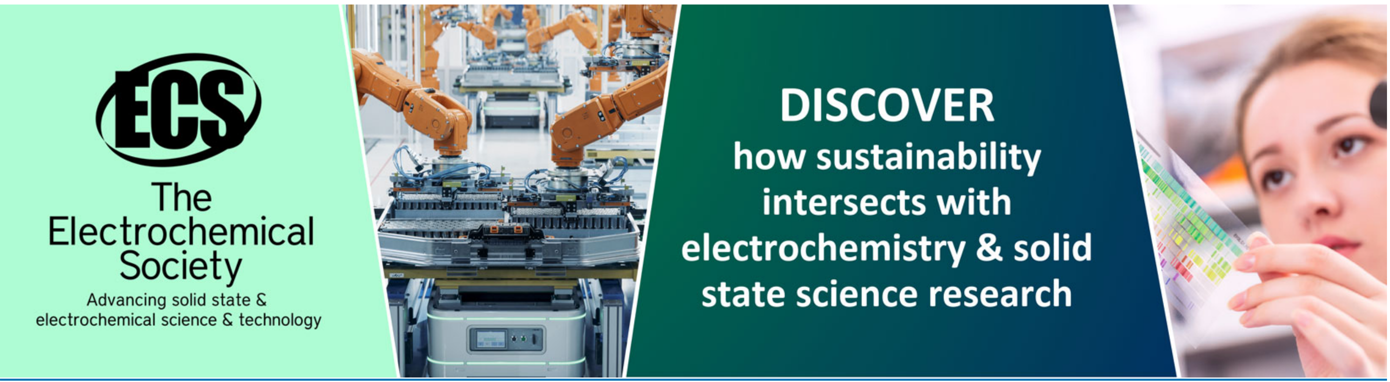
Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Intensity ratio in EUV spectra of highly charged Fe ions: Experimental evaluation of astrophysical plasma model

To cite this article: Erina Shimizu *et al* 2015 *J. Phys.: Conf. Ser.* **635** 052061



Journal of Physics: Conference Series **635** (2015) 052061 doi:10.1088/1742-6596/635/5/052061

Intensity ratio in EUV spectra of highly charged Fe ions: Experimental evaluation of astrophysical plasma model

Erina Shimizu*[1], Safdar Ali*, Hiroyuki A. Sakaue†, Daiji Kato†,‡, Izumi Murakami†,‡, Hirohisa Hara¶, Tetsuya Watanabe¶, and Nobuyuki Nakamura*[2]

* Institute for Laser Science, The University of Electro-Communications, Tokyo 182-8585, Japan
† National Institute for Fusion Science, Gifu 509-5292, Japan
‡ The Graduate University of Advanced Studies (SOKENDAI), Gifu 509-5292, Japan
¶ National Astronomical Observatory of Japan, Tokyo 181-8588, Japan

Synopsis We present spectra of highly charged Fe ions in the extreme ultraviolet region observed with a compact electron beam ion trap. The experimental intensity ratios obtained as a function of the effective electron density is used for evaluating plasma models used in the electron density diagnostics of the solar atmosphere.

Emission lines of highly charged Fe ions are important for astrophysical and laboratory plasma applications. In particular, emission in the extreme ultraviolet region are useful for the electron density diagnostics of the solar corona [1]. In such diagnostics, electron density is determined through the comparison of the observed emission line ratio with model calculation. For reliable diagnostics, it is thus important to test the model with spectra obtained with a well-defined laboratory plasma.

In this study, we use spectra obtained with a compact electron beam ion trap (EBIT) [2] to test the collisional radiative model calculation for the electron-density sensitive lines of Fe XV. In an EBIT, trapped ions with a narrow charge state distribution interact with a quasi-monoenergetic electron beam; thus EBIT spectra can provide a proper benchmark for testing theoretical models.

We have measured line ratios for density sensitive lines as a function of electron density and compared with a collisional-radiative model calculation. The electron density is experimentally determined from the simultaneously-measured electron beam radius and ion cloud distribution. The ion cloud in an EBIT generally spreads wider than the electron beam; therefore, the effective electron density should be obtained by taking the geometric overlap between the electron beam and the ion cloud into account. Liang et al.[3] suggested that the size of the ion cloud depends on ionic charge based on the comparison between the model calculation and the experimental line ratios obtained with the FLASH-EBIT. On the other hand, in this study, we have measured the dependence of the overlap on ionic charge by directly imaging both the electron beam and the ion cloud. This enables valid evaluation of the models describing density dependence.

Figure 1 shows a typical preliminary result obtained for the intensity ratio between the $3s3p\ ^3P_2 - 3s3d\ ^3D_3$ (233.9 Å) and $3s3p\ ^1P_1 - 3s3d\ ^1D_2$ (243.8 Å) transitions in Fe XV. As seen in the figure, discrepancy is found between the experiment and the model. In this study, the origin of the discrepancy is studied from several perspectives.

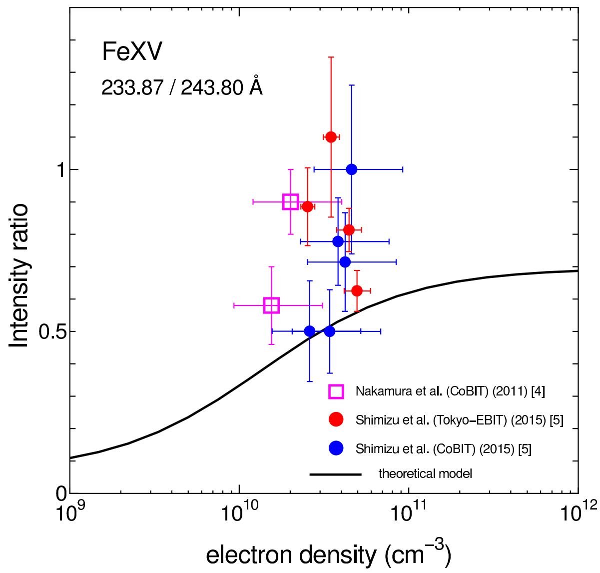


Figure 1. Intensity ratio between the lines at 233.9 Å and 243.8 Å in Fe XV.

References

[1] T. Watanabe *et al.* 2009 *ApJ* **692** 1294
[2] N. Nakamura *et al.* 2008 *Rev. Sci. Instrum.* **79** 063104
[3] G. Y. Liang *et al.* 2009 *ApJ* **702** 838
[4] N. Nakamura *et al.* 2011 *ApJ* **739** 17
[5] E. Shimizu *et al.* 2015 *J. Phys.: Conf. Ser.* **583** 012019

[1]E-mail: e_shimizu@ils.uec.ac.jp
[2]E-mail: n_nakamu@ils.uec.ac.jp