Collisional quenching of the pionic helium long-lived states

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About 60 years ago G. Condo [1] suggested a possible existence of long-lived states of pionic and kaonic helium atoms ($\pi^-\mathrm{He}^+$ and $K^-\mathrm{He}^+$) in order to explain that a some fraction (about 2%) of the negative mesons decays after the stopping in the helium target, contrary to the hydrogen target. A direct experimental evidence of the similar states was obtained by the observation of the time spectra of the products of K^- decay and of the products of K^- and π^- nuclear absorptions. The discovery of the similar metastable states of antiprotonic helium [2] opened a whole new area of the study that bring an extensive information on the exotic atoms and fundamental antiproton characteristics [3,4]. Recently laser-induced transition in pionic helium was observed for the first time [5]. A possibility of the further precision laser spectroscopy of this system depends, in particular, on the stability of the states against the quenching by collisions with the medium atoms. We consider Stark transitions between the highly excited states in the collisions $(\pi^-\mathrm{He}^+)^*_{nL} + \mathrm{He} \to (\pi^-\mathrm{He}^+)^*_{nL'} + \mathrm{He} \quad (L' \neq L)$, which can be expected as the most probable due to a small difference of the inner initial and final energies. The cross sections and transition rates are calculated by solving the close coupling equations involving the different L at a fixed n. In order to obtain an interaction between the colliding systems we calculate the Potential Energy Surface (PES) of the three electrons in the field of three heavy particles (two α-particles and π^-). (Similar PES calculations were done in the paper [6], however no results for the potential were published.) Dependencies of the Stark transition cross sections on the quantum numbers of the states and on the initial kinetic energy will be presented in the talk.

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