§19. LHD Simulated Experiment for Solar Non-Equilibrium Plasmas and Development of its Spectroscopic Diagnostic Tools

Watanabe, T., Hara, H. (Nat. Astron. Obs., NINS), Kato, T., Murakami, I., Sato, K., Funaba, H., Morita, S., Goto, M., Muto, S. (NIFS, NINS), Yamamoto, N. (Ecot. Cen., Nagoya Univ.)

A Japanese Sun Observing Satellite, Hinode was launched on 23-Sep-2006. The EUV imaging spectrometer (EIS) on board Hinode accommodates the multilayer coated mirror and concave grating with back-illuminated CCDs for detectors, and realizes the highest sensitivity ever achieved in the two EUV wavelengths, i.e. 17 - 21 nm and 25 - 29 nm, for solar observation. Thanks to the normal incidence optics, the flexibility of designing the spectrograph was best optimized to obtain excellent imaging capability[1] After opening of the instrument doors, the first light of EIS (see Fig. 1) took place successfully on 28-Oct-2006. Functions for scientific observations were verified during the commissioning phase in November. Diagnostic capability of iron emission lines appearing in these wavelengths observed with EIS has been tested in orbit and found as expected.[2]

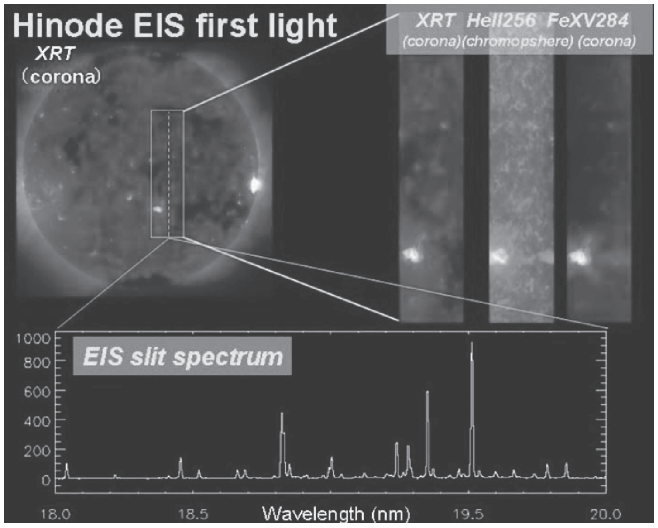

Fig. 1 First Light Spectra of EIS on board Hinode

Time-dependent collisonal-radiative model is developed to analyze the data taken by this EIS instrument, and to diagnose temperatures and densities of those plasmas in the outer atmospheres of the Sun. No systematic models yet exist for iron ions of L- and M-shells, which are very important for coronal plasma diagnostics. Atomic data for iron ions of Fe^{9+} to Fe^{14+} are surveyed and evaluated, and most recommended data are determined.[3] Parameters for analytical fitting functions are obtained and provided. EUV spectra in the wavelengths of 170 – 190 Å are taken by LHD, injecting iron TESPEL (tracer-encapsulated solid pellet). Data taken by this experiment is analyzed. Calculations of collisional excitation cross sections of Fe^{+12} lines are compared with LHD spectra with cross sections of proton collisions taken into account.

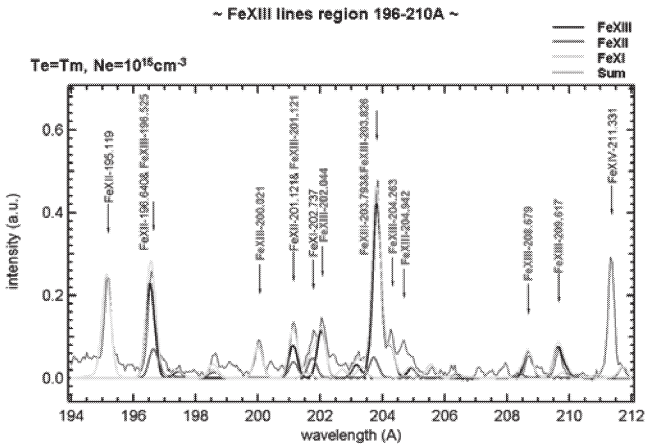

Fig. 2 Comparison of theoretical iron line spectra generated by our model in ionization-equilibrium with observed LHD spectra in the wavelengths of 196 − 210 Å.

Possibility of getting experimental atomic data for iron ion emission lines is examined and a compact EBIT (electron beam ion trap) facility suitable for measuring a lower energy region less than a few keV is manufactured. Experimental data of ionization and recombination cross sections for iron ions could be also produced by an instrument called NICE (Naked Ion Collision Experiment).

Hinode Science Center (HSC) was founded at NAOJ in 2005 to encourage observational solar physics promoted by the Hinode mission. The enhanced DARTS system developed in collaboration with ISAS/JAXA constitutes the kernel of the data archiving system of the Hinode mission. The center will construct the “Level 2” database that is a science-value added database. Hinode Science Center will be able to provide three-dimensional photospheric magnetic field structures and movies of co-aligned images in X-ray, EUV, and optical wavelengths. Coordinated data analysis workshops and courses will take place regularly, and extensive PO activity will be also expected dispatched out of HSC. Newly developed time-dependent collisional-radiative models in this study will be also included in the data-analysis software system in Solar-B Science Center, and available for use of world-wide researchers, both of solar physics and plasma physics among others.

References

1) Culhane, J. L. et al.: 2007, submitted to Solar Phys.

2) T. Watanabe et al.: 2007, submitted to Publ. Astron. Soc. Japan.

3) T. Kato et al. : 2006, NIFS-DATA95