Nonlinear mode couplings in a cylindrical magnetized plasma

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For understanding anomalous transports in magnetized plasmas, study of drift wave turbulence has been an important subject. Recently, theories have predicted that the nonlinear couplings between the drift waves should generate meso-scale structures, such as zonal flows and streamers, which should have a strong influence on the anomalous transports [1]. We present the first experimental identification of a streamer (state of bunching of drift waves) in a linear cylindrical magnetized plasma by use of a poloidal multi-channel probe array [2]. The streamer is a poloidally localized and radially elongated global structure that lives longer than the characteristic turbulence correlation time. Our results revealed that the streamer was produced by nonlinear mode coupling process, that is, the nonlinear phase locking of major triplet modes. The nonlinear mode coupling was confirmed by bi-spectral analysis. Multi-channel probe array allows two-dimensional (frequency and wave number) bi-spectral analysis. By the analysis, the formation of the plasma turbulence was regarded as a result of nonlinear interaction of a small number of parent modes, which were driven by linear instabilities such as drift mode. The two-dimensional power spectrum showed broadband fluctuations, and the two-dimensional bi-spectral analysis identified the nonlinear couplings between coherent–coherent, coherent–broadband and broadband–broadband fluctuation components.

[1] P. H. Diamond *et al.*, Plasma Phys. Control. Fusion **47** (2005) R35.
[2] T. Yamada *et al.*, Nature Phys. **4** (2008) 721.