Alpha decay by cubic plus Yukawa plus exponential model

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Introduction

Cluster Radio Activity is an important field of research where heavy nuclei like Fr, Ra, Ac, Th, Pa, U and Np have been found to emit clusters which are heavier than alpha nuclei.

The first experimental discovery of this new kind of natural radio activity by emission of C^{14} from Ra^{233} was reported in January 1984 by Rose and Jones (1).

Cubic plus Yukawa plus exponential model (CYCM) model

Several authors tried to explain the cluster radioactivity by constructing several theoretical models

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In this project we calculate the half life of alpha decay in some nuclei by using cubic plus Yukawa plus exponential model (CYCM) of Shanmugam and Kamalaharan(2) and compared it with the available experimental values.

Here we have considered the alpha emission similar to the emission of cluster. In this model the shape of the barrier in the overlapping region which connects the ground state and the contact point is approximated by a third order polynomial.

Potential equation

The potential for the post session region has been calculated using the formula

$$V(r) = \frac{Z_1 Z_2 e^2}{r} + V_p(r - rt) - Q$$

Half life calculation

Half life of the alpha emission is calculated using the formula

$$T = \frac{\left[1.433 \times 10^{-21}(1 + \exp L)\right]}{E_v}$$

Results

Table 1 show that CYCM is able to give half values for Alpha emission which are closer to experimental values.

So we suggest that CYCM model is very good model to explain alpha decay apart from the cluster emission in the medium and heavy mass region.

References

[1] H J Rose and G A Jones, Nature 307, (1984), 245

[2] G Shanmugam and B Kamalakaran Phy.Rev C 38, (1988), 1377

Parent Nuclei	Q Value MeV	Log T sec This Work	Log T sec Expt. Work
$^{152}Gd_{64}$	2.203	21.35	21.54
$^{190}Pt_{78}$	3.245	19.19	19.34
$^{198}Po_{84}$	6.306	1.88	2.03
$^{208}Rn_{86}$	6.266	3.01	3.16
$^{222}Ra_{88}$	6.678	1.43	1.58
$^{226}Ra_{88}$	4.871	10.51	10.70
$^{228}Th_{90}$	5.520	7.60	7.78
$^{230}Th_{90}$	4.771	12.20	12.39
$^{230}U_{92}$	5.992	6.17	6.26
$^{236}U_{92}$	4.573	15.06	14.88
$^{242}Pu_{94}$	4.984	12.90	13.09
$^{244}Cm_{96}$	5.902	8.96	8.76
$^{252}Cf_{98}$	6.217	7.73	7.92
$^{256}Fm_{100}$	7.027	3.78	3.97