

§11. Non-Equilibrium Plasma Diagnostics of Solar Coronal Plasma Verified by Large Helical Device (LHD)

Watanabe, T., Hara, H. (NAOJ),
Imada, S. (Nagoya Univ.),
Yamamoto, N. (Chubu Univ.),
Nakamura, N. (Electro-Communication Univ.),
Kato, D., Sakaue, H.A., Suzuki, C., Murakami, I.

The EUV Imaging Spectrometer (EIS) on board *Hinode* is observing, and an EUV Spectroscopic Telescope (EUVST) to be on board the *SOLAR-C* mission will observe a number of emission lines from iron ions at various ionization stages. Atomic models and their atomic parameters used in these models for solar application could be improved through the experiment of the Large Helical Device (LHD). Independent measurements of plasma temperatures and densities restrict the other plasma parameters in the atomic models in case of the laboratory experiments, which would result to improve the accuracy of these models¹⁾. The improved models verified by the laboratory experiments will be able to develop new research area in the physics of solar transition region and the mechanisms of chromospheric and coronal heating.

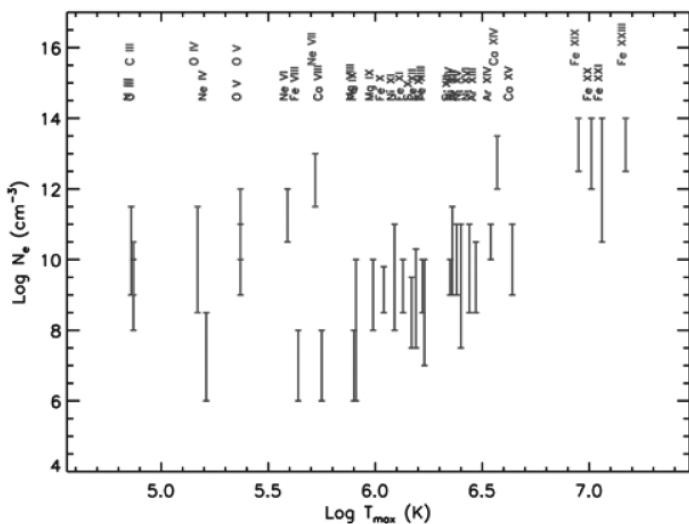


Fig. 1. Density sensitive line pairs to be observed by EUVST on board the *SOLAR-C* mission.

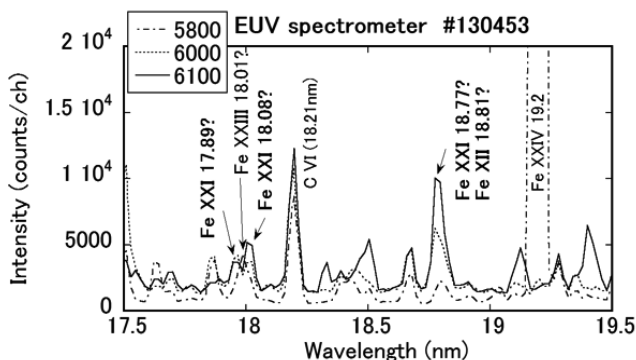


Fig. 2. a) FeXXI emission lines observed at the shot # 130453 in the EUV wavelengths of 175 – 195 Å, and b) the density dependence of FeXXI lines at 178.9 Å and 187.9 Å.

The next Japanese solar observing mission (nicknamed as “Solar-C”)²⁾ has now proposed to JAXA in response to the Announcement of Opportunity 2014. One of the candidate payloads for FUV/EUV spectroscopic observation (EUVST) will have a capability of observing solar atmospheres in a wider temperature range with higher sensitivity than those of *Hinode*/EIS. Diagnostic capability with density-sensitive line ratios in higher temperatures above $T_e \sim 10^7$ K is of much interest (see Fig. 1), and it is one of the scientific targets for next cross validation of atomic models and parameters. There are three strong FeXXI lines, i.e. $\lambda 178.9$, $\lambda 180.8$, and $\lambda 187.9$, in the EUV wavelengths of 170 – 215 Å covered by *SOLAR-C*/EUVST, and one of the best candidates for diagnosing these high temperature plasmas is a line pair of FeXXI $\lambda 178.9$ / $\lambda 187.9$ (see Fig. 2b). The LHD measurement for this density-sensitive line pair has already started, and Fig. 2a shows a spectrum taken by the TESPEL experiment conducted on January 26, 2015 in the cycle 18 experiment.

The FeXXI $\lambda 178.9$ line has the largest emissivity among the three lines noted above, but the intensities of the $\lambda 187.7$ and $\lambda 187.9$ lines dominate, when the electron density (n_e) becomes $n_e > 10^{12} \text{ cm}^{-3}$. The spectrum taken at the shot of #130453 tells that the FeXXI $\lambda 178.9$ line seems blended by a line formed at the lower temperature, possibly originated from the FeXX ion. We will have to see spectra in the longer wavelengths covering FeXXI $\lambda 242.0$, $\lambda 247.0$, $\lambda 250.5 \text{ \AA}$, and simultaneously compare these density-sensitive line ratios.

We cordially acknowledge their great help of the experiment team.

- 1) Murakami, I. et al.: 2014, "Validation of spectroscopic model of Fe ions for non-equilibrium ionization plasma study in LHD and HINODE," PFR, 9, 1401056 (8pp).
- 2) Watanabe, T.: 2014, Solar-C Mission," SPIE, 9143, 91431O (10pp).

