Plasma spectroscopy in fusion device

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The spectroscopy for fusion plasma can take two different approaches. One focuses on the emission line profile, where the broadening and splitting of an isolated emission line are measured in detail. The ion temperature measurement which makes use of the Doppler broadening, for example, is categorized in this approach. In the Large Helical Device (LHD), the ion temperature at the plasma core is evaluated from the broadening of the resonance line of helium-like argon ion which is observed with a crystal spectrometer.

The Zeeman splitting measurement in the visible wavelength range is another example. In LHD most of the emission lines in the visible wavelength range are located in a narrow layer at the outermost boundary of the plasma. When the plasma is observed with a collimated field of view, there are two emission locations on a line-of-sight in most cases. Since the magnetic field strength at different emission locations is generally different, the individual components can be separately obtained. With this kind of measurement for an entire poloidal cross section of the plasma, the inhomogeneous distribution of the emission intensity around the plasma has been made clear.

The other approach is based on the intensity measurement of various emission lines. In LHD, a number of emission lines in the VUV and visible wavelength ranges are monitored simultaneously and a population distribution over the excited levels of various ions are determined. This approach aims at a comprehensive understanding of the plasma condition through a comparison between the measurement and model calculation with the collisional-radiative model. The formation of recombining plasma in the self-sustained detached plasma is found in this kind of analysis for neutral hydrogen.