§23. Construction of a Neutral Transport Code which Includes Radiation Trapping Effect

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The heat control in divertor plasmas is one of the most important issue for ITER and DEMO projects. Utilization of the detached recombining plasma is recognized as one of the promising methods. However, it has been pointed out that the radiation trapping effect of Lyman series of atomic hydrogen decreases the recombination rate. In almost divertor codes, the radiation trapping effect is not included at this time. The absorption of photons of an atom depends on radiation flux emitted from the remainder of the plasma. Because atoms influence each other through the emission or absorption, a self-consistent treatment of radiation trapping is necessary; We have developed an iterative self-consistent collisional-radiative model [1)].

For the SlimCS DEMO [2)] detached divertor plasmas, a simulation code SONIC [3)] is used. In this study, we applied the iterative method to the SlimCS DEMO. We deal with the inner divertor plasma with a typical detached plasma condition. Parameters of the detached plasma,the electron temperature, T_e, electron density n_e, atomic hydrogen temperature T_H, and atomic hydrogen density n_H, calculated with SONIC [4, 5)] are used in the radiation trapping calculation (Figs.1(a) and 1(b)).

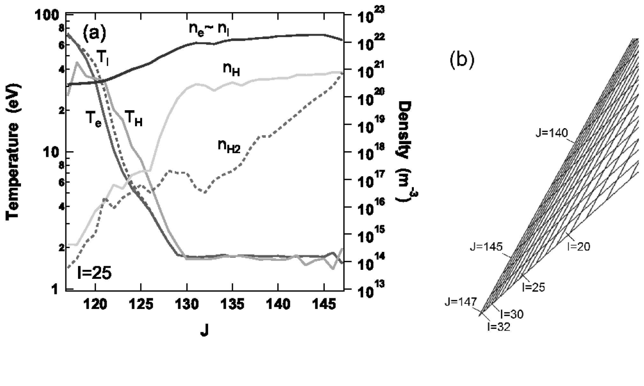

Fig. 1: (a) Plasma parameters along I=25 cells. (b) Cell labels I and J in SONIC.

When these values are given, the following iterative algorithm is applied: (1) Compute the excited-state population density for each cell ignoring the photo-excitation. (2) Compute the radiation field intensity of each cell using the population density obtained in step (1) considering emission and absorption in each cell. (3) Considering the photo-excitation, compute the population distribution for each cell. (4) Iterate steps (1)-(3) until the above values converge.

Figures 2(a) and 2(b) show recombination and ionization rates in the inner divertor plasma obtained ignoring the radiation trapping, respectively. Figures 3(a) and 3(b) show those obtained considering the radiation trapping. Figure 3(a) indicates that the recombining plasma near the wall seen in Fig.2(a) disappears when radiation trapping is included. In this calculation, the given plasma parameters are fixed. As a nest step, we are preparing to calculate these parameters self-consistently using effective ionization or recombination rate coefficients obtained considering the radiation trapping effect.

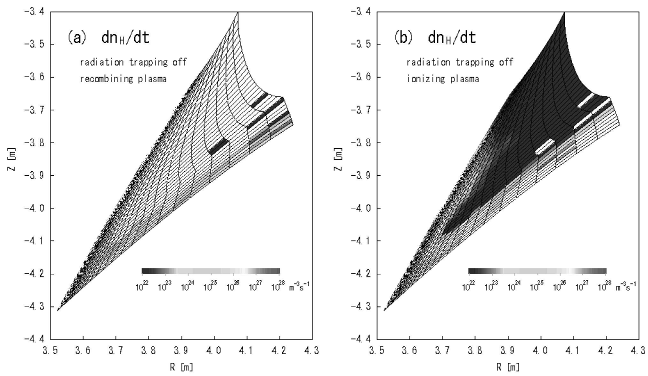

Fig. 2: (a) Recombination and (b) ionization rates obtained ignoring the radiation trapping.

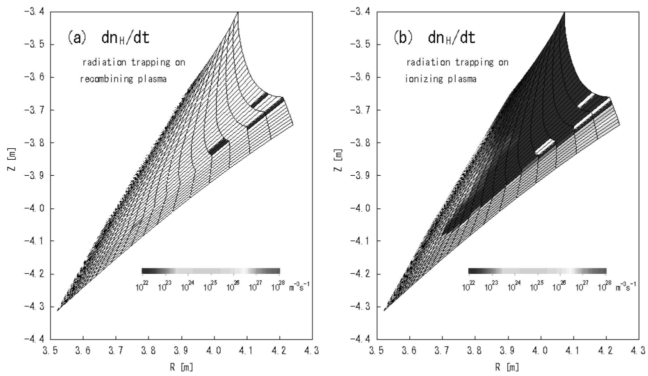

Fig. 3: (a) Recombination and (b) ionization rates obtained considering the radiation trapping.

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2) Tobita, K. et al. : Nucl. Fusion 47 (2007) 892.

3) Shimizu, K. : et al. : Nucl. Fusion 49 (2009) 065028.

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