Atomic Data Evaluation with Statistical Methods for Plasma Spectroscopic Diagnostics

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Spectroscopic diagnostics for plasmas is one of basic methods to obtain physical condition of plasmas. Traditionally spectral line intensities and intensity ratios are used to estimate ion density and electron temperature and density. Dependence on electron temperature and density for spectral line intensities should be known accurately to obtain reliable results. Line intensities are calculated with a spectroscopic model such as a collisional-radiative model, which uses many atomic data and they should be evaluated. Conventionally atomic data obtained by various methods are compared for each process and most “reliable” or “appropriate” one is selected or an “appropriate curve” is obtained as “evaluated” data (eg. [1,2]). This method is not effective to evaluate a large set of atomic data such as electron-impact excitation cross sections / rate coefficients which are necessary to calculate spectral line intensities using a collisional-radiative model. Murakami et al. [3] selected sets of electron-impact excitation rate coefficients of Fe ions by comparing the calculating method and its conditions. The selected sets should be evaluated by the spectroscopy. For example, Yamamoto et al. [4] calculated spectral line intensity ratios of Fe XIII lines and compared with measured ratios obtained from EBIT and the Large Helical Device experiments. They found the set of the excitation rate coefficients obtained by Aggarwal et al. [5] agreed better with the experiments. This method can be used for separate spectral lines of K- and L-shell ions. However, M- and N-shell ions or lower charged ions of high Z elements have complex spectral features. Overlapped many spectral lines produce blended broad feature and sometimes quasi-continuum structure so-called unresolved transition array (UTA) (eg. [6]). Statistical methods to evaluate those spectra and spectroscopic models are necessary to be developed. We will discuss the requirement for such methods and possibility of new methods for data evaluation.

References

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