§19. Effects of Electron Temperature and Density on Ion-dust Bremsstrahlung Spectrum in Dusty Plasmas

Jung, Y.-D. (Hanyang Univ.),
Murakami, I.

The effects of electron temperature and density on the ion-dust grain bremsstrahlung process in dusty plasmas are studied[1]. The ion-dust bremsstrahlung radiation cross section is obtained as a function of the dust charge, dust radius, Debye length, collision energy, radiation energy, electron density, and electron temperature by using the Born approximation.

Figure 1 shows the scaled bremsstrahlung radiation cross section $\partial_{\bar{\varepsilon}}^2 \bar{\chi}_b = d^2\chi_b / d\bar{\varepsilon} / \pi a_0^2$ in units of πa_0^2, where a_0 is the first Bohr radius of the hydrogen, for the interaction of the ion with the negatively charged dust grain in dusty plasmas as a function of the temperature ratio T_e/T_i (ratio of the electron temperature and ion temperature) for various values of the density ratio n_{e0}/n_0 (where n_{e0} is the equilibrium electron density and n_0 is the total plasma density). Charge number of dust grain $-Z_d e$ and the ion charge ze are assumed as -200e and 1e, respectively. The Debye lengths λ_D/a=50 is set, where a is the radius of the spherical dust grain. $E_0 \equiv m_i v_0^2 / 2Ry$ is the scaled initial collision energy, Ry is the Rydberg constant, and $\bar{\varepsilon} \equiv \varepsilon / Ry$ is the scaled photon energy. Figure 2 represents the scaled bremsstrahlung radiation cross section as a function of the density ratio n_{e0}/n_0 for various values of the temperature ratio T_e/T_i.

It is shown that the ion-dust bremsstrahlung radiation cross section decreases with an increase of the electron density in dusty plasmas. It is also shown that the electron temperature suppresses the bremsstrahlung radiation cross section. In addition, the effect of electron temperature on the ion-dust bremsstrahlung process is found to be more significant than the effect of electron density in dusty plasmas. These results would provide useful information on the ion-dust bremsstrahlung emission spectrum and also the radiation due to the interaction between dust chains and streaming ions in the plasma sheath in dusty plasmas.

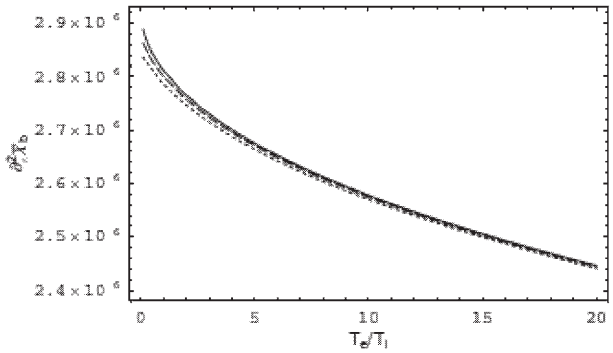

FIG. 1 The scaled ion-dust grain bremsstrahlung radiation cross section $\partial_{\bar{\varepsilon}}^2 \bar{\chi}_b$ as a function of the temperature ratio T_e / T_i for $\bar{E}_0 = 5$, $\bar{\varepsilon} = 2$, $T_e = 5\times10^3$ K, $n_0 = 10^{10}$ cm^{-3}, and $a = 9.7\times10^{-5}$ cm. The solid line represents the case of $n_{e0} / n_0 = 0$. The dashed line represents the case of $n_{e0} / n_0 = 0.2$. The dotted line represents the case of $n_{e0} / n_0 = 0.5$.

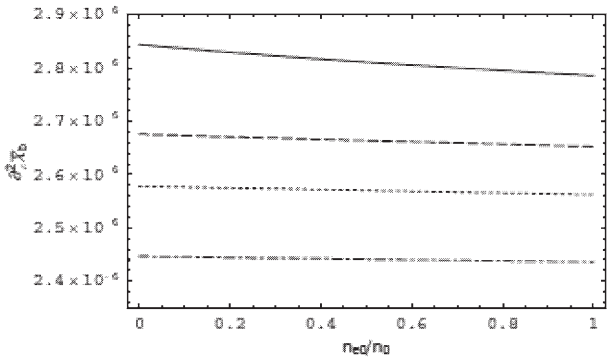

FIG. 2 The scaled ion-dust grain bremsstrahlung radiation cross section $\partial_{\bar{\varepsilon}}^2 \bar{\chi}_b$ as a function of the temperature ratio n_{e0} / n_0 for $\bar{E}_0 = 5$, $\bar{\varepsilon} = 2$, $T_e = 5\times10^3$ K, $n_0 = 10^{10}$ cm^{-3}, and $a = 9.7\times10^{-5}$ cm. The solid line represents the case of $T_e / T_i = 0.5$. The dashed line represents the case of $T_e / T_i = 5$. The dotted line represents the case of $T_e / T_i = 10$. The dot-dashed line represents the case of $T_e / T_i = 20$.

1) Jung, Y.-D., Murakami, I.: J. Appl. Phys. **105** (2009) 106106