Experimental investigation of geodesic acoustic mode spatial structure, intermittency, and interaction with turbulence in the DIII-D tokamak

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Geodesic acoustic modes (GAMs) and zonal flows are nonlinearly driven, axisymmetric ($m = 0,\ n = 0$) $E \times B$ flows, which are thought to play an important role in establishing the saturated level of turbulence in tokamaks. Results are presented showing the GAM's observed spatial scales, temporal scales, and nonlinear interaction characteristics, which may have implications for the assumptions underpinning turbulence models towards the tokamak edge ($r/a \gtrsim 0.75$). Measurements in the DIII-D tokamak [J. L. Luxon, Nucl. Fusion **42**, 614 (2002)] have been made with multichannel Doppler backscattering systems at toroidal locations separated by 180°; analysis reveals that the GAM is highly coherent between the toroidally separated systems ($\gamma > 0.8$) and that measurements are consistent with the expected $m = 0,\ n = 0$ structure. Observations show that the GAM in L-mode plasmas with $\sim 2.5 - 4.5$ MW auxiliary heating occurs as a radially coherent eigenmode, rather than as a continuum of frequencies as occurs in lower temperature discharges; this is consistent with theoretical expectations when finite ion Larmor radius effects are included. The intermittency of the GAM has been quantified, revealing that its autocorrelation time is fairly short, ranging from about 4 to about 15 GAM periods in cases examined, a difference that is accompanied by a modification to the probability distribution function of the $E \times B$ velocity at the GAM frequency. Conditionally averaged bispectral analysis shows the strength of the nonlinear interaction of the GAM with broadband turbulence can vary with the magnitude of the GAM. Data also indicates a wavenumber dependence to the GAM's interaction with turbulence.

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