# Simulation study on configuration dependence of GAM in LHD plasmas

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In this study, configuration dependence of geodesic acoustic mode (GAM) in LHD plasmas is investigated by using a drift-kinetic simulation. GAMs are observed by the magnetic probe[1] and heavy-ion-beam-probe (HIBP)[2] in recent LHD experiments. It is reported [3] that the real frequency of the GAM observed in LHD plasmas is similar to but little lower than the analytical estimation for a simple circular cross-section tokamak, i.e., $\omega_G \sim \sqrt{7/4 + \tau_e}(v_{thi}/R_0)$, where $\tau_e = T_e/T_i$ is the ratio of the electron temperature to the ion one, $v_{thi}$ is the ion thermal velocity, and $R_0$ is the major radius of the plasma, respectively. On the other hand, it has been shown by a gyrokinetic analysis[4] that the GAM frequency and the damping rate in a non-axisymmetric plasma are affected by the details of its magnetic field spectra and the rotational transform. To assess the experimental observations with the kinetic theory, it is beneficial to investigate in detail how the GAM oscillation in LHD plasma depends on the magnetic field configuration. Previously, we have examined the dependence of GAM on the magnetic axis position of LHD plasma by using a $\delta f$ drift-kinetic simulation code FORTEC-3D[5]. With only the ion drift-kinetic equation and radial electric field being solved, FORTEC-3D simulation is identical to the $\tau_e \to 0$ limit of the gyrokinetic analysis. Though a drift-kinetic model is simpler than a gyrokinetic one, the dependence of GAM on magnetic field configuration can be examined in detail by the drift-kinetic simulation. In Ref. [5], it has been shown that the change in magnetic field spectra caused by the shift of magnetic axis position affects the GAM frequency and damping rate and that the dependence of GAM on the magnetic axis qualitatively agrees with the gyrokinetic analysis. In experiments, however, it is found that the GAM oscillation is easy to be observed if the magnetic axis is in a certain range. Then, to examine the configuration dependence of GAM and to check the HIBP observation with theory, it is profitable to investigate the configuration dependence concerning other than the axis position, such as elongation and rotational transform profile, which can be controlled in LHD experiments. By using FORTEC-3D simulation, detailed analysis on the GAMs in several LHD configurations will be reported in the presentation. A new numerical technique will also be presented, in which a band-limited white noise is introduced as a source term of GAM. It enables us to evaluate the GAM frequency if the damping of GAM is too fast to analyze the GAM spectrum, as it is in the case in LHD plasmas.

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