Finite-orbit-width effects on the geodesic acoustic mode in the toroidally rotating tokamak plasma

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Using the modified gyro-kinetic equation which is applicable to low-frequency microinstabilities in a toroidally rotating tokamak, the Landau damping of geodesic acoustic mode (GAM) is analytically investigated by taking into account the finite-orbit-width (FOW) resonance effect to the 3rd order. We first present the collisionless damping rate of GAM by considering the finite FOW effect to the third order.

The analytical result is shown to agree well with the numerical solution. The dependence of the damping rate on the toroidal Mach number M relies on $k_r\rho_i$. It is illustrated that for sufficiently small $k_r\rho_i$, the damping rate monotonically decreases with M. For relatively large $k_r\rho_i$, the damping rate increases with M until approaching the maximum and then decreases with M.

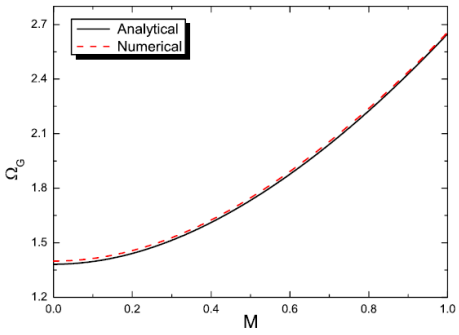

FIG. 1. The GAM frequency versus the Mach number with q = 4 and $k_r\rho_i = 0.1$. The solid curve is plotted according to the analytical frequency and the dashed one is plotted according to the exact numerical solution of the general dispersion relation

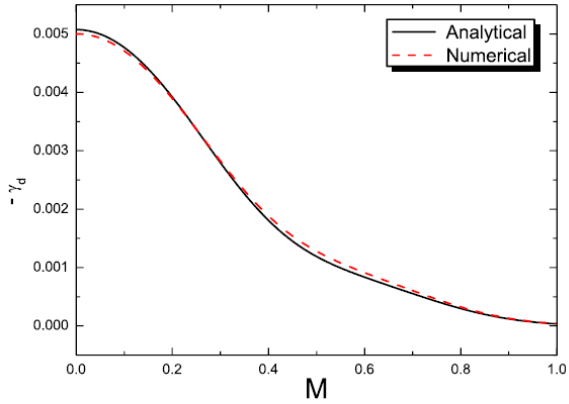

FIG. 2. The damping rate versus the Mach number with q = 4 and $k_r\rho_i = 0.05$. The solid curve is plotted according to the analytical damping rate, and the dashed one is plotted according to the exact numerical solution of general dispersion relation. It is clearly shown that the damping rate monotonically decreased with increasing M.

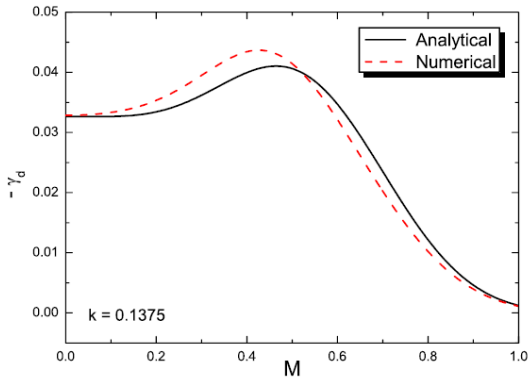

FIG. 3. The damping rate versus the Mach number with q = 4 and $k_r\rho_i = 0.1375$. The solid curve is plotted according to the analytical damping rate, and the dashed one is plotted according to the exact numerical solution of general dispersion relation. In this case, the damping rate increases with M first and then decreases with M.

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