

## Spectroscopy of Hadronic Molecules and Molecules with Superheavy Elements: Spectra, Energy Shifts and Widths for Different Nuclear Models

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A great interest to studying the superheavy elements and their molecular compounds has been stimulated by inaugurating the heavy-ion synchrotron storage cooler ring combination SIS/ESR at GSI. With this facility, which allows to produce, store and cool fully stripped heavy ions beams up to  $U^{92+}$  and to create the superheavy molecules [1], new ways are opened in the field of molecular and nuclear spectroscopy from this side. Paper is devoted to studying the spectra, potential curves, radiative corrections for hadronic molecules and molecules with superheavy elements X113, X114 with account of the definite nucleus structure modelling. One of the main purposes is establishment a quantitative link between quality of the nucleus structure modelling and accuracy of calculating energy and spectral properties of the molecular systems. We apply our numerical code [2] to calculating spectra of the hadronic (pion, kaon, hyperon) molecules. A new ab initio approach [2] to relativistic calculation of the spectra for superheavy molecules (XH) with an account of relativistic, correlation, nuclear, radiative effects on the basis of gauge-invariant QED perturbation theory is proposed. Zeroth approximation is generated by the effective ab initio model functional, constructed on the basis of the comprehensive gauge invariance procedure [2]. The wave functions zeroth basis is found from the Klein-Gordon (pion atom) or Dirac (kaon, hyperon) equation. The potential includes the core ab initio potential, the electric and polarization potentials of a nucleus (the Fermi and Gauss models and the uniformly charged sphere model are considered). For low orbits there are important effects due to the strong hadron-nuclear interaction (pion system. The energy shift is connected with length of the hadron-nuclear scattering (scattering amplitude under zeroth energy). For superheavy elements the correlation corrections of high orders are accounted within the Green functions method. The magnetic inter-electron interaction is accounted in the lowest order, the Lamb shift polarization part – in the Uhling-Serber approximation, self-energy part – within the Green functions method. We are carrying out the calculation of the following systems :1).energy levels, hfs parameters for superheavy X113, X114 atoms and one-centre studying the spectra and potential energies for the XH molecules for different models of charge distribution in a nucleus; 2). Shifts and widths of transitions (2p-1s,3d-2p, 4f-3d) in some exotic pionic and kaonic molecules with  $^{18}O$ ,  $^{24}Mg$  etc. and also  $K^{-4}He$ .

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