§5. Behavior of Neutral Particles in a Large Diameter Plasma

Tsushima, A. (Yokohama National Univ.), Saitou,Y. (Utsunomiya Univ.), Amagishi, Y. (Shizuoka Univ.), Tanaka, M.Y.

Spatial distribution of neutral particles is important from the viewpoint of plasma production, because a pair of ion and electron are generated from one neutral particle by electron impact ionization. In addition, the existence of neutral particle influences the propagation characteristics of various waves in plasma, for example, the field pattern of the kinetic Alfvén wave is drastically changed by the existence of neutral particles.[1] The purpose of this study is to investigate the radial distribution of the neutral density in the HYPER-I device [2] through the spectroscopic measurement. The intensity of line emission from the neutral particles is expressed by

$$I_0 = n_0 n_e f_0 (T_e)$$

and that from the singly ionized particles by

$$I_1 = n_1 n_e f_1 (T_e)$$

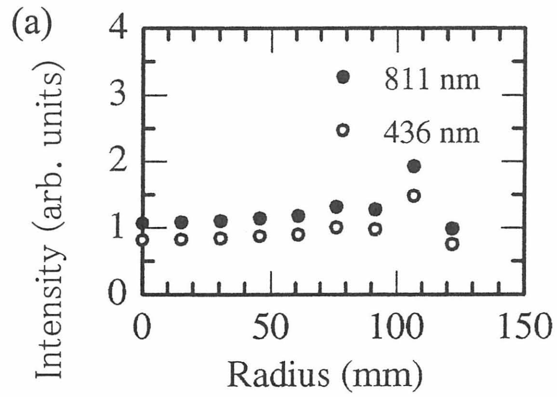
where, n_0 is the density of neutral particle, n_1 the density of singly ionized particles, n_e the electron density, and f_0 (T_e) and f_1 (T_e) are the line-excitation rate coefficients of the neutral particle and the singly ionized particle, respectively, which are functions of electron temperature T_e. In an argon plasma with a electron temperature T_e =10 eV, the most of ions are singly ionized, and the quasi-neutral condition, $n_e = n_1$, is satisfied. Then we have the neutral density profile:

$$n_0 = \frac{I_0}{\sqrt{I_1}} \frac{\sqrt{f_1 (T_e)}}{f_0 (T_e)}$$

and the ion density profile:

$$n_1 = \sqrt{I_1} \frac{1}{\sqrt{f_1 (T_e)}} ,$$

from which we easily obtain the radial distribution of the neutral density n_0 if the electron temperature is uniform. Figure 1 (a) shows the radial distributions of the emission intensity at λ = 811nm and 436nm, which correspond to the emission lines from the neutral argon atom and the singly ionized one, respectively, in the HYPER-I plasma (p = 1 x 10^{-3} *Torr* and P = 5 kW). It is worthwhile to note that the radial distributions of these line intensities are obtained by using the Abel inversion under the assumption of axi-symmetric distributions. Figure 1 (b) shows that the radial profiles of the neutral and ion densities determined from the results presented in Fig. 1(a). The radial distribution of the neutral density agrees with the result obtained in the numerical calculation with the Monte Calro method.



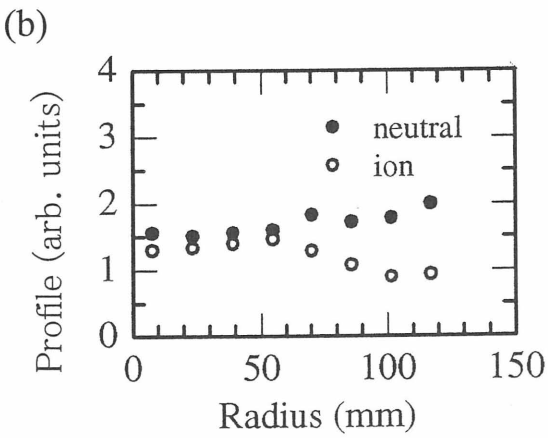


Fig.1. (a): radial distributions of emission intensity at 811 nm and 436 nm, (b): radial distributions of neutral and ion densities.

References

1) Amagishi Y. and Kitagawa S., J. Phys. Soc. Jpn. **63** (1994) 2021.

2) Tanaka M.Y. et al., Ann. Rep. NIFS (1998--1999) 259.