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HALF-LIVES AND CLUSTER RADIOACTIVITY

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Abstract:

George Gamow provided the first model to explain alpha-decay, which can be used to formulate the relationship between energy of alpha particle and the tunnelling probability. In the present work we have employed Gamow's theory for evaluating the decay rates of cluster emitters. The pre-formations of cluster radioactivity have been analysed in the framework of the preformed cluster model for heavy nuclei. The penetration probability mainly determines the half-life of the cluster radioactivity. This work is theoretical where a simple square well potential is assumed for quantum mechanical tunnelling.

Using the modified formula, the penetration probability and thereby the half lives of the element has been calculated. In recent years we have access to a large amount of experimental data available on the newly synthesised alpha emitters. We have calculated half lives for 21 elements where Half lives varied from 1.0×10^{11} sec to 1.5×10^{32} sec. The graph has been plotted between the experimental log T1/2 to calculated log T1/2 and was found to be linear. This shows that the calculated half-lives are in good agreement with the experimental half-lives within one order of magnitude.

Gamow's theory has been experimentally verified using Geiger-Nuttal law. This law is valid for the radioactivity of all clusters (including α particles), by considering the clusterization and subsequent decay of nucleons within the nucleus. The law has been verified by plotting several graphs between calculated log T1/2 and the energy Q (MeV). It shows a linear relation between the half-lives of the decaying clusters and their corresponding Q-values. We have divided the α-decaying nuclei into four regions:
(I) N≤126, Z≤82;
(II) N≤126, Z>82;
(III) N>126, Z>82;
(IV) N>126, Z≤82.
Our work is concentrated on the elements from III region.

The Barrier height, Barrier width and Barrier area have been calculated for the above elements. Graphs have been also plotted between experimental log T1/2 and Barrier area. It was found to be linear which is in agreement with the theory. The model reproduces cluster decay half-lives using the same radius constant as 1.2 fm.

Keywords: Gamow's theory, cluster decay, Pre-formation factor, half life, G.N.Law,

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