§16. Rate Coefficient of Electron Impact Ionization for Electron Truncated Maxwellian Distribution – Double Electron Temperature –

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The rate coefficient of electron impact ionization for the case of plasma with higher-energy component is considered. The normalized velocity distribution function is expressed as:

$$f_e(\vec{v}) = n_e\{(1-\frac{n_{eh}}{n_e})\frac{2}{1+\mathrm{erf}(\sqrt{\frac{\varepsilon_c}{T_{el}}})}(\frac{m_e}{2\pi T_{el}})^{3/2}\exp(-\frac{m_e}{2T_{el}}v^2)$$

$$+\frac{n_{eh}}{n_e}\frac{2}{1+\mathrm{erf}(\sqrt{\varepsilon_c/T_{eh}})}(\frac{m_e}{2\pi T_{eh}})^{3/2}\exp(-\frac{m_e}{2T_{eh}}v^2)\}\ . \quad (1)$$

Here subscripts h and l denote the higher- and lower-energy components, respectively. The quantity n_e is the total electron density and ε_c is the truncated energy of electrons. In this case the floating wall potential ϕ_f is given:

$$e\phi_f / T_e = \frac{\xi_{e1}}{2}\ln(2\pi m_e / Z_i m_i \xi_{e2}^2 \xi_{e3}) \quad (2)$$

Here the parameters ξ_{e1}, ξ_{e2}, and ξ_{e3} are defined by the densities and temperatures of the higher- and lower-energy components:

$$\xi_{e1} \equiv 1-\frac{n_{eh}}{n_e}+\frac{n_{eh}}{n_e}\frac{T_{eh}}{T_{el}},, \quad (3\text{-}1)$$

$$\xi_{e2} \equiv 1-\frac{n_{eh}}{n_e}+\frac{n_{eh}}{n_e}\sqrt{\frac{T_{eh}}{T_{el}}},, \quad (3\text{-}2)$$

$$\xi_{e3} \equiv 1-\frac{n_{eh}}{n_e}+\frac{n_{eh}}{n_e}\frac{T_{el}}{T_{eh}} \quad (3\text{-}3)$$

Here one can see the higher-energy component makes deepen the wall potential.

The effects of truncation of electron velocity distribution due to the floating wall potential is calculated. Fig.1 shows the ratio of the rate coefficient due to the truncation to the Maxwellian distribution for the hydrogen plasma; (a) T_{el} = 1.0 eV, T_{eh} = 2.0 eV and (b) T_{el} = 1.0 eV, T_{eh} = 10.0 eV. In Fig.3 the rate coefficients are shown for the case of helium plasma, respectively. In case of the higher temperature of high-energy component in hydrogen plasma, small amount of higher component changes appreciably the rate coefficient, Fig.2. On the other hand the effect of higher component in helium plasma is quite small, Fig.3.

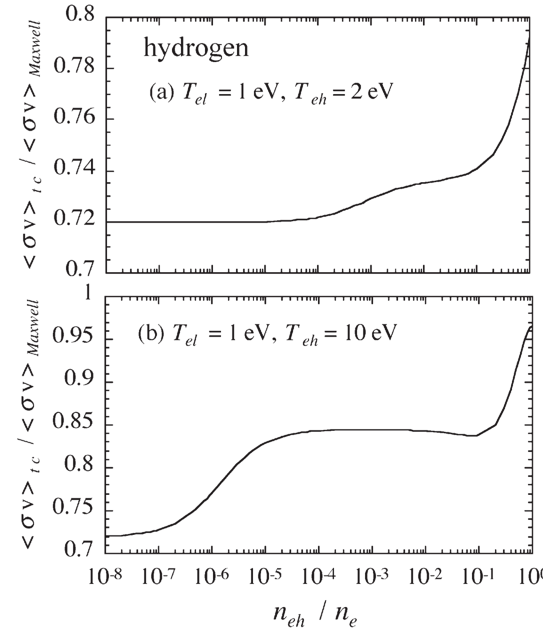

Fig. 1 Ratios of the rate coefficient of the truncated velocity distribution to the Maxwellian distribution for hydrogen plasma as a function of density fraction of the high-energy component: (a)) T_{el} = 1 eV,) T_{eh} = 2 eV and (b)) T_{el} = 1 eV,) T_{eh} = 10 eV.

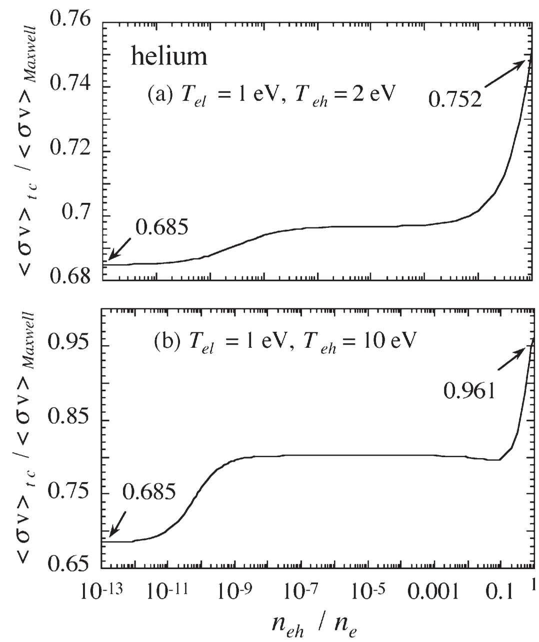

Fig. 2 Ratios of the rate coefficient of the truncated velocity distribution to the Maxwellian distribution for helium plasma as a function of density fraction of the high-energy component: (a)) T_{el} = 1 eV,) T_{eh} = 2 eV and (b)) T_{el} = 1 eV,) T_{eh} = 10 eV.