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Hyperfine structure of S-states in muonic ions of lithium, beryllium and boron

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Precision investigation of the hyperfine structure (HFS) of the energy spectrum of light muonic atoms is an important task nowadays. It allows us to check the standard model and obtain more precise values of fundamental physical constants. The relevance of such research is connected with the experiments carried out by CREMA Collaboration. In these experiments Lamb shift of 2S and 2P and HFS for muonic hydrogen and muonic deuterium was obtained by means of laser spectroscopy. To calculate HFS of muonic ions we use quasipotential method in quantum electrodynamics, where the bound state of muon and nucleus can be described by means of Schrodinger equation and the potential is constructed with the use of scattering off-shell amplitude. The main contribution to the interaction operator of two particles is given by the well-known Breit Hamiltonian. In perturbation theory infinite series for the interaction operator of particles includes contributions of different kinds of interactions, primarily electromagnetic. Relativistic corrections of order α^6 and also the contribution of anomalous magnetic moment of muon are known in analytical form. One- and two-loop vacuum polarization effects of order α^5 and α^6 in first and second order perturbation theory were obtained in integral form and evaluated numerically. One of the leading contributions to the HFS is given by the nuclear structure effect. Such effects can be described by means of two-photon exchange amplitudes. To calculate these amplitudes and also to calculate amplitudes of higher order of α the approach of projection operator was used. We also calculate more complicated corrections that involve combined effects of vacuum polarization, relativism and nuclear structure of order α^6. Furthermore the dependance of the calculated contributions on the charge Z of the nucleus was studied and final numerical values of HFS were obtained.

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