DPP06-2006-000057

Abstract for an Invited Paper
for the DPP06 Meeting of
the American Physical Society

Observation and Identification of Zonal Flows in a Basic Plasma Physics Experiment[1]

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The role of self-generated zonal flows (ZF) in transport regulation in magnetic confinement devices via its shear is a potent concept and a physics issue [1]. A basic physics experimental study of zonal flows associated with ITG (ion temperature gradient) drift modes has been performed in the Columbia Linear Machine [2]. The difficult problem of detection of ZF has been solved via a novel diagnostic using the paradigm of FM (frequency modulation) in radio transmission. Using this and Discrete Short Time Fourier Transform, we find a power spectrum peak at ITG (carrier) frequency of $\sim 120kHz$ and FM sidebands at frequency of $\sim 2kHz$. We have definitively identified ZF with azimuthal (poloidal) and axial (toroidal) symmetry ($k_\theta \approx 0, k_\| \approx 0$) and radially inhomogeneous ($k_r \neq 0$) flow structures in cylindrical plasmas. However, the stabilizing effect of ZF shear appears to be small and no significant isotopic effects are observed. The dependence of amplitude of ZF versus presumed damping ratio ν_{ii} is also reported. Collaborators: X.Wei and A.K.Sen, Plasma Research Laboratory, Columbia University, New York, New York 10027.

[1] P.H. Diamond, S-I Itoh, K.Itoh and T.S.Hahm, Plasma Phys.Controlled Fusion 47, R35 (2005).
[2] V. Sokolov and A. K. Sen, Nucl. Fusion 45, 439 (2005).

[1]The research was supported by U.S.Department of Energy Grant No. DE-FG02-98ER-54464.