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Role of a weakly bound core nucleus in the breakup of a weakly bound halo nucleus

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A study of breakup reactions involving the $^{9}\mathrm{C}$ and $^{30}\mathrm{F}$ weakly bound nuclei is presented. The $^{9}\mathrm{C}$ is modelled as $^{9}\mathrm{C} \to {}^{8}\mathrm{B} + p$, where $^{8}\mathrm{B} \to {}^{7}\mathrm{Be} + p$, with a proton ground state separation energy of $S_p = -0.137$\,MeV. The $^{30}\mathrm{F}$ is modelled as $^{30}\mathrm{F} \to {}^{29}\mathrm{F} + n$, where $^{29}\mathrm{F} \to {}^{27}\mathrm{F} + n + n$, with a two neutrons ground state separation energy of $S_p = -1.443$\,MeV. In order to analyze the role of these weakly bound core nuclei on the breakup observables, instead of taking on more complicated four-body and five-body systems, we limit the study to the role of static effect which is associated with the ground state wave function. To this end, the core-target nuclear potentials are constructed as follows. For the $^{9}\mathrm{C}$ nucleus, the $^{8}\mathrm{B}$-target nuclear potential is constructed by first obtaining the density of the halo proton within the $^{8}\mathrm{B} + p$ system. Then, this density together with the density of the ^{7}Be nucleus are used to obtain the density of the core nucleus ^{8}B. This density is then used to construct the ^{8}B-target nuclear potential by means of a double folding procedure. For the ^{29}F-target nuclear potential, the ^{29}F is treated as $^{29}\mathrm{F} \to {}^{27}\mathrm{F} + {}^{2}n$. The potential parameters are tuned such that the obtained wave function matches the asymptotic behavior of the ^{29}F three-body wave function. Then, the ^{29}F-target nuclear potential is constructed using the same approach. In both cases, the three-body breakup observables are obtained by means of the continuum discretized coupled-channels (CDCC) formalism.

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