Study of alpha decay and energy in MeV in superheavy element using SK Model

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Introduction

It is now known that the neutron magic number is 184 as per the conclusions reached by the scientific community [1]. So far the doubly magic number is predicted to be Z=124, N=184 or Z=126, N=184 by various theoretical models. But still proton magic number and the long-living superheavy element is yet to be found. Now first, the aim is to find the next proton magic number.

This aim can be achieved using SK model in the post scission region and Coloumb plus Yukawa plus exponential model in the post scission region by calculating the life-times of nuclei in the island of stability in alpha decay or spontaneous fission [2]. In this model, the zero-point vibrational energy is explicitly included without violating conservation of energy and an inertial mass coefficient dependent on the center-of-mass distance has been used.

In our calculations, we study Q alpha for Z=124 and Z=126. It is seen that there is an increase in lifetime of one order of magnitude for a decrease in Q MeV from 1 MeV - 0.6 MeV with more stability for 124 than 126 for even Z and even N. The different values of Z, N and Q_α are taken from Figure [3]. Since Z and N are even the nucleus is assumed to be spherical.

From the results shown in Table 1, we infer the island of stability is close to 124 with lifetime of 0.0031 s rather than 126 with life-time of 0.00056 s with Q 12.4 and 13 MeV respectively according to SK Model. The predictions earlier with Z=126 as the proton magic number are inferred from Nilsson-Strutinsky calculations [3]. This difference in this inference may be due to shell and pairing corrections of the microscopic part of the LDM calculated using the Strutinsky and BCS methods [4].

TABLE I: Lifetimes of alpha decay from $^{308}_{124}X_{184}$, $^{310}_{126}X_{184}$, $^{295}_{120}X_{175}$, $^{299}_{120}X_{179}$

Ad	Zd	Q (MeV)	Log_{10} T	T calc
304	122	12.4	-2.508612	3.1ms
304	122	13.2	-4.258249	0.055 ms
304	122	13.4	-4.670148	0.021 ms
304	122	13.6	-5.072617	0.0085 ms
306	124	13	-3.251644	0.56 ms
306	124	13.8	-4.908114	0.012 ms
306	124	14.4	-6.055679	0.00088 ms
306	124	14.6	-6.421859	0.00038 ms
295	120	11.2	-0.063232	0.864506 s
296	120	11.2	-0.080522	0.830765 s
297	120	11.2	-0.097727	0.798496 s
298	120	11.2	-0.11485	0.767626 s
299	120	11.2	-0.131891	0.738089 s
295	120	12.1	-2.305054	0.004954 s
296	120	12.1	-2.322185	0.004762 s
297	120	12.1	-2.339232	0.004579 s
298	120	12.1	-2.356194	0.004404 s
299	120	12.1	-2.373073	0.004236 s

According to the the predictions of research in JINR, Dubna the Z = 120 nuclei with N = 175 , 179 are expected to have Q about 12.1 - 11.2 MeV and lifetimes 1.7 ms - 0.16 s [3]. In this paper we show that these predictions are in accordance with our calculations with the order of few $\log_{10}$ T.

References

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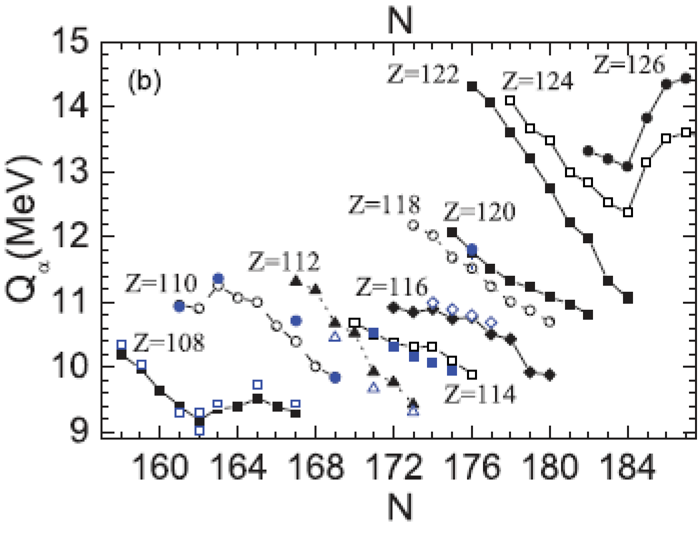

Fig I: N Vs Binding energy for various Z [3]