Atomic and Nuclear quantum optics: Multiphoton and autoionization resonances in a strong DC electric and laser field

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We present an advanced combined relativistic operator perturbation theory (PT) and energy approach [1,2] and apply it to studying interaction dynamics of the finite Fermi systems (heavy atoms, nuclei, molecules) with an intense external (DC electric and laser) field. The approach allows uniform, consistent treating the strong field and quasistationary and collisional problems. It is based on the Gell-Mann and Low adiabatic formalism and method of the relativistic Green's function for the Dirac equation with complex energy. The essence of the operator PT is the inclusion of the well-known method of "distorted waves approximation" in the frame of the formally exact PT. Results of the calculation for the multi-photon resonance and ionization profile in Na,Cs, Ba atoms are listed. We have studied the cases of single-, multi-mode, coherent, stochastic laser pulse shape. An account for stochastic fluctuations in a field effect is of a great importance. New data on the DC, AC strong field Stark resonances, multi-photon and autoionization resonances, ionization profiles for a few heavy atoms (Eu, Tm, Gd, U) are presented. It has been firstly studied earlier discovered a giant broadening effect of the autoionization resonance width in a sufficiently weak electric (laser) field for uranium It is declared that probably this effect is universal for optics and spectroscopy of lanthanides and actinides and even superheavy elements. The direct interaction of super intense laser fields in the optical frequency domain with nuclei is studied within the operator PT and the relativistic mean-field (plus Dirac-Woods-Saxon) model [2]. The ac-Stark shifts of the same order as in typical quantum optical systems relative to the respective transition frequencies are feasible with state-of-the-art or near-future laser field intensities. A nuclear dynamic (AC) Stark shift of low-lying nuclear states due to off-resonant excitation by laser field (10^{25}-10^{35} W/cm^2) is studied and is described within the operator PT and the relativistic mean-field (RMF) model for the nucleus [2]. We present the results of AC Stark shifts of single proton states in the nuclei ^{16}O, ^{168}Er and compared these data with known results by Keitel et al [3]. New data are also listed for the ^{57}Fe and ^{171}Yb nuclei. Shifts of several keV are reached at intensities of roughly 10^{32}-10^{34} W/cm^2 for ^{16}O, ^{57}Fe and heavier nuclei. It is firstly presented a consistent relativistic theory of multi-photon resonances in nuclei and first estimates of energies and widths for such resonances are presented for ^{57}Fe and ^{171}Yb nuclei.

References

[1] A. Glushkov *et al.* Eur. Phys. J. **T160**, 196–208 (2008); Phys.Scripta. **T135**, 014022 (2009)
[2] A. V. Glushkov *et al.*, *Adv. in Theory of Quantum Systems in Chem. and Phys., Ser.: Progress in Theor.Phys. and Chem., Eds. P.Hoggan, E.Brändas et al* (Springer, Berlin, 2011) **22**, 51–70; J.Phys.: C Ser. **397**, 012011 (2012)
[3] V. Gol'dansky and V. Letokhov JETP. **78** 213–218 (1974); T. Burvenich, J. Evers, C.Keitel Phys.Rev. **C74**, 044601 (2007)