§11. Eigenmode Analysis of Geodesic Acoustic Mode and Zonal Flow

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A simple collisionless plasma with $T_i >> T_e$ is considered in the previous work [1]. We solve analytically the linear response of plasma to a rigid constant electrostatic potential around a magnetic surface in large aspect ratio toroidal plasmas and report a series of GAM eigenmodes. Among them, there are the standard GAM, a branch of low frequency mode and a series of ISW-like modes.

In the present work, we will extend these results to the case of finite electron temperature. When the electron response is included, the poloidal variation of potential has to be considered. The coupling of the sideband potential $\phi_{m=1,n=0}$ to the zonal flow will influence the frequency and damping rate of different eigenmodes, respectively. We only consider the case of $k->0$ in [1] for the sake of identifying various eigenmodes, although we employ the gyrokinetic formalism. Here, we investigate the finite k-effect on these modes. It turns out that the finite gyroradius effect enhances the collisionless damping of the standard GAM, while the enhancement is not monotonic as q varies. Due to the finite gyroradius effect, fluctuations localized on different magnetic surface interfere with each other, so it is possible to form a radial eigenmode. Therefore, we also discuss the mode structure of GAM.

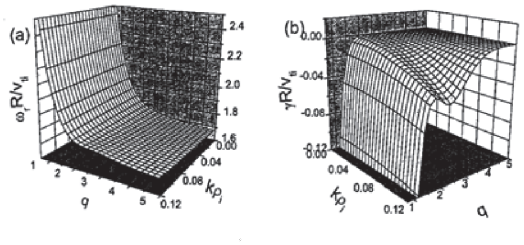

Fig.1 Real frequency and damping rate for the standard GAM at $\tau \equiv T_e/T_i = 1$ as functions of $k\rho_i$ and q.

It is seen from Fig.1 that, although the collisionless damping is enhanced for all q as $k\rho_i$ increases, the enhancement is especially strong in the region near $q \approx 2$. As a result, the damping rate of the GAM with finite spectrum width is probably not monotonic as q varies. Similar results are obtained in simulations [2]. Also, we study the low-/zero frequency eigenmode at $\tau \equiv T_e/T_i = 1$. It is found that the collisionless damping of this mode is slightly weakened by finite k.

References:

[1] Zhe Gao, K.Itoh, H. Sanuki and J.Q.Dong, Phys. of Plasmas **13**,100702(2006).

[2] X.Q.Xu et al., Proc. of 19th IAEA conference in Chengdu, China, TH/P6-23.

[3] Zhe Gao, K.Itoh, H. Sanuki and J.Q.Dong, Proc. of 19th IAEA conference TH/P2-5.