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Observation of Zonal Flows in Core Plasma with Collective Scattering Density Fluctuation Measurement

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In this paper, we extend the indirect approach using Instantaneous Frequency Method (IFM) on the density fluctuations measured by the CO2 laser collective scattering diagnostics in HT-7 tokamak to estimate the velocities of plasma poloidal rotation. The error analysis shows that the estimated poloidal rotation velocities are very reliable with high signal-to-noise ratio. A coherent mode is observed in the fluctuations of poloidal velocities with the mode frequency from 10kHz to 20kHz. It is identified as geodesic acoustic mode (GAM) zonal flow with poloidal symmetry (m=0) andits mode frequency coinciding with the theoretical expected GAM frequency, which is decided by the local plasma temperature. In the meantime, the envelope analysis is carried out on the high frequency density fluctuations. 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 radians. These results strongly recommended that the envelope modulation on the density fluctuation only reflects the shearing effect by the GAM. The results confirm that the envelope modulation in the high frequency density fluctuations only comes from the shearing by GAM.

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Author: Dr YU, Yi (University of Science and Technology)

Co-authors: Dr LIU, Adi (University of Science and Technology of China); Dr TI, Ang (Institute of Plasma Physics, ChineseAcademy of Sciences); Prof. YU, Changxuan (University of Science and Technology of China); Mr SHEN, Huagang (University of Science and Technology of China); Prof. LI, Jiangang (Institute of Plasma Physics, Chinese Academy of Sciences); Dr XIE, Jinlin (University of Science and Technology of China); Prof. YE, Minyou (University of Science and Technology of China); Dr LAN, Tao (University of Science and Technology of China); LIU, Wandong (University of Science and Technology of China); Dr ZHANG, Wenyang (Institute of Plasma Physics, ChineseAcademy of Sciences); Dr LI, Yadong (Institute of Plasma Physics, ChineseAcademy of Sciences)

Presenter: Dr YU, Yi (University of Science and Technology)

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