Radiation Transition Probability of Nuclear Energy States for Even-Even Nuclei with Mass Greater than 48

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ABSTRACT

The purpose of this study is to compare and analyze available data for the reduced transition probabilities from first excited state $B(E2:0_2^+ \rightarrow 2_1^+)$ with the seconded excited state $B(E2:0_2^+ \rightarrow 2_2^+)$ of even-even nuclei with mass number greater than 48. As well as analyze other E2 transition e.g. $B(E2:4_1^+ \rightarrow 2_1^+)$ $B(E2:2_2^+ \rightarrow 0_1^+)$ $B(E2:2_1^+ \rightarrow 0_1^+)$ and **,** The seconded low-lying level states only exist in some nuclei, this work looks only at the general trend . The results have been converted to Weisskopf unit with respect to mass.

INTRODUCTION

An electric quadrupole can be represented as the energy of an electromagnetic radiation field and described mathematically in terms of a multipole moment expansion. A nucleus contain only positive charge, but due to quadruple os

Quantum Number:
A total of four quantum numbers are used to describe the movement and trajectories of sub-atomic particles. The follower expression of ***B(E2***; J(K) J(F)) represents the transition rate going from J(K) to J(F).(Where J=Angular momentum and K=states(1,2,3...n represents nth excited states))

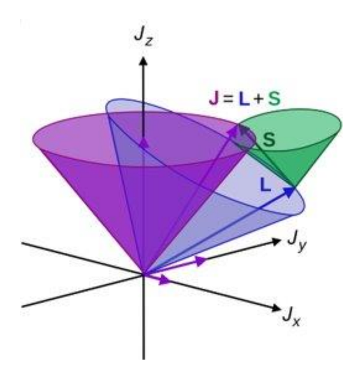

Fig 1. 3-D Total angular momentum vector J, Sum of vector S and L [1]

B(E2) value are essential for nuclear transition properties as well as the basic nuclear information complementary to our knowledge of low-lying levels in these nuclides

B(E2)-Reduced Electric Quadrupole Transition Probability

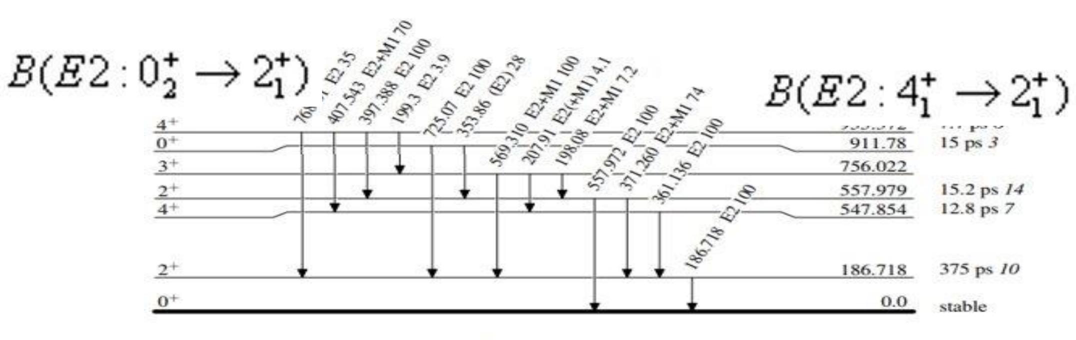

Fig 2. ENSDF Nuclear Shell Model of 190-Os [2]

HYPOTHESIS

For even-even nuclei with mass greater than 48, if the $B(E2:0_2^+ \rightarrow 2_1^+)$ is low, then it will instead transition to $B(E2:0_2^+ \rightarrow 2_2^+)$

METHODS

This work is a meta-analysis, all data that present in this work are collected from the National Nuclear Data Center (NNDC), mainly the chart of nuclides and the data source is from Evaluated Nuclear Structure Data File (ENSDF) as well as the Experimental Unevaluated Nuclear Data List (XUNDL), which provides recommended nuclear structure and decay information; Spin and parity assignments, nuclear mass excesses, half-life, isotopic abundances decay modes and ***B(E2)*** value. For some nuclei on the ENSDF only shows the ***B(E2)*** in e^2b^2 unit. A useful scale of ***B(E2)*** value is provided by the Weisskopf single particle unit (W.u) calculated assuming a uniform charge density. [3-5]

$$1wu = 5.94 \times 10^{-6} \times A^{4/3} \times B(E2) e^2 b^2$$

B(E2) value can be measured though experimentation or predicted though theoretical model calculations. There are many ways to carry out each method,
e.g., For the seconded excited state, Dr L.E Svensson experimented using the Coulomb excited method of firing beams of 16-O, 58-Ni and 208-Pb at 106-Pd and 108-Pd.[8]

RESULTS

The even-even nuclei with mass greater than 48 from ground states to the first and second excited states has been compared and analyzed. The graphs generated from the ENSDF data are shown below from Fig 3. through Fig 6. Table 1 shows the specific value of the transition of the mean interest. ($B(E2:0_2^+ \rightarrow 2_1^+)$ $B(E2:0_2^+ \rightarrow 2_2^+)$)

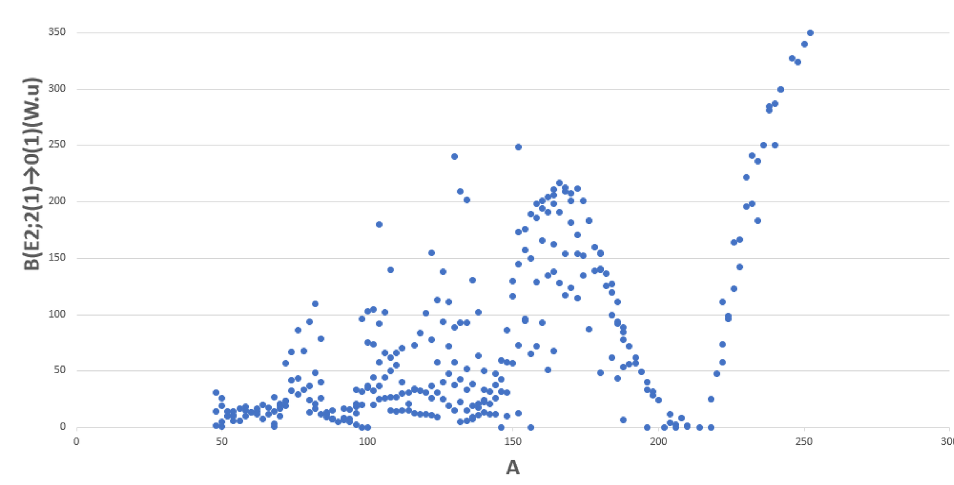

Fig 3. $B(E2:2_1^+ \rightarrow 0_1^+)$ values for even-even nucleus with mass number greater than 48.

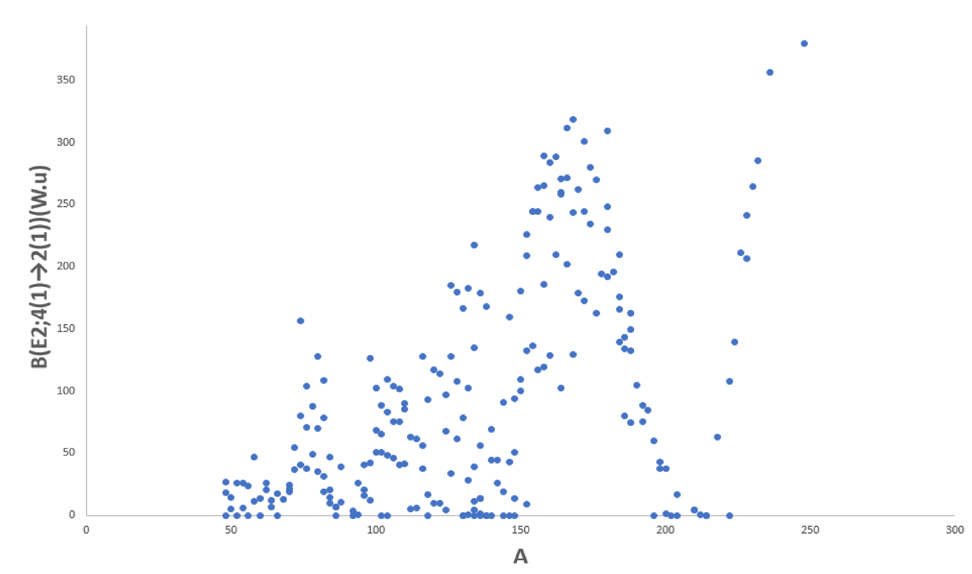

Fig 4. $B(E2:4_1^+ \rightarrow 2_1^+)$ values for even-even nucleus with mass number greater than 48.

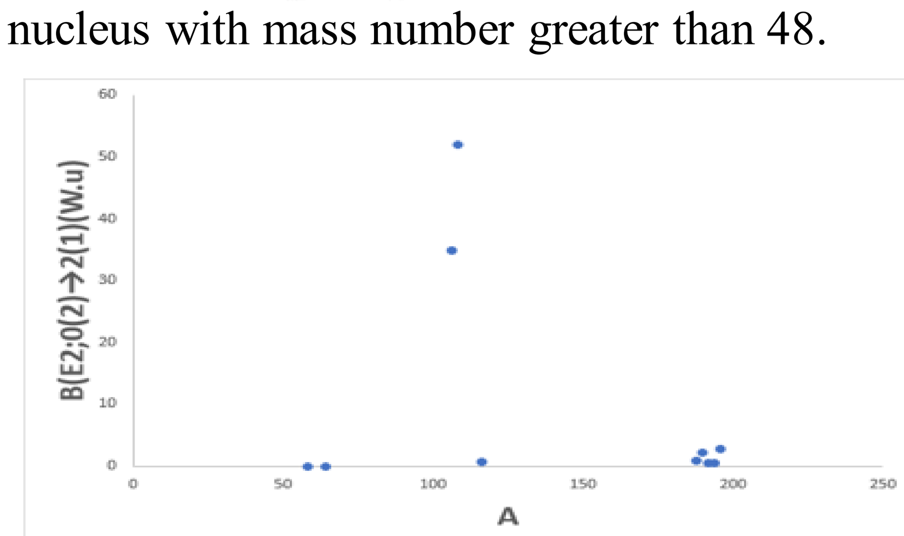

Fig 5. $B(E2:0_2^+ \rightarrow 2_1^+)$ values for even-even nucleus with mass number greater than 48.

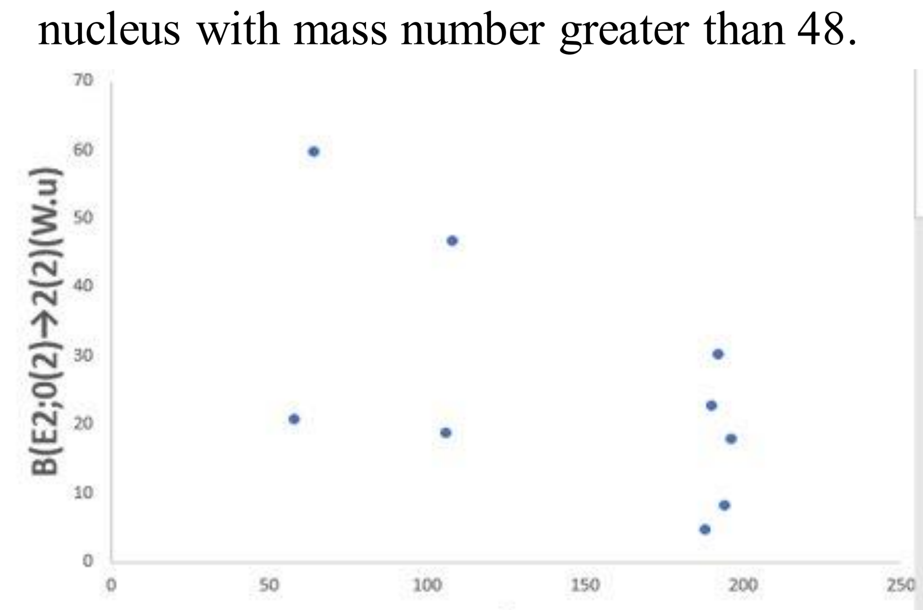

Fig 6. $B(E2:0_2^+ \rightarrow 2_2^+)$ values for even-even nucleus with mass number greater than 48. (116-Cd were not included on the graph.)

0(2) to 2(1)	A	B(E2)(W.u)		0(2) to 2(2)	A	B(E2)(W.u)
58Ni	58	0.0004		58Ni	58	21
64Zn	64	0.057		64Zn	64	60
106Pd	106	35		106Pd	106	19
108Pd	108	52		108Pd	108	47
116Cd	116	0.79		116Cd*	116	(3.0X10^4) *
188Os	188	0.96		188Os	188	4.8
190Os	190	2.2		190Os	190	23
192Os	192	0.57		192Os	192	30.4
194Pt	194	0.63		194Pt	194	8.4
196Pt	196	2.8		196Pt	196	18

Table1. Comparison of first and second transition ***B(E2)*** value corresponding with atomic mass A.

DISCUSSION

The general trend for 2(1)+ to 0(1)+, 4(1)+ to 2(1)+ showing on Fig.3 and Fig.4 are similar in a way with small margin of variability. $B(E2:4_1^+ \rightarrow 2_1^+)$ value tends to be higher than $B(E2:2_1^+ \rightarrow 0_1^+)$ The series of low-lying excited nuclear states in nuclei with even numbers of protons and neutrons indicates that the nucleus can be excited to quadrupole oscillations around its equilibrium spherical shape.

A sphere oscillates during becoming in the process of expansion then going back and forth. The shape of its surface, roughly speaking, waves becomes waving which is measured by its angular momentum. One quantum of such vibration vibrations has angular momentum J=2, and this is the lowest excited level 2+. The excitation of two quanta can give angular momenta 4+, 2+ (the second 2+) and 0+(the second 0+ after the ground state). Therefore Therefor the quadrupole oscillation for $B(E2:4_1^+ \rightarrow 2_1^+)$ is a relatively a more intense transition than $B(E2:2_1^+ \rightarrow 0_1^+)$

On Fig.5 and Fig.6 the data shows the general trend of nuclear energy transitioning from the second excited state J=0 to the first excited states J=2 is relatively low, it would rather go to the second excited state J=2. There are still large amount of ***B(E2)*** value for the seconded transition has not been evaluated. It may not be significance to conclude the all even-even nuclei share such properties. Although, this frame work only looks at the general trend systemic of ***B(E2)*** value.

FUTURE RESEARCH

The first and second excited E2 transitions have been compared for the first time. The results included the nuclear transition properties and nuclear information. It could potentially be compared with Dr. Zelvensky's prior work of Anhormanic Correction of approximation to ***B(E2)*** and by adding more accurate physical constants to get a better estimation of ***B(E2)*** value.

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