Laser-gamma-nuclear spectroscopy of multicharged ions: "Shake-up" and co-operative excitation effects, New data

V. Buyadzhi[1], O. Khetselius[1], A. Svinarenko[1], and T. Florko[1]

[1] *Odessa State University - OSENU, Odessa*

Presenting Author: vbuyad@mail.ru

We study the class of problems which have been arisen and connected with modelling the cooperative laser-electron-nuclear phenomena such as the electron shell shake-up and NEET or NEEC (nuclear excitation by electron transition or capture) effects in heavy neutral atomic/nuclear systems [1-3]. Though the shake-up effects in the neutral atoms (molecules) are quite weak (because of the weak coupling of the electron and nuclear degrees of freedom), the possibilities of their realization significantly differ in a case of the multicharged ions and neutral atoms correspondingly. We develop an advanced relativistic approach to calculation of the probabilities of the different co-operative laser electron-gamma-nuclear processes in the multicharged ions (characteristics of the electron satellites in gamma-spectra of nuclei of the multicharged ions and the resonant NEET (NEEC) effects in heavy nuclei of multicharged ion). The theory is based on the relativistic energy approach (S-matrix formalism of Gell-Mann and Low) and relativistic many-body perturbation theory [3,4]. Within the energy approach, decay and excitation probability (of the electron shell shake-up process or etc) is linked with the imaginary part of energy of the excited state for the "electron shell-nucleus-photon" system. For radiative decays it is manifested as effect of retarding in interaction and self-action and calculated within QED perturbation theory formalism. We present new data about intensities of the electron satellites in gamma-spectra of nuclei in the neutral (low lying transitions) and the F-like, Ne-like multicharged ions for isotopes ^{133}Cs, ^{169}Tm, ^{173}Yb, which show existence of an new effect of the giant increasing (up 3-4 orders) electron satellites intensities (electron shell shake-up probabilities) under transition from the neutral atoms to the corresponding multicharged ions. We present the similar relativistic energy approach to the NEET (NEEC) process in the heavy multicharged ions and present new quantitative estimates of the corresponding NEET probabilities in the nuclei of ^{193}Ir, ^{235}U of the corresponding multicharged ions. The presented data demonstrate an effect of changing the corresponding NEET probabilities under transition from the neutral atomic/nuclear systems to the corresponding multicharged ions.

References

[1] M Morita Progr.Theor.Phys. **49**, 1574–1592 (1973); L.N. Ivanov, V. S. Letokhov JETP. **93**, 396–408 (1987); A. V. Glushkov, L.N. Ivanov Phys. Lett. **A170**, 33–37 (1992); A. Glushkov, L. Ivanov, V. Letokhov *Preprint ISAN N-AS4* (Moscow-Troitsk, ISAN, 1992), 12p.

[2] I. Ahmad *et al.* Phys. Rev. **C61**, 051304 (2000); S. Kishimoto *et al.* Phys. Rev. **C74**, 031301 (2006); A. Palffy *et al.* Phys. Rev. **A73**, 012145 (2006); E Tkalya Phys.Rev.A. **75**, 022509 (2007)

[3] A. Glushkov O. Khetselius, S. Malinovskaya *Frontiers in Quantum Systems in Chemistry and Physics Ser.: Progress in Theoretical Chemistry and Physics, Eds. S. Wilson et al* (Springer, Berlin, 2008) **18**, 523-545; Europ. Phys. Journ. **T160**, 195–208 (2009)

[4] O. Khetselius Int. J. Quant. Chem. **109**, 3330-3336 (2009); Phys. Scripta. **T135**, 014023 (2009); J. of Phys: C Ser. **397**, 012012 (2012)