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Geodesic Acoustic Mode and Zonal Flow Measurements in DIII-D*

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Geodesic acoustic modes (GAMs) and zonal flows are nonlinearly driven, axisymmetric (m=0, n=0) *ExB* flows, which may play an important role in establishing the saturated level of turbulence in tokamaks. Doppler backscattering (DBS) measures the flow of turbulent structures and the level of intermediate-k ($k_\perp\rho_i$~1-4) density fluctuations. Measurements have been made with multichannel DBS systems at toroidal locations separated by 180°. Observations show that the GAM in L-mode DIII-D plasmas often occurs as a radially coherent eigenmode, rather than as a continuum of frequencies, consistent with theory when finite $k\rho_i$ effects are included. The intermittency of the GAM has been quantified, revealing that its autocorrelation time is fairly short, ranging from ~3 to ~12 GAM periods in cases examined; observations are consistent with this being due to the lack of coherence of the drive—turbulence—rather than strong damping or others sources that would cause a broad frequency spectrum. Bispectral analysis of the GAM, conditionally averaged on the GAM's RMS velocity, shows variation of the summed bicoherence at the GAM frequency with the magnitude of the GAM. Finally, toroidally correlated, low-frequency (f<2 kHz) flows near the q=2 surface have been directly observed in steady-state, monotonic-q discharges; notably, these flows appear at well-defined, modal frequencies throughout the majority of the duration of the discharges where measurements have been acquired.

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