm and τ_c~5-8 μs, respectively), poloidal wavenumbers in the range of $k_\theta < 3$ cm^{-1} and a broad frequency spectrum. In the core periphery the correlation is significantly larger ($\lambda_c >> 10$ mm, τ_c~30 μs), the wavenumbers are shorter $k_\theta < 0.5$ cm^{-1} and the spectrum is dominated by low frequency components (10-25 kHz).

A significant correlation (up to 0.7) has been found in the core periphery between probe systems toroidally apart measuring floating potential, which increases when probes are approximately at the same radial location. Furthermore, this correlation is only significant for frequencies around 10-25 kHz and its cross-phase is close to zero.

We can conclude therefore that the characteristics of the potential fluctuation in the SOL are consistent with the typical broad band turbulent fluctuations while in the core periphery they are consistent with a symmetric structure in the poloidal and toroidal directions.