§28. EUV Spectroscopy of Highly Charged Iron Ions with Electron Beam Ion Traps

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The spectroscopic investigations of highly charged ions are very important not only for atomic physics but also for astrophysical and laboratory fusion plasmas. For example, the atomic data of highly charged iron ions with charge state around 10 is needed for the spectroscopic diagnostics of the solar corona with the recently launched satellite Hinode. To properly diagnose the non-equilibrium plasma in the solar atmosphere, we are studying the spectroscopic properties of highly charged iron ions with laboratory devices, EBITs (electron beam ion traps) and LHD (large helical device), under the collaboration among research groups of three different areas: astrophysics, fusion plasma physics, and atomic physics.

An EBIT[1] is a versatile tool for the study of HCIs. It is composed of an ion trap and a high density electron beam compressed by a strong magnetic field. Highly charged ions are produced through successive electron impact ionization of trapped ions. Radiation from the trapped highly charged ions excited by the electron beam can be observed through the slit in the trap. An EBIT is especially useful for the study of electron energy dependence of line intensity because it has a quasi-monoenergetic electron beam, unlike plasma light sources. The cross sectional view of the EBIT and the spectrometer is shown in Fig.1. We used the flat filed grazing incidence spectrometer. This grating is the holographic grating (1200 lines/mm) of the Shimadzu Corporation and detector is the back-illuminated CCD. Typical EUV spectra of highly charged iron ions are shown in Fig.2. The electron energy range is 1.8~2.4keV. The wavelength range from 100 to 300Å can be measured at a time and the resolution is about 0.3Å. It is possible to expose a long time (>1 hour), because the EBIT is a stable continuous wave light source. As shown in this example, various charge state ions can be selectively produced with a narrow charge state distribution by adjusting the electron beam energy. Thus the charge state of unknown lines can be identified through such energy dependence measurements. On the other hand, the electron density dependence of line ratios, which are very important for plasma diagnostics, can be studied by changing the electron beam current at a fixed energy.

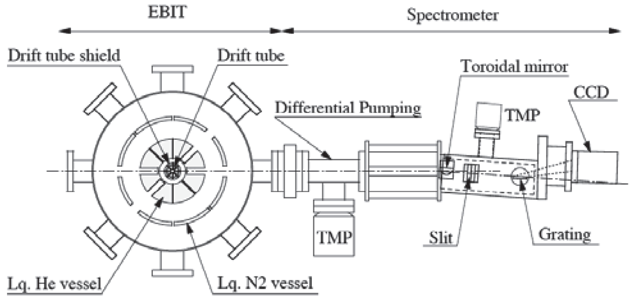

Fig. 1 Schematic drawing of the electron beam ion trap and EUV spectrometer.

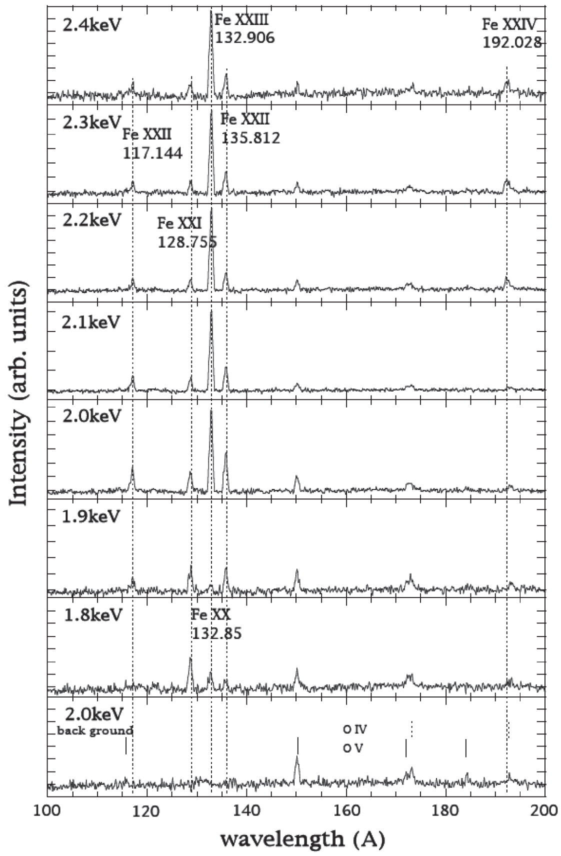

Fig. 2 The highly charged iron ion EUV spectra. ions.

1) N. Nakamura et al., Phys. Scr. T73 (1997) 362-364.