# Spectroscopic studies in LHD focusing on atomic processes

**Motoshi Goto**

National Institute for Fusion Science, Toki 509–5292, Japan

The Large Helical Device (LHD) at the National Institute for Fusion Science is equipped with various types of spectrometers to cover a wide range of wavelengths from the visible to the X-ray region, and many studies based on spectral measurements are being performed. Among these, recent researches focused on atomic processes are presented.

Helium gas was injected into the LHD plasma and the intensities of several visible emission lines of neutral helium atoms were measured simultaneously. The helium atom emissions are known to occur in the outermost region of the plasma. Using a collisional radiative model, the electron temperature and electron density were derived from the line intensity ratios and it was found that these parameters vary strongly with plasma conditions. It was also found that the radial position of the helium atom emission was almost fixed at the location where the magnetic field line connection length to the divertor plates suddenly increases to over 100 m [1]. This result indicates that the magnetic field structure is important for determining the neutral particle transport in the plasma boundary region.

It is known that atomic emission lines due to electron collision excitation are generally polarized. If the electron velocity distribution function in the plasma is anisotropic, the atomic emission lines can be polarized. Inspired by CLASP (Chromospheric Lyman-Alpha Spectro-Polarimeter) by the National Astronomical Observatory of Japan [2], a polarization measurement in the LHD was attempted and a few percent polarization was detected, with a tendency for the polarization to relax with increasing collisionality. A collisional radiation model was constructed and the anisotropy of the electron temperature was evaluated from the detected degree of polarization [3]. It was successfully demonstrated the atomic emission line polarization can be used as a method for measuring plasma anisotropy.

Hydrogen pellets were injected into the LHD plasma and a spectral measurement was conducted for the ablation cloud surrounding the pellet. The discrete lines show large Stark broadening, and the electron temperature and density of the ablation cloud were obtained by fitting the experimental data with a spectral model assuming the complete local thermodynamic equilibrium. The penetration characteristics of the pellet changed depending on the state of the target plasma, and in particular, it was confirmed that the penetration length became shorter as the temperature of the target plasma increased. In addition, it was found that the maximum electron density of the ablation cloud little changed irrespective of the penetration length [4]. These results are helpful for developing pellet ablation simulation models.

References

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