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EX/P7-07: Generation of Large Scale Coherent Structures by Turbulence in Edge Plasmas of HL-2A Tokamak

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The generation mechanisms as well as the spatial and spectral characteristics of three dimensional large-scale coherent structures (LSCSs) in the form of blobs or filaments, stretching along magnetic field lines in the edge plasmas of the HL-2A tokamak are investigated using 10-tip poloidal and 8-tip radial probe arrays toriodally separated by 2100 mm [1,2]. The LSCSs in frequency range of 15 - 100 kHz, with radial and poloidal size of about (20-30)micros ˜ (10-15) mm and finite parallel wave vector have been experimentally observed with high spatial and temporal resolutions. The turbulence energy from 30 to 60 kHz is found to contribute significantly to the growth of the turbulent eddies of broad spectrum. The latter gradually increase, following the increasing turbulence energy of 30 - 60 kHz, and then break up into LSCSs with dipolar potential fluctuations at the inner side of the LCFS, where the Reynolds stress driven ExB flow is strong, the flow shearing rate has a maximum and the flow shearing time is close to the LSCS generation time. The LSCSs are then ejected by the ExB flow shear across the LCFS and into the SOL, the back reaction of the ejection on the turbulence is also observed and may result in intermittent behaviors of the LSCS generation. Thus, the increasing turbulent energy, the spontaneous ExB flow shear are identified responsible for the generation of LSCSs, which is in agreement with the theoretical prediction and provides unambiguous experimental evidences for LSCS generation mechanism in tokamak edge plasmas for the first time. The correlation between the sheared flow and Reynolds stress is demonstrated. The evidence for the back-reaction of LSCS ejection on turbulence is also presented. Furthermore, the particle and energy transports induced by the LSCSs and the ambient turbulence are estimated and analyzed in detail.
[1] J. Cheng et al., Plasma Phys. Control Fusion 52, 055003 (2010).
[2] L. W. Yan et al., Journal of Nuclear Materials 415, S475–S478 (2011).

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