§5. Collisional-Radiative Modeling of the B III Ion Abundance

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Reliable knowledge of ion charge distribution in plasma is very important for correct plasma diagnostics. This becomes especially crucial for Stark widths experiments where Doppler width is to be independently determined from other than line width measurements, so that information on ion abundance may give extra check of plasma parameters. Here we calculate ion abundance for boron, and our attention is mainly paid to Li-like B III which has recently been used in Stark line widths measurements [1]. (Note also that critical discussion of these experiments is given in Ref. [2].)

For our calculations we used the time-dependent collisional-radiative code NOMAD (Weizmann) [3]. Since we are most interested in the ion abundance of the Li-like ion of boron, the other ion states were represented only by corresponding ground states and one aggregate 'superstate' for each ion, the latter effectively taking into account the excited ion levels. For B III, the levels included are 9 nl-resolved states up to n=4 (2s,2p,...,4f) and the aggregate state. Effect of the continuum lowering which is important for construction of the aggregate state was considered in the Debye-Hückel approximation.

The oscillator strengths for spontaneous radiative transitions were calculated with the Hartree-Fock code by Cowan. In addition to radiative transitions, the account was made for the following collisional processes: electron impact excitation and deexcitation; electron impact ionization; dielectronic, radiative and 3-body recombination. All excitation as well as photorecombination cross sections were calculated with the Coulomb-Born-exchange-with-normalization code ATOM by Vainshtein. The ionization cross sections were taken from the recommended data from Belfast group, while the 3-body recombination rates were calculated based on the detailed balance principle. Dielectronic recombination rates were derived from the Z-scaled Hahn formula. Most of calculated collisional data were compared with the available data from the NIFS database, and a good correlation was found in practically all cases.

Calculations were carried out for electron temperatures T_e = 1-10 eV and electron densities $N_e = 10^{17} - 10^{19}$ cm^{-3}. These ranges of plasma parameters are most important for the gas-liner pinch experiments [1] where Stark width of the B III 2s - 2p line (λ = 2066 Å) was measured. On Fig.1 the B III abundance is shown vs. electron temperature for different electron densities. It is seen that B III has its highest abundance for temperatures $T_e \approx$ 2-6 eV. Note that increase in density leads to a shift of the B III highest abundance to higher temperatures because collisional 3-body recombination becomes more important ($\propto N_e^2$) comparing to electron impact ionization ($\propto N_e$).

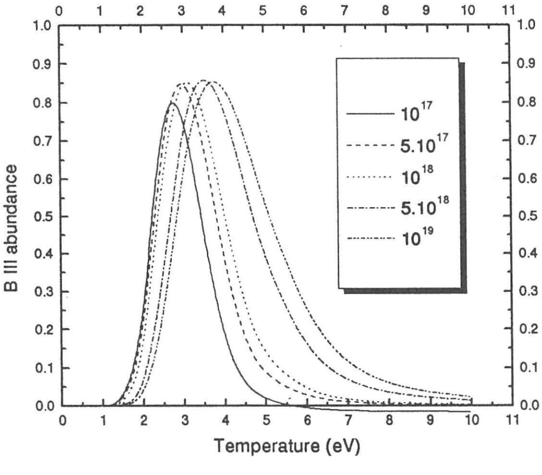

Fig.1. B III abundance for different electron densities vs. electron temperature.

[1] S.Glenzer and H.-J.Kunze, Phys.Rev. A53, 2225 (1996).
[2] H.R.Griem, Yu.V.Ralchenko and I.Bray, Phys.Rev. E, to be published (1997).
[3] Yu.V.Ralchenko, V.Fisher and Y.Maron, J.Quant.Spect.Rad.Transf., to be published (1997)