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THRESHOLD ENERGY VALUES FOR SUPER HEAVY ELEMENTS(SHE) FROM Z= 104 TO 117

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ABSTRACT

Super heavy elements (SHE) are the heavy elements in the periodic table.Generally transuranic and transactinide elements having Z > 92 come under this category. The surface energy,coulomb energy,threshold energies for the super heavy elements from Z=104 to 117 are calculated here. applications The to the astrophysics are discussed.

KEYWORDS: SHE, transuranic elements, threshold energy, coulomb energy, nucleosynthesis
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INTRODUCTION

From the late 1940s to the early 1960s , the early days of the synthesis of heavier transuranic elements, it was predicted that since that since such heavy elements did not occur in nature, they would have shorter and shorter half-lives to spontaneous fission. A doubly magic isotope having magic numbers of proton and neutrons would be stabilized against radioactive decay. The doubly magic isotope after lead-208 is flevorium-298 with 114 protons and 184 neutrons, form the center of a so called ‘island of stability’[1] . Transuranic elements can be artificially generated synthetic elements, via nuclear reactors or particle accelerators. The half lives of these elements show a general trend of decreasing as atomic numbers increase. There are exceptions however, including dubnium and several isotopes of curium. Further anomalous elements in this series have been predicted by Glenn T. Seaborg, and are categorised as the “island of stability” [2].Einsteinium is the heaviest transuranic element that has ever been produced in macroscopic quantities.

Methods applied to find out E_c,E_s&E_{th}

The liquid drop model

In nuclear physics this model treats the nucleus as a drop of incompressible nuclear fluid. It was first proposed by George Gamow and then developed by Niels Bohr and John Archibald Wheeler. The nucleus is made of nucleons (protons and neutrons), which are held together by the strong nuclear force. This is very similar to the structure of spherical liquid drop made of microscopic molecules. This is a crude model that does not explain all the properties of the nucleus, but does explain the spherical shape of most nuclei. It also helps to predict the nuclear binding energy and to assess how much is available for consumption.

Mathematical analysis of the theory delivers an equation which attempts to predict the binding energy of a nucleus in terms of the numbers of protons and neutrons it contains. This equation has five terms on its right hand side. These correspond to the cohesive binding of all the nucleons by the strong nuclear force, a surface energy term, the electrostatic mutual repulsion of the protons, an asymmetry term (derivable from the protons and neutrons occupying independent quantum momentum states) and a pairing term (partly derivable from the protons and neutrons occupying independent quantum spin states).

$$E_B = a_V A - a_S A^{2/3} - a_C \frac{Z^2}{A^{1/3}} - a_A \frac{(A-2Z)^2}{A} \pm \delta(A,Z)$$

Bohr Wheeler ‘s theory

The deformed nucleus is presumed to be modeled as a sphere of initial radius *Ro* which is distorted:

$$r(\theta) = R_0[1 + \alpha_0 + \alpha_2 P_2(cos\theta)]$$

Where P_2 is a Legendre polynomial. The idea is that both perturbing coefficients $\alpha_0$and $\alpha_2$are small. Two coefficients are included on the rationale that the volume of the nucleus is assumed to be conserved (incompressible) even as it distorts, so that one can then solve for say $\alpha_0$in terms of α_2. It turns out that the lowest-order contributions to the surface and Coulomb energies are considered. We have the surface energy U_s as [3]

$$U_s \sim (a_s A^{2/3}) \; [1 + \tfrac{2}{5}\alpha_2^2 + \cdots]$$

The change in surface energy is given by

$$\Delta U_s = U_s^{sphere}[\frac{2}{5}\alpha_2^2 + \frac{5}{7}\alpha_3^2 + \cdots]$$

Coulomb energy has the expression

$$U_c = \frac{3}{5}\frac{Z^2 e^2}{4\pi\epsilon_0 R_0 A^{1/3}}[1 + \alpha_2\left(\frac{3}{2}cos^2\theta - \frac{1}{2}\right) + \cdots]^{-1}$$

The change in coulomb energy is given by

$$\Delta U_c = -U_c^{sphere}[\frac{1}{5}\alpha_2^2 + \frac{10}{49}\alpha_3^2 + \cdots]$$

When $U_s^{sphere} > U_c^{sphere}$ the configuration is a stable one.

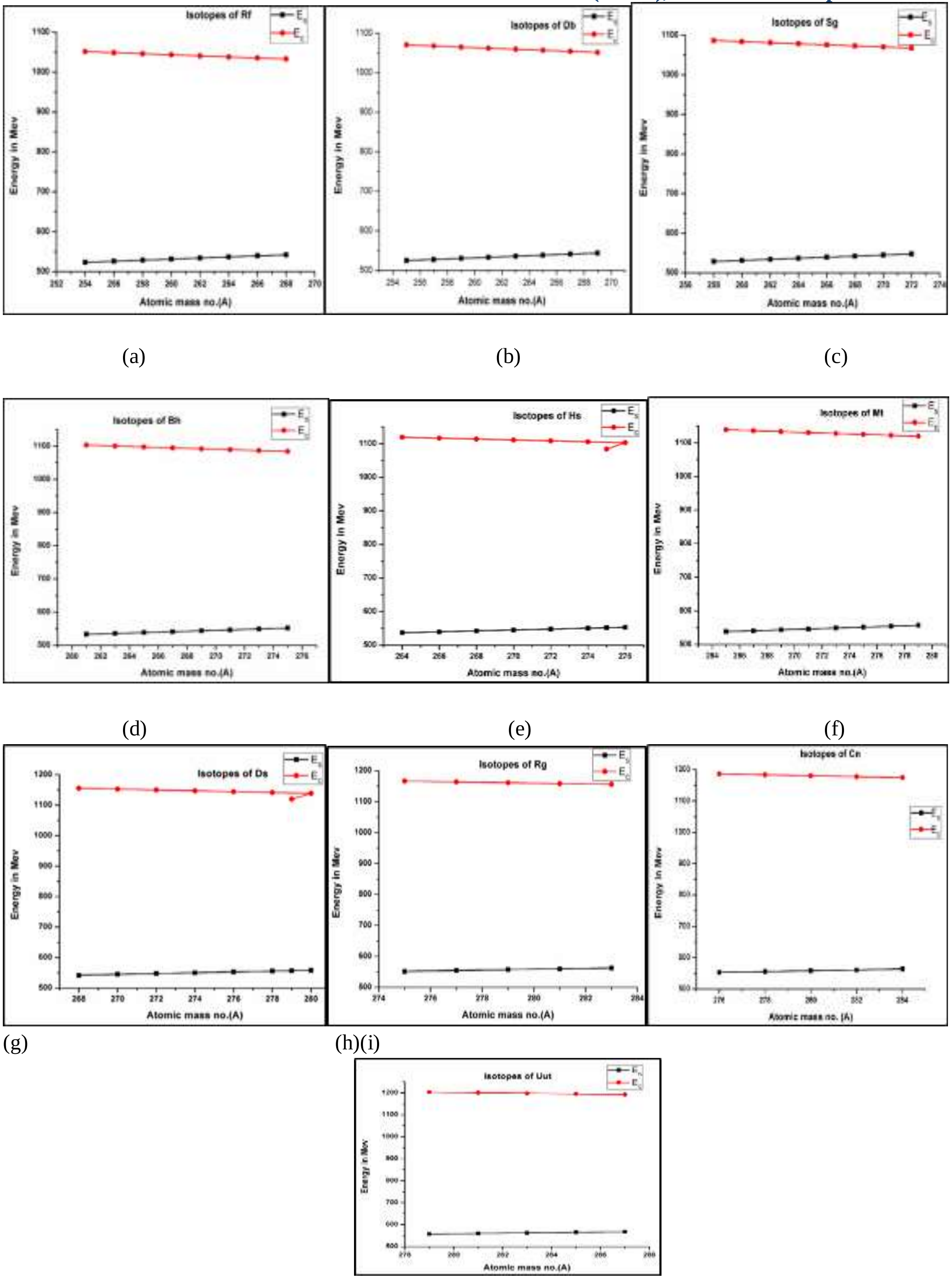
For spontaneous fission, $(\frac{Z^2}{A})_{lim} = 2(\frac{a_s}{a_c})$

The ratio $\frac{U_c^{sphere}}{U_s^{sphere}}$ gives the critical parameter, represented by χ and when χ < 1, the nuclei is stable against spontaneous fission. All the isotope of Rf is stable against spontaneous fission, some isotope of Db are not stable (^{255}Db, ^{257}Db, ^{259}Db) whereas others are stable against spontaneous fission. The four isotopes of ^{261}Bh to ^{267}Bh are unstable whereas the next higher isotopes are stable against the spontaneous fission.

The SHE having atomic no. 109 to 117 are quite unstable which are purely artificially synthesized in the laboratory. The unstable nuclei undergo fission under suitable condition to give stable one [4,5]

RESULT AND DISCUSSION

When we see the variation of energy with respect to atomic mass number, we see that the nature of the graph remains same.In the tabulation part, it is seen that with the increase in the atomic mass of the SHE, the surface energy and coulomb energy value increase gradually whereas the the threshold values of energy decreases.



(a) (b) (c)

(d) (e) (f)

(g) (h)(i)

Figure:1 (a),(b),(c),(d),(e),(f),(g),(h),(i),(j) shows the variation in surface energy (E_s) and columb energy (E_c) for different isotopes of Rf, Db, Sg, Bh, HS, Mt, Ds, Rg, Cn, U ut respectively

(j)

Table*1:*Surface energy, Coulomb energy and Threshold energy of most stable isotope of SHE

Element	**Atomic Mass(A)**	**Surface Energy (E_s) In MeV**	**Coulomb Energy (E_c) in MeV**	**Threshold Energy (E_{th}) in MeV**
Rf	268	542.3481	1032.9483	29.9686
Db	269	543.6964	1051.6019	28.3139
Sg	272	547.7312	1067.7730	27.6245
Bh	275	551.7513	1084.0438	26.9206
Hs	276	553.0881	1103.0656	25.2233
Mt	279	557.0887	1119.5456	24.4919
Ds	280	558.4191	1138.8230	22.7655
Rg	283	562.4007	1155.5108	22.0068
Cn	284	563.7248	1175.0422	20.2514
Uut	287	567.6877	1191.9365	19.4656

CONCLUSION

When we consider the electronic configuration of the SHE,and the transitions between different states we get r- and p- processes which play the basis of nucleosynthesis.The superheavy elements gives much more information about the astrophysics.Our future plan is to find the deformation into different states of the SHE from their normal configuration.

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