§26. T_e and n_e Determination with Hydrogen Spectroscopy in Plasma Decay Phase of CHS

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After turning off the NBI pulse in CHS, the plasmas are typically maintained for several tens of millisecond. Since the magnetic surface for the confinement is steadily formed, the electron density slowly decays rather than the electron temperature. In this plasma decay phase, line radiations from neutral hydrogen atoms are strongly emitted. The behaviors of the electron density and H_α line intensity are shown in Fig. 1.

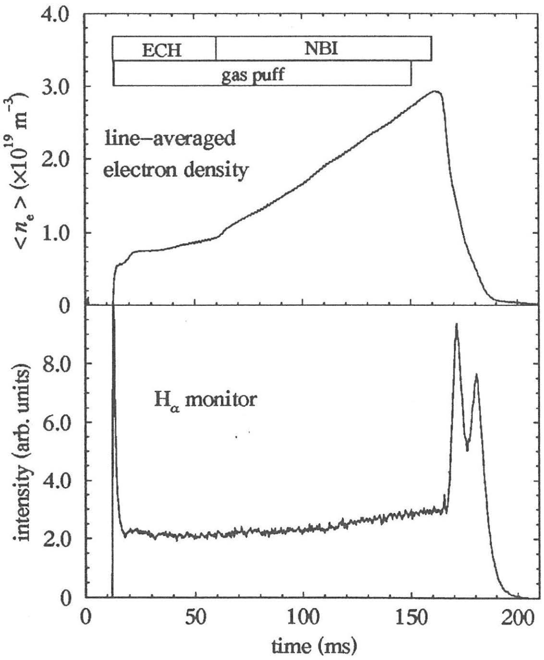

Fig. 1. Electron density and H_α behaviors.

In such operation the Balmer series lines of neutral hydrogen atoms were observed and the three sequential spectra from t = 180 ms were analyzed. The population densities of the excited levels which were determined from the line intensities are plotted in Fig. 2 with the solid circles. The population distributions in the highly excited levels ($n \geq 7$) clearly indicate that those levels are in partial local thermodynamic equilibrium (LTE). Here, the definition of LTE is that the population density of level p is described by the Saha-Boltzmann equation. From the figure T_e = 0.1 eV is determined in a manner of the best fitting with the experimental data. The curve of the Saha-Boltzmann equation of $T_e = 0.1$ eV is also shown in Fig. 2.

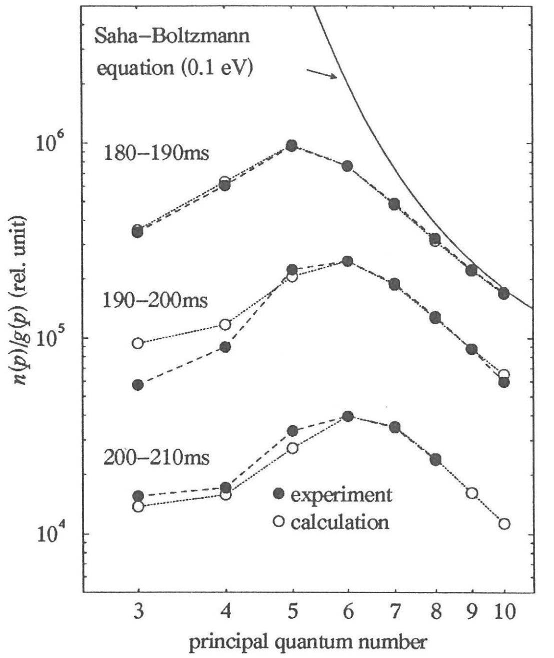

Fig. 2. Excited level populations in time intervals of t = 180–190 ms, 190–200 ms and 200–210 ms.

The electron density is determined from the peak position of the population distribution. From the comparison between the collisional-radiative model calculation and the experimental result in Fig. 2 the densities of 4.0×10^{18}, 1.4×10^{18} and 8.0×10^{17} m^{-3} are obtained for time intervals of t = 180–190 ms, 190–200 ms and 200–210 ms, respectively. In the calculations the radiation trapping effect is also considered, which depends on the hydrogen ground state density $n(1)$ and the hydrogen atom temperature T_H. We assumed $T_H = T_e$. The ground state density $n(1)$ is determined as 1.0×10^{18} m^{-3} with which the population density profile gives the best fit for the experimental result of 180–190 ms.