Evolution of alpha cluster preformation probability in neutron-rich $^{41,45,49}Ca^*$ nuclear systems

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The light neutron-rich nuclei play a key role in the nucleosynthesis and α-clustering can significantly affect the astrophysical reaction rates. Therefore, it is intriguing to study the isotopic dependence of α-clustering in light mass Ca isotopic chain with magic proton number. In this work, the clustering effects in $^{41,45,49}Ca^*$ nuclei formed in neutron induced reactions have been investigated within the quantum mechnaical fragmentation theory based dynamical cluster decay model (DCM) [1]. The results present that while moving towards neutron-rich $^{45}Ca^*$ and $^{49}Ca^*$ nuclei, the α-cluster preformation factor P_0 deceases considerably. The inculcation of relativistic mean field theory (RMFT) based microscopic T.B.E. [2, 3] within DCM, give comparatively an enhanced α-cluster preformation factor for $^{41,45,49}Ca^*$ nuclei in comparison to the case of macroscopic T.B.E. based upon Davidson mass formula. Further, the cross-section associated with α-cluster emission falls off considerably with increasing n/p asymmetry of Ca^* nuclei. This trend is analogous to α-cluster preformation factor trend, demonstrating that P_0 contains the nuclear structure information of decaying nucleus. Furthermore, we inculcate the microscopic nuclear potential constructed via folding the RMFT cluster densities and M3Y nucleon-nucleon interaction within the DCM [4] to calculate the P_0. The neutron skin thickness R_{skin} of the Ar cluster, complementary to α-cluster, is varied by changing the half-density radius of cluster density and its subsequent impact upon the α-cluster preformation factor is investigated. The results depict that with evolution of neutron skin thickness of Ar cluster, there is a reduction in the α-cluster preformation factor. It portrays a strong correlation among R_{skin} and P_0 in these light mass nuclear systems.

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