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Neutron Transfer Reactions for Deformed Nuclei Using Sturmian Basis

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Abstract

We study the spin-parity distribution P(J^{π},E) of ^{156}Gd excited states above the neutron separation energy $S_n = 8.536$ MeV [1] that are expected to be populated via the neutron pickup reaction ^{157}Gd(^{3}He,^{4}He)^{156}Gd. In analogy with the rotor plus particle model [2], we view excited states in ^{156}Gd as rotational states built on intrinsic states consisting of a neutron hole in the ^{157}Gd core; that is, a neutron removal from a deformed Woods-Saxon type single-particle state [3] in ^{157}Gd. To understand the impact of the deformation and what should be considered as a small deformation, calculations of Woods-Saxon type single-particle states were performed using several codes [4–10]. For small non-zero deformation we used the codes from Ref. [5–8], while for large deformation we selected only the code by Cwiok *at al.* [5]. The pairing effects within the core are accounted for through the BCS pairing model [11,12] while the particle-core interaction usually dominated by a Coriolis coupling are accounted via first order perturbation theory to the particle-core Coriolis coupling [12]. The reaction cross section to each excited state in ^{156}Gd is calculated as coherent contribution using standard reaction code [10] based on spherical basis states. The spectroscopic factor associated with each state is the expansion coefficient of the deformed neutron state in a spherical Sturmian basis along with the spherical form factors [12]. A smooth total cross section, as a function of the excitation energy, is generated using Lorentzian smearing distribution function. Our calculations show that, within the assumptions and computational modeling, the reaction ^{3}He+^{157}Gd $\rightarrow$ ^{4}He+^{156}Gd* has a well-behaved formation probability P(J^{π},E) within the energy range relevant to the desired reaction ^{155}Gd+n $\rightarrow$ ^{156}Gd*.

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