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Two-neutron decay of ^{16}Be in a three-body model

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Recently, two-proton and two-neutron decays have become the focus of both experiment [1] and theory [2]. A 2012 experiment at the National Superconducting Cyclotron Laboratory saw the first measurement of a dineutron decay, from the neutron-rich nucleus ^{16}Be [3]. Based on fits to the two-neutron energy and the opening angle between the two neutrons, it was claimed that ^{16}Be decays to ^{14}Be by a dineutron decay. ^{16}Be is ideal for simultaneous two-neutron decay as a lower limit to the ground state of ^{15}Be was set at 1.54 MeV [4], making the ground state in ^{15}Be energetically inaccessible for a sequential decay. Although an $l = 2$ state was observed in ^{15}Be [5] at 1.8 MeV, very little is known about this nucleus. Depending on the width of this intermediate state, sequential decay could still be possible.

Three-body models are often used to study such systems as they allow exact treatment of the degrees of freedom relevant for the decay. In our three-body system, ^{14}Be + n + n, the degrees of freedom in the core are frozen, and it is therefore important to accurately reproduce the two-body subsystems with suitable nn and n-^{14}Be effective interactions. These interactions are often constrained by experimental data; however, since there has only been one level observed in ^{15}Be [5], we rely on shell model calculations to fix the other partial waves of the n-^{14}Be interaction. Three-body interactions are typically included to account for the extra binding that is missing when the degrees of freedom in the core are removed. Occupied states in the core and anti-symmetrization between the two valence neutrons must also be taken into account. In this work, the three-body Schr\"odinger equation is solved using hyperspherical harmonics and the R-matrix method, from which resonance energies and widths are extracted. [6]

Here, we will present our calculations for the resonant ground state of ^{16}Be, assuming a $d_{5/2}$ or $s_{1/2}$ ground state in ^{15}Be. We will discuss the convergence of the system, which requires a significantly larger model space than bound state calculations using similar methods (for example, [7]). Also, we will investigate the role of the nn interaction in this system, giving insight into future work that can further our understanding of the decay in two-neutron systems, both in ^{16}Be as well as in other neutron-rich nuclei.

References:

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