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The contribution of the sigma-meson to the Lamb shift of muonic hydrogen

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Among the various electromagnetic interactions, the processes of two-photon meson production take a special place. First, they have been studied experimentally for quite a long time, for which a rich material has been accumulated. Secondly, with the development of the quark model and nonperturbative methods of quantum chromodynamics, such reactions, as well as the reverse decay processes of mesons into two photons, were constantly in the field of intensive theoretical studies. A new round of interest in such processes is connected with their possible role as a new source of interactions between leptons and nucleons. Since in atomic physics there are precise experiments to measure the fine and hyperfine structure of the spectrum, any new contributions to the particle interaction operator are important and can be studied experimentally. The first estimate of the contribution of effective meson exchanges in muonic hydrogen, which have already appeared, show that this contribution can be significant. In this study we extend our analysis to the case of scalar mesons. There are several scalar mesons with the mass near 1 GeV, which can contribute to the effective muon-proton interaction: f0(550) (or sigma), f0(980), a0(980), f0(1370). On the basis of quasipotential method in quantum electrodynamics we construct the muon-proton interaction amplitudes due to scalar meson exchange. Analytical expressions for corresponding energy shifts in the case of 2S- and 2P-states are obtained. Using quark model we calculate parameters of two-photon - scalar meson transition form factor and obtain numerical estimate of the contribution to the Lamb shift (2P-2S) in muonic hydrogen.

Primary author(s) : Dr. DOROKHOV, Alexandr; Dr. MARTYNENKO, Alexey; MARTYNENKO, Fedor; Mr. RADZHABOV, Andrei

Presenter(s) : MARTYNENKO, Fedor

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