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Theoretical Half-life Time and Alpha Energies of the Elements: Part-8; Z=108 (Hassium, Hs)—Island of Stability

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Abstract

This paper is the eighth part of a series of eleven of QAM-UQAM-NMT-2017-Ver-3&4. It is based on the novel mass quantization and the variable neutron mass concepts of my new nuclear theory, the Nuclear Magneton Theory of Mass Quantization, NMT. Three methods for prediction of the α-decay half-life formulae, the Viola-Seaborg, the Royer GLDM, and the Sobiczewski-Parkhomenko, are applied to evaluate the half-life of the atomic masses theoretically calculated. NMT found out 20 isotopes belong to Hassium Hs element that have long half-life T1/2 and 3 of them exceed 1010 year. NMT considered them as part of the Island of stability. In the previous article, NMT found out 115 isotopes belonging to Z=100–107 (Fm–Bh) that have long T1/2 and 20 isotopes exceed 1010 year.

Keywords: half-life, alpha decay atomic masses, new isotopes, superheavy nuclei

Introduction

The experimental estimation of alpha decay is very important tool to identify the product nuclides during the synthesis reactions. The decay modes is dominant in the highly neutron deficient nuclei, which usually terminate by the spontaneous fission (SF) [1–5]. These evaluations usually face technical difficulties due to the extremely short t1/2 of the nuclidic products.

Many phenomenological formulae have been derived from the Geiger–Nuttall rule to predict α-particle kinetic energy Tα. The most well-known formulae are Sobiczewski-Viola-Seaborg formula [6], Royer formula [7], Sobiczewski-Parkhomenko [8], and Koura [9]. Most of these are simple formulas and give different values. I have examined the first three and applied them on more than 14000 theoretical nuclides. They give accepted values.

In my previous articles, in a series of papers, a detailed explanation of the methods of the evaluation of the accurate quantized atomic masses has been discussed in seven parts [10–16]. In brief, the methods of theoretical calculations are of two types: hybrid of macroscopic and microscopic, and pure HF-SCF models [17–74]. All these theoretical methods first calculate the binding energy and then evaluate the neutral atomic mass.

Unfortunately, none of these models can be used with total confidence due to several deficiencies. Consequently, the accurate estimation of the atomic masses of the existent and non-existent isotopes in astrophysics is considered an unsolved problem. The output of most theoretical calculations cannot predict the atomic masses precisely which lead to improper alpha energies and half-lives. The atomic masses calculated by Wang-Audi-Wapstra (WAW) et al. [36], Moller et al. [42] and Duflo-Zucker [51] failed to give the positive incremental difference in alpha energies between two sequential isotopes. The mass evaluations usually use short-range connection between close-lying neighbors' isotopes. The researchers are looking for an extended complicate connectivity between multiple isotopes. The AME of WAW et al worked along 50 years since 1961 till 2012 but their methods failed to find long-range connection between close-lying neighbors' isotopes. The mass evaluations up till now contain mostly connections between 2 (or a few) close lying neighbours. The said that the future AMEs will in addition be characterized by long-range relations. My new theory NMT succeeded in 2013 to many long-range connections through five methods which can evaluate more than 100 isotopes from eight known accurately measured isotopes as explained below.

1. Calculation of the Atomic Masses of Hassium, Z=108 Isotopes

The author succeeded in setting up a creative extended connectivity between multiple isotopes. An innovative semi-empirical atomic mass formula has been derived to calculate quantized atomic masses more precisely than macro-micro formula and purely microscopic HF-self-consistent methods. It is based on the novel mass quantization and the variable neutron mass concepts of my new nuclear theory, the **N**uclear **M**agneton **T**heory of Mass Quantization, **NMT**. This formula can calculate the atomic masses of non-existent isotopes based on the existing experimentally measured nuclides. NMT called the mass of the single bound neutron in the nuclide as **s**ingle **v**ariable **n**eutron **m**asses: **SVNM**; M_n^* = (M_A-ZM_H)/N, as seen in Figure-1 and the whole bound neutrons in the nuclide as the **t**otal **v**ariable **n**eutron **m**asses: **TVNM**; NM_n^* = (M_A-ZM_H) as seen in Figure-2 [10-16].

The polynomial equations of the 2nd power of **Generalized SVNM** lead to the prediction of the quantized atomic masses (QAM) of light and heavy elements, and the polynomial equation of the 2nd power of **Generalized TVNM** lead to the prediction of the quantized atomic masses of superheavy elements (Z=100–226) [10-16]. These calculations required processing of 8713 files in 10 years. Table-1 shows the quantized atomic masses (QAM) of Hassium isotopes calculated from GTVNM and Table-2 shows the quantized atomic masses (QAM) of Hassium isotopes calculated from GTVNM and GSVNM. Unfortunately, Hs elements does not have enough isotopes masses to set up a polynomial curve for the even-even isotopes. Hs has 7 even-odd isotopes and 3 even-even isotopes. Therefore, NMT created new five methods for prediction of M_A of non-existent isotopes and elements as follow [10-16].

NMT believes that all nuclei obey **Mass Quantization Principle (MQP)**, (a new NMT concept) and the **Neutron MQP**, (also new NMT concept) in all nuclear processes and decays. Based on **NMQP**, **NMT** can uses the isotopes of the isoprogenic isobaric ancestors; grandparent, great-grandparent, great-great-grandparent, and so forth; for example, the A=282 from the even-elements Z=106,108,110, and 112 will birth the new isotopes A=282 for the successor's even element Z=114 (M_A=282.17952996799). Consequently, in stage-I, **NMT** invented two novel additional empirical methods to create the generalized single variable neutron mass GSVNM of isotopes of the successors' elements and two additional methods to generate the generalized total variable neutron mass TVGNM of isotopes of the successors' elements [10-16].

The created Consonant SVNM and TVNM from the ancestors must be converted to generalized SVNM and TVNM. The GSVNM and GTVNM will be used to calculate the quantized atomic mass of non-existent isotopes of element Z=108-118. The empirical methods are **Analytical** Quantized Mass Formula **(AQMF)**, **Numerical** Quantized Mass Formula **(NQMF),** and total neutron matrix **(TVNMM)**. Another method was also used to hybrid the CNM from IAEA and AQMF; **HIA**. The four methods generate CNM, while the fifth method, the Isodiapheric Energy Quantized Mass Formula (**IEQMF**), generates GNM i.e., produces QAM. The application of each method generated more than 1000 new isotopes for the elements for Z=100-118 (of total of 4000 isotopes) with their alpha energies which will be used by the fifth method **IEQMF** to create the GNM for 16000 isotopes for the elements Z=100-231. In the next articles, I will publish the detail mathematical procedures for the novel five methods.

The discrepancy (RMS) of the mass model in calculation of the QAM of Hs isotopes are 418 keV (A=263-274) and 869 keV (A=263-278). This high accuracy enables NMT to calculate the most precise alpha energy Q_α^{Th} in the literature. The values of RMS of QAM do not reflect the accuracy of the calculated QAM values; rather, they show the discrepancies with IAEA values. Figure-3: Comparison of the NMT-QAM with other models H. Geissel, Yu.A., Litvinov et al., [75].

The quantized atomic masses of 16000 nuclei ranging from Z=1 to Z=232 have been calculated, and 90 nuclides of them belong to Z=108. The results are compared with those of other recent macroscopic–microscopic.

Figure 1: The Consonant Neutron Mass CNM of Hassium (Odd-Even) -IAEA

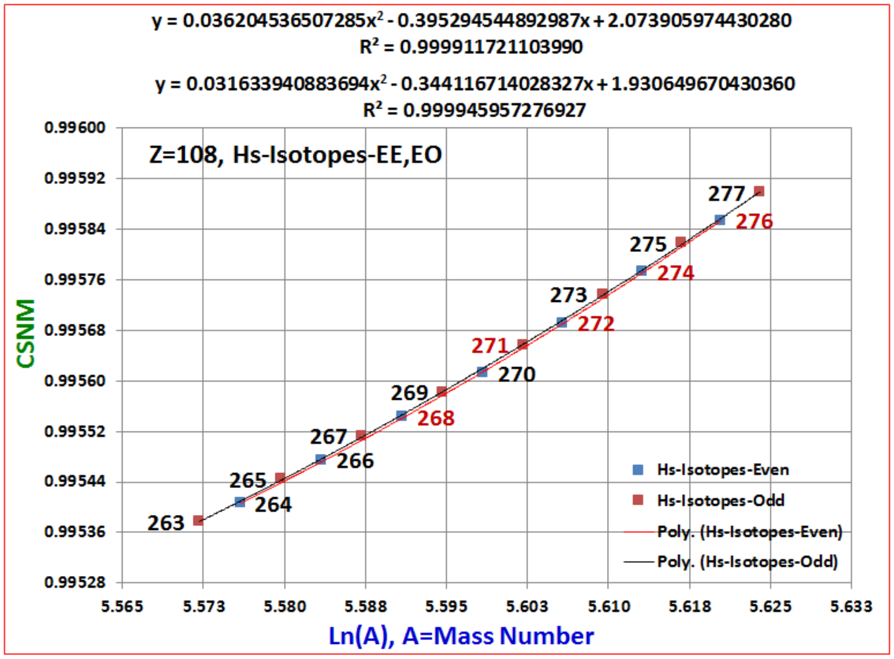


Figure 2: The Generalized Neutron Mass GNM of Hassium (Odd-Even)-NMT

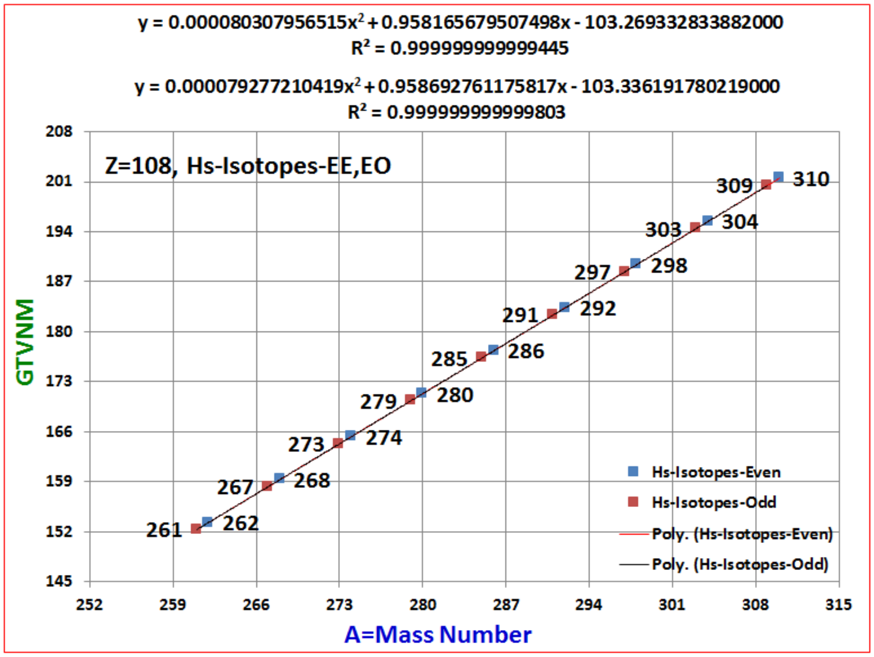
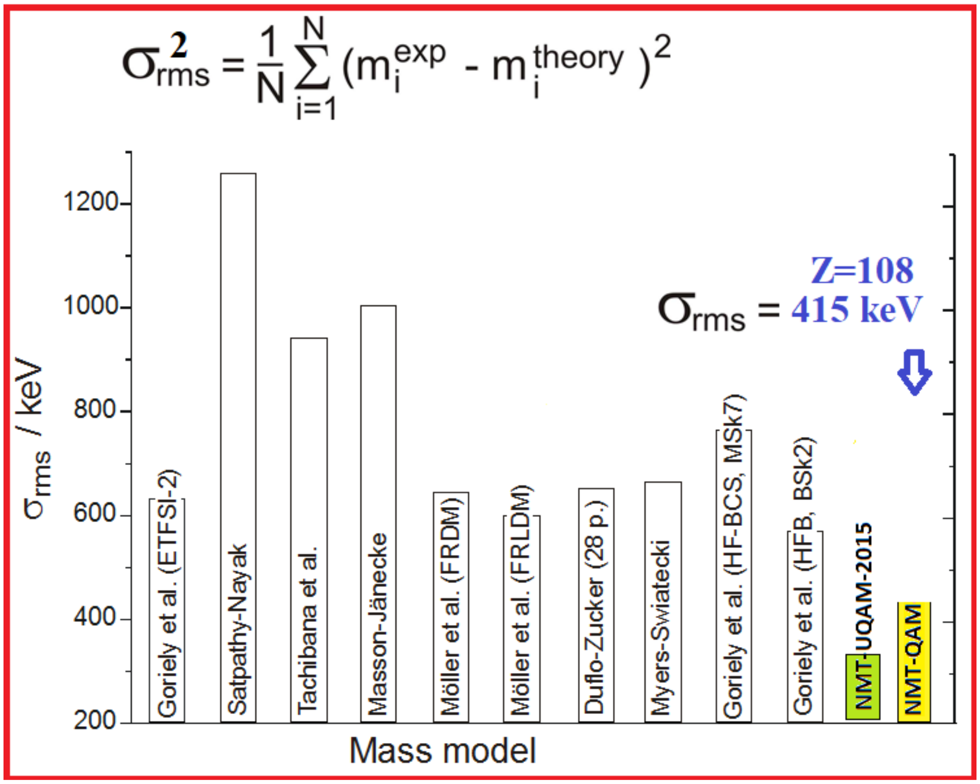


Table 1: The Royer Formula $T_{1/2}$ of the Most Stable QAM of Hassium Isotopes (Hs)

	NMT-MQ, QAM-Z-108				IAEA					NMT			
	Isotope	**IAEA/WAW**	**NMT-QAM TVNM**	**ΔM= IAEA-QAM**	**$T_{1/2}$**	**β^-**	**β^+**	**α**	**Δα (ee, oo)**	**β^-**	**β^+**	**α**	**Δα (ee, oo)**
1	**108Hs-244**		**244.14738229202**							**-13912**	**10738**	**12823**	**179**
2	108Hs-245		245.14552258563							-12460	11704	12747	185
3	**108Hs-246**		**246.14272492429**							**-13299**	**10037**	**12644**	**190**
4	108Hs-247		247.14120417890							-11747	11079	12562	196
5	**108Hs-248**		**248.13868601945**							**-12676**	**9336**	**12454**	**201**
6	108Hs-249		249.13749583636							-11038	10439	12365	207
7	**108Hs-250**		**250.13526557752**							**-12041**	**8635**	**12253**	**212**
8	108Hs-251		251.13439755801							-10332	9784	12158	218
9	**108Hs-252**		**252.13246359848**							**-11394**	**7934**	**12042**	**223**
10	108Hs-253		253.13190934384							-9631	9114	11941	229
11	**108Hs-254**		**254.13028008235**							**-10737**	**7232**	**11819**	**233**
12	108Hs-255		255.13003119386							-8933	8429	11712	240
13	**108Hs-256**		**256.12871502911**							**-10068**	**6531**	**11586**	**244**
14	108Hs-257		257.12876310807							-8238	7729	11472	250
15	**108Hs-258**		**258.12776843878**							**-9388**	**5829**	**11341**	**255**
16	108Hs-259		259.12810508647							-7548	7014	11222	261
17	**108Hs-260**		**260.12744031134**							**-8697**	**5126**	**11086**	**266**
18	108Hs-261		261.12805712906	**ΔM, RMS**						-6861	6285	10960	272
19	**108Hs-262**		**262.12773064681**							**-7994**	**4424**	**10820**	**277**
20	108Hs-263	263.1284792120	263.12861923583	0.000000019606673	0.74ms		5183	10694	225	-6178	5540	10688	283
21	**108Hs-264**	**264.1283563303**	**264.12863944518**	**0.000000080154026**	**0.8ms**		**3509**	**10594**	**245**	**-7280**	**3722**	**10543**	**288**
22	108Hs-265	265.1297917442	265.12979140679	0.000000000000113	2.0ms	-5783	4544	10469	435	-5499	4780	10405	294
23	**108Hs-266**	**266.1300487832**	**266.13016670644**	**0.000000013905869**	**2.3ms**	**-6822**	**3033**	**10349**	**731**	**-6555**	**3019**	**10255**	**299**
24	108Hs-267	267.1316781020	267.13157364194	0.000000010911903	52ms	-5142	3883	10035	698	-4823	4005	10111	305
25	**108Hs-268**	**268.1320113220**	**268.13231243061**	**0.000000090666392**	0.4s	**-6320**	**2021**	**9618**	**553**	**-5819**	**2316**	**9956**	**310**
26	108Hs-269	269.1336491410	269.13396594128	0.000000100362419	9.7s	-4751	3074	9337	-170	-4151	3215	9806	316
27	**108Hs-270**	**270.1343100000**	**270.13507661767**	**0.000000587702655**	**3.6s**	**-5605**	**882**	**9065**	**-722**	**-5071**	**1613**	**9646**	**321**
28	108Hs-271	271.1371700000	271.13696830481	0.000000040680950	4s	-3325	1783	9508	-143	-3483	2410	9491	327
29	**108Hs-272**	**272.1385000000**	**272.13845926764**	**0.000000001659125**		**-4574**	**220**	**9787**	**224**	**-4312**	**909**	**9325**	**332**
30	108Hs-273	273.1414584010	273.14058073252	0.000000770301953	0.76s	-2618	1258	9650	211	-2818	1590	9164	337
31	**108Hs-274**	**274.1433000000**	**274.14246038051**	**0.000000704960896**		**-3675**	**-231**	**9563**	**279**	**-3542**	**206**	**8994**	**343**
32	108Hs-275	275.1465306370	275.14480322443	0.000002983954196	0.15s	-2003	931	9440	388	-2158	755	8827	348
33	**108Hs-276**	**276.1484600000**	**276.14707995627**	**0.000001904520693**	**2.11**	**m**	**-2919**			**-2761**	**-498**	**8651**	**353**
34	108Hs-277	277.1517724800	277.14963578052	0.000004565484675	34.8	**m**	-1274			-1500	-95	8478	359
35	**108Hs-278**	**278.1537533220**	**278.15231799494**	**0.000002060163776**	**32.78**	**m**				**-1968**	**-1202**	**8298**	**364**
36	108Hs-279		279.15507840080	**869 Kev for all**	10.36	h				-847	-960	8119	370
37	**108Hs-280**		**280.15817449650**	**418 Kev for 263-274**	**11.25**	**h**				**-1164**	**-1906**	**7934**	**375**
38	108Hs-281		281.16113108527		10.44	d				-198	-1839	7749	381
39	**108Hs-282**		**282.16464946097**		**13.37**	**d**				**-349**	**-2611**	**7558**	**386**
40	108Hs-283		283.16779383392		357.99	d				448	-2734	7368	392
41	**108Hs-284**		**284.17174288834**		**1.52**	**y**				**478**	**-3315**	**7172**	**397**
42	108Hs-285		285.17506664676		50.60	y				1090	-3644	6976	403
43	**108Hs-286**		**286.17945477860**		**98.86**	**y**				**1316**	**-4020**	**6775**	**408**
44	108Hs-287		287.18294952380		4222.67	y				1729	-4569	6574	413
45	**108Hs-288**		**288.18778513177**		**1.08E+04**	**y**				**2165**	**-4725**	**6367**	**419**
46	108Hs-289		289.19144246501		6.26E+05	y				2364	-5509	6160	424
47	**108Hs-290**		**290.19673394784**		**2.24E+06**	y				**3025**	**-5431**	**5948**	**430**
48	108Hs-291		291.20054547042		1.86E+08	y				2994	-6464	5736	435
49	**108Hs-292**		**292.20630122681**		**9.96E+08**	y				**3897**	**-6136**	**5519**	**441**
50	108Hs-293		293.21025854002		1.29E+11	y				3622	-7433	5301	446
51	**108Hs-294**		**294.21648696867**		**1.15E+12**	y				**4780**	**-6842**	**5078**	**452**
52	108Hs-295		295.22058167380		2.63E+14	y				4245	-8418	4855	457
53	**108Hs-296**		**296.22729117344**							**5674**	**-7547**	**4626**	**462**
54	108Hs-297		297.23151487177							4865	-9418	4398	468
55	**108Hs-298**		**298.23871384111**							**6580**	**-8254**	**4164**	**473**
56	108Hs-299		299.24305813393							5481	-10433	3930	479
57	**108Hs-300**		**300.25075497168**							**7496**	**-8960**	**3691**	**484**
58	108Hs-301		301.25521146028							6093	-11462	3451	490
59	**108Hs-302**		**302.26341456514**							**8424**	**-9666**	**3206**	**495**
60	108Hs-303		303.26797485082							6702	-12507	2962	500
61	**108Hs-304**		**304.27669262151**							**9364**	**-10373**	**2711**	**506**
62	108Hs-305		305.28134830554							7307	-13567	2461	511
63	**108Hs-306**		**306.29058914078**							**10314**	**-11080**	**2205**	**517**
64	108Hs-307		307.29533182445							7908	-14642	1950	522
65	**108Hs-308**		**308.30510412295**							**11276**	**-11787**	**1688**	**528**
66	108Hs-309		309.30992540756							8505	-15731	1428	533
67	**108Hs-310**		**310.32023756802**							**12249**	**-12494**	**1160**	**539**
68	108Hs-311		311.32512905484							9099	-16836	895	544
69	**108Hs-312**		**312.33598947598**							**13233**	**-13202**	**621**	**550**
70	108Hs-313		313.34094276632							9689	-17956	351	555
71	**108Hs-314**		**314.35235984685**							**14229**	**-13909**	**72**	**561**
72	108Hs-315		315.35736654199							10275	-19090	-204	566
73	**108Hs-316**		**316.36934868062**							**15236**	**-14617**	**-489**	**572**
74	108Hs-317		317.37440038184							10858	-20240	-769	576
75	**108Hs-318**		**318.38695597729**							**16254**	**-15325**	**-1060**	**582**
76	108Hs-319		319.39204428588							11437	-21405	-1346	587
77	**108Hs-320**		**320.40518173686**							**17284**	**-16034**	**-1643**	**593**
78	108Hs-321		321.41029825411							12012	-22584	-1933	598
79	**108Hs-322**		**322.42402595933**							**18324**	**-16742**	**-2236**	**604**
80	108Hs-323		323.42916228652							12583	-23779	-2531	609
81	**108Hs-324**		**324.44348864470**							**19376**	**-17451**	**-2840**	**615**
82	108Hs-325		325.44863638313							13151	-24989	-3140	620

*$\mathbf{T_{1/2}}$ is calculated from Royer Formula, G. Royer, *J. Phys. G*: *Nucl. Part. Phys.* **26** (2000) 1149-1170.

Figure 3: Comparison of the NMT-QAM with other models H. Geissel, Yu.A. Litvinov et al., *Nucl. Phys.* A746 (2004) 150c



2. Comparison of Atomic Masses of Z=108 Isotopes with Literature

The atomic masses calculated by IAEA, JAEA, Wang-Audi-Wapstra et al., (WAW) [36], Duflo-Zucker (DZ) [51] and by Moller et al. [42] have been investigated and compared with the present work of NMT calculation. The WAW values are remarkably close to IAEA values, as they are the most reliable source for IAEA, and both give limited isotopes to each element. WAW calculations are highly corrected based on experimental nuclear data such as atomic masses and nuclear reactions, etc. Although Moller et al. values are based on theoretical macro-micro (MM) equations, they also made several corrections and amendments over the course of three decades.

The atomic masses values from IAEA, WAW and Moller are not able to give to the positive incremental difference in alpha energies i.e., $\Delta\alpha$ (ee,oo) and $\Delta\alpha$ (eo,oe), which are responsible for generating the accurate atomic masses (i.e., that they are not quantized). The atomic masses values of IAEA and Moller show high deviation from NMT values especially in the far neutron-poor and neutron-rich regions. Figure 4 shows the deviation of the theoretical atomic masses of (all vs WAW); DZ [51] and by Moller et al. [42] from WAW [36], while the theoretical QAM of NMT of present work is very close to modified experimental WAW. Figure 5 shows the deviation of the atomic masses of (all vs NMT). In both figures 4&5 DZ and Moller are far from WAW and NMT.

3. Calculation of Q_α^{Th} Energies of Z=108 Isotopes

In a previous series article, I explained the methods of the theoretical calculations of alpha energies. The theoretical alpha energy Q_α^{Th} are calculated from 1- SMT (based on **m**ass **d**efect MD, ΔM_A), 2- NMT (based on **n**eutron **m**ass **d**efect NMD, ΔM_n) and 3- NMT **standard energy of formation of nuclide,** E_f^o, SEFN [10-16]. The following equations describe the three methods.

The three methods give the same results:

SMT-MD; The Q-value of β^-, β^--decay (MeV) can be calculated from the mass defect

$$\text{SMT-MD; } \alpha\text{: } Q_{\alpha}^{Th} = M(A,Z)-M(A,Z-2)-M_{\alpha} \qquad (1)$$

$$\text{NMT-NMD;} Q_{\alpha}^{Th} = \Delta M_n = [(M_A-ZM_H)_M - \{(M_A-ZM_H)_D + (M_A-ZM_H)_{\alpha}\}] \qquad (2)$$

$$\text{NMT-SEFN; } \Delta E_f^o = \sum \Delta E_f^o (C+D)_{pro} - \sum \Delta E_f^o (A+B)_{rea},\ B=0 \qquad (3)$$

Where M=mother, D=daughter, α=alpha

Table 2: The QAM and UQAM of the Isotopes of Z=108 Calculated by TVNM and the Comparison with IAEA, DZ, WAW and Moller (FRDM)

Isotope	IAEA	DZ	WAW	Moller	NMT-UQAM TVNM*	NMT-QAM TVNM**	NMT-QAM SVNM***
108Hs-240		**240.15902946267**			**240.14952356041**	**240.16127202402**	**240.15836251374**
108Hs-241		241.15742451416			241.15477659401	241.15836680234	241.15443857789
108Hs-242		**242.15396018719**			**242.14469452396**	**242.15502025312**	**242.15245674878**
108Hs-243		243.15253237347			243.14924294417	243.15249266438	243.14906328494
108Hs-244		**244.14885011704**			**244.14042173766**	**244.14941094587**	**244.14717710603**
108Hs-245		245.14711849032			245.14433851592	245.14725274410	245.14429855551
108Hs-246		**246.14367026651**			**246.13670520151**	**246.14444410226**	**246.14252358549**
108Hs-247		247.14231330671			247.14006330927	247.14264704150	247.14014438960
108Hs-248		**248.13925370588**			**248.13354491550**	**248.14011972232**	**248.13849618717**
108Hs-249		249.13826389817			249.13641732421	249.13867555659	249.13660078722
108Hs-250		**250.13558540552**		**250.13596436661**	**250.13094087965**	**250.13643780602**	**250.13509491105**
108Hs-251		251.13495416156		251.13536318188	251.13340056074	251.13533828936	251.13366774836
108Hs-252		**252.13264926227**		**252.13302285563**	**252.12889309395**	**252.13339835338**	**252.13231975715**
108Hs-253		253.13237121434		253.13256123165	253.13101301886	253.13263523981	253.13134527303
108Hs-254		**254.13043346714**		**254.13048929144**	**254.12740155839**	**254.13100136438**	**254.13017072546**
108Hs-255		255.13050002688		255.13029605349	255.12925469857	255.13056640795	255.12963336122
108Hs-256		**256.12892191698**		**256.12842808667**	**256.12646627299**	**256.12924683905**	**256.12864781599**
108Hs-257		257.12932771667		257.12849249932	257.12812559988	257.12913179377	257.12853201294
108Hs-258		**258.12810172925**		**258.12687144765**	**258.12608723773**	**258.12813477736**	**258.12775102872**
108Hs-259		259.12884140117		259.12723645267	259.12762572278	259.12833139728	259.12804122818
108Hs-260		**260.12762400210**		**260.12614143763**	**260.12626445263**	**260.12766517932**	**260.12748036367**
108Hs-261		261.12824021645		261.12709689193	261.12775506727	261.12816521846	261.12816100694
108Hs-262		**262.12723001140**		**262.12654938441**	**262.12699791767**	**262.12783804494**	**262.12783582083**
108Hs-263	263.128480000	263.12813178849	263.12852000000	263.12781616651	263.12851363335	263.12863325733	263.12889134923
108Hs-264	**264.128360000**	**264.12743076416**	**264.12836000000**	**264.12755851591**	**264.12828763287**	**264.12865337421**	**264.12881740020**
108Hs-265	265.129792000	265.12863206006	265.12979300000	265.12891118154	265.12990142103	265.12973551389	265.13023225504
108Hs-266	**266.130050000**	**266.12825309898**	**266.13005000000**	**266.12878235624**	**266.13013359821**	**266.13011116713**	**266.13042510179**
108Hs-267	267.131670000	267.12976679623	267.13167000000	267.13024237629	267.13191843030	267.13147198812	267.13218372438
108Hs-268	**268.131860000**	**268.12972385446**	**268.13187000000**	**268.13021016996**	**268.13253581370**	**268.13221142370**	**268.13265892559**
108Hs-269	269.133720000	269.13156498268	269.13375000000	269.13200298869	269.13456466116	269.13384268005	269.13474575724
108Hs-270	**270.134310000**	**270.13187094276**	**270.13429000000**	**270.13234652282**	**270.13549427935**	**270.13495414393**	**270.13551887160**
108Hs-271		271.13405345802	271.13717000000	271.13456875921	271.13784011361	271.13684758965	271.13791835363
108Hs-272		**272.13472334957**	**272.13850000000**	**272.13572818689**	**272.13900899514**	**272.13833932780**	**272.13900493982**
108Hs-273	273.141590000	273.13726228148	273.14168000000	273.13876631684	273.14174478766	273.14048671694	273.14170151353
108Hs-274		**274.13830898703**	**274.14330000000**	**274.14041957483**	**274.14307996108**	**274.14236697533**	**274.14311713025**
108Hs-275	275.146670000	275.14121829168	275.14667000000	275.14364020728	275.14627868330	275.14476006191	275.14609523697
108Hs-276		**276.14265898793**	**276.14846000000**	**276.14547596777**	**276.14770717718**	**276.14703708651**	**276.14785544290**
108Hs-277	277.151900000	277.14431117237	277.15190000000	277.14855703949	277.15144180053	277.14966762456	277.15109952393
108Hs-278		**278.14604387263**		**278.15007073674**	**278.15289064342**	**278.15234966135**	**278.15321987776**
108Hs-279		279.14951571441		279.15301224771	279.15723413935	279.15520940490	279.15671437441
108Hs-280		**280.15144809388**		**280.15470844747**	**280.15863035981**	**280.15830469983**	**280.15921043483**
108Hs-281		281.15511317361		281.15787540271	281.16365569976	281.16138540292	281.16293978841
108Hs-282		**282.15726133545**		**282.15983998850**	**282.16492632635**	**282.16490220197**	**282.16582711411**
108Hs-283		283.16113682984		283.16337194876	283.17070648177	283.16819561863	283.16977576594
108Hs-284		**284.16351687722**		**284.16577668765**	**284.17177854304**	**284.17214216776**	**284.17306991561**
108Hs-285		285.16761888941		285.16977027189	285.17838648537	285.17564005201	285.17722230700
108Hs-286		**286.17024692549**		**286.17234677785**	**286.17918700988**	**286.18002459720**	**286.18093883932**
108Hs-287		287.17459263221		287.17647992283	287.18669571056	287.18371870308	287.18527941157
108Hs-288		**288.17748476015**		**288.17931407938**	**288.18715172687**	**288.18854949030**	**288.18943388524**
108Hs-289		289.18209133810		289.18353310789	289.19563415735	289.19243157184	289.19394707968
108Hs-290		**290.18526473461**		**290.18663565049**	**290.19567269401**	**290.19771684704**	**290.19855505337**
108Hs-291		291.19014828695		291.19108012327	291.20520182572	291.20177865828	291.20322531130
108Hs-292		**292.19361905518**		**292.19454767087**	**292.20474991130**	**292.20752666744**	**292.20830234372**
108Hs-293		293.19953213636		293.20033407384	293.21539871569	293.21175996240	293.21311410645
108Hs-294		**294.20389824042**		**294.20418809734**	**294.21438337874**	**294.21797895149**	**294.21867575628**
108Hs-295		295.20981024806		295.20987788134	295.22622482725	295.22237548420	295.22361346513
108Hs-296		**296.21419245528**		**296.21401102631**	**296.22457309633**	**296.22907369920**	**296.22967529105**
108Hs-297		297.22011412481		297.22794562938	297.23768016041	297.23362522369	297.23472338732
108Hs-298				**298.23191774274**	**298.23531906407**	**298.24081091055**	**298.24130094803**
108Hs-299				299.22927682413	299.24976471515	299.24550918086	299.24644387305
108Hs-300				**300.23338849822**	**300.24662128196**	**300.25319058556**	**300.25355272722**
108Hs-301				301.23867033544	301.26247849149	301.25802735571	301.25877492229
108Hs-302				**302.24257803615**	**302.25847975000**	**302.26621272422**	**302.26643062863**
108Hs-303				303.24801016955	303.27582148942	303.27117974825	303.27171653507
108Hs-304				**304.25197154746**	**304.27089446818**	**304.27987732653**	**304.27993465225**
108Hs-305				305.25748956439	305.28979370894	305.28496635847	305.28526871136

Isotope	IAEA	DZ	WAW	Moller	NMT-UQAM TVNM*	NMT-QAM TVNM**	NMT-QAM SVNM***
108Hs-306				**306.26161197393**	**306.28386543652**	**306.29418439249**	**306.29406479808**
108Hs-307				307.26723734527	307.30439515006	307.29938718638	307.29943145118
108Hs-308				**308.27143490290**	**308.29739265501**	**308.30913392211**	**308.30882106613**
108Hs-309				309.27722130587	309.31962581277	309.31444223197	309.31420475452
108Hs-310				**310.28174092674**	**310.31147612364**	**310.32472591537**	**310.32420345638**
108Hs-311				311.28798895369	311.33548569707	311.33013149524	311.32958862139
108Hs-312				**312.29293799223**	**312.32611584243**	**312.34096037229**	**312.34021196885**
108Hs-313				313.29935778624	313.35197480296	313.34645497619	313.34558305178
108Hs-314				**314.30452153361**	**314.34131181137**	**314.35783729287**	**314.35684660353**
108Hs-315				315.31102721116	315.36909313044	315.36341267483	315.36218804570
108Hs-316				**316.31626610661**	**316.35706403045**	**316.37535667709**	**316.37410736043**
108Hs-317				317.32291134490	317.38684067952	317.38100459115	317.37940360314
108Hs-318				**318.32825759476**	**318.37337249969**	**318.39351852497**	**318.39199423953**
108Hs-319				319.33492430394	319.40521745019	319.39923072515	319.39722972410
108Hs-320				**320.34041011454**	**320.39023721907**	**320.41232283649**	**320.41050724085**
108Hs-321				321.34723785534	321.42422344245	321.41809107684	321.41566640859
108Hs-322				**322.35300278742**	**322.40765818861**	**322.43176961167**	**322.42964636438**
108Hs-323				323.36017406234	323.44385865630	323.43758564621	323.43471365660
108Hs-324				**324.36597120076**	**324.42563540829**	**324.45185885051**	**324.44941161013**
108Hs-325				325.37314247568	325.46412309175	325.45771443327	325.45437146814
108Hs-326				**326.37915432292**	**326.44416887813**	**326.47259055299**	**326.46980297808**
108Hs-327				327.38643295226	327.48501674879	327.47847743801	327.47463984320

Table 2: The QAM and UQAM of the Isotopes of Z=108 Calculated by TVNM and the Comparison with IAEA, DZ, WAW and Moller (FRDM). Continued

Isotope	IAEA	DZ	WAW	Moller	NMT-UQAM TVNM*	NMT-QAM TVNM**	NMT-QAM SVNM***
108Hs-328				**328.39253068303**	**328.46325859811**	**328.49396471913**	**328.49082046825**
108Hs-329				329.39994887310	329.50653962742	329.49987466043	329.49551878178
108Hs-330				**330.40621837094**	**330.48290456824**	**330.51598134892**	**240.15836251374**
108Hs-331				331.41404450779	331.52869172764	331.52190610053	241.15443857789
108Hs-332				**332.42063606888**	**332.50310678853**	**332.53864044236**	**242.15245674878**
108Hs-333				333.42840852852	333.55147304945	333.54457175832	243.14906328494
108Hs-334				**334.43507523769**	**334.52386525896**	**334.56194199945**	**244.14717710603**
108Hs-335				335.44296578720	335.57488359286	335.56787163379	245.14429855551
108Hs-336				**336.44926749136**	**336.54517997954**	**336.58588602020**	**246.14252358549**
108Hs-337				337.45751231043	337.59892335786	337.59180572695	247.14014438960
108Hs-338				**338.46447961196**	**338.56705095027**	**338.61047250459**	**248.13849618717**
108Hs-339				339.47297134619	339.62359234445	339.61637403779	249.13660078722
108Hs-340					**340.58947817116**	**340.63570145264**	
108Hs-341					341.64889055264	341.64157656631	
		DZ	**WAW**	**Moller**	**NMT-UQAM TVNM***	**NMT-QAM TVNM****	**NMT-QAM SVNM*****
	σ_{rms} (with IAEA) =	**3.516811 MeV**	**0.082295 MeV**	**2.091750 MeV**	**0.647592 MeV**	**0.738886 MeV**	**0.601112 MeV**

* The unquantized atomic masses UQAM failed to give positive incremental difference in alpha energies between two sequential even-A & even-A and odd-A & odd-A mass number A; Δα (ee,oo) and two sequential even-A & odd-A and odd-A & even-A mass number A; Δα (eo,oe). While the QAM succeeded to give positive incremental difference in Δα (ee,oo) and Δα (eo,oe).

**TVNM= quantized atomic masses from total variable neutron mass [10-16].

***SVNM= quantized atomic masses from single variable neutron mass [10-16].

The calculated quantized atomic masses (QAM) from GTVNM values (see item 1) result in sequential positive values in Δα (ee,oo) and Δα (eo,oe) in alpha energy Q_α^{Th} as seen in Table 1 (see last column). This proves the atomic masses of the 82 isotopes are quantized. The tenth column of Table 1shows the oscillating values in Δα (ee,oo) and Δα (eo,oe) in the IAEA alpha energy Q_α^{Th} which proves that their atomic masses are unquantized. The fourth column denoted the NMT neutron-poor in green color and the NMT neutron-rich in red color. NMT Q_α^{Th} of Hs isotopes compared with Duflo-Zucker and Moller et al. Table 2 shows the high deviation of alpha energy Q_α^{Th} of Duflo-Zucker (σ_{rms} =3.51 MeV) and Moller et al (σ_{rms} =2.09 MeV) with IAEA. The σ_{rms} for NMT results are in the range 0.6-0.74 MeV. The values of Δα (ee,oo) and Δα (eo,oe) in alpha energy $Q_\alpha^{Th}$of Duflo-Zucker and Moller et al have been calculated and they showed a fluctuated values and did not give positive values. Figure-6: Alpha energies vs neutron number of Hassium, while Figure-7: Alpha energies vs mass number of Hassium.

Figure-8: Alpha energies from DZ, Moller, WAW and NMT vs Neutron Number of Hassium (Odd-Even)-NMT and Figure-9: Alpha energies from DZ, Moller, WAW and NMT vs Mass Number of Hassium (Odd-Even)-NMT. Figures 8&9 show the chaotic and irregularities in the theoretical alpha energy Q_α^{Th} of DZ, Moller, WAW. In my previous article, I explained that all these wrong calculations of the atomic masses come from the incorrect concepts firstly; the magic numbers and secondly; the binding energies [13-15].

First, NMT scrutinized the **n**eutron **m**agic **n**umbers NMN of the neutrons in details from Z=2 up to 118 and found out they are active only in few nuclei (of small Z) but they are mostly inactive in the other nuclei. They seem as if they are stochastic complementary number with some selective proton numbers in some nuclei to give stable nuclide more than phenomenological numbers. They do not have any influence at nuclei with Z greater than 90. For NMN, N=8, which is available in 13 elements, Z=2-14, has two stable nuclides only $^{15}_{7}\mathrm{N}$, $^{16}_{8}\mathrm{O}$. For NMN, N=20, which is available in 19 elements, Z=9-28, has five stable nuclides only $^{36}_{16}\mathrm{S}$, $^{37}_{17}\mathrm{Cl}$, $^{38}_{18}\mathrm{Ar}$, $^{39}_{19}\mathrm{K}$, $^{20}_{20}\mathrm{Ca}$. For NMN, N=28, which is available in 21 elements, Z=12-32, has four stable nuclides only $^{50}_{22}\mathrm{Ti}$, $^{51}_{23}\mathrm{V}$, $^{52}_{24}\mathrm{Cr}$, $^{54}_{26}\mathrm{Fe}$. For NMN, N=50, which is available in 24 elements, Z=27-50, has five stable nuclides only $^{86}_{36}\mathrm{Kr}$, $^{88}_{38}\mathrm{Sr}$, $^{89}_{39}\mathrm{Y}$, $^{90}_{40}\mathrm{Zr}$, $^{92}_{42}\mathrm{Mo}$. For NMN, N=82, which is available in 29 elements, Z=45-73, has six stable nuclides only $^{138}_{56}\mathrm{Ba}$, $^{139}_{57}\mathrm{La}$, $^{140}_{58}\mathrm{Ce}$, $^{141}_{59}\mathrm{Pr}$, $^{142}_{60}\mathrm{Nd}$, and $^{144}_{62}\mathrm{Sm}$. For NMN, N=126, which is available in 18 elements, Z=76-93, has one stable nuclide only $^{208}_{82}\mathrm{Pb}$. For higher NMN; neither Z=114 nor N=184 shows stability effect in the superheavy isotopes of Z=100-200.

NMT found similar results for the known **p**roton **m**agic **n**umbers PMN; Z=2, 8, 20, 28, 50, 82, 108, 114, 124, 126 and 164. Elements with Z = 2, 8, 20, 28, 50, and 82 have several isotopes. For example, the stable isotopes of, helium (Z=2) have A; 3 and 4, oxygen (Z=8) have A; 16, 17 and 18, calcium (Z=20) have A; 40, 42, 43, 44, 46, and 48, tin (Z=50) have A; 112, 114-120, 122 and 124, lead (Z=82) have A; 206, 207 and 208.

Figure 4: Mass Difference among DZ, Moller and NMT in relation to WAW, Z=108

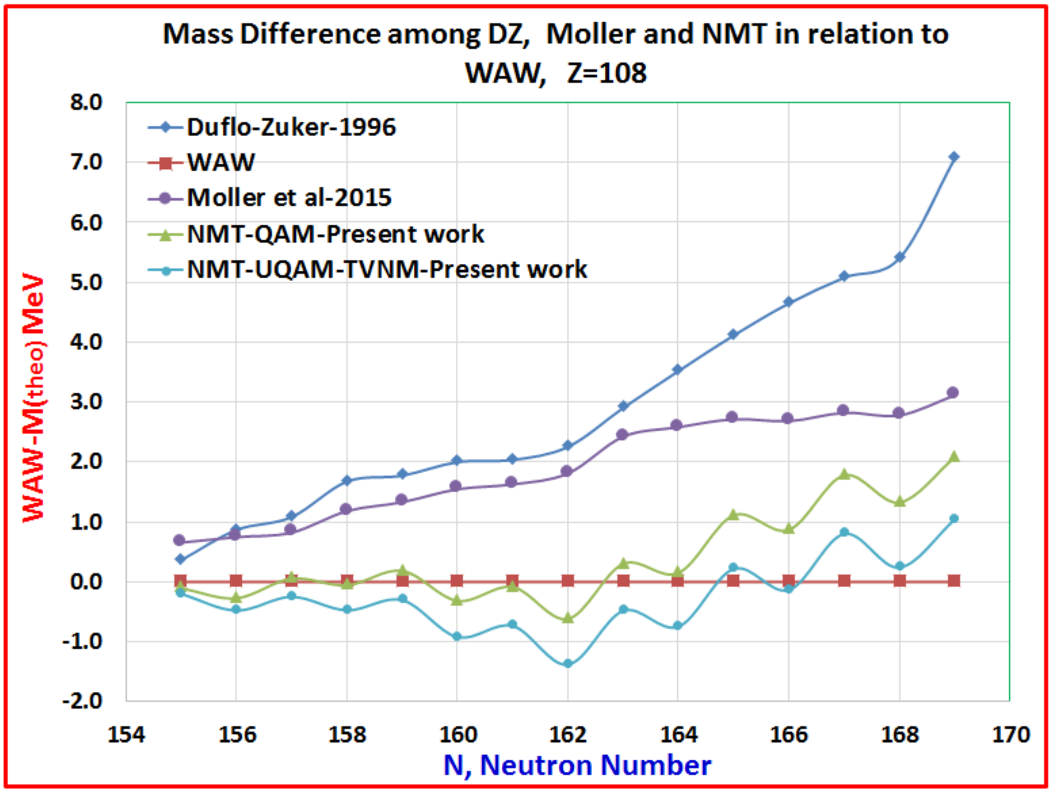


Figure 5: Alpha energies vs N, Neutron Number of Hassium (Odd-Even)-NMT

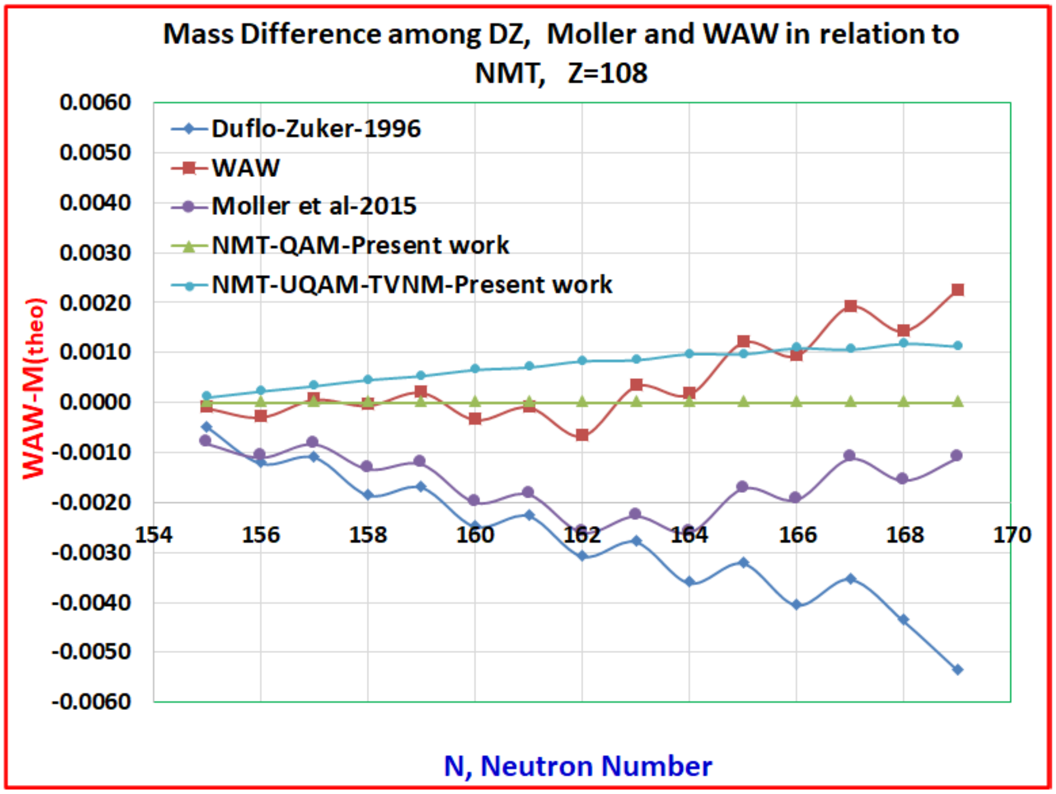


Figure 6: Alpha energies vs N, Neutron Number of Hassium (Odd-Even)-NMT

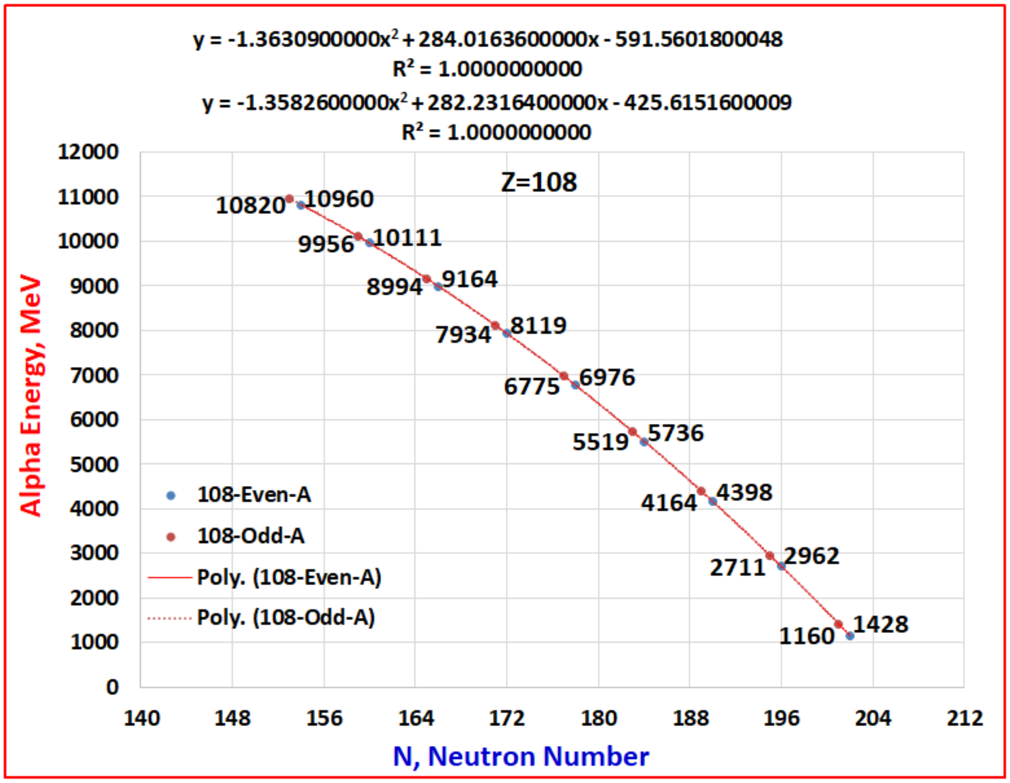
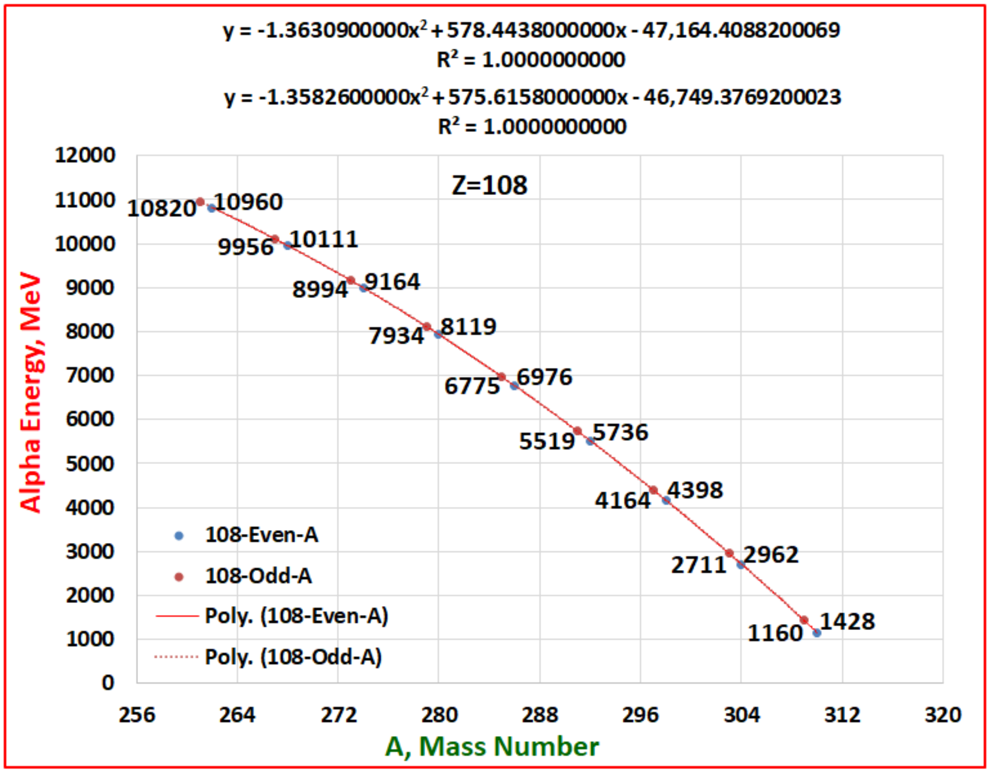


Figure 7: Alpha energies vs A, Mass Number of Hassium (Odd-Even)-NMT



The total stable nuclides from P and N magic are 44 nuclides of 280 stable nuclides. We must notice that the most stable nuclide in the universe $^{12}_{6}C$ which does not have any magic number, while the unstable isotope $^{14}_{6}C_{8}$ (5.70x10^{3}y) has NMN=8. What does that mean? Can we say that the magic numbers select arbitrarily some nuclides to make them stable and select the other to be unstable?

Why NMN=8 makes $^{16}_{8}O_{8}$ nuclide high stable and makes $^{14}_{6}C_{8}$ nuclide unstable? Why NMN=20 makes ^{36}S, ^{37}Cl, ^{38}Ar, ^{39}K, and ^{40}Ca stable nuclides, while makes ^{35}P (47.3s) and ^{41}Sc (596ms) unstable nuclides? And why the NMN 126 makes ^{82}Pb nuclide one of the most stable in the universe and makes its neighbors nuclides ^{207}Tl (4.8m) and ^{210}Po (137.37d) and ^{218}U (0.51ms) totally instable? Does the magic number make themselves active in some nuclides and inactive in the other? There are more than 70 examples.

It is supposed that when P and N magic numbers combined in any nuclide, they must give the highest stable nuclides, but in reality, this did not happen. Only five nuclei with doubly MN are stable such $^{4}He_{2}$, $^{16}O_{8}$, $^{40}Ca_{20}$, $^{48}Ca_{28}$ and $^{208}Pb_{126}$ while other nuclei are unstable such $^{48}_{28}Ni_{20}$ (2.1ms), $^{56}_{28}Ni_{28}$ (6.07d), $^{78}_{28}Ni_{50}$ (0.11s), $^{100}_{50}Sn_{50}$ (1.16s), $^{132}_{50}Sn_{82}$ (39.7s). Table-1 shows the doubly magic nuclei which is generated from combinations of the Z and N magic numbers. Only five stable isotopes are stable which explain the suspicion of their concepts. The microscopic-macroscopic models expected Z=114 and N=184 for the next doubly magic nucleus. NMT calculated the $T_{1/2}$ of this isotope $^{298}_{114}Fl$-184 to be 3.01d, while next isotope $^{298}_{114}Fl$-185 to be with $T_{1/2}$=102.1d. The non-relativistic mean-field models predict these numbers at Z=124 and 126 and N=184 are magic numbers. NMT calculated the $T_{1/2}$ of this isotope $^{308}_{124}$124-184 to be unstable and decay with α=13144 MeV and β^{+}=4659 MeV, while the other isotope $^{310}_{126}$126-184 to be unstable and decay with α=14152 MeV and β^{+}=6076 MeV. The relativistic mean-field models predict these numbers at Z=120 and N=172 are magic numbers. NMT calculated the $T_{1/2}$ of this isotope $^{292}_{120}$120-172 to be unstable and decay with α=13602 MeV and β^{+}=6277 MeV, while the other isotope $^{319}_{120}$120-199 to be with $T_{1/2}$=6158y. The theoretical studies predict the deformed nucleus at Z=108 and N=162 to be more stable. IAEA calculated the $T_{1/2}$ of this isotope ${}^{270}_{108}$Hs -162 to be 3.1s, while NMT the isotope ${}^{282}_{108}$Hs -174 to be 13.37d.

NMT again confirms that the magic P and N are a complementary number (i.e., **Proton-Neutron integral numbers**) to achieve the stable variable neutron masses and not phenomenological numbers. *The above lines are quoted from my last article ref 15 to confirm the wrong concepts of the magic number*. This wrong concept ruined all theoretical models for atomic mass calculations. The IAEA should take of it in their evaluations of the atomic masses.

Figure 8: Alpha energies from DZ, Moller, WAW and NMT vs Neutron Number of Hassium (Odd-Even)-NMT

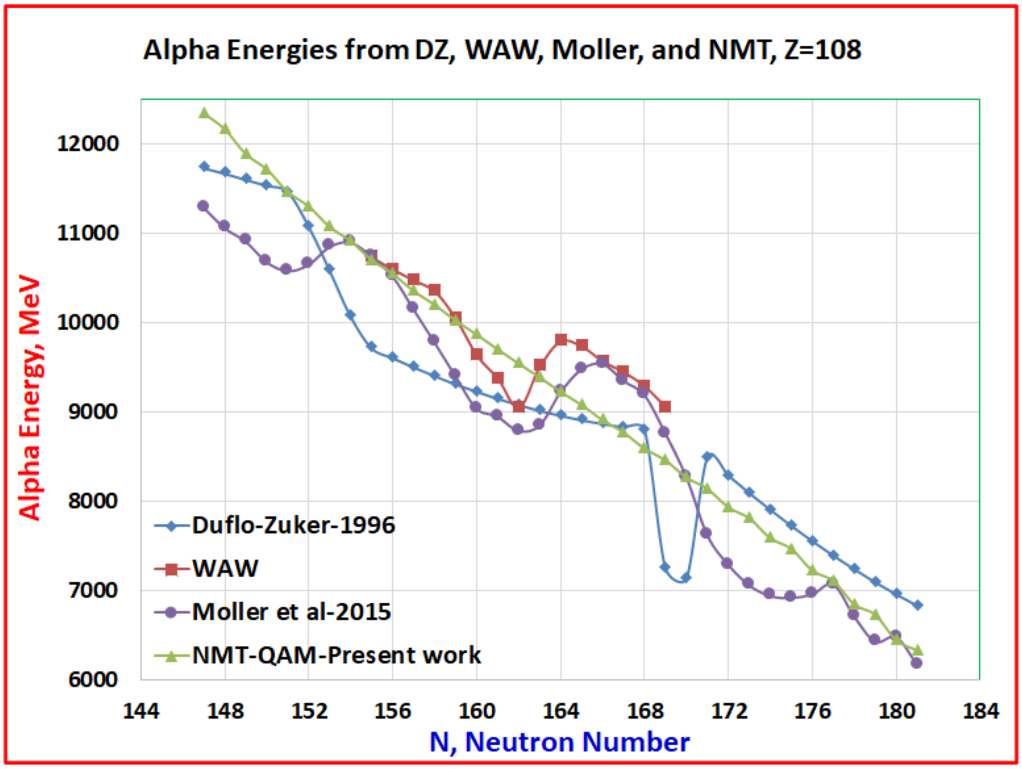
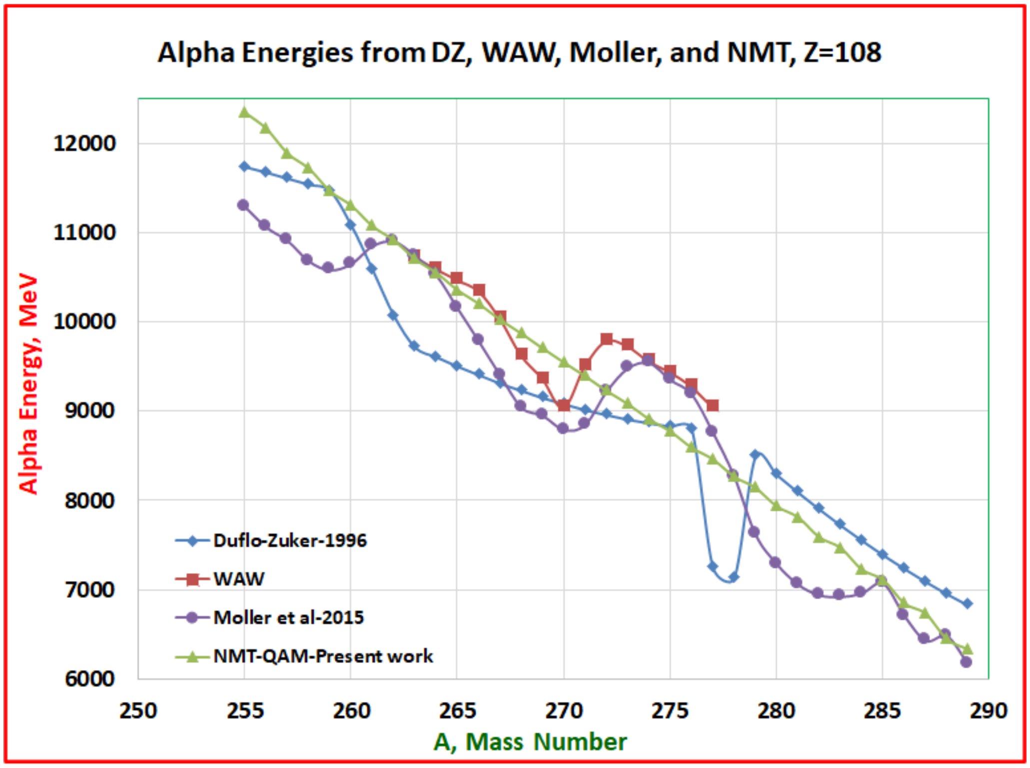


Figure 9: Alpha energies from DZ, Moller, WAW and NMT vs Mass Number of Hassium (Odd-Even)-NMT



Second: NMT-Novel Binding Energy Concept-Interstellar Nucleosynthesis

NMT [64-66] investigated intensively the actual meaning of the SMT atomic mass formula; BE = $ZM_H+NM_N-M_A$, after reviewing all the principles and facts of physics and SMT theory since 1900. It concluded that the mass formula is an abstract, and simply a **hypothetical mass equality** states the mass difference **Δm** (or **mass defect**) between atomic mass M_A and the nucleons; ZM_P+NM_N can be expressed in **unit of energy**.

The **hypothetical mass equality** does not simulate the mechanism of the nucleosynthesis process in the stars. The nucleosynthesis process in the stars is based on p-p chain, CNO and s- and p-processes and not based on this **Δm** putative equality. The concept is inherited from the wrong interpretation of $E=mc^2$. Nuclear scientists cannot create nuclides in their laboratories from adding ZM_P+NM_N to get BE and M_A. **NMT** scrutinized deeply the BE term in this virtual equation and found out it refers to the **mathematical Δm energy** and it does not reflect the actual concept of **binding energy**. There is neither physical condition, nor guarantee to confine the **Δm energy** (mass defect energy) to stay in the nuclei to act as binding energy. It is supposed that the binding energy B.E explains the easy formation of; nucleosynthesis or nucleogenesis, and the degree of the stability of the nuclide, but it seems not. The SMT defines the nuclear binding energy is that in experimental physics is the minimum energy that is required to disassemble the nucleus of an atom into its constituent protons and neutrons, known collectively as nucleons.

NMT defines the binding energy as the acquired energy to bind each two nucleons in one sphere of four nucleons in the nuclides during the nucleosyntheses process in stellar system. NMT derived a novel formula for calculation of the binding energy. NMT-BE refers to the optimal energy that is acquired to bind p-p, p-n*, and n*-n* in the nuclei (Where n*=SVNM). The maximum values of the BE calculated for more than 3400 isotopes of Z=1-118 occur in the range of N/P: 1-1.5. The maximum value of BE of NMT or SMT does not refer to the stability of the nuclide at all, nor does it indicate to long half-life of the nuclide. Nor it does take its highest values at nuclei with single or double magic numbers. The results of NMT-BE will be published later.

For example, the SMT BE calculation showed the Be-8 (unstable; 8.18E-17 s) (7.06244 MeV/A) has higher binding energy than Be-9 (stable) (6.46266 MeV). Another example, the SMT BE calculation showed that ^{218}U nuclide (6 ms) have the highest B.E (7.640638905672570 MeV/c^2) among all uranium isotopes (comparing with 4.468×10^9y of ^{238}U).

Generally, when we move down in excel tables toward the heaviest elements, the SMT BE goes up to neutron deficient isotopes and not to the stable isotopes. These results disagree with the concept and BE definition of SMT above. The inappropriate concepts of the binding energy and magic numbers of **SMT** highly affected the IAEA calculations of the atomic masses.

4. Isotopes Half-life Time Prediction Formulae

I. The Royer Formula (RF)

The GLDM including propinquity effects between the α particle and the daughter nucleus, is utilized in the description of the potential energy barrier and is adjusted to reproduce the experimental Q_α; the α-particle half-life time T_α is deduced from the Wentzel-Karmers-Brillouin (WKB) barrier penetration probability as for spontaneous asymmetric fission.

The model expressions involving Z, A and Q_α were fitted against the $T_\alpha^{\exp}$, for 373 α emitters [7] with Z and A in the range of 52–111 and 107–272, respectively, to arrive at the 12-parameter analytical formula,

$$\log_{10}[T_\alpha(R)] = a + b*(A^{1/6}*\sqrt{Z}) + c*(Z/\sqrt{Q_\alpha}) \qquad (4)$$

where $T_\alpha(R)$ is the calculated alpha partial half-life in seconds and Q_α is in MeV.

The values of the coefficients a, b and c for parent nuclides of Z proton-N neutron even-even (e-e), even-odd (e-o), odd-even (o-e) and odd-odd (o-o) respectively were, (-25.31, -1.1629, 1.5864); (-26.65, -1.0859, 1.5848); (-25.68, -1.1423, 1.592); and (-29.48, -1.113, 1.6971).

II. The Viola-Seaborg-Sobiczewski Formula (VSS)

In 1966, Viola and Seaborg generalized the empirical Geiger–Nuttall formula [76] to include more adjustable parameters and obtained the following 7-parameter formula [6] for the calculated alpha partial half-life T_α(VSS) in seconds,

$$\log_{10}[T_\alpha(VSS)] = (a*Z + b)*(1/\sqrt{Q_\alpha}) + (c*Z + d) + h\log \qquad (5)$$

where the coefficients a, b and c were obtained from fits to e-e α decaying nuclei and Q_α is in MeV. The parameter *h*log is the *h*indrance factor for nuclei with unpaired nucleons and is obtained by fits to odd nuclei. Its value for e-e, e-o, o-e, and o-o Z-N numbers of the parent nuclide were obtained respectively as, 0, 1.066, 0.772, 1.114. For the a, b, c and d parameters I consider the Sobiczewski modified values obtained using the more recent and expanded database of e-e nuclides [17], which are: a = 1.66175; b = -8.5166; c = -0.20228; d = -33.9069.

III. The Sobiczewski-Parkhomenko Formula (SP)

Recently, Sobiczewski and Parkhomenko have introduced a 5-parameter phenomenological formula for the alpha partial half-life T_α(SP) in seconds [3,18] motivated by the need to simplify the VSS formula as follows,

$$\log_{10}[T_\alpha(SP)] = \frac{a*Z}{\sqrt{(Q\alpha - \bar{E}i)}} + b*Z + c \tag{6}$$

where Q_α is in MeV. The parameters, a, b and c are respectively: 1.5372; -0.1607; and -36.573. The parameter $\bar{E}_i$, the average excitation energy of a state of the daughter nucleus to which the α decay goes, is given by,

$\bar{E}_i = 0$ for e-e; $\bar{E}_i = \bar{E}_n = 0.171$ MeV for e-o; $\bar{E}_i = \bar{E}_p = 0.113$ MeV for o-e; $\bar{E}_i = \bar{E}_p + \bar{E}_n$ for o-o.

The values for the 5 parameters above have been obtained by adjusting eqn. 6 to the experimental T_α and Q_α of 201 α decaying nuclei between Z=84-111 and N=128-161. However, nuclei with N close to the shell closures at N=152 and 162 were omitted.

5. Spontaneous Fission Criteria

The existence of long-lived superheavy nuclei is controlled mainly by spontaneous fission and the alpha decay process. The derivation of Weizacker's liquid drop model (LDM) gives the fissility parameter $Z^2/A \approx 39.3 \pm 1.2$ (a factor that determines the "willingness" of nuclei to fission). The fissility parameter must be less than 39.3 for nuclide to be stable. Another derivation for the fissility parameter Z^2/A goes back to Bohr and Wheeler in 1939, [78] and independently to Frenkel in 1939 [79], where they concluded that the minimum values for Z^2/A is 47 for the stable nuclide. Whether the value of Z^2/A is equal to 39.3 or 47 should not be taken too strictly, as they are based on rather arbitrary assumptions for nuclear constants [80]. However, all known nuclides which undergo spontaneous fission as their main decay mode do not reach this value of 47, as the LDM is not fully accurate for the heaviest known nuclei due to strong shell effects. For example, the fissility parameter for ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{250}Cm and ^{252}Cf are 36.0, 35.6, 37.0, 36.8, 36.9 and 38.1, respectively.

In 2011, Poenaru et al. [81] described the fissility of a nucleus, starting from LDM and the macroscopic-microscopic method, as the ratio of Coulomb energy of a spherical sharp surface drop to twice the nuclear surface energy; $\chi = \frac{E_c}{2E_s}$, X= fissility parameter. They concluded that the X values must be less than 1 for stable nuclides.

6. Spontaneous Fission Half-lives Formula

Several authors proposed empirical formulas for determining the half-lives tried to derive empirical relations for spontaneous fission half-lives such Swiatecki [82] in 1955, Smolanczuk et al. [83] Muntain et al. [84]. In 2005, Ren et al. [85, 86] proposed a phenomenological formula for spontaneous fission half-lives. In 2008, Xu et al. [87] proposed an empirical formula for determining the spontaneous fission half-lives and is given as

$$T_{1/2} = \exp\{2\pi[C_0 + C_1 A + C_2 Z^2 + C_3 Z^4 + C_4 (N - Z)^2 - (0.13323\frac{Z^2}{A^{1/3}} - 11.64)]\} \tag{7}$$

Where C_0=-195.09227, C_1=3.10156, C_2=-0.04386, C_3=1.403E-6 and C4=-0.03199.

Although different laboratories succeeded in measuring the spontaneous fission half-lives of several superheavy nuclide [80,88,89], until now there is no clear mechanism to describe the spontaneous fission process. Few authors reported the Spontaneous fission of few isotopes of Hassium [90,91,92] as shown in Table-3. Therefore, no accurate formula is available in the literature to calculate or estimate the spontaneous fission half-lives. In worst scenario, may be few of these 20 long lifetime isotopes will survive to stay without underdoing a fission process.

Table 3: The Spontaneous fission Half-life of Hassium from Literature

	Isotope	Decay Mode IAEA	NMT $T_{1/2}$	Time	Fissilty Param. $Z^2/A<47$	Kind of emitter	β^-	β^+	Q_α^{Th}	Spontaneous fission Ref 90	Spontaneous fission Ref 91	Spontaneous fission Ref 92
1	**108Hs-276**	**α, SF**	**2.11**	**m**	**42.26**	**Pure α**	**-2761**	**-498**	**8651**			
2	108Hs-277	α, SF	34.8	m	**42.11**	**Pure α**	-1500	-95	8478			
3	**108Hs-278**	**α, SF**	**32.78**	**m**	**41.96**	**Pure α**	**-1968**	**-1202**	**8298**			
4	108Hs-279	α, SF	10.36	h	**41.81**	**Pure α**	-847	-960	8119			
5	**108Hs-280**	**α**	**11.25**	**h**	**41.66**	**Pure α**	**-1164**	**-1906**	**7934**	**$2.7x10^{-6}$ s**		**87s**
6	108Hs-281	α	10.44	d	**41.51**	**Pure α**	-198	-1839	7749			182s
7	**108Hs-282**	**α, SF**	**13.37**	**d**	**41.36**	**Pure α**	**-349**	**-2611**	**7558**			
8	108Hs-283	α	357.99	d	**41.22**	**$\alpha+\beta^-$**	448	-2734	7368			
9	**108Hs-284**		**1.52**	**y**	**41.07**	**$\alpha+\beta^-$**	**478**	**-3315**	**7172**			
10	108Hs-285	α	50.60	**y**	**40.93**	**$\alpha+\beta^-$**	1090	-3644	6976			
11	**108Hs-286**		**98.86**	**y**	**40.78**	**$\alpha+\beta^-$**	**1316**	**-4020**	**6775**	**$7.84x10^{-16}$ s**	**61s**	
12	108Hs-287	α	4222.67	**y**	**40.64**	**$\alpha+\beta^-$**	1729	-4569	6574	$2.40x10^{-17}$ s	0.5ms	
13	**108Hs-288**	**α**	**1.08E+04**	**y**	**40.50**	**$\alpha+\beta^-$**	**2165**	**-4725**	**6367**			
14	108Hs-289	SF	6.26E+05	**y**	**40.36**	**$\alpha+\beta^-$**	2364	-5509	6160		6.7ms	
15	**108Hs-290**	**α, SF**	**2.24E+06**	y	**40.22**	**$\alpha+\beta^-$**	**3025**	**-5431**	**5948**		**0.98ms**	
16	108Hs-291		1.86E+08	**y**	**40.08**	**$\alpha+\beta^-$**	2994	-6464	5736			
17	**108Hs-292**		**9.96E+08**	y	**39.95**	**$\alpha+\beta^-$**	**3897**	**-6136**	**5519**	**$8.69x10^{-45}$ s**		
18	108Hs-293		1.29E+11	**y**	**39.81**	**$\alpha+\beta^-$**	3622	-7433	5301			
19	**108Hs-294**		**1.15E+12**	y	**39.67**	**$\alpha+\beta^-$**	**4780**	**-6842**	**5078**			
20	108Hs-295		2.63E+14	**y**	**39.54**	**$\alpha+\beta^-$**	4245	-8418	4855			

7. Results and Discussion

I applied the three formulae (RF, VSS and SP) on the new isotopes of more than 14000 that belong to Z=119–232, but I relied on Royer Formula which gave more reasonable results which will be submitted to the journal later. Table 3 lists the $T_{1/2}$ of 20 isotopes of Hs, Z=108. These 20 isotopes include 13 ($\alpha+\beta^-$) emitters, 7 pure alpha emitters. I selected them based on the scientific nuclear terms, considering the values of positron and negatrons energies which should not exceed 4200 keV. IAEA even accepted nuclide with $E_{\beta+}$ exceed 4.5MeV. For example, see ^{244}Es and ^{239}Cf, etc. on the website of IAEA. Column 6th in Table-3 shows the fissility parameters values. All values are below Bore value i.e., 47 but exceeded the fissility parameter 39.3. These results indicate that the new isotopes are below the threshold of the spontaneous fission limit. I applied Xu's formula to the well-known nuclides that undergo spontaneous fission i.e., ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{250}Cm and ^{252}Cf and I found the results of the formula are inaccurate.

The Hs isotopes with the longest half-lives among these 20 isotopes are: ^{288}Hs ($1.08x10^4$y), ^{289}Hs ($6.26x10^5$y), ^{290}Hs ($2.46x10^6$y), ^{291}Hs ($1.86x10^8$y), ^{292}Hs ($9.96x10^8$y), ^{293}Hs ($1.29x10^{11}$y), ^{294}Hs ($1.15x10^{12}$y), and ^{295}Hs ($2.63x10^{14}$y). NMT considers these 8 isotopes whose $T_{1/2}$ in years as a part of the island of the stability.

Conclusion

In present work, the three well-known phenomenological formulae (RF, VSS and SP) are used to predict the half-lives of the 90 generated isotopes of Hs element: Z=108. I noticed that RF was more practical than the others, therefore, I relied upon RF results and mentioned them in my tables. NMT found out 20 isotopes that have long lifetime and exceed 10^{10} year. NMT considered them as part of the Island of stability. They have been selected among 90 isotopes based on the scientific nuclear terms, considering the values of positron and negatrons energies which should not exceed 5.2MeV. In a previous article [15] I explained how I calculated the QAM. The QAM's are calculated from the isotopic quantized mass formula IQMF of 2nd power.

The Q-values of β^-, β^+, EC, α-decay energies have been calculated through three different nuclear methods: SMT which is based on **m**ass **d**efect (MD) (in proton and neutron mass), NMT which is based on **n**eutron **m**ass **d**efect (NMD) (in neutron mass only), and **standard energy of formation of nuclide** E_f^o (SEFN) [10-16].

My novel nuclear theory NMT examined all experimental and theoretical atomic masses values of IAEA, JAEA, WAW, Moller and Duflo-Zucker which failed to give positive incremental difference in alpha energies between two sequential even-even and odd-odd mass number A; Δα (ee,oo) and two sequential even-odd and odd-even mass number A; Δα (eo,oe). NMT called these values unquantized atomic masses (UQAM). The unquantized atomic masses generate wrong alpha energies.

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