Investigation of Zonal Flows by Using Collective Scattering Measurement of Density Fluctuations

Y. Yu [1] , H. G. Shen [1] , T. Lan 1 , Y.D. Li[2] , A.D. Liu [1], J.L.Xie [1], W.D. Liu [1], C.X. Yu[1], W.Y. Zhang[2], A. Ti[2], J.G. Li[2]

[1]CAS Key Laboratory of Basic Plasma Physics, and Department of ModernPhysics, University of Science and Technology of China, Hefei, Anhui 230026,China

[2]Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, China

E-mail contact of main author: shg@mail.ustc.edu.cn

The instantaneous frequency method is developed to deduce the poloidal $\boldsymbol{E}_r \times \boldsymbol{B}_T$ rotation or radial electric field using the density fluctuations measured by the CO_2 laser collective scattering diagnostics on HT-7 tokamak.

A coherent mode, which mode frequency is from 10 kHz to 20 kHz, is observed in the poloidal $\boldsymbol{E}_r \times \boldsymbol{B}_T$ velocity fluctuations. The coherent mode is proved to be poloidally symmetric (m=0). The toroidal symmetry (n=0) can be circumstantially valid with the assumption that the plasma flow or radial electric field fluctuations is constant on the helical magnetic field line. Its mode frequency agrees with the theoretical expected GAM mode frequency. With these evidences, the observed coherent mode can be identified as GAM.

The relative amplitude of GAM in the envelope depends on the filter band of density fluctuations. In addition, the phase shift between the GAM radial electric field and the envelope of density fluctuations is proved to be $\pi/2$ radians. These results strongly recommended that the envelope modulation on the density fluctuation only reflects the shearing effect by the GAM.

In this paper, the comparison between two approaches to measure zonal flows indirectly using the density fluctuations is provided. For IFM, It makes a good alternative to the direct measurement of zonal flows potential and radial electric field. The amplitude of envelope depends on the spectral distribution and the filter features adopted in the envelop analysis, which interpretation is much more complicated than that of IFM.

Acknowledgments

The authors thank the HT-7 team in ASIPP for the support of these experiments. This work was supported by the National Natural Science Foundation of China (Grant No. 10990210, 10990211, 11375188, 11105144, 11375053).