2^{nd} Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Recent Fusion Related Tungsten Spectroscopy Studies at Shanghai EBITs

J. Xiao, K. Yao, Y. Yang, Y. Shen, Y. Fu, B. Wei, C. Chen, R. Hutton and Y. Zou

[1] Shanghai EBIT Lab, Institute of Modern Physics, and Key Laboratory of Nuclear Physics and Ion-beam Application(MOE), Fudan University, Shanghai 200433

e-mail (speaker):xiao_jun@fudan.edu.cn

Electron beam ion trap (EBIT) is suitable for both high precision spectroscopy measurements of highly charged ions and disentangling study the complex atomic processes in high-temperature plasmas such as Tokamaks, ICF etc.

Tungsten is a strong candidate for the divertor material of the International Thermonuclear Experimental Reactor (ITER), since it has high melting point, low sputtering, corrosion resistance, and low hydrogen retention characteristics. The radiative properties of tungsten ions need to be better understood to fully take advantage of the opportunities tungsten spectra offer for high-temperature fusion plasma diagnostics.

There are three EBITs at Shanghai EBIT laboratory. One is a high-energy EBIT (up to 150 keV), named Shanghai-EBIT[1], and the other two are low-energy EBITs (down to 30 eV), named SH-PermEBIT [2] and SH-HtscEBIT [3]. All of them has been dedicated to the studies of atomic process for applications in fusion research.

In this talk, recent fusion related tungsten spectroscopy studies at Shanghai EBITs will be presented. During the past several years, tungsten spectra from visible to EUV region has been observed for the moderate and high charge state ions[4-11]. By analyzing the spectra with the help of theoretical calculations, using state-of-the-art techniques, we were able to identify term and fine structure splittings in the ground and the first excited configuration for several charge states. Meanwhile, some metastable levels which have extremely long lifetime and high population were also found, which could have large influences on the charge state distribution of tungsten ions in tokamaks. Figure 1 shows a strong visible line in the spectrum of W^{11+}, which could be the unknown line seen in charge exchange spectra recorded at the JET fusion facility[10].
Figure 2 shows an extremely-long-lived metastable level in W^{52+} ions, which can be considered as a second ground for fusion plasma.

References

[1] D. Lu, et al., Rev. Sci. Instrum.,85, 093301(2014)
[2] J. Xiao, et al., Rev. Sci. Instrum.,83, 013303(2012)
[3] J. Xiao. et al., Proc. IPAC2013 MOPFI066(2013)
[4] Z. Fei, et al., Phys. Rev. A 86, 062501(2012)
[5] W. Li, et al., Phys. Rev. A 91, 062501(2015)
[6] Z. Fei, et al., Phys. Rev. A 90, 052517(2014)
[7] M. Qiu, et al., J. Phys. B, 47,175002(2014)
[8] M. Qiu, et al., J. Phys. B, 47, 144029(2015)
[9] W. Li, et al., J.Phys.B.49 105002 (2016)
[10] M. Li, et al., Phys. Scr. 91 105401 (2016)
[11] B. Tu et al., Phy. Rev. A 96, 032705 (2017)

Figure 1 Spectra taken between 510 to 575 nm at 19 different electron beam energies. The W^{11+} line can be seen at 527.61 nm when the electron beam energy is larger than 200 eV.

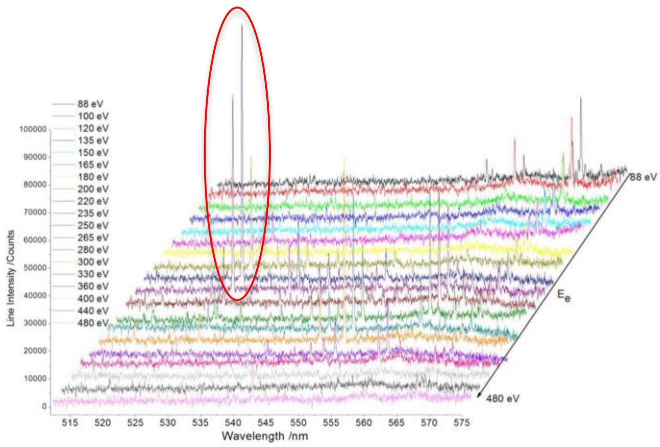

Figure 2 Levels diagram for the ground and first excited configuration of Ti-like W^{52+} ions.