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Spectroscopic studies for tungsten and hydrogen in LHD

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The pellet injection is a standard method for the impurity-relating studies in the Large Helical Device (LHD). We have accumulated experiences and established a technique for providing the plasma with tungsten ions adequate for spectroscopic measurements without causing a radiation collapse. A number of emission lines of tungsten ions in the wavelength range from visible to EUV have been successfully observed to date and are being used for the impurity transport study and for the atomic data evaluation study.

Recently, we have identified visible M1 lines of W^{+26} ion (335.7 nm and 333.7 nm) and W^{+27} ion (337.7 nm) [1], and the radial density structures of these ions are derived with the help of a collisional-radiative model. Under the assumption of ionization equilibrium, the total tungsten ion density is estimated to be approximately 0.5% of the electron density in the core region. In addition to that, in the VUV wavelength range measurement, other M1 lines of W^{37+} ion (64.67 nm) and W^{38+} ion (53.29 nm and 55.91 nm) have been also clearly identified [2]. The temporal development of intensities of these M1 lines and of some E1 lines of higher charge state ions, i.e., W^{45+} (12.70 nm) and W^{41+} (13.12 nm), shows clear correlation with the central electron temperature, and it is confirmed that these line intensities take their maximum in the temperature range where the fractional abundance of the corresponding charge state ion becomes the largest.

As for the hydrogen atom line emissions, the study of anisotropy in the electron velocity distribution function has found a use for the Lyman-α line in combination with the polarization spectroscopy. We have succeeded to detect the polarization degree of several percent for the Lyman-α line [3] with an innovative technique originally developed for the solar radiation observation [4]. An analysis with an atomic model which deals with the alignment as well as the population for the excited level indicates that the electron temperature in the direction perpendicular to the magnetic field is higher than the parallel temperature [5]. This result qualitatively agrees with our understanding of the particle confinement characteristics in the edge open-field region of LHD.

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