# §1. Analysis of Fe XXI Spectral Lines Measured in LHD Plasmas

Murakami, I., Sakaue, H.A., Kato, D., Morita, S.,
Yamamoto, N. (Osaka Univ.),
Watanabe, T. (National Astronomical Observatory of Japan)

Iron ions are one of major impurities in various plasmas. Especially in astrophysical plasmas, Fe is important index of heavy element abundance. It is needed to determine ion density, electron density and other properties precisely from spectral lines for astrophysical plasmas such as the sun, so we need good model to estimate the electron density and other parameters. We have developed a set of collisional-radiative models (CR models) for Fe ions in order to analyze spectral lines from plasmas such as solar transition regions.

Here we are interested in Fe XXI spectral lines measured in extreme ultra violet spectra of LHD plasmas, in which many Fe ions are observed. We focus on the two lines, λ12.12nm ($2s^2\ 2p^2\ {}^3P_2 - 2s2p^3\ {}^3P_2$) and λ 12.875 nm ($2s^2\ 2p^2\ {}^3P_0 - 2s2p^3\ {}^3D_1$), since the intensity ratio of these lines show electron density dependence and can be used for density diagnostics. Figure 1 shows the calculated intensity ratio as a function of electron density by using the CR model[1)]. Dependence on electron temperature and different atomic data set is small for electron density region of LHD plasmas.

Figure 2 shows the temporal distribution of the line intensities and intensity ratio for the shot #64921 in which Fe pellet was injected at t=1.8 sec, and Fig.3(a) shows estimated electron density by using the result of the CR model. Comparing with the measured electron density

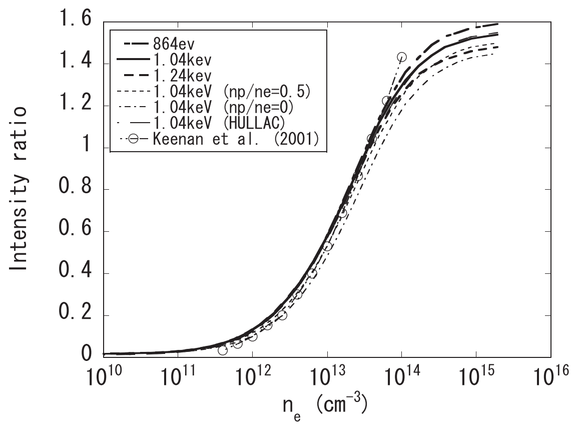


Fig. 1. Calculated intensity ratio as a function of electron density for RMaX model with $n_p/n_e$=1 and $T_e$=864eV (thick long dashed line), 1.04keV (thick solid line), and 1.24keV (thick dashed line); RMaX model with $n_p/n_e$=0.5 and $T_e$=1.04keV (think dashed line); RMaX model with $n_p/n_e$=0 and $T_e$=1.04keV (thin dot-dashed line); Hullac model with $n_p/n_e$=1 and $T_e$=1.04keV (think long dashed line); and $T_e$=$10^7$K model of Ref. 2 (solid circles). $n_p$ is the proton density.

distribution by the FIR interferometer, we can estimate the location of emitting region of Fe XXI as shown in Fig. 3(b). We found that the Fe XXI emitting region moved toward low density peripheral region after staying at ρ~0.75 for about 0.08 sec. The electron temperature of these emitting region is lower than one expected fir ionization equilibrium, and we could expect Fe ions are not in ionization equilibrium.

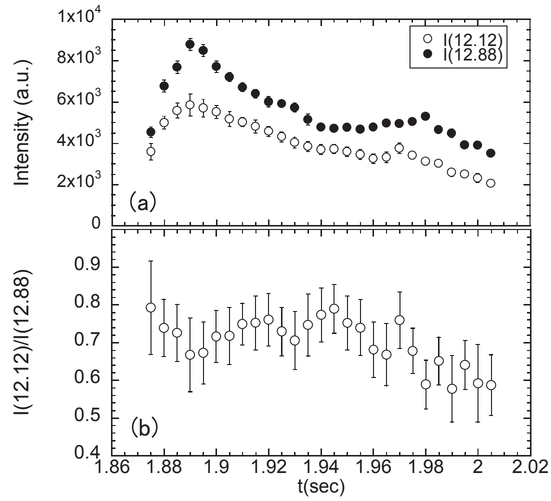


Fig. 2. Temporal distribution of (a) the line intensities of I(λ12.12nm) and I(λ12.88nm) and (b) the line intensity ratio.

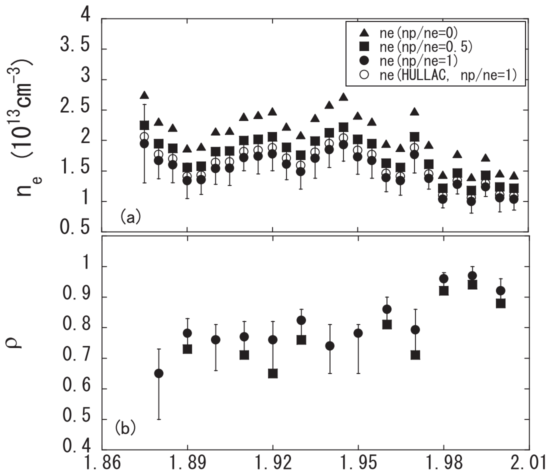


Fig. 3. Temporal distribution of (a) electron density estimated from the measured intensity ratio and CR model, and (b) normalized radius ρ of location of emitting region for different models (RMaX model with Te=1.04keV and $n_p/n_e$=0 (solid triangles), 0.5 (solid squares), and 1 (solid circles), and HULLAC model with Te=1.04keV and $n_p/n_e$=1 (open circles)). Errors are shown only for the RMaX model with $n_p/n_e$=1.

1) Murakami, I. et al.: accepted for PFR (2010)
2) Keenan, F. P. et al. : Mon. Not. R. Astron. Soc., **326** (2001) 1387.