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衝突輻射モデルを用いた高密度ヘリコンプラズマの電子密度、電子温度測定
Determination of Electron Density and its Temperature using Collisional Radiative (CR) Model in High-density Helicon Plasma

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1. Introduction

To develop a highly-efficienct electric thruster, it is important to optimize the plasma parameters. Since an electrostatic probe method, which is one of the methods to measure plasma parameters, disturbs plasma flow. In contrast, spectroscopic methods such as the one based on the Collisional Radiative (CR) model [1, 2], are useful because of no disturbance to the plasma performance. However, the argon CR model does not have an enough accuracy right now. To reduce the errors, we have updated the electron impact cross-section in argon CR model and used the higher energy levels than before. In the present study, we will compare electron densities n_e and its temperatures T_e derived based on the previous CR model and the updated one.

2. Theory

We will show the method of deriving n_e and T_e by a spectroscopic method based on an argon CR model, which can determine population density at each state by solving the balance equation. In our code, elementary reactions are considered various electron and atom process in 65 energy levels.

Additionally, we used a helium CR model [3, 4]. In this model, we employed the least square method in He I lines and considered 15 energy levels.

In the argon CR model, we have been developing an intensity ratio method, to determine n_e and T_e by comparing line intensity ratios between contours derived from the CR model and from optical emission spectroscopic (OES) measurement. By comparing two sets of intensity ratio from OES, we can determine n_e and T_e from the two contours.

3. Experimental setup and Results

Experiments have been carried out in Large Mirror Device (LMD) [5], as shown in Fig. 1. LMD consists of two parts; a quartz discharge tube and a vacuum chamber. A wide range spectrometer can observe emission lines of 360-792 nm.

In this study, we mixed argon and helium gases. Then, we compared the CR model results of argon and helium, and double probe ones to check the accuracy. One of the results of our improved model is shown in Fig. 2.

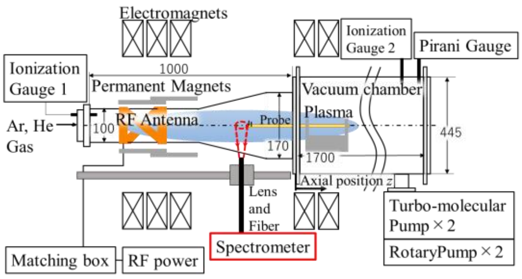

Fig. 1 LMD and experimental setup

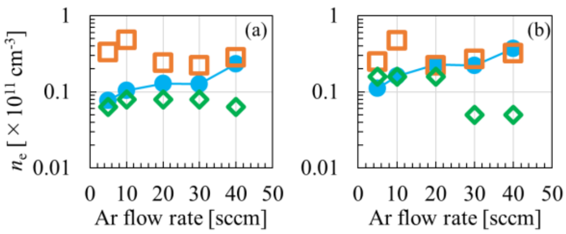

Fig. 2 Results of n_e in He 30 sccm, z = -130 mm, (a) P_{RF} = 1 kW, (b) P_{RF} = 2 kW (blue lines are double probe method, orange open boxes are argon CR model at I (687.1 nm) / I (763.5 nm) and I (549.6 nm) / I (751.5 nm), and green open diamonds are helium CR model.

4. Conclusion

We have found that high Ar (He) flow rate makes more accurate data from the Ar (He) CR model result by the improved model, considering basic data and energy levels. In the presentation, details of these results will be shown.

References

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