**Spectroscopy Of Heavy Hadronic (Pionic) Atoms: Energy Shifts And Widths And Strong Interaction**

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# SPECTROSCOPY OF HEAVY HADRONIC (PIONIC)ATOMS: ENERGY SHIFTS AND WIDTHS AND STRONG INTERACTION CORRECTIONS

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We present the relativistic approach to describe the energy and spectral characteristics of hadronic (pionic) atoms based on the Klein-Gordon-Fockequation with optimized ¯-N interaction optical potential and relativistic many-body perturbation theory with Dirac-BreitKohn-Sham zeroth approximation Hamiltonian and correct treating radiation, electronscreening, nuclear effects (finite size, quadrupole deformation) effects.It is developed a precise theory for calculating energy levels shifts and widths, provided by a strong ¯-N interaction ("strong" width) and the interaction of the pion with QED vacuum (radiation width) within the model optimized optical complex ¯-N interaction potential and relativistic energy approach based on the Gell-Mann and Low formalism with complex relativistic e-e interaction potential. For a number of heavy atoms, including, ¯-$^{165}$Ho,$^{169}$Tm,$^{173}$Yb, $^{175}$Lu, $^{181}$Ta, $^{197}$Au, $^{203}$Tl, $^{208}$Pb, $^{209}$Bi, there are obtained the values 4f and 3d levels shifts and widths, caused by a strong ¯-Ninteraction, including correction directly related to the effect of nuclear quadrupoledeformation.It has been carried out computing energy (electromagnetic) contributions (Coulomb, radiation corrections, incl. polarization of vacuum, such as UehlingSerber, Wichman-Kroll and Kallen-Sabryones, Breit-Rosenthal-Crawford-Schawlow effect etc.).