Ion-acoustic waves in collisional dusty plasma: effects of grain charge fluctuations

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Dust grains acquire electric charges (e_g) due to absorption of electrons (e) and ions (i) from the surrounding plasma, i.e. each grain is charged by the plasma currents $I^{\alpha}_{\rm ch}$ ($\alpha = e,i$) to its surface. The electric field fluctuations influence the charging currents and, thus, give rise to the grain charge fluctuations. Such self-consistent influence gives the additional contribution to the dielectric permittivity of dusty plasma $\varepsilon(\mathbf{k},\omega)$, which determines the dispersion and damping of waves. The obtained expression for dielectric permittivity has the form [1]

$$\varepsilon(\mathbf{k},\omega) = 1 + \sum_{\alpha=e,i,g} \chi_{\alpha}(\mathbf{k},\omega) + \frac{i}{\omega + i\nu_{\rm ch}} \sum_{\alpha=e,i} \nu_{\alpha g}\chi_{\alpha}(\mathbf{k},\omega), \qquad (1)$$

where $\nu_{\rm ch} = \nu^{e}_{\rm ch} + \nu^{i}_{\rm ch}$ is the charging frequency ($\nu^{\alpha}_{\rm ch} = -\partial I^{\alpha}_{\rm ch}/\partial e_g$), $I_{\alpha g} = n_g I^{\alpha}_{\rm ch}/e_{\alpha} n_{\alpha}$ is the frequency of plasma particles collisions with grains, n_{α} is the number density. We used the dielectric susceptibility of collisional plasma $\chi_{\alpha}(\mathbf{k},\omega)$ obtained from the Bhatnagar-Gross-Krook kinetic equation. For the ion charging current $I^{i}_{\rm ch}$, we used the interpolation formula proposed in [2]. The influence of dust charging and charge fluctuations on dispersion and damping of ion-acoustic waves is illustrated in Fig. 1.

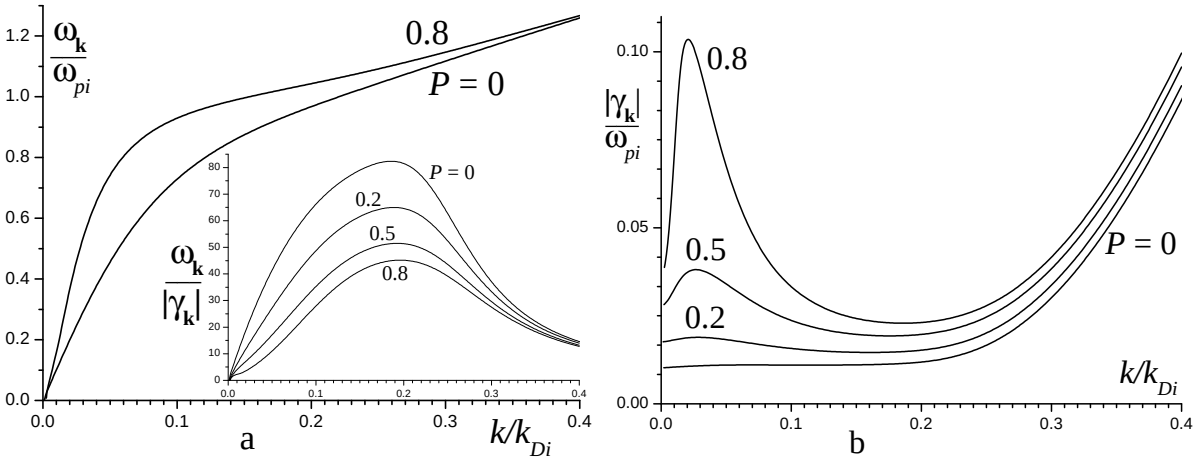

Figure 1: *Eigenfrequencies $\omega_{\mathbf{k}}$ (a) and damping rates $|\gamma_{\mathbf{k}}|$ (b) of ion-acoustic waves in nonisothermal ($T_e/T_i = 100$) argon plasma as results of numerical solution of the dispersion equation $\varepsilon(\mathbf{k},\omega_{\mathbf{k}} + i\gamma_{\mathbf{k}}) = 0$ for $\nu_{in} = 0.02\omega_{pi}$, $a = 0.15\lambda_D$ and $P = e_g n_g/e_e n_i = 0, 0.2, 0.5, 0.8$. The insert shows the ratio $\omega_{\mathbf{k}}/|\gamma_{\mathbf{k}}|$.*

References

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