LASER SEPARATION AND SENSING THE ISOTOPES AND NUCLEAR REACTION PRODUCTS AND DETECTING THE HYPERFINE STRUCTURE PARAMETERS FOR THE HEAVY-ELEMENTS

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New sensing methodic for sensing the hyperfine structure parameters of the heavy elements is carried out. Theoretical scheme for hfs parameters definition is based on gauge-invariant QED perturbation theory with using the optimized one-quasiparticle representation at first in the theory of the hyperfine structure for relativistic atomic systems [2,3]. Within the new method it is carried out calculating the energies and constants of the hyperfine structure for valent states of cesium ^{133}Cs, Cs-like ion Ba, isotopes of ^{201}Hg, ^{223} Ra, ^{252}Cf are defined. The contribution due to inter electron correlations to the hyperfine structure constants is about 120-1200 MHz for different states, contribution due to the finite size of a nucleus and radiative contribution is till 2 dozens MHz. The obtained data for hyperfine structure parameters are used in further in the laser photoionization detecting the isotopes in a beam and the buffer gas for systematic studying the short-lived isotopes and nuclear isomers. We propose a new approach to construction of the optimal schemes of the laser photoionization method for further applying to problem of the nuclear reactions products sensing. It's studied the reaction of spontaneous ^{252}Cf isotope fission on non-symmetric fragments, one of that is the cesium nucleus. The corresponding experiment on detecting the reactions products is as follows [1]. The heavy fragment of the Cf nucleus fission created in the ionized track 10^6 electrons, which are collected on the collector during 2 mks. The collector is charged negatively 40mks later after nuclear decay and 10mks before the laser pulse action. The photo electrons, arisen due to the selective two-stepped photoionization, are drafted into the proportional counter for their detecting. Usually a resonant excitation of Cs is realized by the dye laser pulse, the spectrum of which includes the wavelengths of two transitions $6^2S_{1/2}$-$7^2P_{3/2}$ (4555A) and $6^2S_{1/2}$-$7^2P_{1/2}$ (4593A). This pulse also realizes non-resonant photoionization of the Cs excited atoms. The disadvantages of the standard scheme are connected with non-optimality of laser photoionization one, effects of impact lines broadening due to the using the buffer gas, the isotopic shift and hyperfine structure masking etc [1]. We proposed new laser photoionization scheme, which is based on a selective resonance excitation of the Cs atoms by laser radiation into states near ionization boundary and further autoionization decay of excited states under action of external electric field [4-6]. The corresponding optimal parameters of laser and electric fields, atomic transitions, states, decay parameters etc are presented.

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