Bi-spectral analysis of density and potential fluctuations in high neutral density cylindrical plasma

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The nonlinear mode coupling in drift-wave fluctuation is one of the most important issues to in plasma physics. Bi-spectral analysis is a useful tools to investigate the nonlinear coupling among three waves which satisfy the matching conditions of frequency and/or wave number.

Density and potential fluctuation and fluctuation-induced flux are observed in the LMD-U linear plasma device. Fluctuations in the ion saturation current, I_{is}, and the floating potential, V_f, are measured simultaneously with a 64-channel azimuthal probe array (probe tips alternately measure I_{is} and V_f) and are used as indexes of the density and the potential fluctuations, respectively. Fluctuation structure in LMD-U is changed depending on the neutral density. The 2D bi-spectral analysis, which considers both the matching conditions of azimuthal wave number and frequency, has been performed in the low neutral density plasma and the nonlinear couplings among density fluctuations are identified [1]. In this study, we focus on the high neutral density plasma in which density and potential fluctuation waveforms are non-trigonometric functions similar to sawtooth waves and peaks in power spectrum lie along a straight line on the frequency-wave number [2]. Figure 1 shows squared auto bi-coherence of I_{is} .The conditions of the experiment are magnetic filed B of 0.09T and neutral pressure p of 5 mTorr. The squared auto bi-coherence of V_f is obtained, and similarity and difference between these of I_{is} and V_f are discussed. The flux is induced by coupling of density and the azimuthal electric field fluctuations. The nonlinear effects on turbulent fluctuations and fluctuation-induced flux are discussed based on cross bi-coherence among density-, and azimuthal electric field-fluctuation and flux.
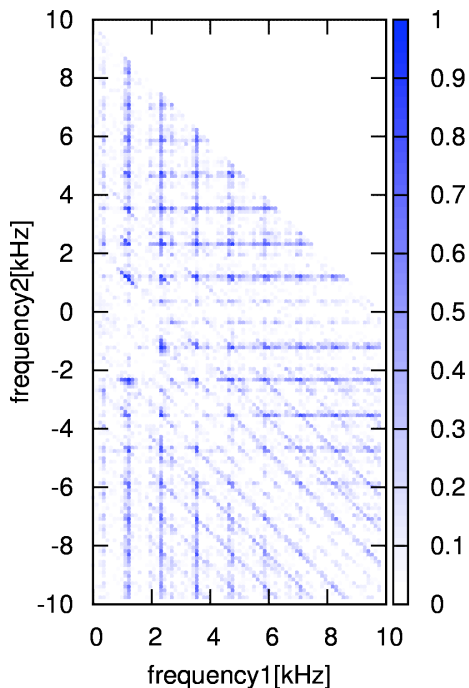

Figure 1: Squared bi-coherence of I_{is} fluctuation. Time-window is 8.192 ms and 60 ensembles are averaged.

[1] T. Yamada, et al., Nature Physics **4** (2008) 721 - 725.
[2] H. Arakawa, et al., Plasma Phys. Control. Fusion, **51** (2009) 085001.