Modeling of transitions probability of tungsten ions in statistical Theory [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.219

Demura A.V., Leontyev D.S., Lisitsa V.S., Shurygin V.A.

NRC “Kurchatov Institute”, [leontievdmitiy@gmail.com](mailto:leontievdmitiy@gmail.com)

In the modern thermonuclear facilities tungsten is used as constructional material, and hence inevitably is found in the plasma discharge. Due to its large nuclei charge the radiative losses of the tungsten impurities in plasma could be quite large, that could lead to collapse and discharge disruption [1]. Therefore, the problem of monitoring tungsten density is an important point in the plasma diagnostics of modern tokamaks and stellarators.

At operational electron temperatures in thermonuclear installations (of the order of several keV), the tungsten ions emission from plasmas contains a quasicontinuum region [2], formed by the lines of transitions 4d-4f and 4p-4d. The goal of the paper is to obtain in the statistical model the envelopes of transition radiative probabilities of the array of spectral lines, calculated by quantum mechanical codes and presented via delta-shaped distributions over wavelengths *gА*(*λ*) for various electronic configurations.

The statistical model assumes that ion excitation, like radiation, is collective and arises with plasma frequencies determined by the local distribution of ion electron density , where *e* is the electron charge, *me* is its mass, *n*(*r*) is the electron density distribution. Also, using the well-known Reiche-Kuhn sum rule, we can relate the effective oscillator strengths *fij* with the electron density distribution *fij*=*4πn(r)r*2*dr*, normalized to the number of electrons in the shell under consideration. Thus, in the statistical approximation, the rates of radiative-collisional processes are functionals of the local ion electron density distribution, which allows their universal description [3]. Here the Slater electron density distribution is used , where the normalization constant *Nsl* is the number of equivalent electrons, , *Ip* is the ionization potential and *k* is the parameter determined from the experimental data. To calculate the probabilities of radiative transitions, we proceed from the expression for the dimensionless probability of radiative transitions *a*(*ω*), expressed via the photoabsorption cross section  as . The  in its turn could be evaluated in the statistical model [3]: After substituting  from [3] and integrating over the frequency with a variable upper limit (current *ω*), the probability distribution of the transitions in the wavelength scale is obtained. This result, multiplied by the statistical weight of the initial state *g* = (2*j* + 1), showed good agreement with the data of the quantum mechanical calculations.

References

1. Pütterich T., Dux R., Neu R., Bernert M. et al., Plasma Phys. Control. Fusion 55 (2013) 124036
2. Harte C. S., Suzuki C., Kato T., Sakaue H.A. et al., J. Phys. B: At. Mol. Opt. Phys. 43 (2010) 205004
3. Demura A.V., Kadomtsev M.B., Lisitsa V.S., Shurygin V.A. HEDP 15 (2015) 49

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Cm/ru/KF-Leontiev.docx) [↑](#footnote-ref-1)