

Study of impurity behavior by using collisional-radiative model in tandem mirror plasma

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In fusion plasmas, behavior of impurities are one of the important issue because of radiation loss and plasma-wall interaction. Impurity line spectra have a lot of important informations of the plasma, such as the impurity density and temperature, the electron density and temperature, rotation velocity of ions and the electric field in the plasma. Then spectroscopic measurements of various wavelength regions (soft X-ray, vacuum ultraviolet, ultraviolet and visible) are carried out in various fusion devices. The emission intensity from the impurity is proportional to the population density of the excited state of the impurity ion. The population density of the excited state depends on the electron density, the electron temperature and the impurity density. The relation of each parameters is given by the collisional-radiative model (CR-model). The CR-model is used in the region between corona-equilibrium (low density) and thermal-equilibrium (high density). In this region, both of the collisional process and the radiation process are important.

In the GAMMA 10 tandem mirror, space and time resolved spectra are observed by using absolutely calibrated ultraviolet/visible spectrometer, vacuum ultraviolet spectrometer and soft X-ray spectrometer. Line emissions from CII, CIII, OII, OIII, OIV and OV are mainly observed spectra in GAMMA 10. The CR-models for CII, CIII and OV have been developed already. Then, we can obtain density profiles of C+, C2+ and O4+ ions. We evaluated impurity penetration and particle balance for several plasma discharge sequences. Carbon ions had different profiles in each plasmas. The result shows that the impurity penetration into the plasma, the transport in the plasma and the ionization process were different in each discharges.

While, we have developed the CR-model for the lower charge state oxygen ions. In GAMMA 10, emissions from oxygen ions have the highest intensity. Therefore, measurements of oxygen ion spectra from lower charge state to higher charge state are very useful for estimation of plasma parameters. We compared oxygen spectra from the GAMMA 10 central cell and the calculation result of the new model.