Unified quantum-mechanical theory precise calculation of the electron-positron pair production in intense laser field and in heavy atomic nucleus collisions, atomic parity nonconservation effect

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A consistent unified quantum mechanical and quantum-electrodynamical approach (operator perturbation theory method and QED perturbation theory) is adapted to collision problem: The electron-positron pair production in collisions between two heavy nuclei and collisions between two atoms with the electron-ejection effect [1-3]. It is proposed the modified version of the many-body perturbation theory for calculation of the atomic parity nonconserving effect (it's applied to calculation of heavy atom of Cs). Method is in some details different from the other approaches (c.f.[1-3]). New calculation schemes for the electron-positron pair production in collisions between two heavy nuclei with near-threshold energy and in the intense laser field is considered. In first case a consistent quantum-mechanical approach (operator perturbation theory method) [1-4] to a electron-nuclear system as a whole is used account being taken of the relativistic nature of the electron subsystem.The model potential of the whole electron-nuclear system accounts the finite size of nuclei and possible resonances of the super-heavy compound nucleus formed from original nuclei [1]. Resonance phenomena in the nuclear subsystem lead to the structurization of the positron spectrum produced. To calculate the electron-positron pair production cross-section in both cases, we use modified versions of the relativistic energy approach, based on the S-matrix Gell-Mann and Low formalism (c.f.[1-3]). Some calculation results (U-U collisions etc.) are presented. New numeral calculation scheme for calculation of collisions process between two atoms with the electron-ejection effect have been proposed. Results are presented of calculations for the energy levels, hyperfine structure intervals, E1-,M1-transitions amplitudes in heavy atoms of Cs,Sn,Pb (parity nonconserving 6s-7p dipole amplitude in Cs; calculations lead to the value: $< 6s|D_z|7s > =$ -0.92 $\times i10^-11i|e|ao(-Qw/N)$.

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