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The photodisintegration cross section of ^{9}Be and ^{12}C within Cluster Effective Field Theory

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The photodisintegration processes $\gamma+^{12}\mathrm{C} \to \alpha+\alpha+\alpha$ and $\gamma+^{9}\mathrm{Be} \to \alpha+\alpha+n$ are reactions of astrophysical relevance, both representing a path to carbon nucleosynthesis. Here we present a thorough study of the latter process [1], which is relevant in specific astrophysical environments involving a large number of neutrons.
The photodisintegration of $^9\mathrm{Be}$ is analyzed in the low-energy regime using a three-body *ab initio* approach, where the cross section is calculated by means of the Lorentz integral transform method [2], in conjunction with a non-symmetrized hyperspherical harmonics basis [3,4]. In studying the three-body system provided by the Borromean $^9\mathrm{Be}$ nucleus, i.e. $\alpha\alpha n$, the two-body interactions are derived using a halo/cluster effective field theory approach [5]. This *effective clustering* description is permitted by the clear separation of energy scales, which are defined by the shallow binding of $^9\mathrm{Be}$ below the $\alpha\alpha n$ threshold (≈ 1.57 MeV) and the deep binding of the α-particle (≈ 20 MeV). To correctly reproduce the $^9\mathrm{Be}$ three-body binding energy, a state-dependent three-body force is also introduced in the model. Our results for the cross section are consistent with the experimental data available from the literature, particularly in the energy range just above the three-body threshold. We will also briefly discuss the interesting results regarding the contribution to the cross section from nuclear current terms beyond the one-body term.
The same approach can also be used to study $^{12}\mathrm{C}$ photodisintegration. However, we are still in the early stages of analysing this process and further research is necessary [6].

References

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