# Rotational transitions in hydrogen-helium muonic molecules

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Rotational $1 \rightarrow 0$ deexcitation of muonic molecule $(^3\mathrm{He}\mu h)^{++}$, in $(^3\mathrm{He}\mu h)^{++}_{J=1} + \mathrm{H} \rightarrow (^3\mathrm{He}\mu p)^{++}_{J=0} + h + e$ process was investigated, where $h$ and $H$ stands for a hydrogen isotope nucleus and atom, respectively. The corresponding cross sections and reaction rates were calculated as functions of collision energy between 0.001eV and 0.5 eV. The results reveal very rich resonant structures below 0.3eV being directly inherited from the elastic domain, especially for $(^3\mathrm{He}\mu p)^{++}_{J=1} - \mathrm{H}$ collisions. The background reaction rates (normalized to LHD) are approximately equal: $2 \cdot 10^{11}\ s^{-1}$ for $(^3\mathrm{He}\mu p)^{++} - \mathrm{H}$, $10^{10}\ s^{-1}$ for $(^3\mathrm{He}\mu d)^{++} - \mathrm{D}$, and $4 \cdot 10^{9}\ s^{-1}$ for $(^3\mathrm{He}\mu t)^{++} - \mathrm{T}$ collisions. The total cross section, calculated with the relative accuracy of $10^{-3}$, is determined by partial waves of the initial channel for $l_i^{max} = 15 - 200$ in the range of collision energy considered. The resonances are relatively narrow especially for collision energies below 0.15 eV. Cross sections at resonant energies exceed the background cross section by at most one order of magnitude. The obtained reaction rates for the $1 \rightarrow 0$ transitions are at most two orders of magnitude smaller than the corresponding muonic molecule decay rates. One can expect, however, that the transition occurring mostly in collisions with hydrogen molecules (instead of atoms) will be faster due to electron screening in the final channel.