Experimental charaterization of a quasi-coherent turbulence structure in the edge plasmas in W7-X

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A quasi-coherent turbulence structure (QC mode) in a frequency range of 10 kHz to 25 kHz has been studied by measuring the electron density fluctuation via a hopping Poloidal Correlation Reflectometer (PCR) [1, 2] in W7-X. It is observed in the standard and narrow mirror configurations, and absence in the high-iota configuration, which implies a certain dependence of the QC mode on the edge rotational transform. The QC-mode appears in the edge region accompanied by a steep electron density gradient inside the last-closed flux surface (LCFS). Its initial typical frequency of 25 kHz decreases to 10 kHz when the probing position moves toward the core. By calculating the cross correlation spectrum within each of the two antennae combination, the poloidal wavenumber of the QC mode is estimated to be $k_\theta \approx -0.21 cm^{-1}$ propagating in the electron diamagnetic drift direction. The turbulence rotation velocity in this standard configuration is $v_{turb} \approx 8.4 km/s$ in the laboratory frame, which is consistent with the result from the slope of the cross-phase spectrum. With the edge electron temperature and the magnetic field in the edge region, the gyroradius at the sound speed of the QC-mode is calculated to be $\rho_s \approx 0.207$, and $k_\theta \rho_s \approx 0.145$. This is qualitatively demonstrates that the QC-mode is in the range expected for drift- waves. Evidence shows that the existence of the QC-mode might be influenced by the edge radiation level, also the turbulence in the low frequency range ($f < 10 kHz$) is suppressed when the QC-mode exists.

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References

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