§7. Intensity Ratio among n=3-2 Transitions for Ne-Like FeXVII in LHD

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In LHD, several FeXVII n=3-2 Lα transitions originated in Ne-like Fe^{16+} ions have been observed at wavelength interval of 15-17Å. Those transitions are identified as

3C: 15.015 Å ($2p^5 3d\ ^1P_1 \rightarrow 2p^6\ ^1S_0$),
3D: 15.262Å ($2p^5 3d\ ^3D_1 \rightarrow 2p^6\ ^1S_0$),
3E: 15.450Å ($2p^5 3d\ ^3P_1 \rightarrow 2p^6\ ^1S_0$),
3F: 16.777 Å ($2p^5 3s\ ^3P_1 \rightarrow 2p^6\ ^1S_0$),
3G: 17.054 Å ($2p^5 3s\ ^1P_1 \rightarrow 2p^6\ ^1S_0$) and
M2: 17.097 Å ($2p^5 3s\ ^3P_2 \rightarrow 2p^6\ ^1S_0$).

The 3G line is blended into the M2 line due to a limited spectral resolving power. The 3E line is usually weak for the observation. The 3G+M2 and 3C lines show the strongest intensity in the Fe Lα transition array composed of ionization stages of Ne-like Fe^{16+} to Li-like Fe^{23+} ions. The FeXVII vertical profiles are plotted in Fig.1 (a) against different transitions of 3C, 3D, 3F and 3G+M2. The radial emissivity profiles derived from the vertical profiles are shown in Fig.1 (b).

The emissivity of 3C, 3D and 3F transitions is analyzed by taking the ratio against the 3G+M2 transition. The ratio is evaluated at the peak position of emissivity profiles in electron density range of n_e = 1-5×10^{13}cm^{-3}. The emissivity ratios analyzed here is shown in Fig.2 as a function of electron temperature. The result from theoretical calculation with CR model is also shown in Fig. 2. The CR model predicts that the emissivity ratios of 3D and 3F to 3G+M2 transitions, i.e., $\varepsilon_{3D}/\varepsilon_{(3G+M2)}$ and $\varepsilon_{3F}/\varepsilon_{(3G+M2)}$, are not sensitive to T_e, while the emissivity ratio, $\varepsilon_{3C}/\varepsilon_{(3G+M2)}$, increases with T_e. The comparison between the model and measurement indicates that the measured ratio is smaller than the theoretical calculation by 25-40%. Since the ratios of $\varepsilon_{3D}/\varepsilon_{(3G+M2)}$ and $\varepsilon_{3F}/\varepsilon_{(3G+M2)}$ are in good agreement between the measurement and calculation, the discrepancy in the ratio of $\varepsilon_{3C}/\varepsilon_{(3G+M2)}$ should be attributed to an overestimate of the 3C emissivity. The discrepancy related to the 3C emissivity has been also studied in laboratory and astrophysical plasmas based on the analysis of the ratio, R≡$\varepsilon_{3C}/\varepsilon_{3D}$. Although there is no atomic theory explaining the discrepancy at present, a result from EBIT at LLNL suggests that the theoretical excitation cross section of the 3C transition is obviously underestimated, while the cross section of the 3D transition is in a good agreement with theory[1]. A recent study on the oscillator strength of 3C/3D suggests that the discrepancy is caused by the accuracy in atomic wave functions [2].

Figure 3 shows the measured ratio as a function of n_e. The ratios obtained here agree well with the theoretical calculation in density range of n_e=4-22×10^{13} cm^{-3}. The density effect on the FeXVII emissivity ratio is clearly confirmed through the present study.

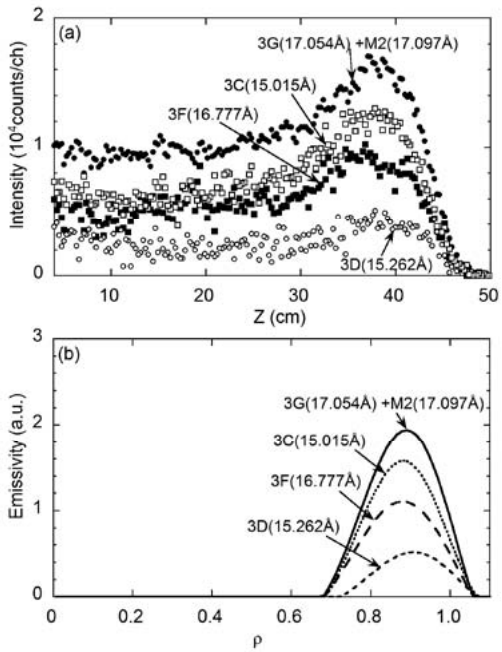

Fig.1 (a) Vertical profiles of chord-integrated intensity and (b) emissivity profiles as a function of normalized radius in Ne-like ArVII n=3-2 transitions.

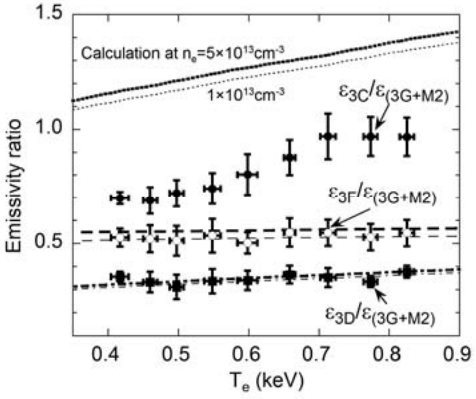

Fig.2 Emissivity ratios of FeXVII transitions as a function of electron temperature (circles and squares: measurement, lines: CR model calculation).

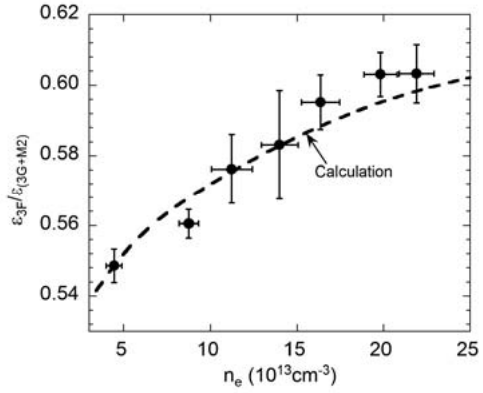

Fig.3 Emissivity ratio of $\varepsilon_{3F}/\varepsilon_{(3G+M2)}$ as a function of electron density (closed circles: measurement, dashed line: CR model calculation).

1) Browm,G.V. Can. J. Phys. **86**,199 (2008).
2) Bernitt, S., *et al*., Nature, **492**, 225 (2012).