ATOMIC DATA RESEARCH FOR VISIBLE M1 LINE EMISSION OF GROUND-STATE HIGHLY CHARGED TUNGSTEN IONS IN PLASMA

D. Kato[a,b], K. Fujii[c], M. Goto[a,b], I. Murakami[a,b], N. Nakamura[d], T. Oishi[a,b], H. A. Sakaue[a], N. Tamura[a], S. Morita[a,b] and LHD Experimental Group[a]

[a]National Institute for Fusion Science, Toki 509-5292, Japan
[b]Department of Fusion Science, The Graduate University for Advanced Studies SOKENDAI, Toki 509-5292, Japan
[c]Graduate School of Engineering, Kyoto University, Kyoto 615-8540, Japan
[d]Institute for Laser Science, The University of Electro-Communications, Tokyo 182-8585, Japan

Magnetic-dipole (M1) lines of ground-state highly charged tungsten ions in near-UV and visible ranges have diagnostic usefulness for D-T burning ITER plasmas. M1 lines in these wavelength ranges enable the use of fiber optics, and absolute intensity calibration of spectrometers is facilitated with standard lamps. A large number of previously unreported visible emission lines of tungsten ions W^{q+} (q = 8 – 28) are measured by using low-energy electron beam ion traps [1,2]. Some of them are identified as the ground-state M1 lines of W^{q+} in accord with theoretical predictions. We suceeded in observing an M1 line at 389.4 nm of ground-state W^{26+} ions ($4f^2$ $^3H_5 - {}^3H_4$) produced in Large Helical Device (LHD) [3]. Since then, a number of near-UV and visible M1 line emission from W^{q+} (q = 23 – 28) have been observed at the LHD [4].

M1 line intensity profiles are closely related to charge state distributions at given local electron temperatures. Ionization/recombination rate coefficients can be assessed based on poloidal distributions of the M1 line intensities because local electron temperatures on the poloidal cross section of LHD plasmas are precisely measured by Thomson scattering. An M1 line intensity at 337.7 nm of ground-state W^{27+} ions ($4f\ ^2F_{7/2} - {}^2F_{5/2}$) is measured and it is found that the intensity distribution has a peak at about 1 keV. This temperature agrees with that at which the theoretical ion abundance becomes maximum. Proton collision effects in population distributions of excited levels are theoretically investigated in the electric quadruple approximation for proton impact (de-)excitation cross sections. The present calculations predict a large enhancement of ground-state M1 line intensities induced by the proton collisions at temperatures of a few keV or higher. Based on this theoretical prediction, tungsten ion densities in LHD core plasmas are deduced from the measured M1 line intensities [5].

References

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