§23. First Result on Impurity Transport Study at Plasma Core of LHD Using Fe n=3-2 Lα Transition Array

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Iron spectrum with n=3-2 Lα transitions between 10 and 20Å has been measured by injecting an iron impurity pellet[1]. A typical result is shown in Fig.1. A lot of Lα transitions from highly ionized Fe ions are observed in the spectrum. Since many Fe lines are blended with other Fe lines at several wavelength intervals, the spectrum appears with structure like pseudo continuum. In particular, it is enhanced in the wavelength range of 12-16Å. The reason may be due to a lack of the spectral resolution. It is often hard to distinguish the spectral line individually. Nevertheless, the ionization stage of Fe Lα transitions basically increases step-by-step when the wavelength decreases from 20Å to 10Å. The resultant spectrum at such a narrow wavelength interval then exhibits Fe transitions in a variety of ionization stages of Ne-like to Li-like ions, i.e., FeXVII to FeXXIV.

The vertical profile of the Fe Lα transition from FeXVII to FeXXIV is analyzed by carefully choosing the wavelength interval at each ionization stage. The result is shown in Fig.2(a). The electron density and temperature profiles are also shown in Fig.2(b) of which the coordinate is converted into the vertical position at horizontally elongated plasma cross section by taking into account the elliptical magnetic surface calculated with VMEC code. The vertical profiles are normalized at each peak position. The peak position of each profile moves inside with increasing the ionization stage, reflecting the centrally peaked electron temperature profile. The FeXXIII and FeXXIV indicate an almost flat profile in the vicinity of plasma center reflecting a hollow iron density profile.

Since many lines appear in the wavelength range of 10-130 Å, the line identification is often difficult, even if the line is theoretically predicted in the wavelength list. If the radial profile measurement is applied to the line identification, the spectrum identification is really reliable. For instance, several lines are predicted in the vicinity of 17.6Å as Lα transitions from FeXV, FeXVI and FeXVIII. In order to identify the transition at 17.6Å in Fig.1, the vertical profile is compared with profiles of Fe Lα transitions in neighboring ionization stages of FeXVII, FeXVIII and FeXIX which have been already identified. From the comparison among the profiles we can clearly understand that the vertical profile of the line emission at 17.6 Å is identical to that of FeXVIII (14.121-14.256Å). The line emission at 17.6 Å is thus determined as the FeXVIII at 17.62Å, of which the transition is $2s^2 2p^4 3p\ ^2P_{3/2}$-$2s^2 p^6\ ^2S_{1/2}$. The Lα transitions shown in Fig.1 are identified based on this technique.

An example of the transport analysis is shown in Fig.3. The FeXVI profile is well fitted with indicated transport coefficients. The full impurity transport analysis is being done based on the Fe Lα profiles shown in Fig.2(a).

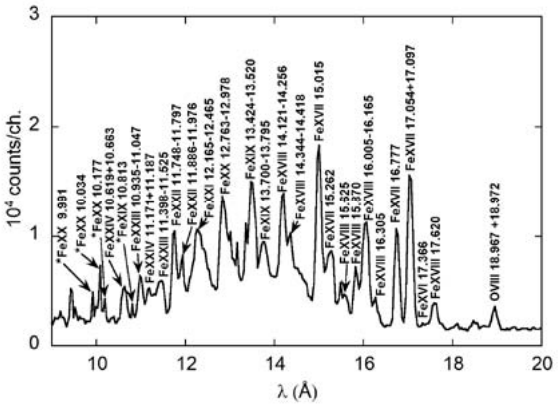

Fig.1 Fe n=3-2 Lα spectrum below 20Å measured after an iron impurity pellet injection. The asterisk (*) with wavelengths denotes that two or more lines are blended into the same wavelength position.

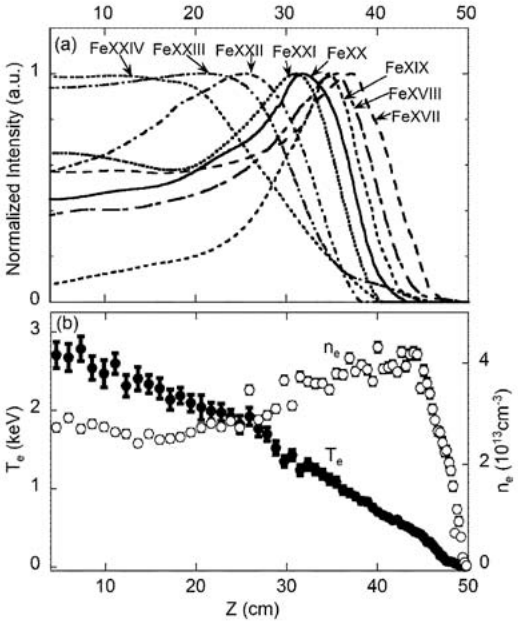

Fig.2 (a) Line-integrated vertical intensity profiles of FeXVII (17.054Å+17.097Å), FeXVIII (14.121-14.256Å), FeXIX (13.424-13.520Å), FeXX (12.763-12.978Å), FeXXI (12.165-12.465Å), FeXXII (11.748-11.797Å), FeXXIII (10.935-11.047Å) and FeXXIV (10.619Å+10.663Å) and (b) T_e (closed circles) and n_e (open circles) profiles.

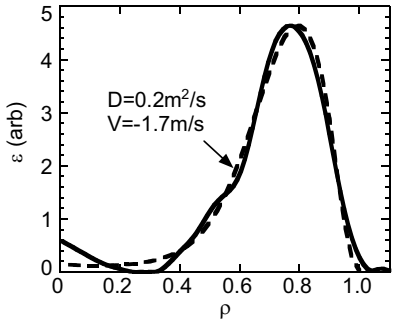

Fig.3 Example of transport analysis for FeXVII profile (solid line: experiment, dashed line: simulation).

1) Huang, X.L., Morita, S. et al., RSI **85** (2014) 043511.