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Spectral Features of the Geodesic Acoustic Mode and its Interaction with Turbulence in a Tokamak Plasma

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The measurements of the geodesic acoustic mode (GAM) by a set of probe arrays with large poloidal and toroidal separations in the edge region of the HL-2A tokamak have been performed. By the two-point cross-correlation technique, the three-dimensional wavenumber and frequency spectrum for the GAM is measured for the first time. The spectrum for the GAM exhibits a anisotropic feature: the poloidal and toroidal wavenumber spectra are peaked at $k_\theta = k_\phi = 0$ with a width given by the spectral variance, while the radial spectrum shows a peak in the range of $q_r\rho_i \simeq 0.05 \sim 0.09$ with the FWHM of$\Delta q_r\rho_i \simeq 0.04 \sim 0.07$. The spectrum also shows the GAM propagates in the radially outward direction. Using a newly developed method based on the poloidal momentum equation, the generation of the GAM by the triad interaction of turbulence via the Reynolds stress has been directly measured. The result manifests that the energy is transferred from small scale turbulence into the GAM by the gradient of the Reynolds stress and the GAM saturation amplitude is determined by balancing between the generation and damping rates of the GAM. In addition, it is found that the envelope of the radial electric field fluctuations $\tilde{E}_r$ is modulated by the GAM and the cross-phase between the envelope and GAM oscillation is aboutπ. The numerical investigation shows that the modulation of the $\tilde{E}_r$ envelope is dominantly induced by the amplitude modulation. This fact together with the anti-phase relation between the $\tilde{E}_r$ envelope and GAM oscillation imply that the modulation of the $\tilde{E}_r$envelope is accompanied with the GAM generation in the energy-conserving triad interaction. These results suggest that the GAM is generated dominantly by the parametric instability driven by the turbulent Reynolds stress. In collaboration with T. Lan, A.D. Liu (USTC, China); L.W. Yan, W.Y. Hong, K.J. Zhao, J. Q. Dong, Q.W. Yang (SWIP, China).