§13. Density Effects of Emission Lines from Carbon Atom and Ions in Divertor Plasmas

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We have been developing a collisional radiative model (CRM) for carbon atom and ions to understand the density effect on the emission lines as well as ionization and recombination processes in dense plasma. We have prepared the rate coefficients for dielectronic recombination into the low excited states for these ions. However the method to include the cascade effect from highly excited states through recombination process in CRM is not resolved yet. This problem is important to estimate the density dependence of the radiation loss by recombination in low temperature plasma.

Here we present the density dependence of line emissions in the divertor plasmas where the visible lines are often observed. In divertor plasma the line emission of neutral atoms and low ionized ions is used to derive the influx from the wall. The flux Γ is generally obtained by the relation

$$\Gamma = 4\pi S^{eff} I / E^{eff} \qquad (1)$$

where S^{eff}, E^{eff} and I are the effective ionization rate coefficients, effective emission rate coefficients and the line intensity. Generally the values in low density limit are used for S^{eff} and E^{eff}. However we have to know the effect of the density on these quantities. In Fig.1 we present the density effect of line intensities E^{eff} of carbon ions in ionizing plasma; CII (6579.7A), C III (5696.0A) and C IV (5804.9A).

It is important to know the radiation loss caused by impurities in the divertor plasma. Therefore it is convenient if possible to estimate the radiation loss using an observed line intensity of one transition. We have calculated the ratio of the radiation loss rate R(Watt) to the line emission rate E(photons /s) in Fig.2. By multiplying the ratio R/E by the observed intensity I, the radiation loss can be obtained.

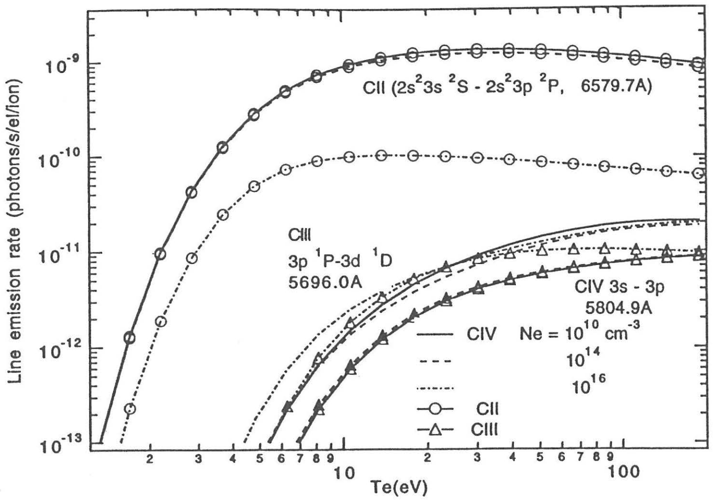

Fig.1 The effective emission rate coefficients as a function of the electron temperature for several densities.

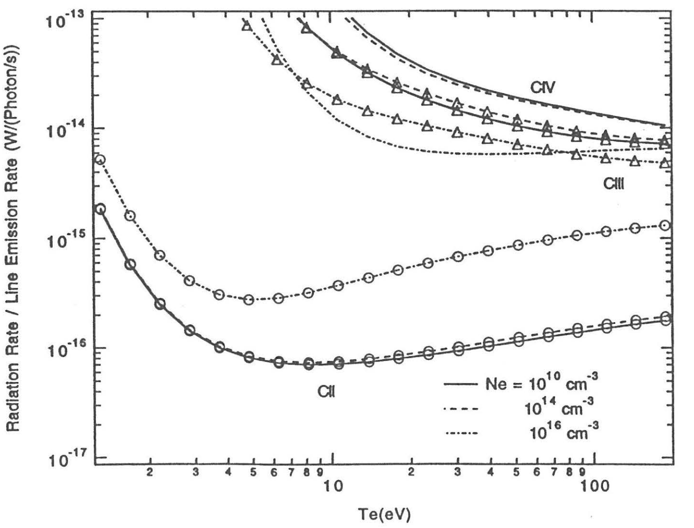

Fig.2 The ratio of the radiation rate to the line emission rate