

Pion absorption from the lowest atomic orbital in ${}^2\text{H}$, ${}^3\text{H}$ and ${}^3\text{He}$

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The $\pi^- + {}^2\text{H} \rightarrow n + n$, $\pi^- + {}^3\text{H} \rightarrow n + n + n$, $\pi^- + {}^3\text{He} \rightarrow n + d$ and $\pi^- + {}^3\text{He} \rightarrow p + n + n$ capture reactions from the lowest atomic orbitals are studied under full inclusion of final state interactions. Our results are obtained with the single-nucleon and two-nucleon transition operators derived at leading order in chiral effective field theory. The initial and final three-nucleon states are calculated with the chiral nucleon-nucleon SMS potential up to N^4LO^+ augmented by the consistently regularized chiral N^2LO three-nucleon potential. We found that absorption rates depend strongly on the nuclear pion absorption operator used, and its two-body parts change the rates by a few orders of magnitude. The final state interactions between nucleons generated by the two-nucleon forces are also important, while the three-nucleon interaction plays a visible role only in the $\pi^- + {}^3\text{He} \rightarrow n + d$ reaction. Our absorption rate for the $\pi^- + {}^2\text{H} \rightarrow n + n$ process is in good agreement with the experimental data from the hadronic ground-state broadening in pionic deuterium. The capture rates on ${}^3\text{He}$ are also generally consistent with the spectroscopic data within error bars, though our central values are found to be systematically below the data. We show that for the three-body breakup processes the dominant contributions to the absorption rates arise from the quasi-free scattering and final-state interaction kinematical configurations.

Collaboration

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