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Cubic potential models for cluster radioactivity

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Abstract. Cluster radioactivity is a process by which nuclei equal and heavier than the α-particle is emitted spontaneously. The clusters usually emitted in this process are the α-particle, carbon, oxygen, neon, magnesium, silicon etc. When the mass of the cluster becomes comparable with the mass of the daughter, symmetric fission takes place. Thus the cluster radioactivity is an intermediate process between the well known α-decay and the spontaneous fission. In earlier years such cluster radioactivity was found mostly in actinide nuclei like radium, uranium etc. Very recently it has been predicted that such decays are possible in a new region around ^{114}Ba. There has been an exciting experimental detection of the emission of ^{12}C from ^{114}Ba leading to ^{102}Sn, which is attracting a lot of attention recently.

To study the phenomenon of cluster radioactivity there are various theoretical models in vogue. The existing models generally fall under two categories: the unified fission model (UFM) and the preformed cluster model (PCM). The physics of the UFM and the PCM are completely different. The UFM considers cluster radioactivity simply as a barrier penetration phenomenon in between the fission and the α-decay without worrying about the cluster being or not being preformed in the parent nucleus. In the PCM clusters are assumed to be preborn in a parent nucleus before they could penetrate the potential barrier with a given Q-value. The basic assumption of the UFM is that heavy clusters as well as the α-particle have equal probability of being preformed. In PCM, clusters of different sizes have different probabilities of their being preformed in the parent nucleus.

We have developed three fission models during the last decade using the cubic potential for the pre-scission region. The use of these models in the study of cluster radioactivity in both the actinide and barium regions will be discussed in this talk in comparison with the other existing theories.

Keywords. Cluster radioactivity; fission models.

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