TEMPEST Simulations of the Geodesic Acoustic Mode*

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The Geodesic-Acoustic Mode (GAM) is an asymmetric mode, which involves parallel ion dynamics, cross-field drifts, and acceleration. Earlier GAM theory and simulations focused on the large aspect ratio, small orbit regime. Recently Sugama and Watanabe found that the damping rate is sensitive to $k_\perp \rho_i$ at large q due to the effect of large banana orbits [1]. In our 4D TEMPEST GAM simulations, the charge is radially separated by an initial sinusoidal perturbation of the ion density. The electron model is Boltzmann $n_e = \langle n_i(\psi, \theta, t = 0)\rangle \exp(e\phi/T_e)/\langle \exp(e\phi/T_e)\rangle$, where $\langle\rangle$ represents the flux surface average. This choice of coefficient for Boltzmann electron model means that there is no cross field electron transport. Both radial and poloidal boundary conditions are periodic. The full-f, self-consistent TEMPEST simulation results of collisionless damping of geodesic acoustic modes and zonal flow are presented. Good agreement is shown between theory [1,2] and simulations for the frequency of GAMs and damping rate. The large effect of the orbit size dramatically changes the GAM damping rate. For the same parameters, the damping rate is almost zero if the finite banana orbit effect is ignored. The simulations shows that the GAM damping rate has a strong dependence on the safety factor q. For q=10, there is almost no damping. Comparisons with theory and HL-2A experimental measurements for systematic scans in q [3] and collisionality will be discussed. The impact of the magnetic separatrix on the GAM will be reported.

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