Muonic atom scattering from hydrogen molecules using the Morse potential

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The differential cross sections for the scattering $d\mu + H_2$ and $t\mu + H_2$ have been calculated for different initial rotational states and for the collision energies $\varepsilon \leq 30$ eV. The previous model, based on the harmonic internuclear interaction [1], is insufficient at collision energies close and greater than the molecular-dissociation energy $E_{diss} \approx 4.7$ eV. In our approach, the Morse potential has been used, which describes muonic hydrogen scattering from hydrogen molecules in a more realistic and accurate way. Both the vibrational anharmonicities and centrifugal distortions in the highly excited states, as well as the molecular dissociation, have been taken into account. The presented model reproduces results obtained in the harmonic and in the free-nuclei approximations in a low and in a high energy limits, respectively. Comparison between the results obtained using the Morse and the harmonic potentials has been performed. The calculated differential cross sections are necessary for a proper description of higher-energy muonic-atom experiments with low-density hydrogen targets. These calculations represent a clear improvement on the previous models, which provides a good description of the muonic atom scattering in a wide energy range.

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[1] A. Adamczak, Phys. Rev. A **74**, 042718 (2006).