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Modeling proton–deuteron interactions for the femtoscopic correlation method using exact calculations of two-body dynamic.

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One of the most compelling topics in interaction studies in recent years is the investigation of the proton-deuteron (\textit{p-d}) system. This system is of particular interest because it involves interactions between three nucleons, as the deuteron is composed of both a proton and a neutron. Therefore, it serves as a valuable laboratory for exploring many-body physics. A widely used method for investigating such interactions is femtoscopy, which analyzes momentum correlations between particles. However, modeling \textit{p-d} system is particularly challenging. Due to the deuteron's large size, the interaction can extend over several femtometers, raising questions about the extent to which it can be described as a two-body problem and highlighting the limitations of commonly used approximations. In this work, two approaches for describing \textit{p-d} correlations are examined: the Lednick\'{y}-Lyuboshits formalism and exact, fully numerical solutions of the Schr\"odinger equation. The study reveals significant differences between the two methods. Furthermore, it demonstrates advanced improvements in two-body description by incorporating higher-order partial waves into the calculations.

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