Collisional-radiative model for EUV spectra of Pm-like ions in EBIT

Daiji Kato*†1, Hiroyuki A. Sakaue*, Izumi Murakami*†, and Nobuyuki Nakamura‡

* National Institute for Fusion Science, Gifu 509-5292, Japan
† Department of Fusion Science, SOKENDAI, Gifu 509-5292, Japan
‡ Institute for Laser Science, University of The Electro-Communications, Tokyo 182-8585, Japan

Synopsis Extreme ultraviolet (EUV) spectra of the Pm sequence from W^{13+} through Au^{18+} ions in electron beam ion traps (EBITs) are calculated by using a collisional-radiative (CR) model. Although the ground state for the Pm-like ions of heavier than Ir^{16+} is the $4f^{14}5s$ state, the EUV spectra are dominated by emission lines due to $4f^{13}5s^2$ - $4f^{13}5s5p$ transitions manifesting population trapping of the metastable excited state $4f^{13}5s^2$.

Loosely bound 4f orbital collapses as the nuclear charge increases along an isoelectronic sequence. Since it is predicted theoretically that the Pm sequence has the alkaline metal-like ground configuration ($4f^{14}5s$) for heavier elements of $Z > 77$ [1, 2], search for 5s-5p resonance lines in emission spectra of the Pm-like heavy ions has been attracting interests of atomic and plasma physicists. Kobayashi et al. [3] and Bekker et al. [4] studied extreme ultraviolet (EUV) spectra of the Pm-like ions in electron beam ion traps (EBITs) for Bi^{22+}, Au^{18+} and W^{13+} and from Pt^{17+} through Re^{14+}, respectively. However, the spectra for all the elements are dominated by the $4f^{13}5s^2$ – $4f^{13}5s5p$ transitions.

In this contribution, we present the EUV spectra of the Pm-like sequence from W^{13+} through Au^{18+} calculated by using a collisional-radiative (CR) model. In the present mode, excited state populations are calculated by solving an equilibrium equation of electron-impact (de)excitations and radiative decays of ions trapped in EBITs. Atomic data are obtained by calculations using HULLAC code (v.9.601) [5]. Figure 1 shows calculated spectra at an electron density of 10^{10} cm^{-3} which is a typical value in the compact EBIT (CoBIT) [6]. Strong lines (*a* and *b* in Fig. 1) are due to the $4f^{13}5s^2$ – $4f^{13}5s5p$ transitions and the wavelengths agree with the EBIT measurements [3, 4] within 2%. Although the ground state changes from $4f^{13}5s^2$ to $4f^{14}5s$ at Pt^{17+} and heavier elements, structures of the spectra change little because in the collisional-radiative equilibrium the metastable excited state $4f^{13}5s^2$ has a dominant population. Other emission lines are apparent in the W^{13+} spectrum due to a large population of the lowest excited state $4f^{12}5s^25p$. The present result is similar with that reported in [7]. However, the calculated spectrum is hardly reconciled with the experimental spectrum of [3].

†1 E-mail: kato.daiji@nifs.ac.jp

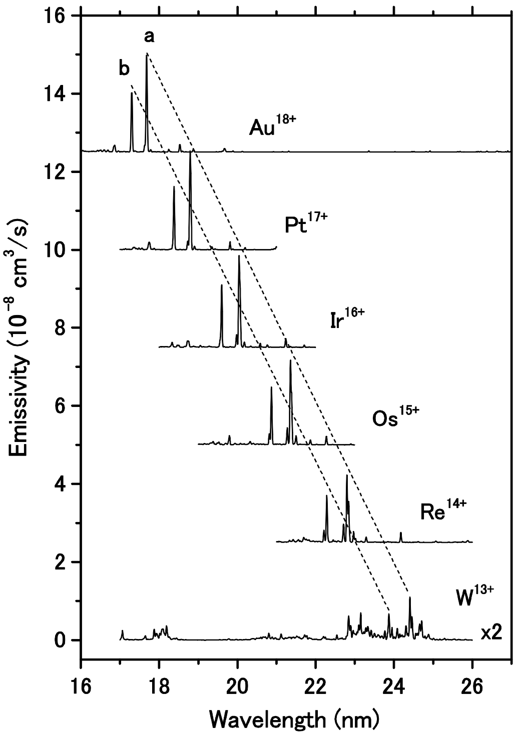

Figure 1. EUV spectra of the Pm sequence from W^{13+} through Au^{18+}. Electron beam energies are 300 eV, 330 eV, 360 eV, 400eV, 440eV, and 480eV, respectively. Lines indicated by *a* and *b* are due to $4f^{13}5s^2$ – $4f^{13}5s5p$ transitions.

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