§6. Atomic and Molecular Hydrogen Spectroscopy in LHD Plasma

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We are constructing a collisional-radiative model of molecular hydrogen. In this model, the electronic, vibrational, and rotational states are considered to deal with molecular processes whose cross sections strongly depend on the initial vibrational and rotational states, e.g., the dissociative attachment. The number of 4133 states are considered for $n < 7$ (n : principal quantum number of the united atom). This model gives molecular spectra which can be directly compared with experimental spectra. We applied this model to an LHD plasma. An experimental data (Shot Number 121750, Time 6 s, 1-O port z=0.026 m) of Hasuo and Fujii (Kyoto Univ.) is analyzed.

In order to calculate the line-of-sight integrated spectra, we evaluated molecular hydrogen density n_{H_2} using our neutral transport code (Fig.1). Absolute densities of hydrogen species in the calculation is determined using the observed absolute intensity of the atomic Balmer α.

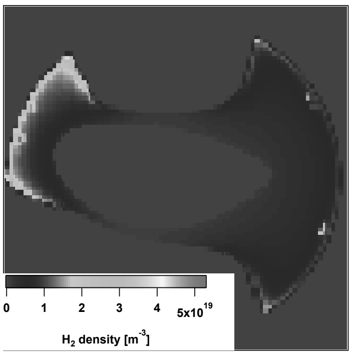

Fig. 1: Calculated n_{H_2} (1-O port).

By using measured electron temperature T_e and density n_e (Fig.2), and the evaluated n_{H_2} (Fig.3), the molecular spectra is calculated. Figures 4 (a) and (b) show the experimental and calculated absolute intensities, respectively. In Fig. 4(b), only H_2 spectra is shown.

Calculated Fülcher band $(d^3\Pi_u \rightarrow a^3\Sigma_g^+)$ intensity is about 5 times larger than the experimental one. The reliability of the excitation cross section $X^1\Sigma_g^+ \rightarrow d^3\Pi_u$ is confirmed by RF plasma experiments at Shinshu University. The difference may come from the molecular density calculated by the neutral transport code. Recycling condition of atomic hydrogen, i.e., H_2 forming ratio, may not be given properly. It will be determined from the observed H_2 spectra intensity.

Line profile of atomic hydrogen is also influenced by molecular processes in which the atomic hydrogen is produced. We will determine the wall reflection condition of atomic hydrogen from the intensity of the molecular spectra and the line profile of atomic hydrogen.

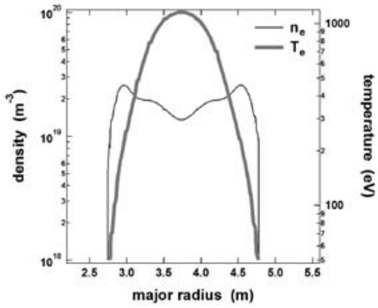

Fig. 2: T_e and n_e along the line-of-sight.

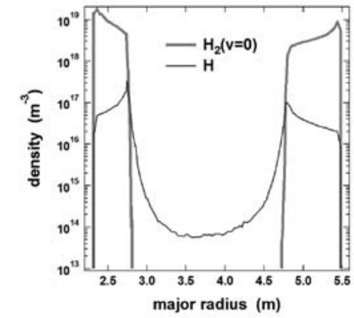

Fig. 3: Calculated n_{H_2} along the line-of-sight.

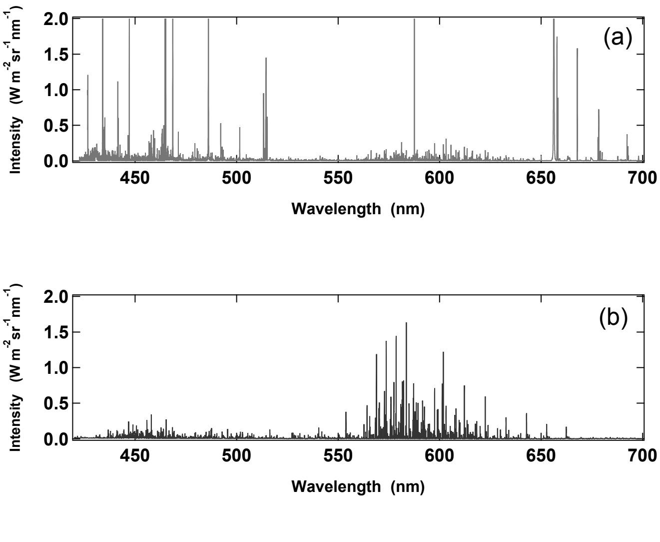

Fig. 4: (a) LHD spectra. (b) Calculated H_2 spectra.