§39. 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 models. 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.

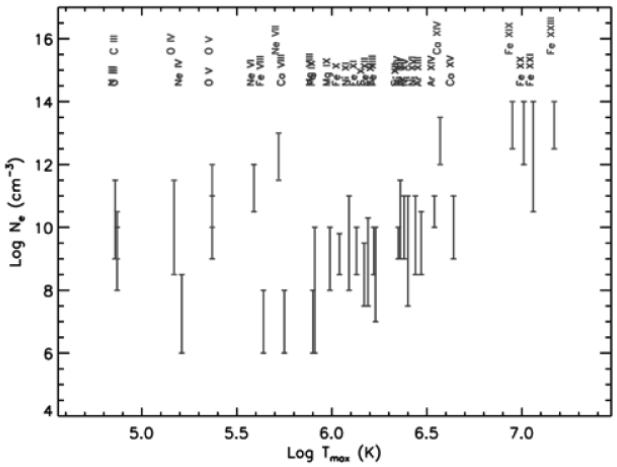

Fig. 1. Density sensitive line pairs to be observed by EUVST on board the *SOLAR-C* mission: Blue-line pairs can be observed in the same spectral channels.

The next Japanese solar observing mission (nick-named as "Solar-C") 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, 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. λ178.9, λ180.8, and λ187.9, 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 at λ178.9 and λ187.9 (see Fig. 1). The LHD measurement for this density-sensitive line pair has already started, and Fig. 2 shows a spectrum taken by the TESPEL experiment conducted on January 26, 2015 in the cycle 18 experiment.

The FeXXI λ178.9 line has the largest emissivity among the three lines noted above, but the intensities of the λ187.7 and λ187.9 lines dominate, when the electron density (n_e) becomes $n_e > 10^{12}$ cm.$^{-3}$ The spectrum taken at the shot of #130453 tells that the FeXXI λ178.9 line seems blended by a line formed at the lower temperature, possibly originated from the FeXII ion. We will have to see spectra in the longer wavelengths covering FeXXI λ242.0, λ247.0, λ250.5 Å, and simultaneously compare these density-sensitive line ratios.

A new novel method is investigated possibly to measure coronal magnetic field strengths (Li et al. 2015)[1]. The sensitivity against magnetic field strengths is studied for the magnetic field induced transition of FeX line at λ257.3 Å using the full CCD spectra taken by the EIS instrument on board the *Hinode* mission

We cordially acknowledge their great help of the experiment team.

1) Li, W.-X. et al.: 2015, 'A novel method to determine magnetic fields in low-density plasma facilitated trough accidental degeneracy of quantum states in Fe^{9+},' ApJ, 807, 69 (6pp).

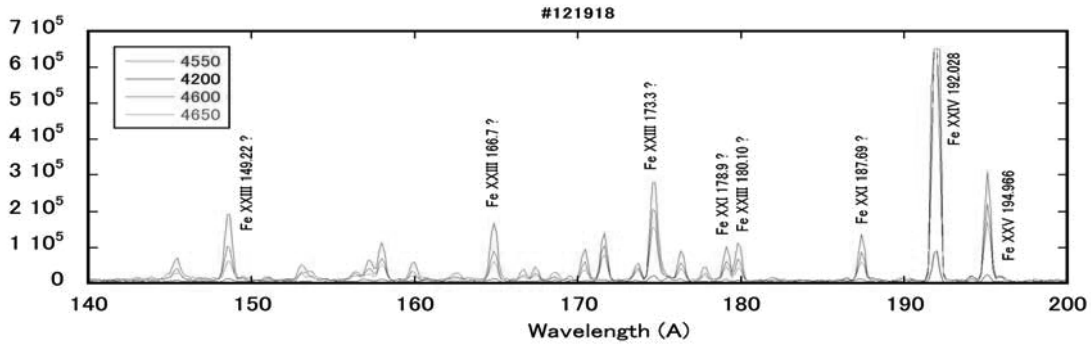

Fig. 2. FeXXI emission lines observed at the shot # 121918 in the EUV wavelengths of 140 – 200 Å.