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「GAMMA10における分光診断のための衝突輻射モデル計算コードの構築」

Construction of calculation code of collisional-radiative model for spectroscopy in GAMMA10

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Study of impurity behavior is one of the most important issues in experiments of plasmas for achieving controlled nuclear fusion. Radiation loss caused by impurities in plasmas makes a critical reduction of energy confinement. On the other hand, impurity injection attracts interest in plasma detachment from diverter plate using radiation loss of impurity. Moreover, impurity emission spectra have a lot of important information of fusion plasmas, such as the electron temperature (T_e), electron density (n_e), ion temperature, electric field, magnetic field, rotation velocity and so on.

In GAMMA10, spectroscopic measurements have been carried out and some impurity spectra, such as carbon and oxygen ions, are observed. It is important for observing the impurity behavior in GAMMA10 plasma by using collisional-radiative model (CR model) analysis. We constructed calculation code of CR- model.

In the CR-model, the temporal development of population density $n_z(p)$ of level p of z charged ion is described as below,

$$
\begin{aligned}
\frac{d}{dt}n_z(p) &= \left(\sum_{q\neq p} C(q,p)n_e + \sum_{q>p} A_z(q,p)\right) n_z(q) \\
&- \left(\sum_{q\neq p} C(p,q)n_e + \sum_{p>q} A_z(p,q)\right) n_z(p) \\
&+ \sum S_{z-1}(l,p)n_e n_{z-1}(l) - \sum S_z(p,k)n_e n_z(p) \\
&+ \sum(\alpha_{z+1}(k,p)n_{ez})n_e n_{z+1}(k) - \sum(\alpha_z(p,l)n_{ez})n_e n_z(p)
\end{aligned}
$$

Here, z, z+1 and z-1 express the charge number, p and q express the level in z charged ion, k and l express the level of z+1 and z-1 charged ion, respectively. $A_z(q,p)$ shows spontaneous transition probability from level p to level q. C $(p,q)_e$ and $S_z(p,k)$ shows the rate coefficients of electron impact transition (excitation, ionization), respectively.

$\alpha_{z+1}(k,p)$ shows recombination coefficient.

In this study, we constructed CR-model for carbon ions. In our CR-model, we used spontaneous transition rate from NIST and rate coefficients of electron impact transitions calculated with Flexible Atomic Code (FAC) and neglected the recombination.

We carried out the calculation of carbon ion (CIII calculated n is up to n=4) in a plasma with electron density and electron temperature of $n_e=10^{12}$-10^{13} cm^{-3} , Te=20-100eV, respectively.

In Fig.1, we show the calculated spectra of CIII at Te =30eV and $n_e=2\times10^{12}$cm^{-3}

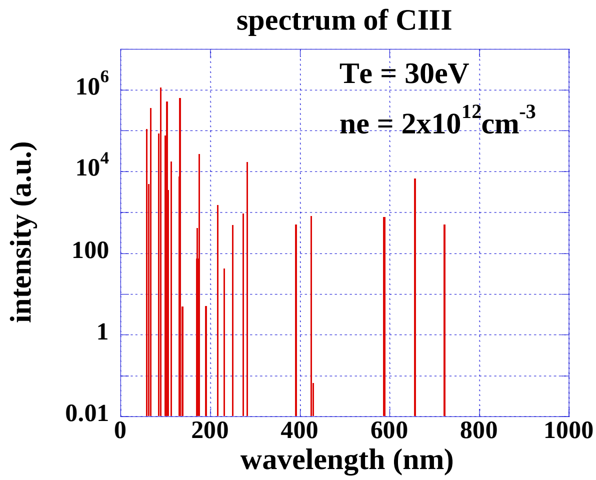

Fig. 1 calculated spectra of CIII

When we consider 1s22s2p (CIII) as metastable state, the calculation result is similar to experimental result. We discussed population density distribution of carbon in GAMMA10 plasmas with CR-model.