ATLAS OF NUCLEAR ISOMERS & THEIR SYSTEMATICS

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Meeting of the International Network of NSDD Evaluators, IAEA, Vienna, 4-8 April 2011

LIST OF COLLABORATORS

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- P. Arumugam
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BASICS AND GENERAL INFORMATION

- All the data extracted from ENSDF by using a computer code
- Isomers defined as the excited states having half-life $\geq$ 1*ns*
- Total number of isomers with confirmed half-lives – 2252
- Total number of nuclei having isomers – 1116
- Isomers with upper limit on half-lives – 606
- Isomers including all half-lives and tentative spins – 3175

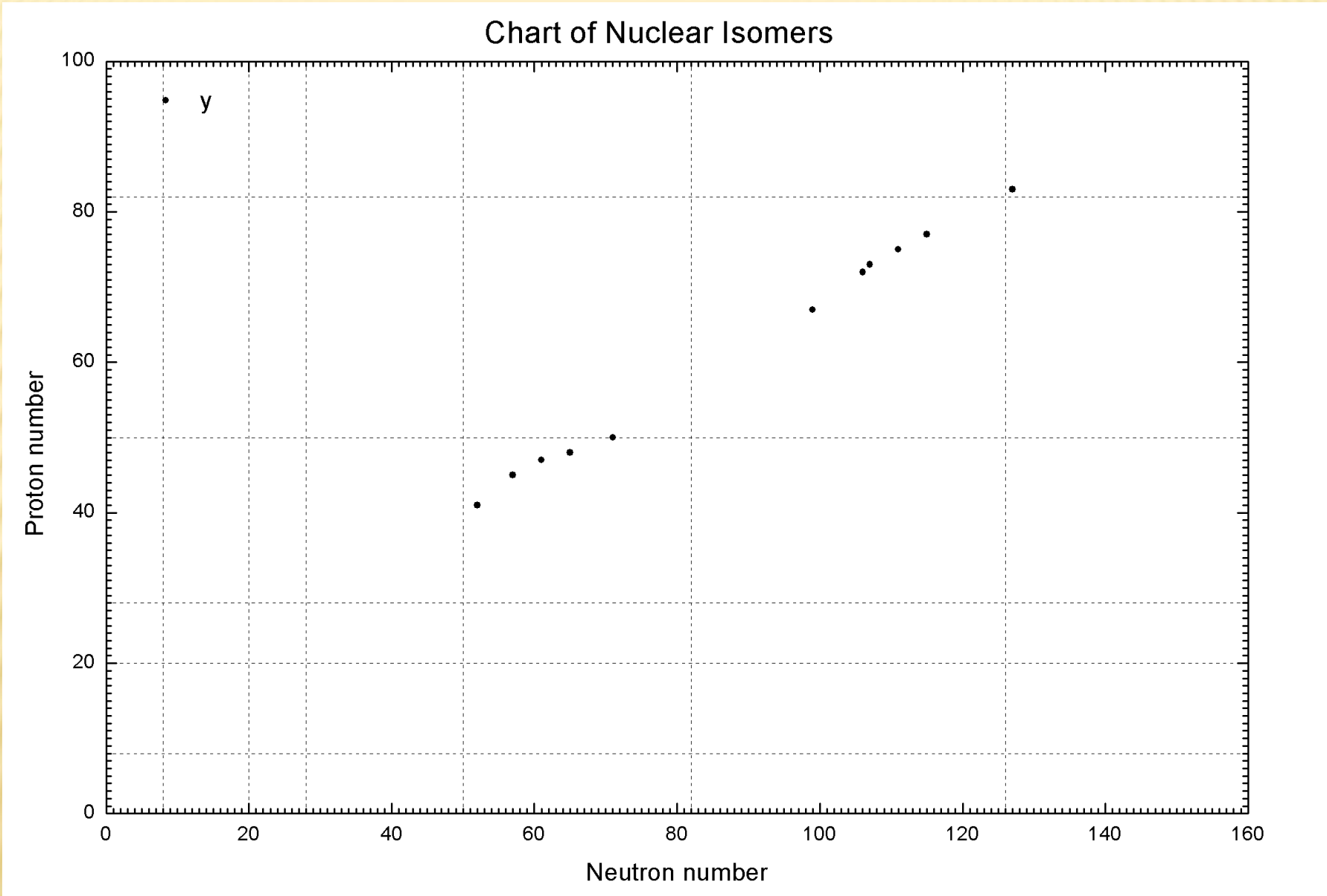
Chart of Nuclear Isomers
y
Proton number
Neutron number
0
20
40
60
80
100
120
140
160

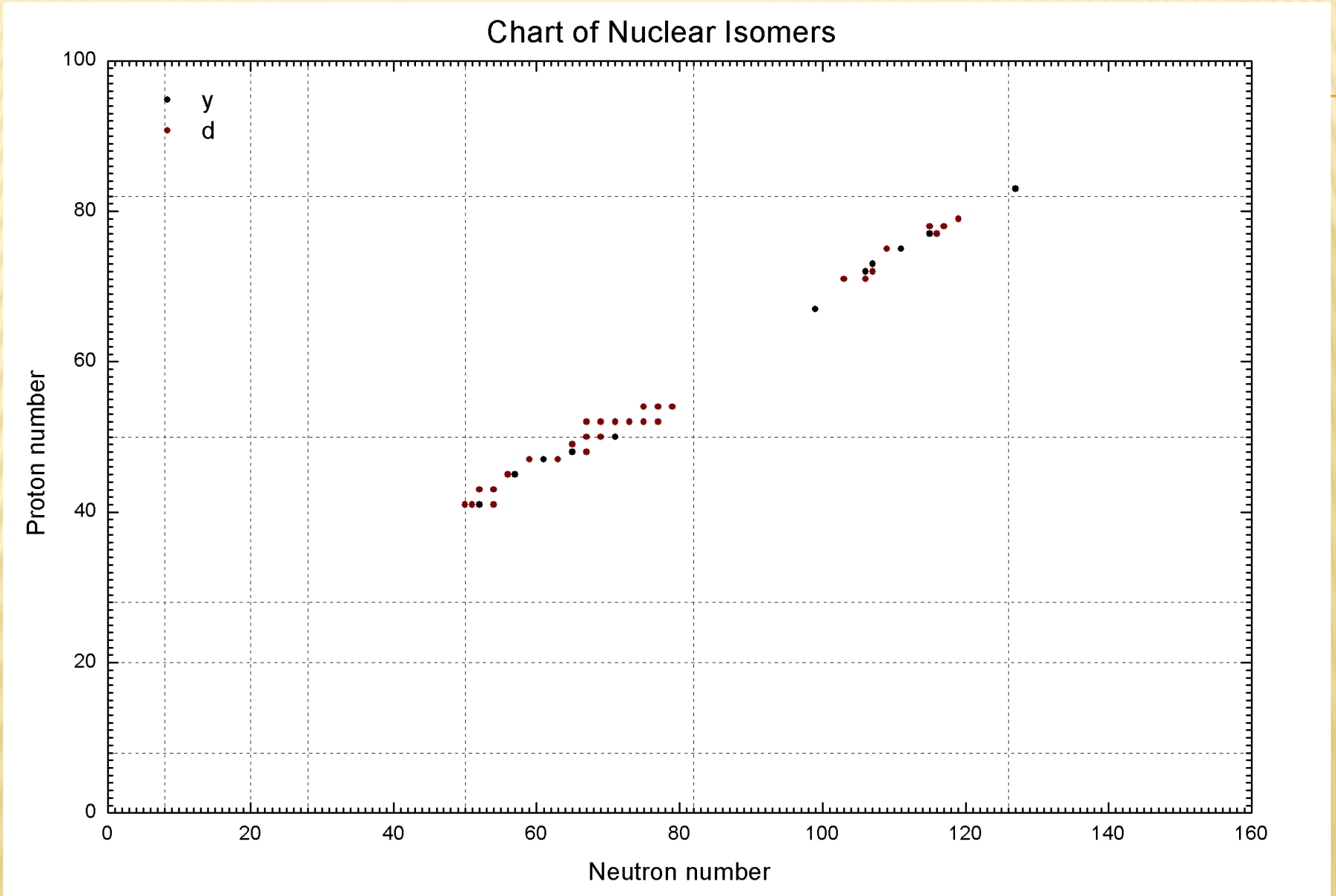
Chart of Nuclear Isomers
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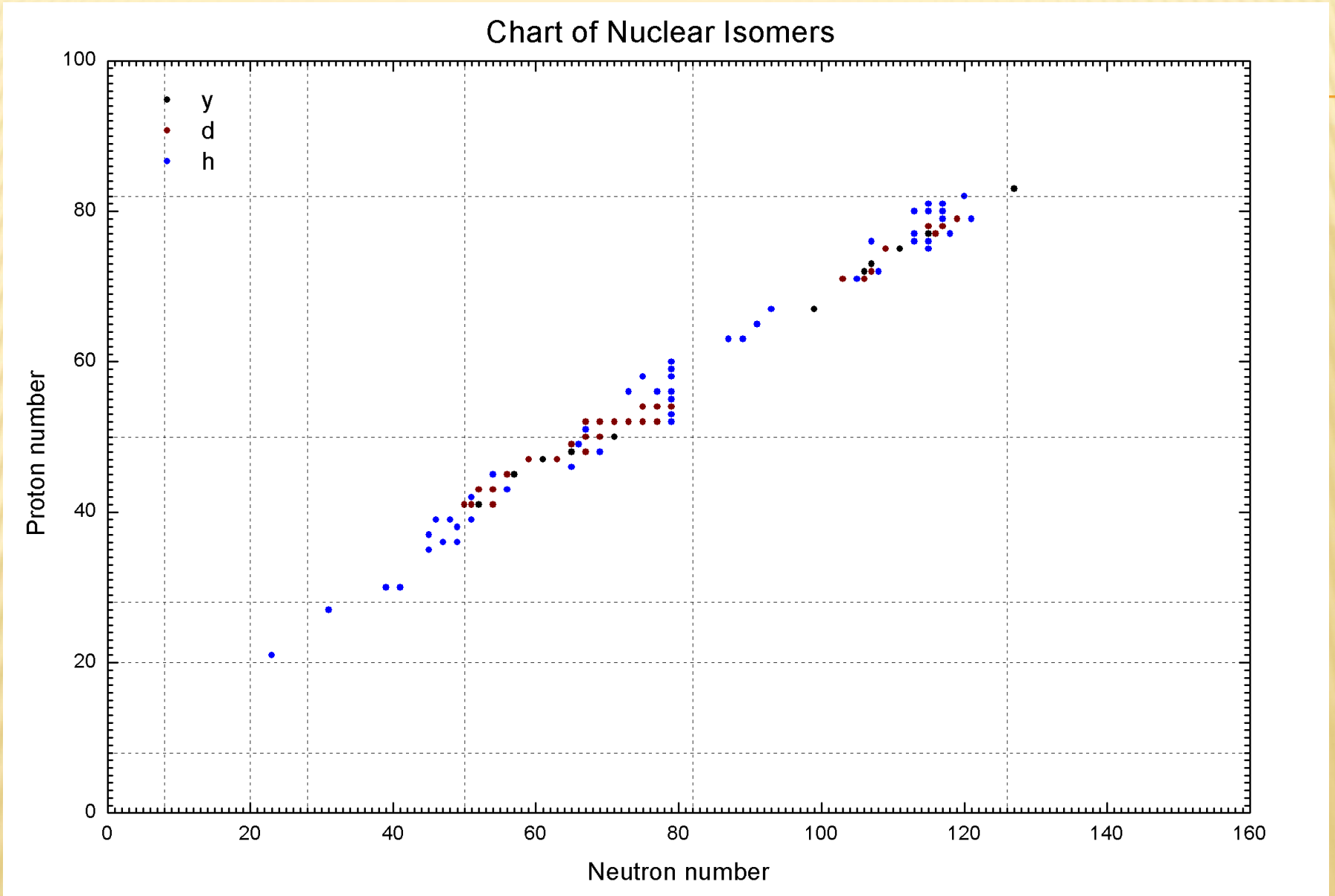
Chart of Nuclear Isomers
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Proton number
Neutron number
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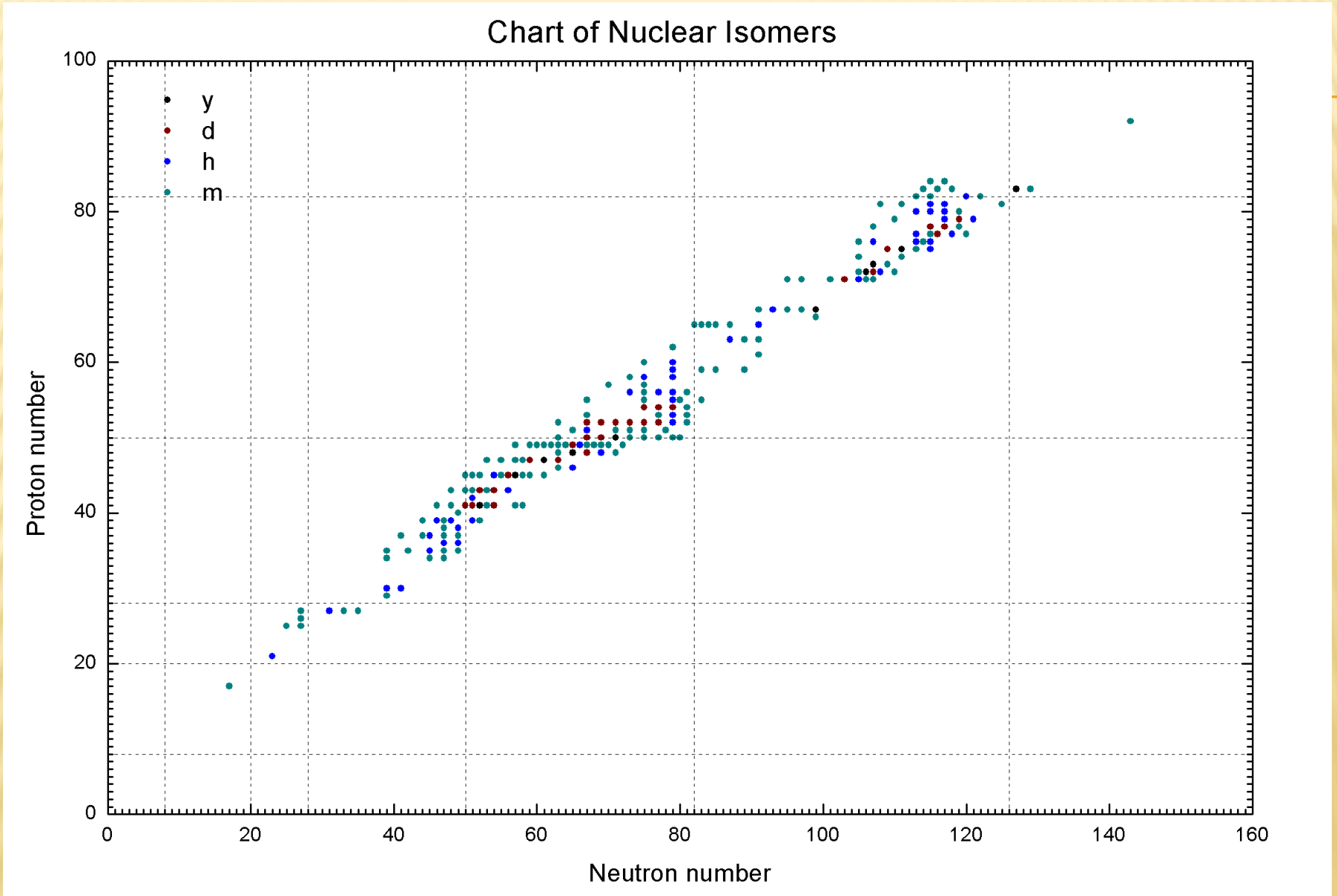
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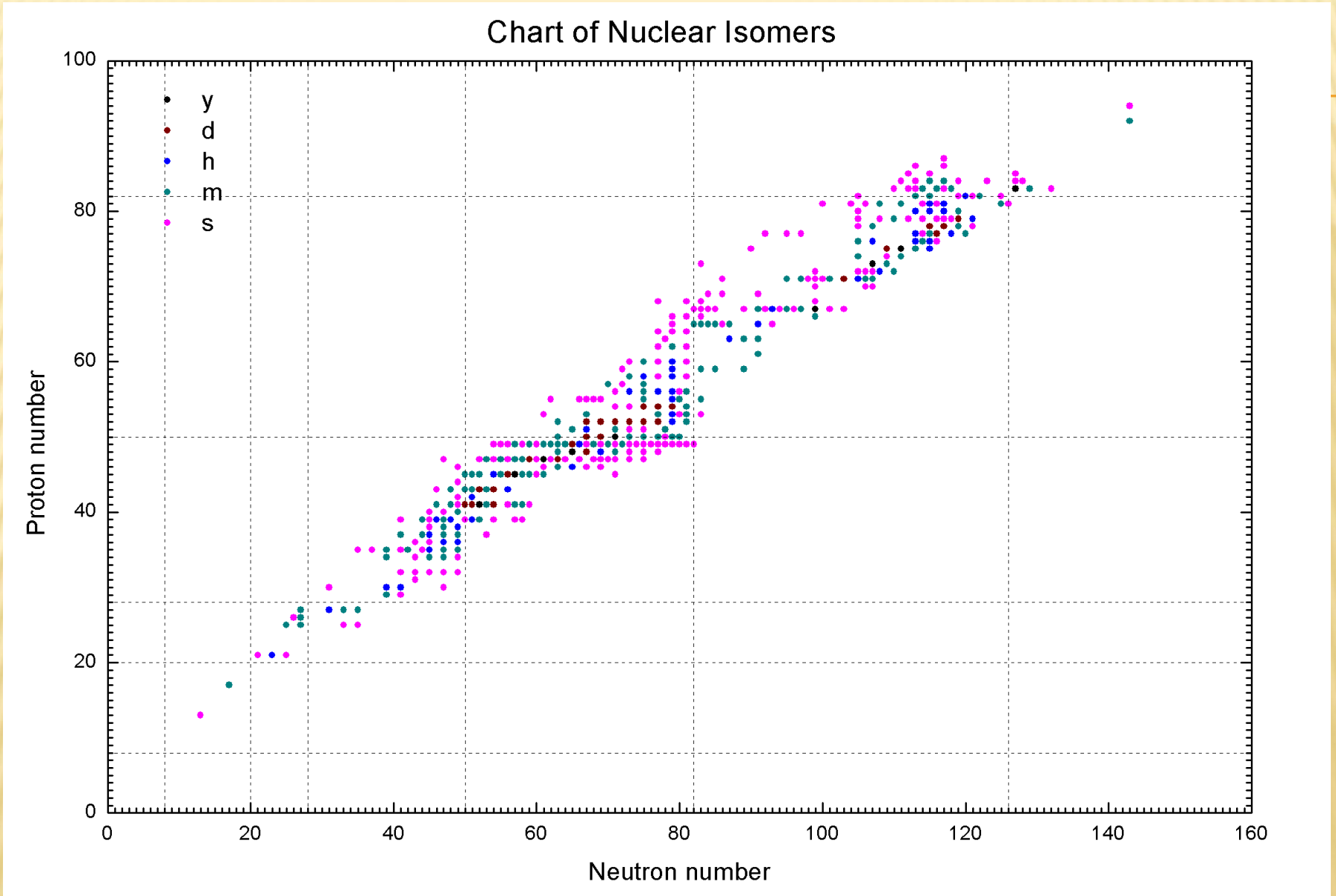
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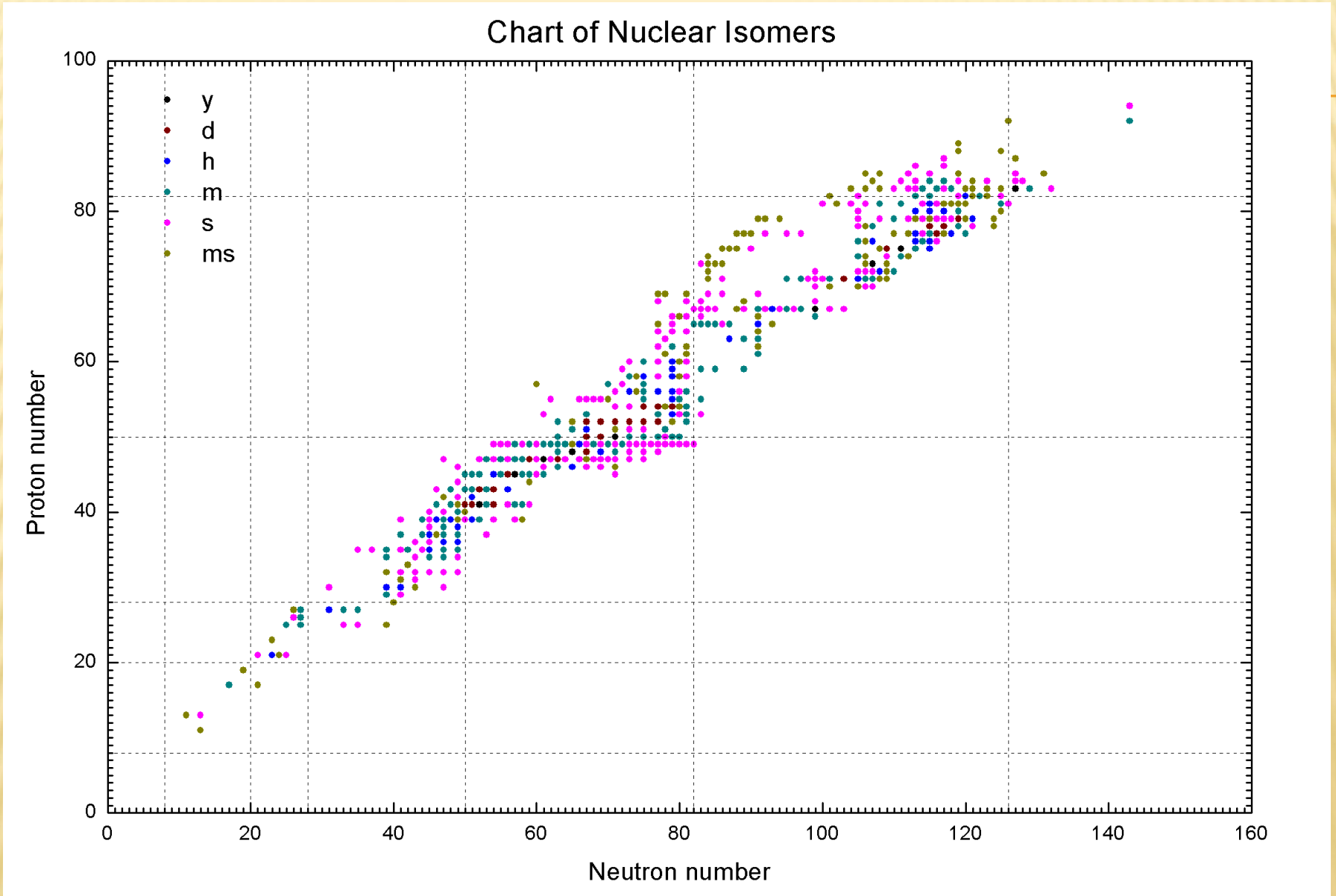
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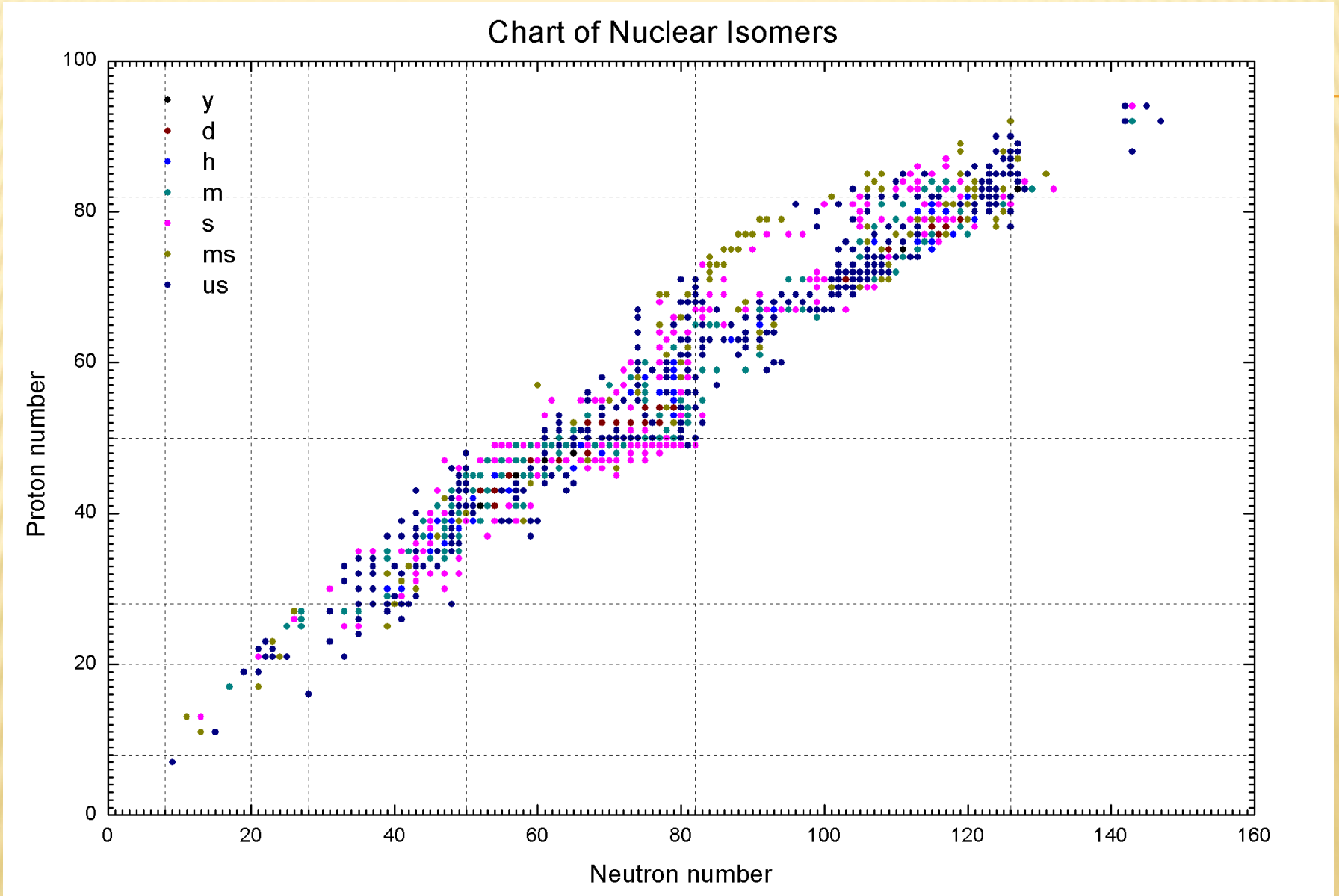
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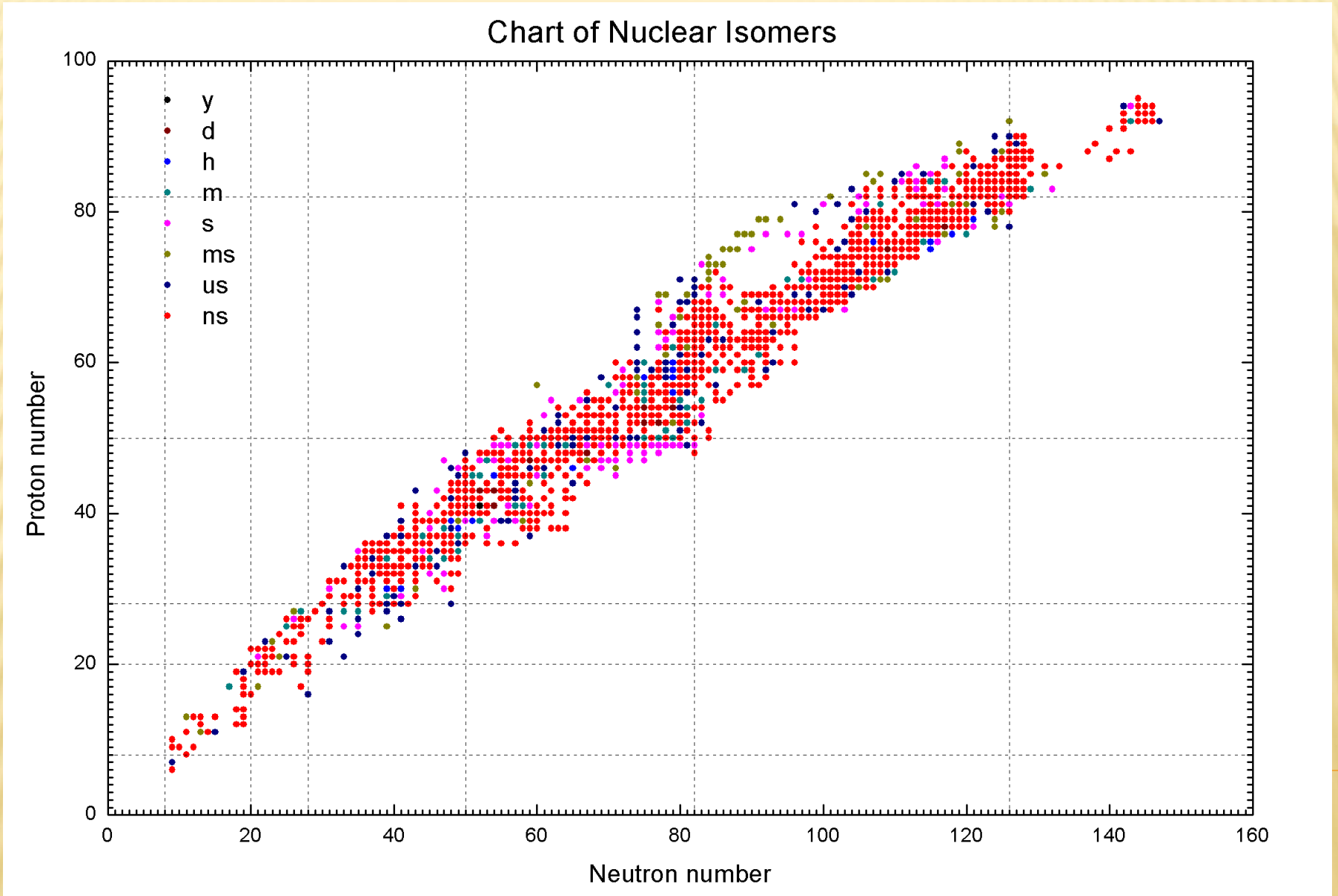
Chart of Nuclear Isomers
y
d
h
m
s
ms
us
ns
Proton number
Neutron number
0
20
40
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140
160

NUCLEI HAVING ISOMERS WITH :

- $\tau \geq 1ns = 1116$
- $\tau \geq 5ns = 1010$
- $\tau \geq 100ns = 815$
- $\tau \geq 1\mu s = 674$
- $\tau \geq 1ms = 479$
- $\tau \geq 1s = 371$
- $\tau \geq 1m = 220$
- $\tau \geq 1h = 89$
- $\tau \geq 1d = 40$
- $\tau \geq 1y = 11$

GAPS IN NUCLEAR CHART

- Proton number varying from 70 –80
- Neutron number varying from 86 –96
- Largest gaps are for even protons i.e.

W = 159 –173

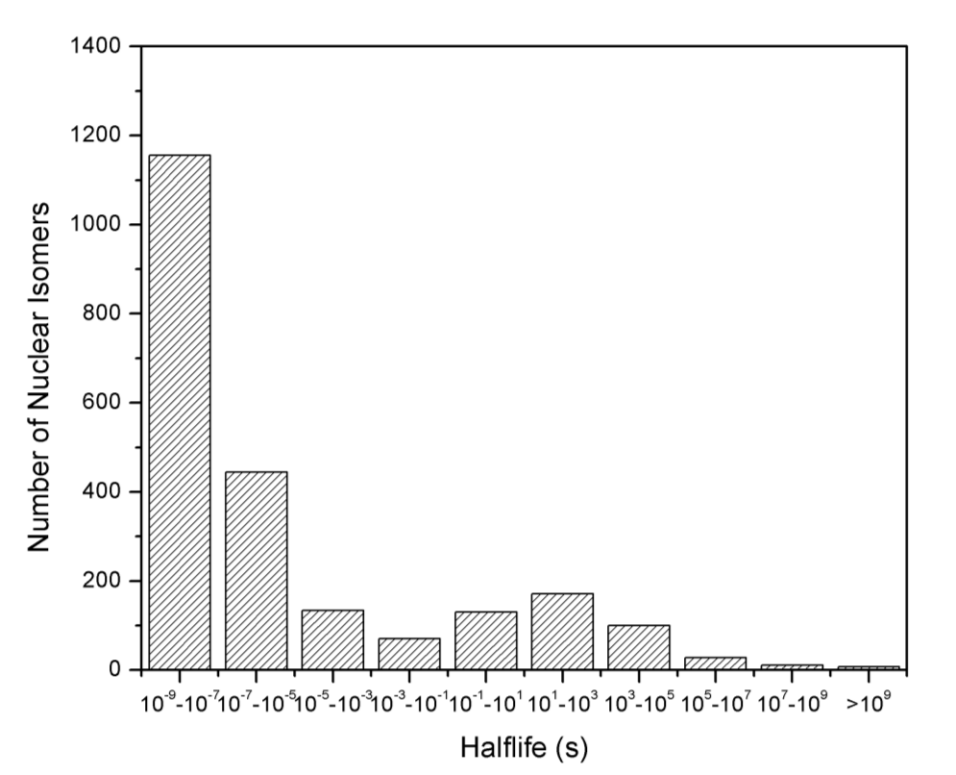
Os = 163 –172

Pt =168 –176

& Hg =172 –178,180 –184

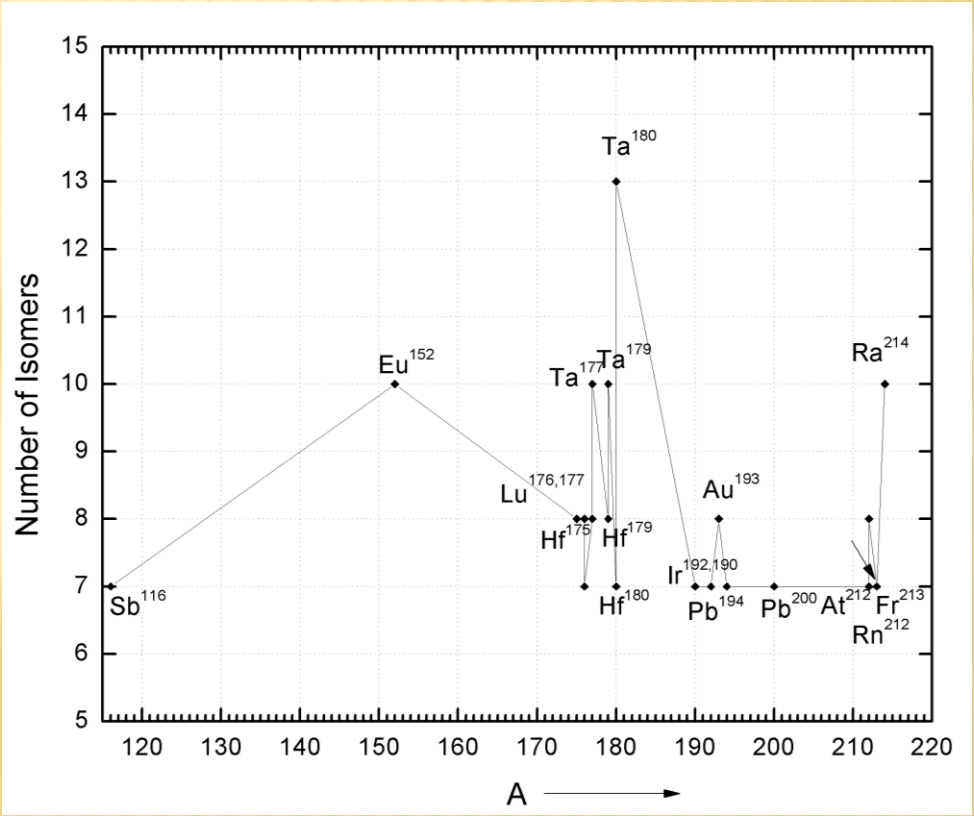
STATISTICS OF HALF-LIVES

- Maximum number of Isomers are observed at time scale of 10^{-9} – 10^{-7}
- Number falls considerably with increasing half-lives
- Dip can be seen at half-lives of the order of 1*ms* to 0.1*s*
- Otherwise, half-lives are decaying almost exponentially.

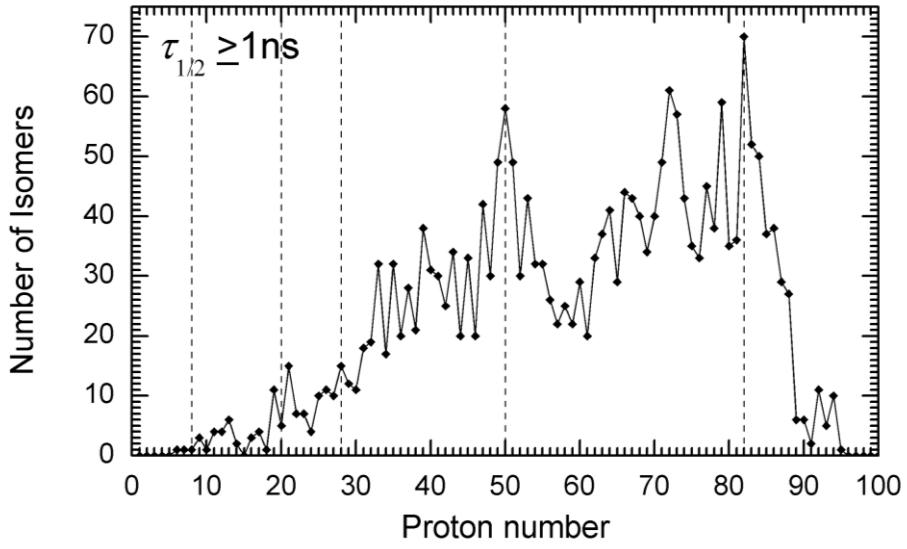


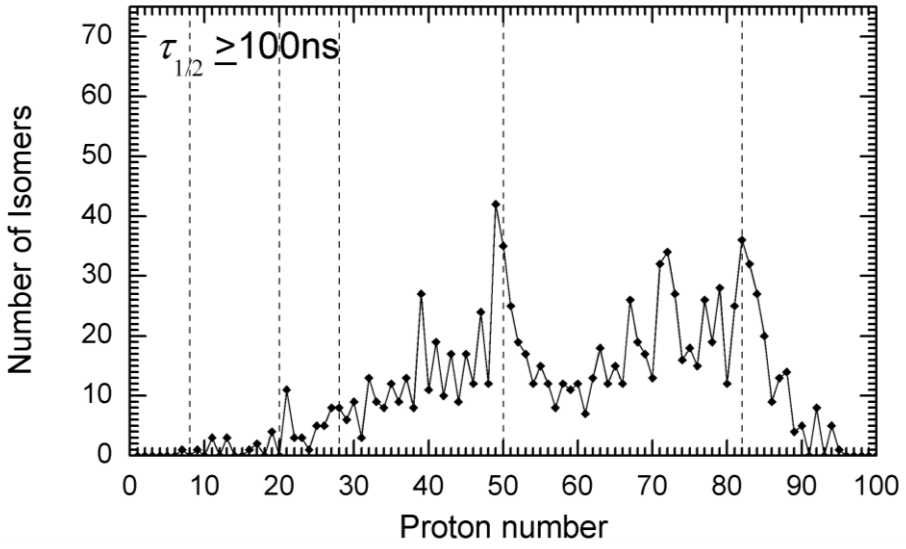
NUCLEI WITH EXTREMELY LARGE NUMBER OF NUCLEAR ISOMERS

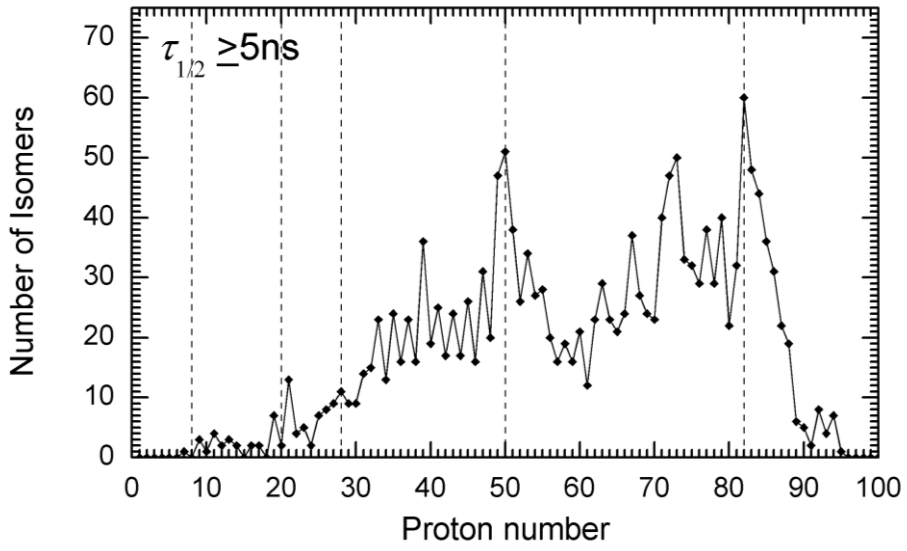
- Nuclei having isomers ≥ 7 are plotted
- ^{180}Ta found to have largest isomeric states = 13
- Other isotopes ^{179}Ta, ^{177}Ta have 10 isomers each.
- ^{152}Eu and ^{214}Rn also have 10 isomers.
- Gap between A=115-151 is seen.

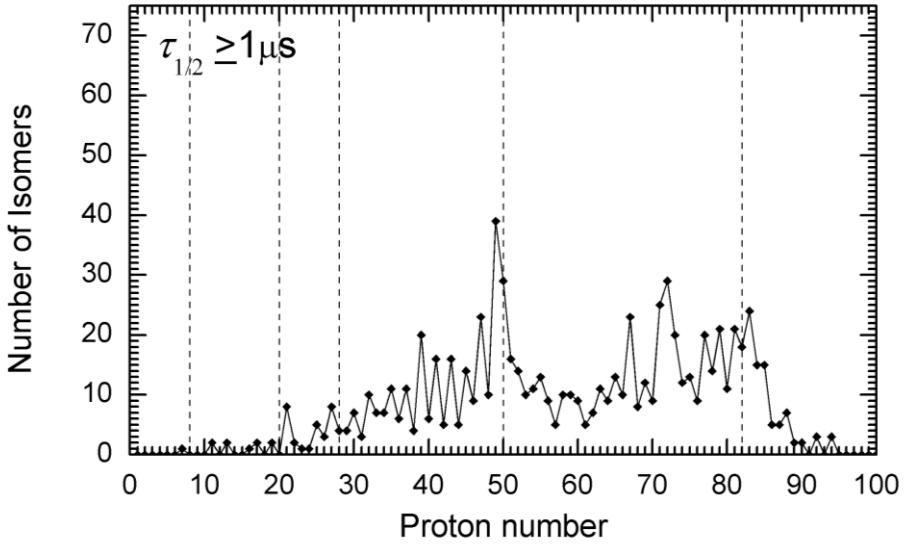


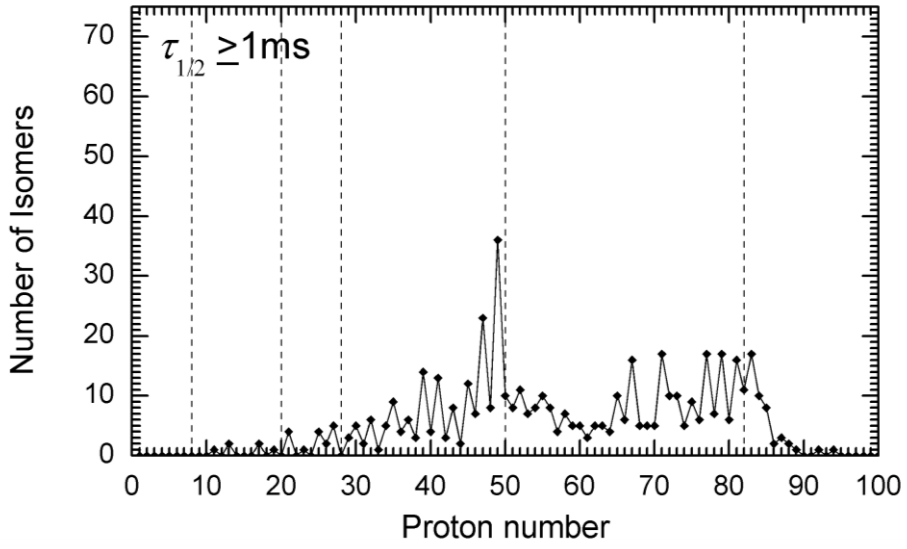
SYSTEMATICS WITH PROTONS

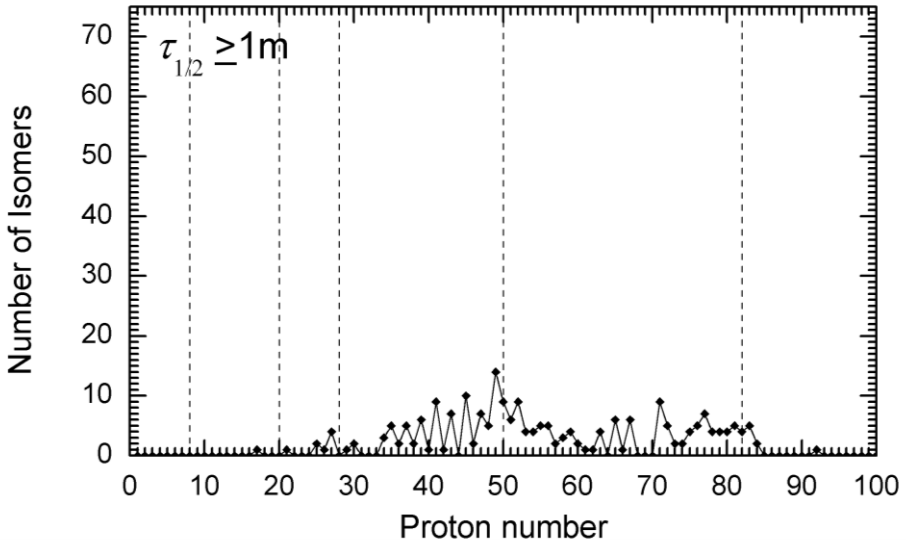


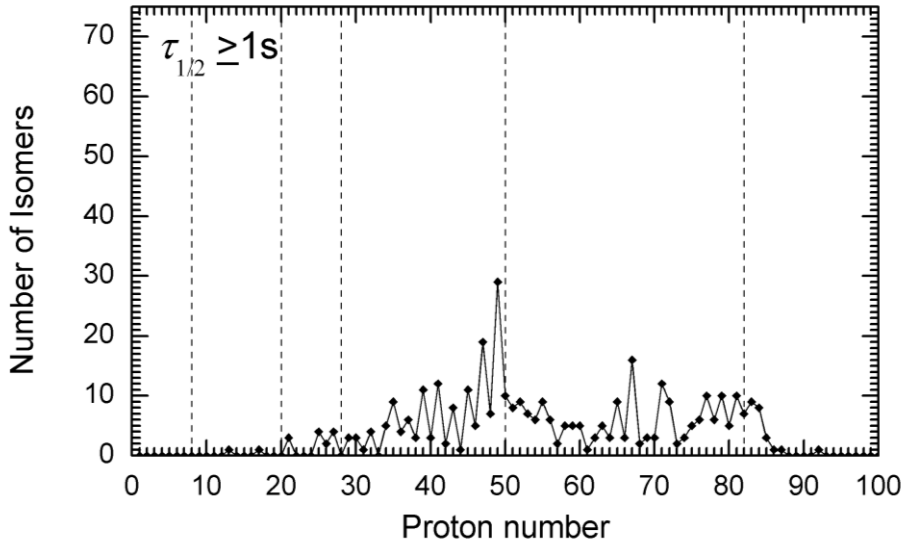


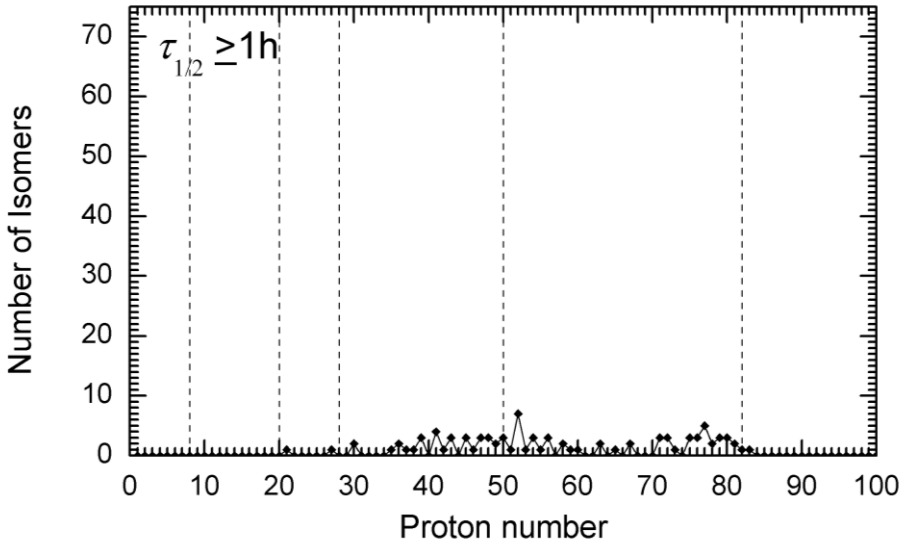


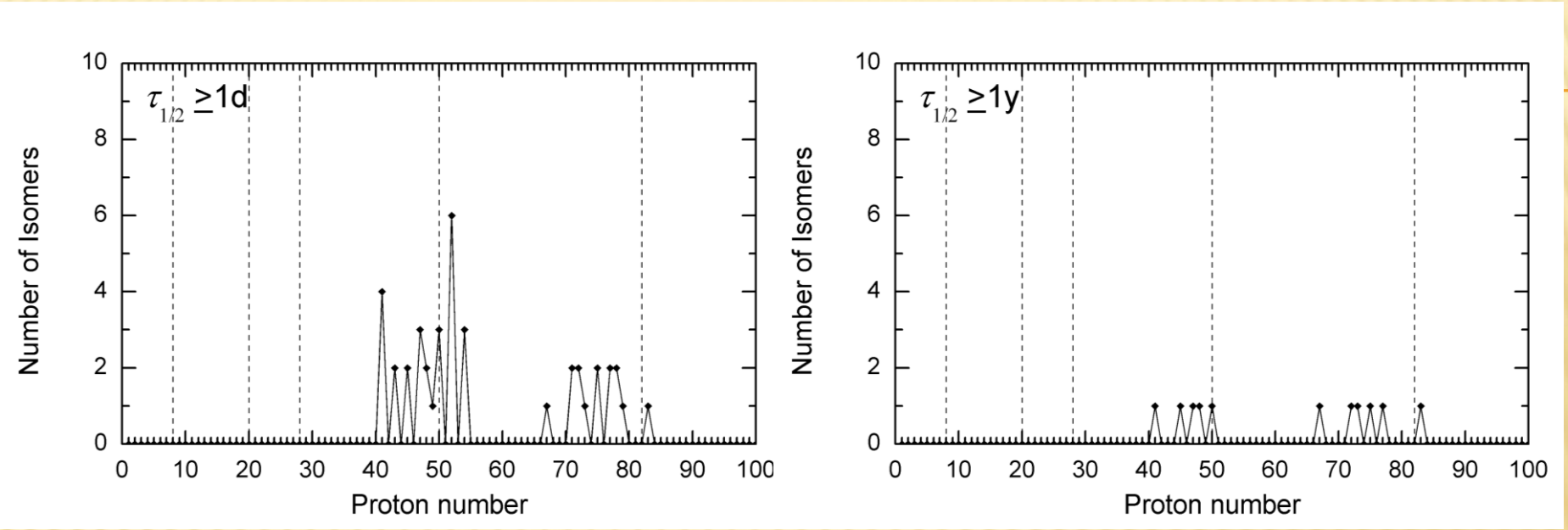



$\tau_{1/2} \geq$1ms
Number of Isomers
Proton number


$\tau_{1/2} \geq$1m
Number of Isomers
Proton number

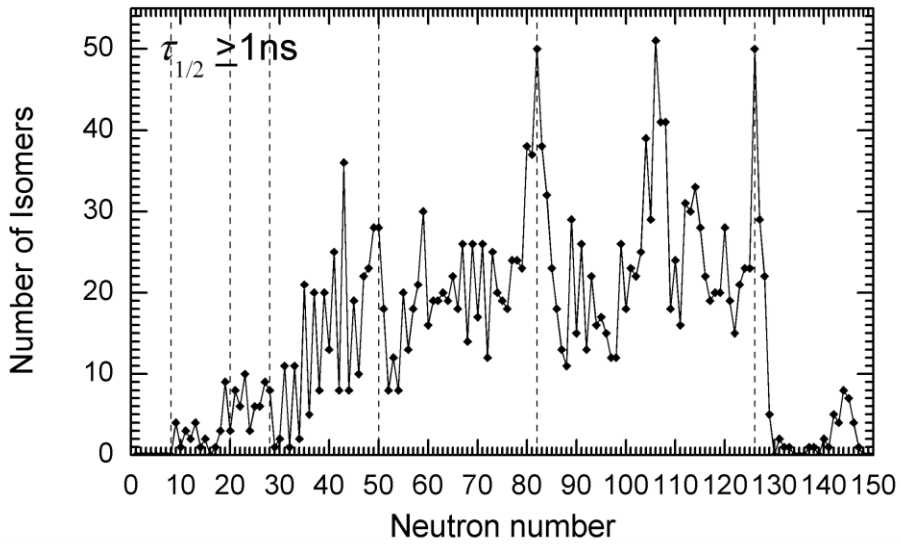

$\tau_{1/2} \geq$1s
Number of Isomers
Proton number

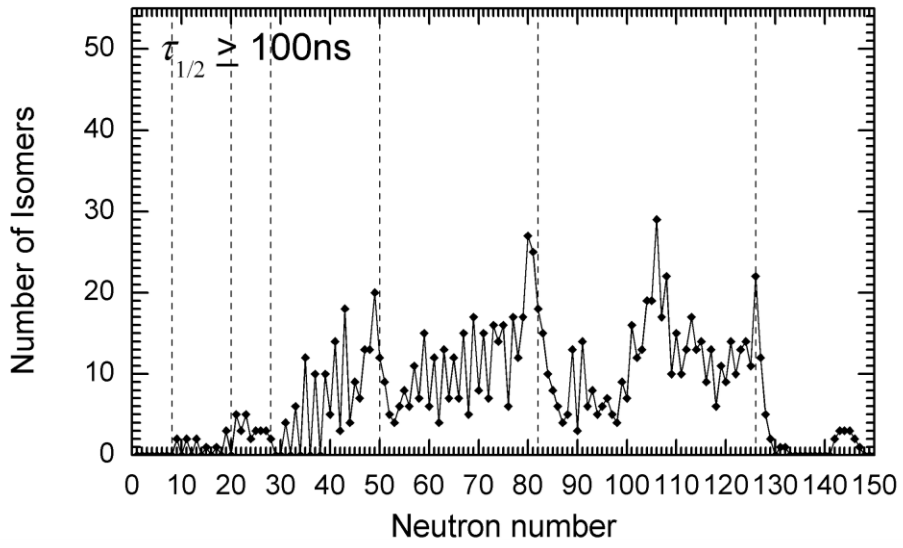

$\tau_{1/2} \geq$1h
Number of Isomers
Proton number

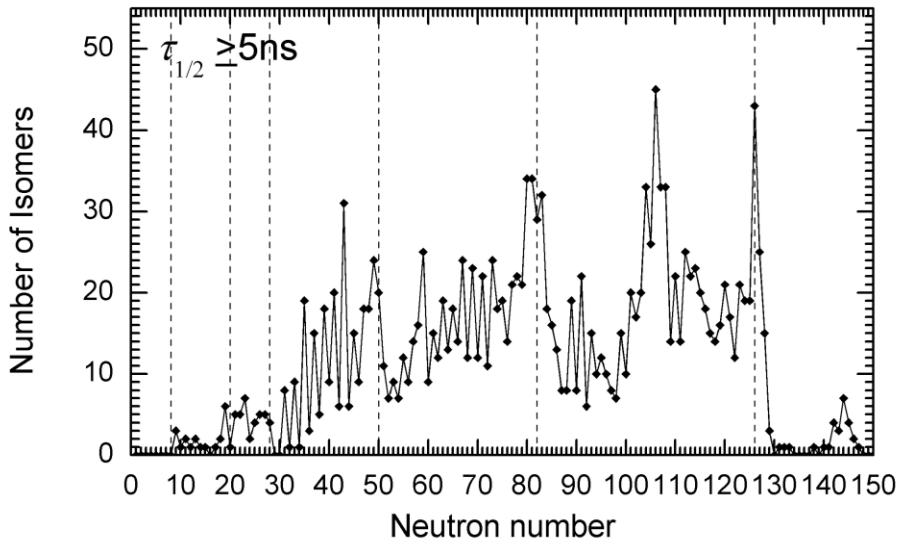


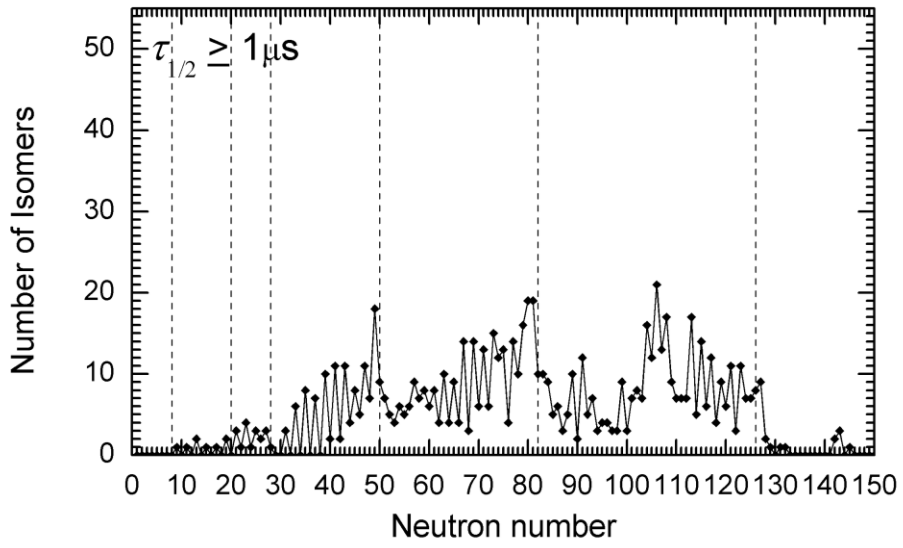
- High peaks are observed near magic numbers.
- Between Z=35 to 50, odd-Z nuclei have much larger number of isomers than even-Z ones.
- Long lived isomers ($\tau \geq 1y$) are mostly in odd-Z nuclei.

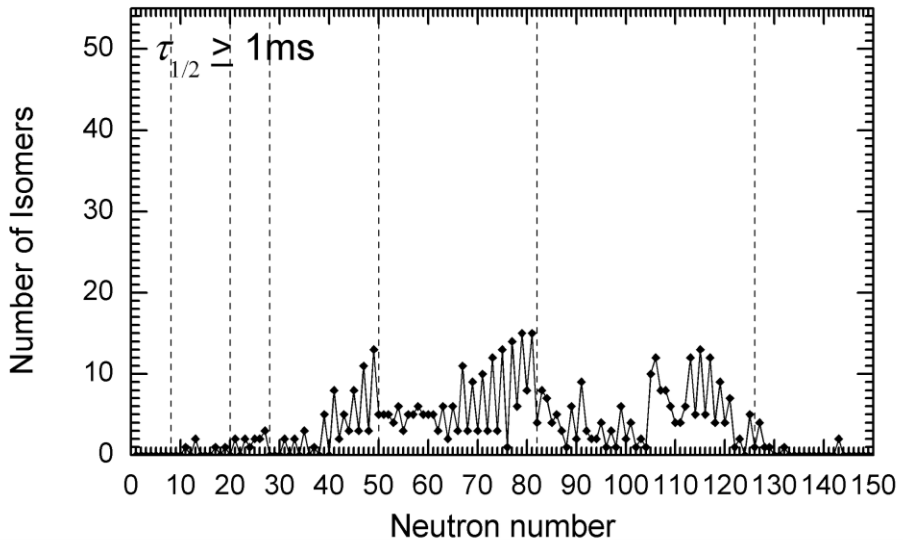
SYSTEMATICS WITH NEUTRONS

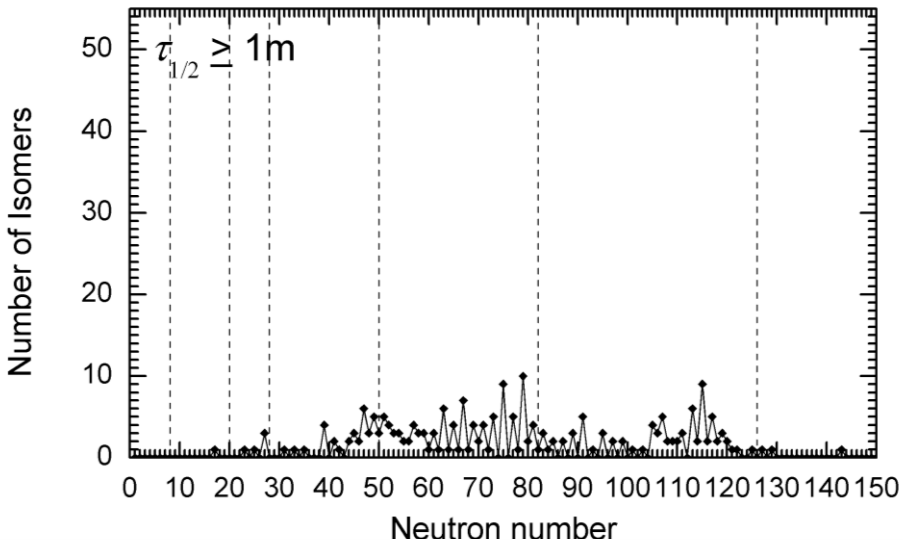









$\tau_{1/2} \geq$ 1ms
Number of Isomers
Neutron number
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0 10 20 30 40 50


$\tau_{1/2} \geq$ 1m
Number of Isomers
Neutron number
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
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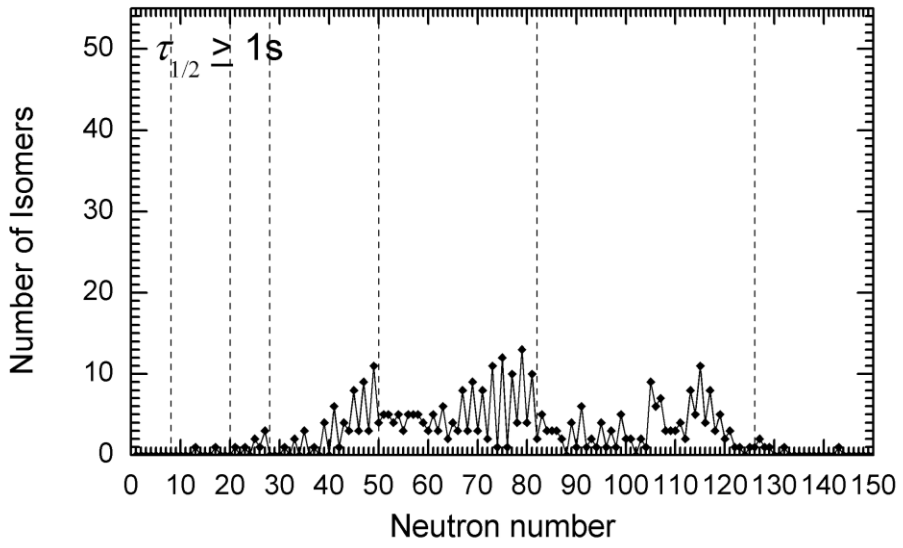
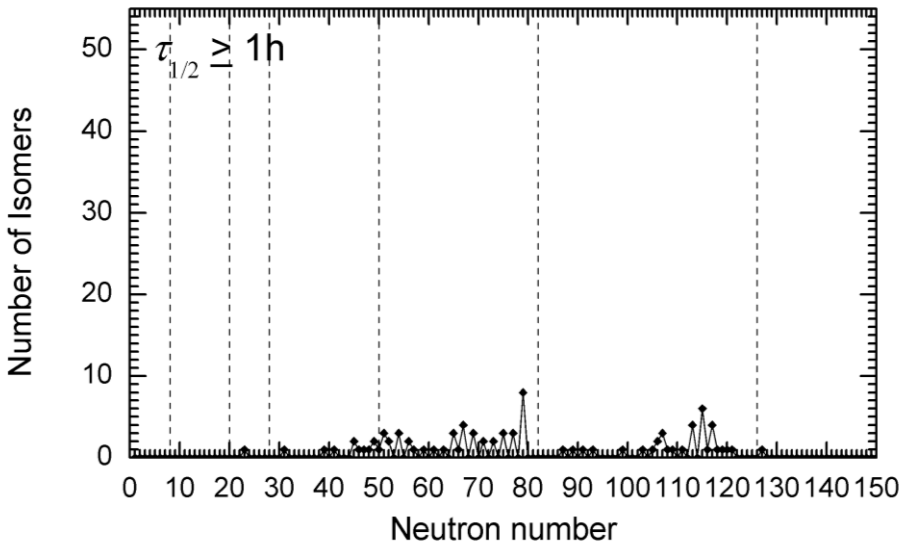
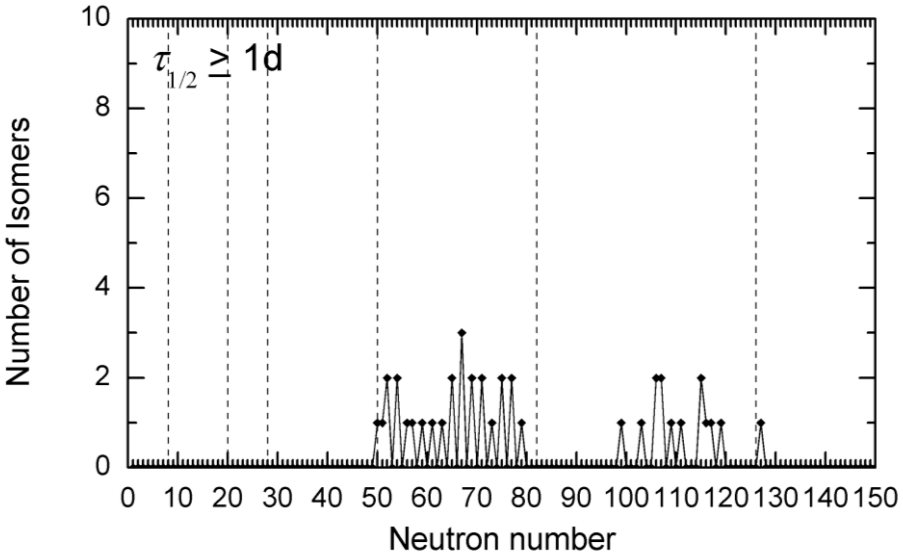
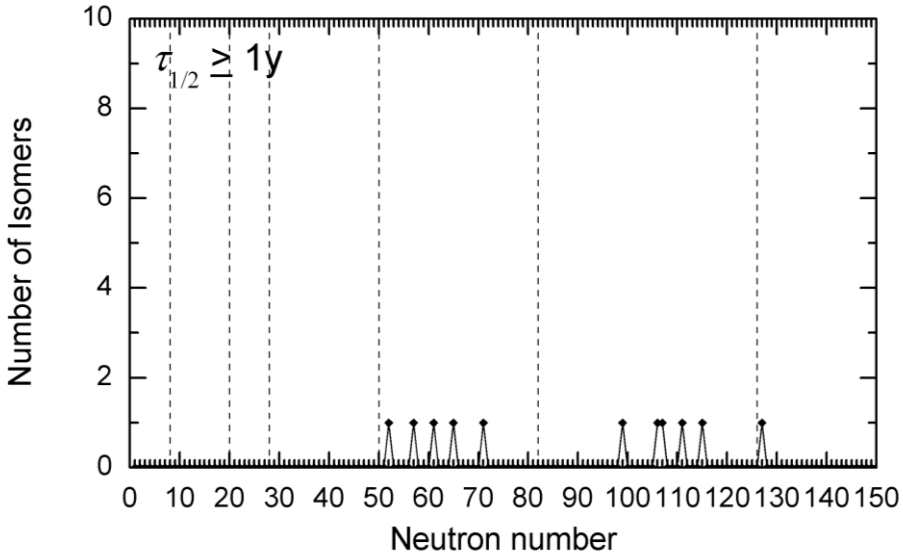

$\tau_{1/2} \geq$ 1s
Number of Isomers
Neutron number
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0 10 20 30 40 50


$\tau_{1/2} \geq$ 1h
Number of Isomers
Neutron number
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0 10 20 30 40 50

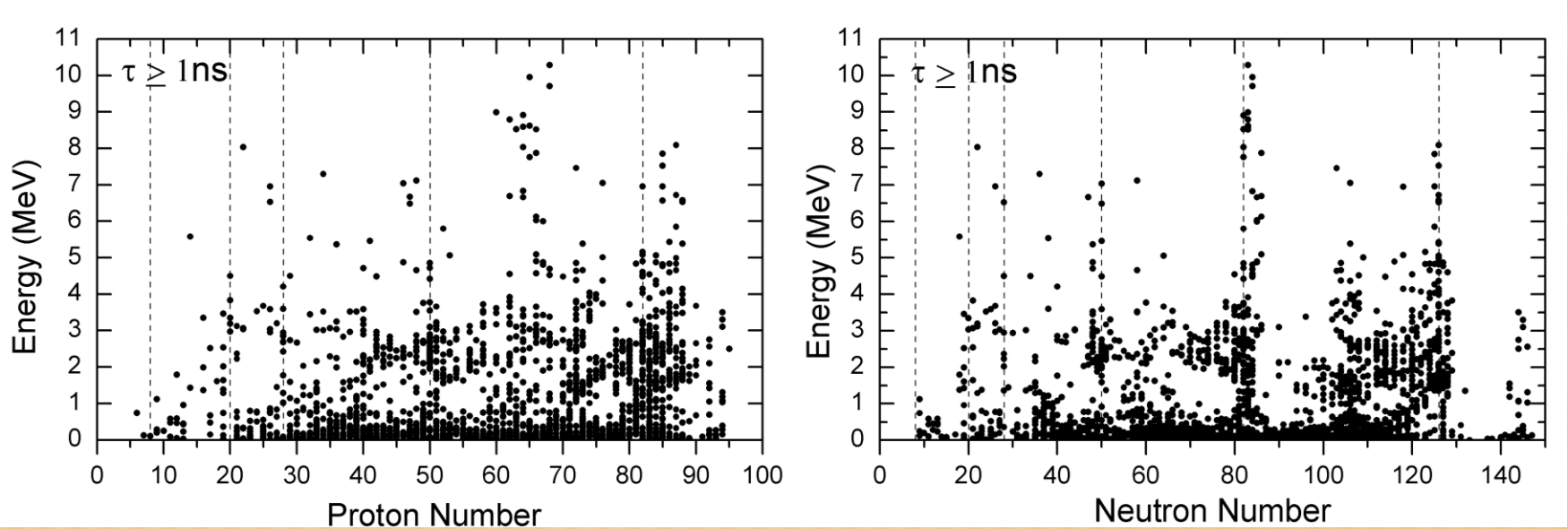




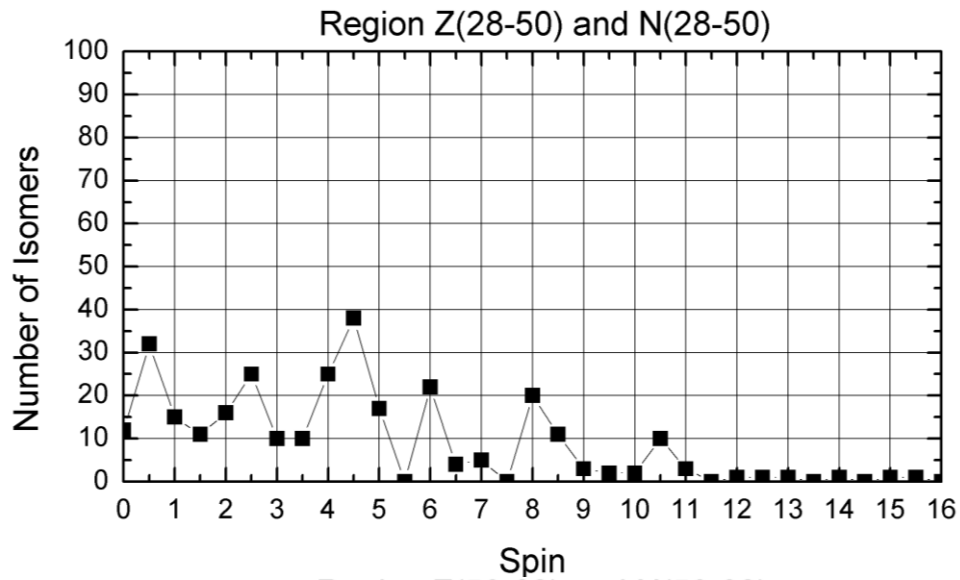
- Besides the peaks near the magic numbers, a rise in the number of isomers is observed between N = 82-126. This corresponds to the deformed nuclei and most probably the K-isomers.

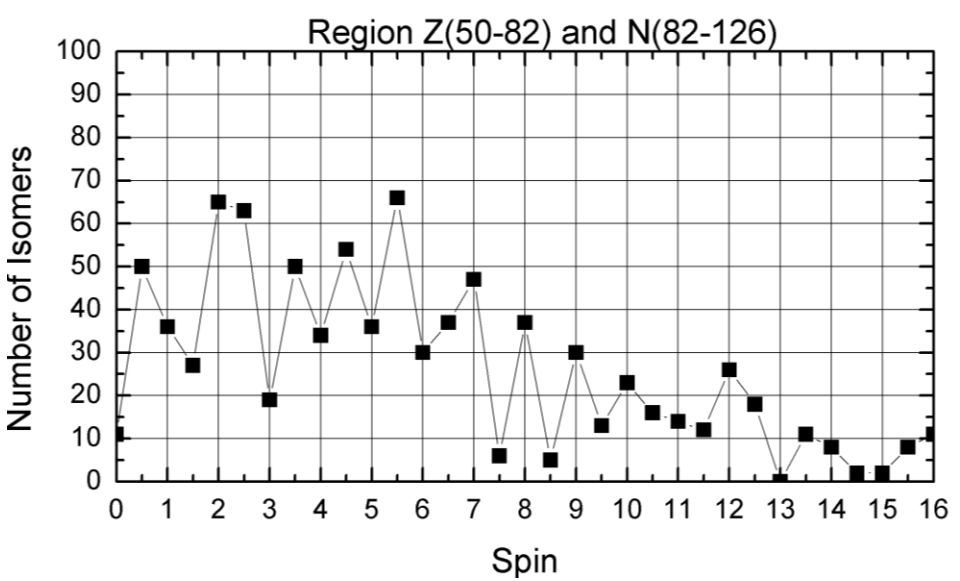
EXCITATION ENERGY

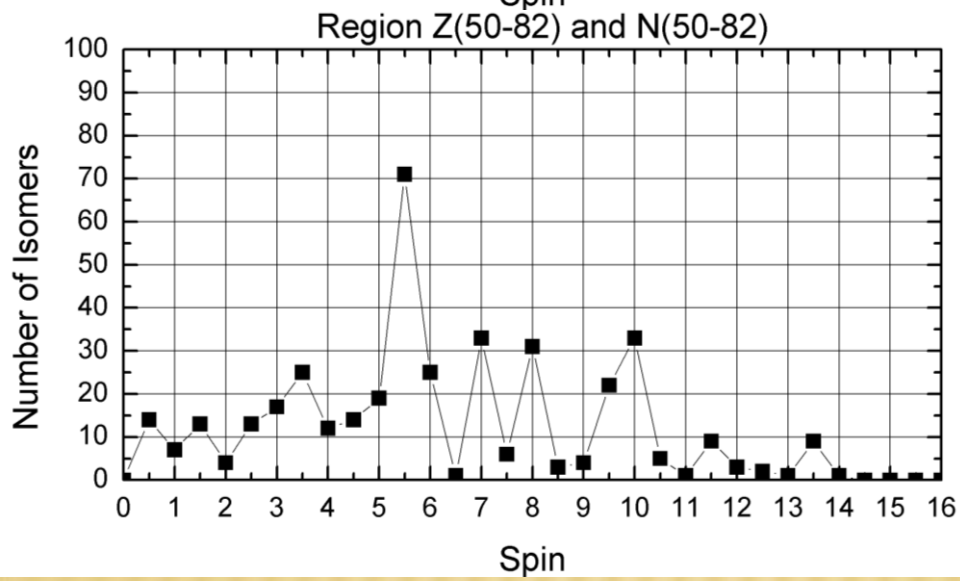
- High excitation energies seen near magic numbers.
- Highest lying isomer seen at 10.286 MeV in ^{151}Er.
- Faint gaps do exist which probably correspond to changing isomer configuration from 1-qp to 3-qp or, 2-qp to 4-qp.

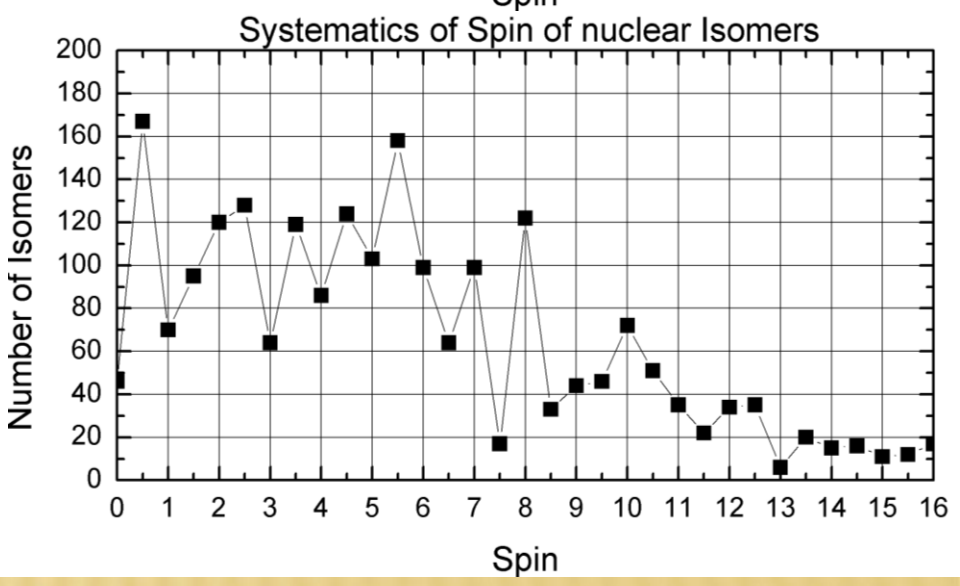


SYSTEMATICS OF SPINS







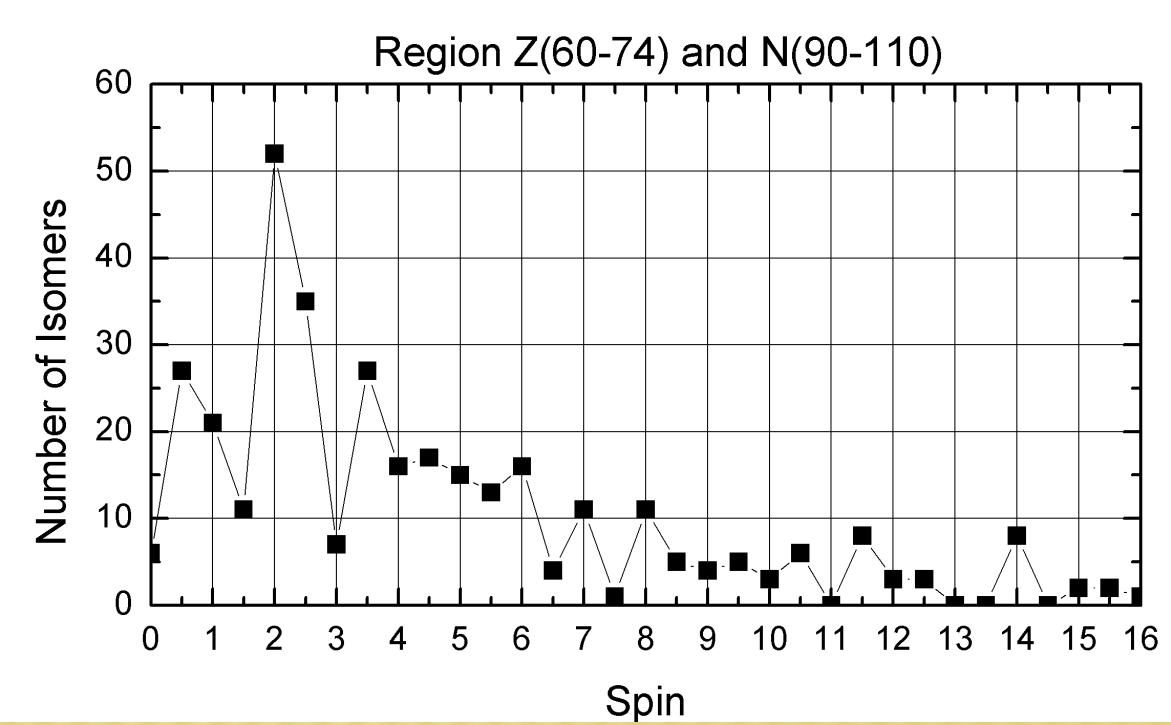


SYSTEMATICS OF SPINS OF NUCLEAR ISOMERS HAVING HALF-LIVES ≥ 1 *NS*

- There is always a peak at spin 0.5
- Half-integral spin isomers are lying at the peaks below spin 5
- The spin range keeps on rising from 4.5 to 5.5 as per active orbital of highest spin in that mass region.
- Pattern changes at higher spins where integral spin isomers are at the peaks.
- High spin isomers are more likely in even-even or, odd-odd nuclei.

ISOMERS IN THE DEFORMED REGION

- Largest number of isomers found at spin 2 rather than spin 0.5
- Systematics noted earlier don't hold as strongly.



Thank you..... for your patience