Turbulence in Toroidal Plasma

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Turbulence is a ubiquitous phenomenon widely observed in nature, thus is associated with many aspects of physically understanding our surroundings (the sun, aurora, the ionosphere, dynamo, etc.) and developing the modern technologies (nuclear fusion, display, plasma rocket, carbon nano-tube, etc.). Recent researches of plasma turbulence have made a great progress in its understanding by the outstanding development of the experimental apparatus and data analysis techniques. Nowadays the plasma turbulence can be regarded as a system of micro-scale fluctuations (such as drift waves) and meso-scale structures, such as zonal flows and streamers generated from the background micro-scale fluctuations [1,2]. Moreover, the view has been extended to include the macro-scale fluctuating structures excited by the turbulence. The modern view is that the turbulence should be a system of micro-, meso- and macro-scale fluctuating structures interacting with each other, and this has contributed to fundamental understanding of structural formation in turbulent plasma and to more exact prediction of ITER performance. In this paper the recent experiments and the modern view of plasma turbulence are presented with the development of analysis methodologies to elucidate the nonlinear couplings and energy transfer direction between the elementary waves in plasma turbulence [3]. Particularly, the emphasis is put on the results from small and medium sizes of laboratory experiments, for instance, the identification of the zonal flows and magnetic fields, which could be a decisive experimental progress toward the understanding the turbulent transport of magnetically confined plasma, and the verification of the hypothesis for the historical enigma of dynamo problems.

References