Lunch Seminar of the Center for Exotic Nuclear Studies , the Institute for Basic Science, 2 September 2020.

우리들의 시작과 그 출발점들

The starting points of our view at CENS

문 창범

MOON Chang-Bum

1 배경: 핵주기율표
2 시작점
3 출발선에 선 핵종들
4 갈 길

말

교육이냐

연구냐

배경 背景

background

바탕

모국어냐

국제어냐

글

1. 배경: 핵주기율

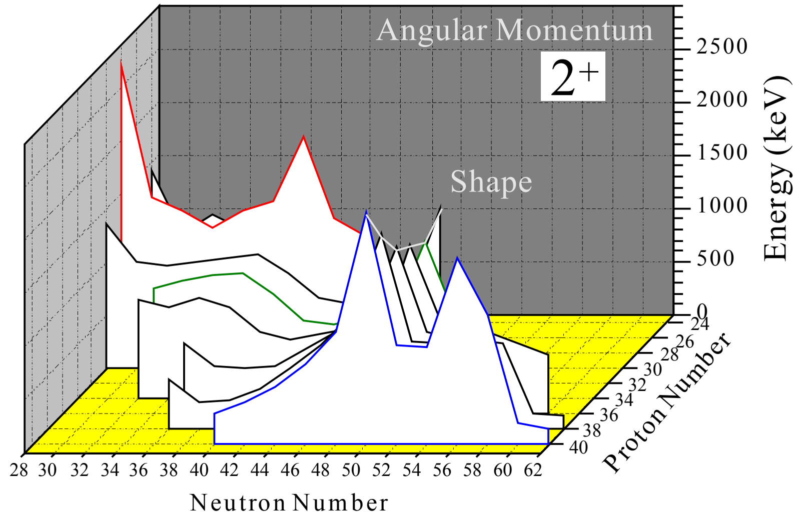
Science is centered on the search for spatiotemporal patterns because nature is organized around

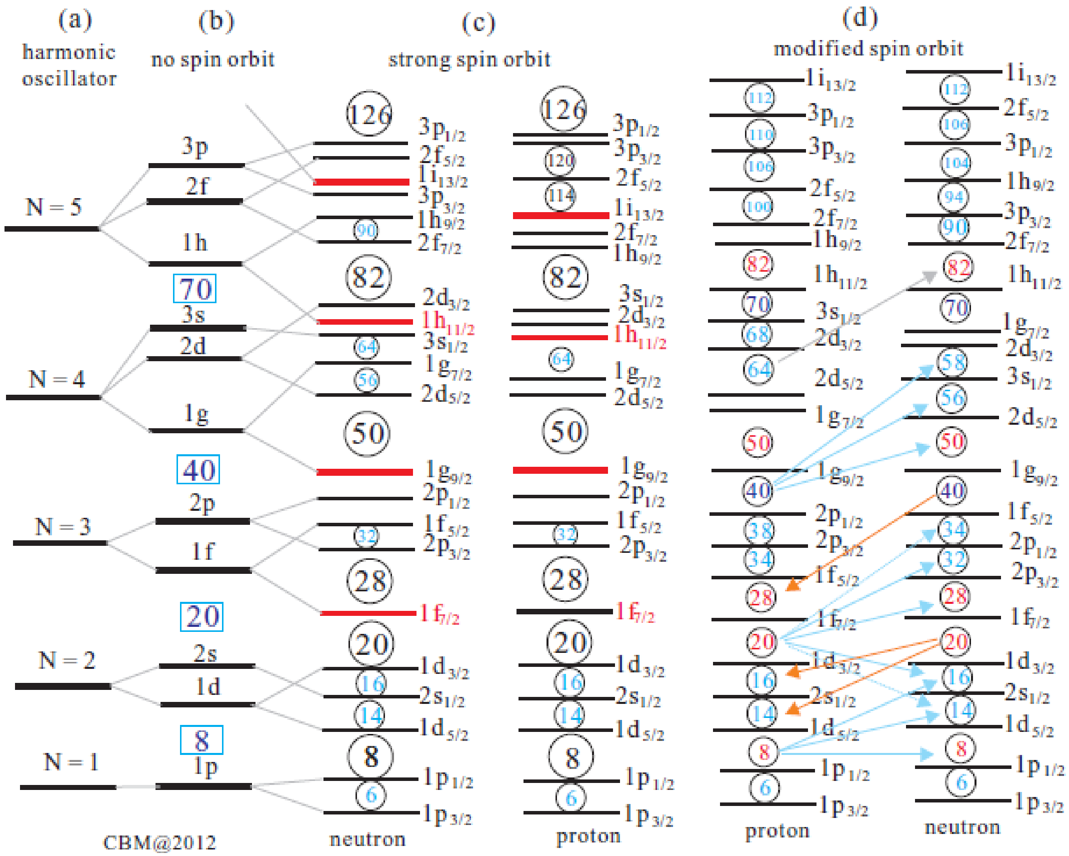
configurations (spatial patterns) and rhythms (temporal patterns).

규칙성 => 눈으로 듣고 귀로 본다

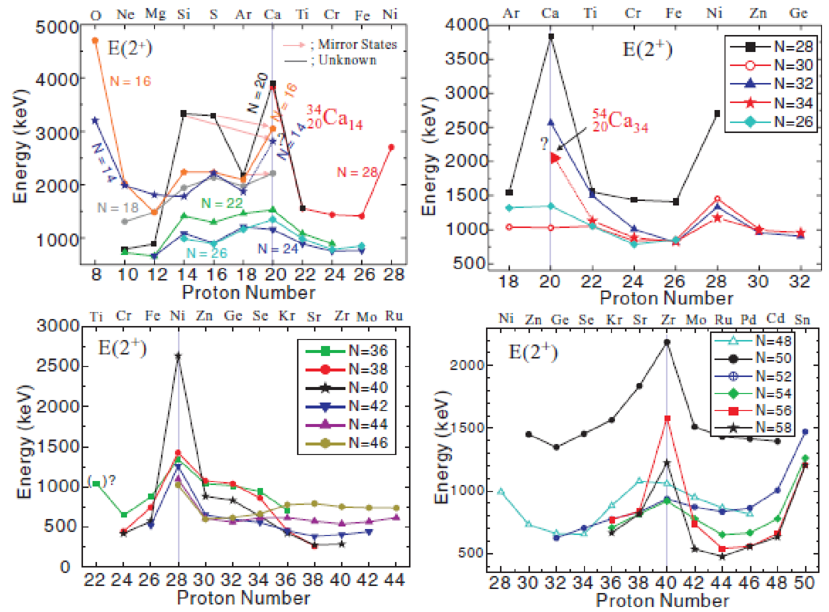
Configuration is arrangement of elements (nucleons, atoms, molecules, cells and so forth) in space, combined with the properties or attributes of each element, such as velocity (momentum), mass (energy) or shape (force).

Pattern means the change to a configuration over a period of time, or a configuration is a cross section of a dynamic pattern at any moment of time.

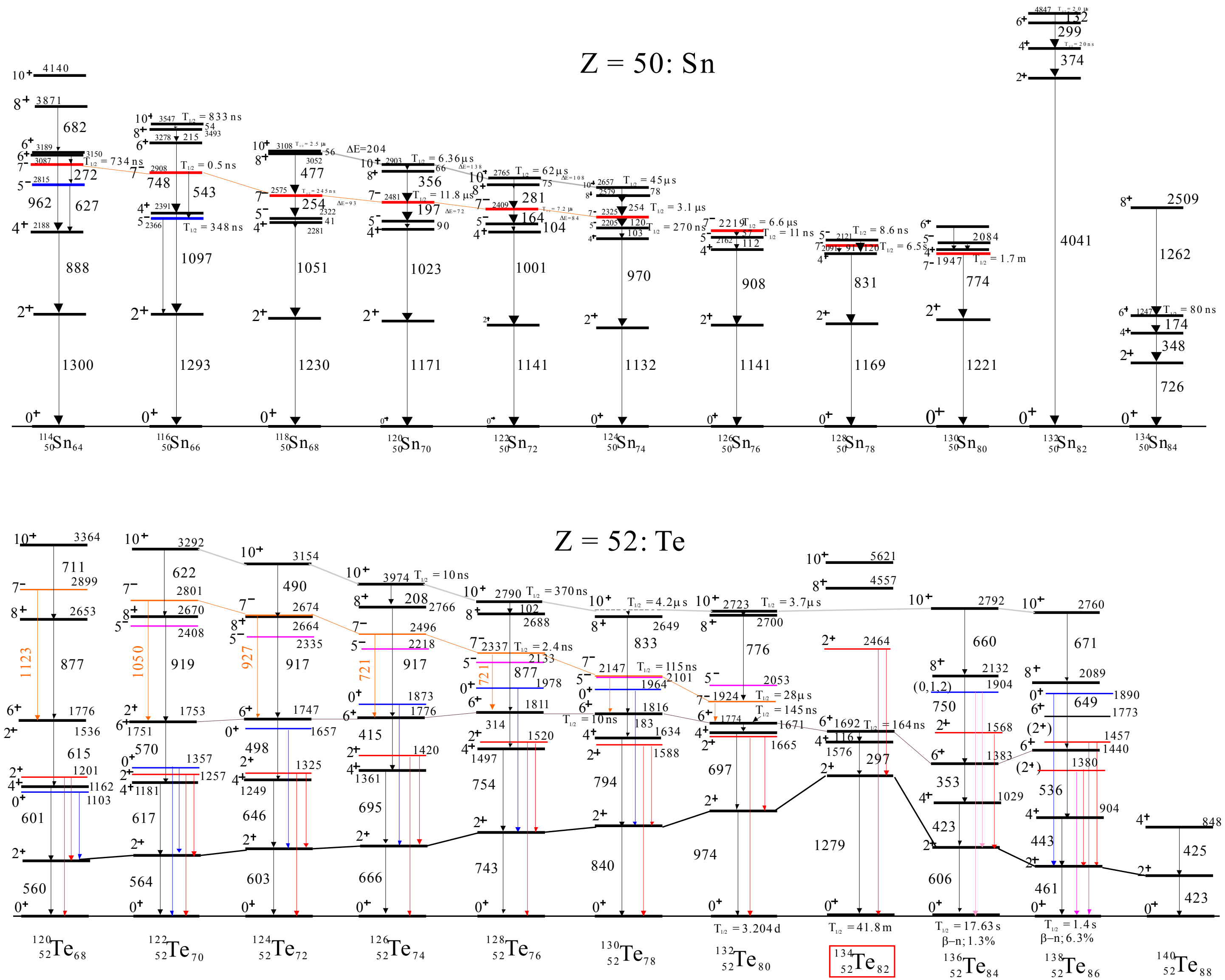




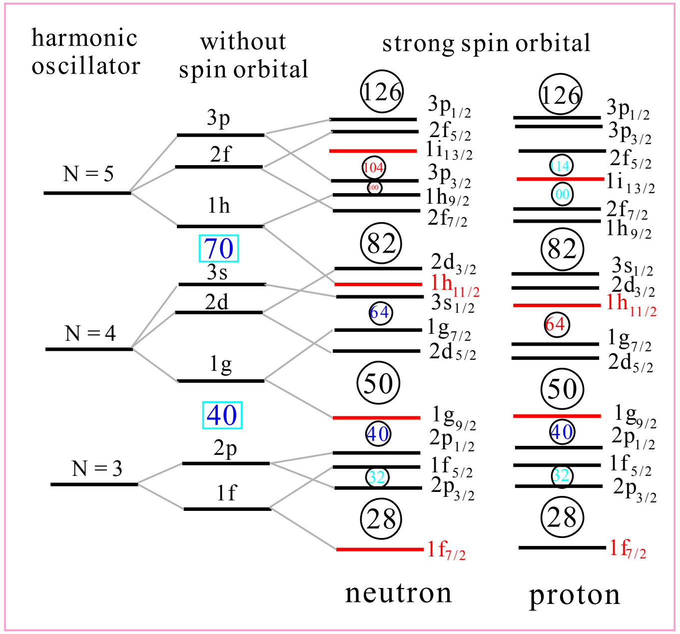
(a)
harmonic oscillator
(b)
no spin orbit
(c)
strong spin orbit
(d)
modified spin orbit
N = 5
N = 4
N = 3
N = 2
N = 1
CBM@2012
neutron
proton
proton
neutron

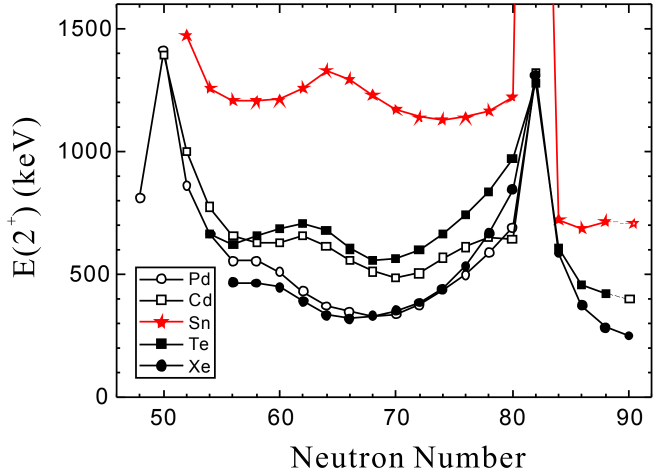


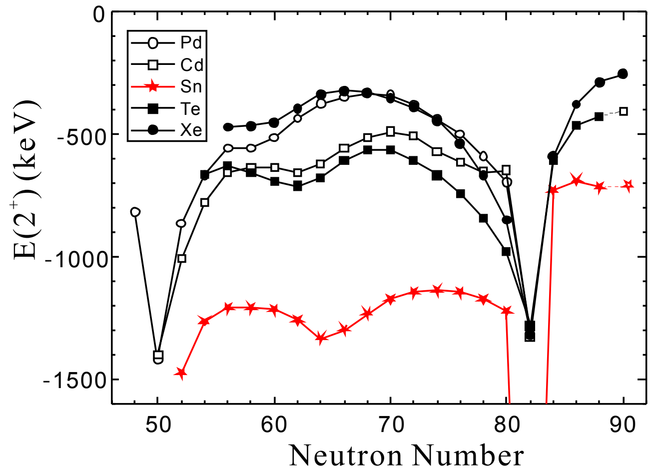
E(2+)
Energy (keV)
Proton Number
; Mirror States
; Unknown
N = 16
N = 18
N = 14
N = 20
N = 22
N = 26
N = 24
N = 28
N=28
N=30
N=32
N=34
N=26
N=36
N=38
N=40
N=42
N=44
N=46
N=48
N=50
N=52
N=54
N=56
N=58

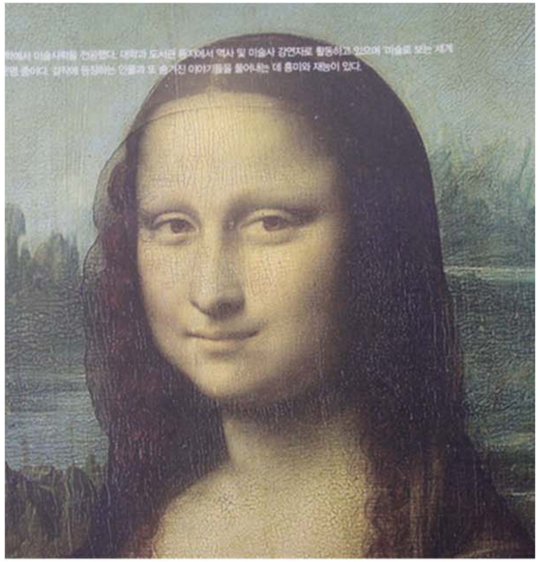


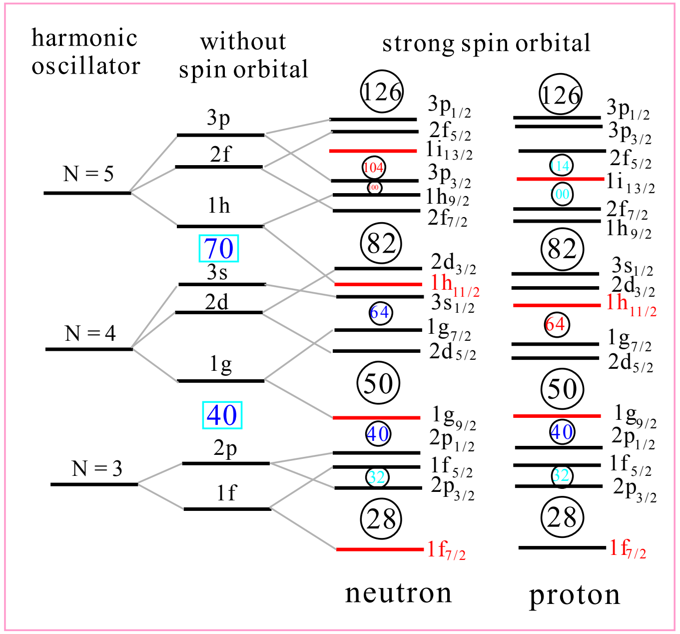
Z = 50: Sn
$^{114}_{50}Sn_{64}$
$^{116}_{50}Sn_{66}$
$^{118}_{50}Sn_{68}$
$^{120}_{50}Sn_{70}$
$^{122}_{50}Sn_{72}$
$^{124}_{50}Sn_{74}$
$^{126}_{50}Sn_{76}$
$^{128}_{50}Sn_{78}$
$^{130}_{50}Sn_{80}$
$^{132}_{50}Sn_{82}$
$^{134}_{50}Sn_{84}$
Z = 52: Te
$^{120}_{52}Te_{68}$
$^{122}_{52}Te_{70}$
$^{124}_{52}Te_{72}$
$^{126}_{52}Te_{74}$
$^{128}_{52}Te_{76}$
$^{130}_{52}Te_{78}$
$^{132}_{52}Te_{80}$
$^{134}_{52}Te_{82}$
$^{136}_{52}Te_{84}$
$^{138}_{52}Te_{86}$
$^{140}_{52}Te_{88}$
$T_{1/2}$ = 3.204 d
$T_{1/2}$ = 41.8 m
$T_{1/2}$ = 17.63 s
β–n; 1.3%
$T_{1/2}$ = 1.4 s
β–n; 6.3%


harmonic oscillator
without spin orbital
strong spin orbital
N = 5
N = 4
N = 3
3p
2f
1h
3s
2d
1g
2p
1f
70
40
126
82
50
28
104
64
40
32
3p1/2
2f5/2
1i13/2
3p3/2
1h9/2
2f7/2
2d3/2
1h11/2
3s1/2
1g7/2
2d5/2
1g9/2
2p1/2
1f5/2
2p3/2
1f7/2
neutron
proton

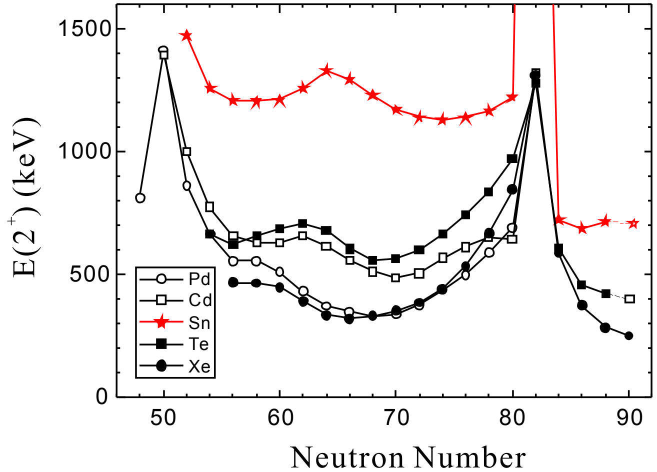

E(2+) (keV)
Neutron Number
Pd
Cd
Sn
Te
Xe
0
500
1000
1500
50
60
70
80
90

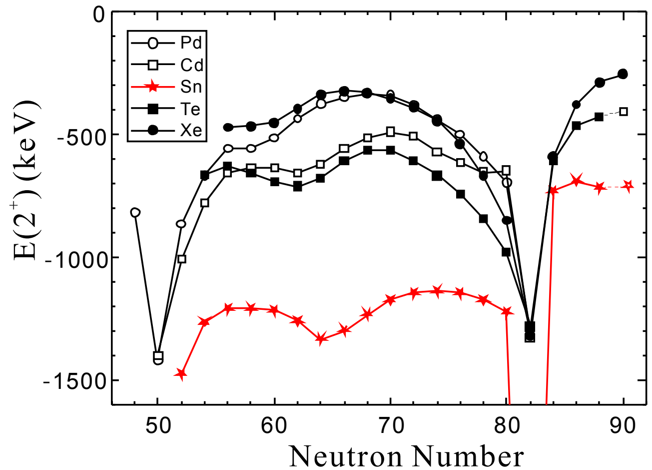

E(2+) (keV)
Neutron Number
Pd
Cd
Sn
Te
Xe
0
-500
-1000
-1500
50
60
70
80
90

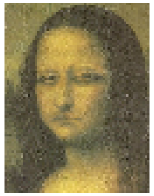

미술사학을 전공했다. 대학과 도서관 등지에서 역사 및 미술사 강연자로 활동하고 있으며
등장하는 인물과 또 숨겨진 이야기들을 찾아내는 데 흥미와 재능이 있다.



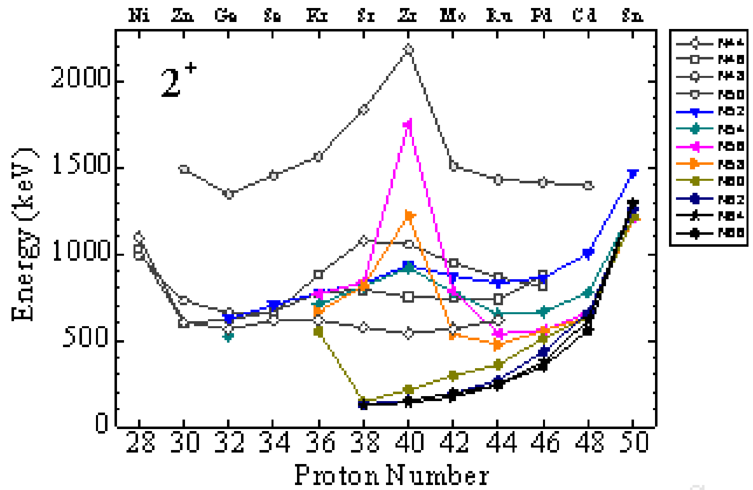
Mapping the Mind by Rita Carter



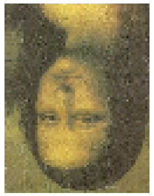




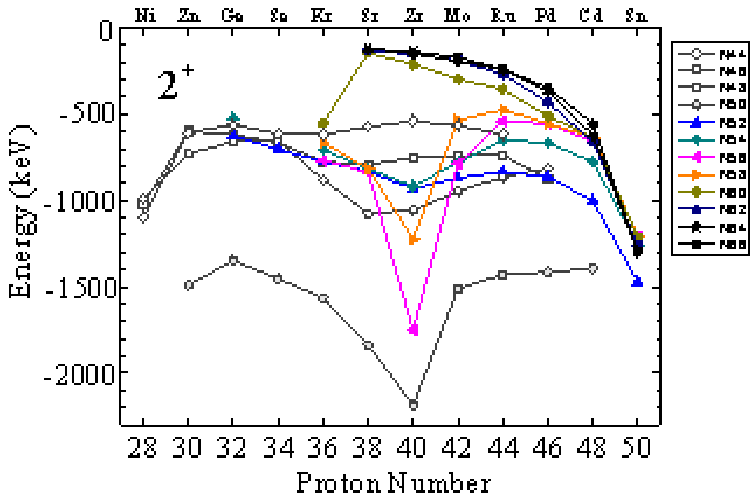
Mirror 거울

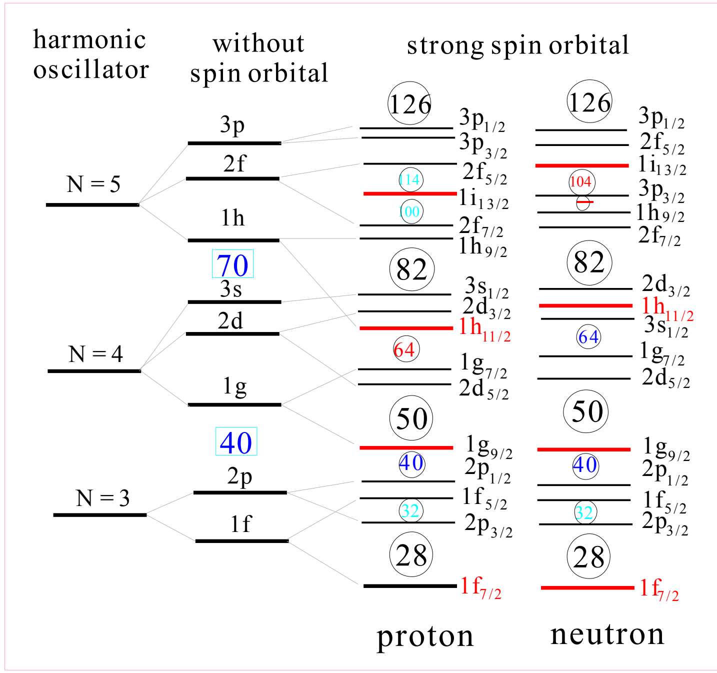


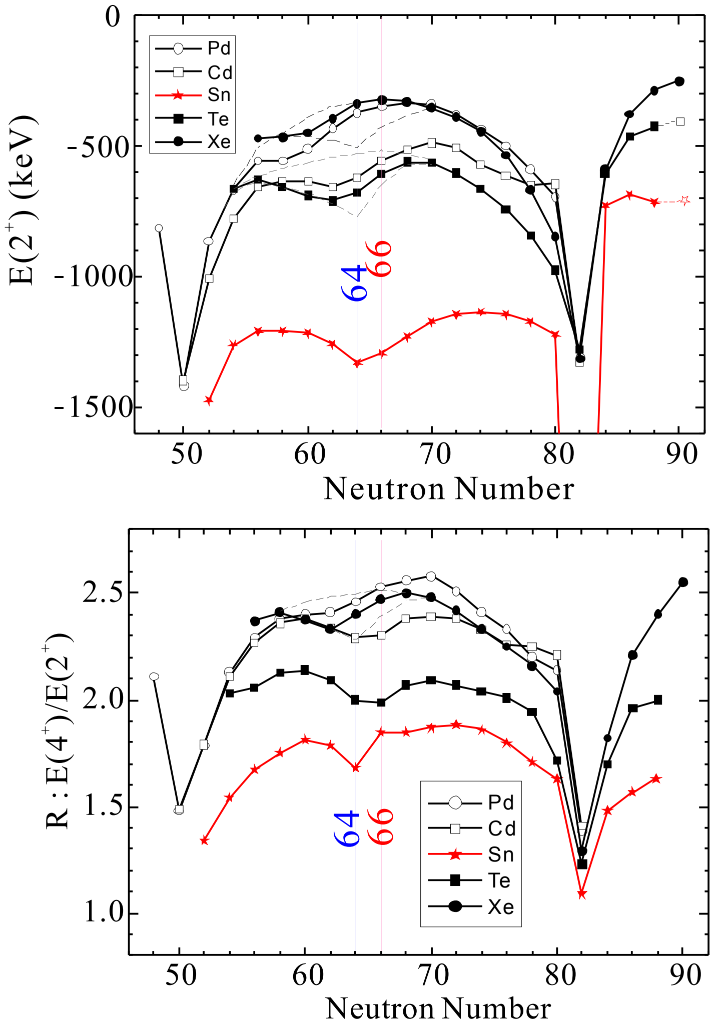
Symmetry

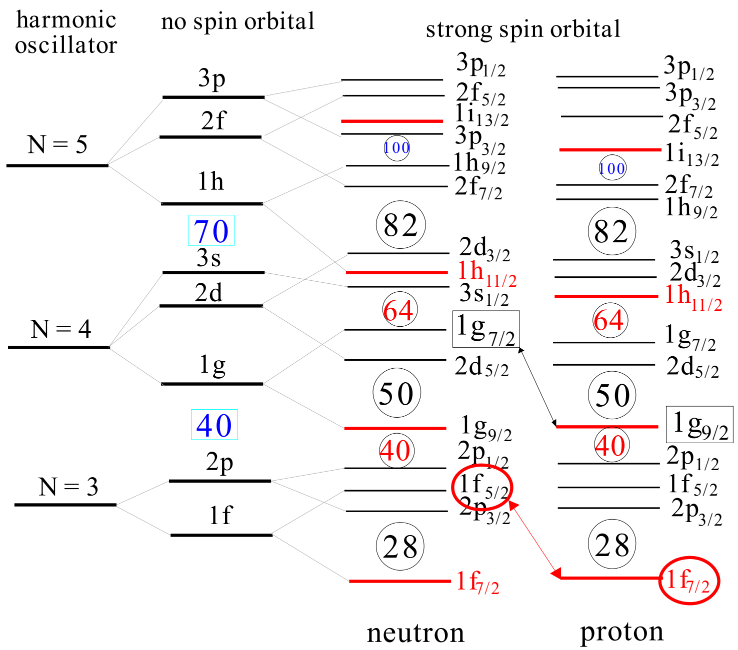


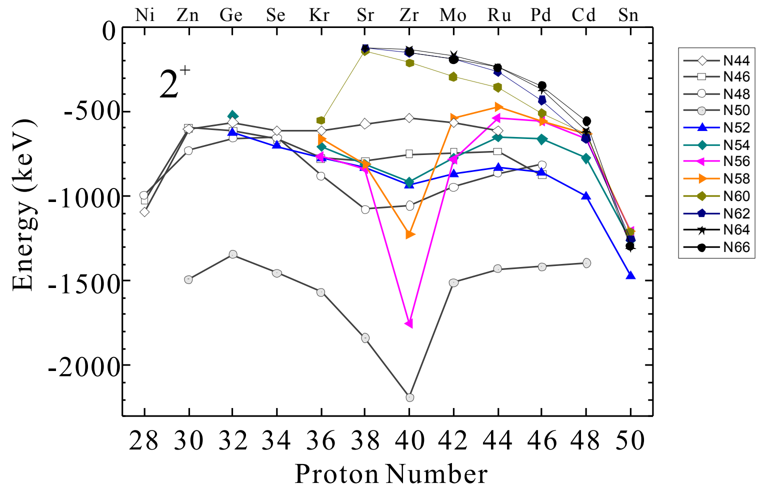
Mirror 거울

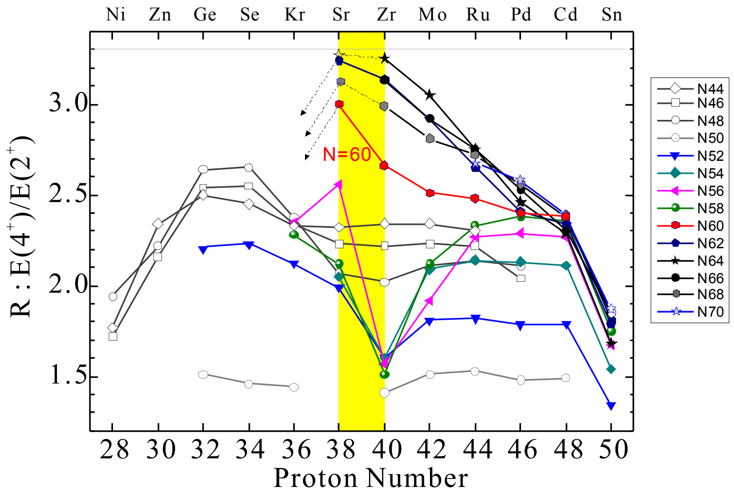



harmonic oscillator
without spin orbital
strong spin orbital
N = 5
N = 4
N = 3
3p
2f
1h
70
3s
2d
1g
40
2p
1f
126
82
64
50
40
32
28
114
100
104
3p1/2
3p3/2
2f5/2
1i13/2
2f7/2
1h9/2
3s1/2
2d3/2
1h11/2
1g7/2
2d5/2
1g9/2
2p1/2
1f5/2
2p3/2
1f7/2
proton
neutron


E(2+) (keV)
0
-500
-1000
-1500
Pd
Cd
Sn
Te
Xe
64
66
Neutron Number
50
60
70
80
90
R : E(4+)/E(2+)
2.5
2.0
1.5
1.0


harmonic oscillator
no spin orbital
strong spin orbital
N = 5
N = 4
N = 3
3p
2f
1h
70
3s
2d
1g
40
2p
1f
3p1/2
2f5/2
1i13/2
3p3/2
1h9/2
2f7/2
100
82
2d3/2
1h11/2
3s1/2
64
1g7/2
2d5/2
50
1g9/2
40
2p1/2
1f5/2
2p3/2
28
1f7/2
3p1/2
3p3/2
2f5/2
1i13/2
2f7/2
1h9/2
3s1/2
2d3/2
1h11/2
1g7/2
2d5/2
1g9/2
2p1/2
1f5/2
2p3/2
1f7/2
neutron
proton

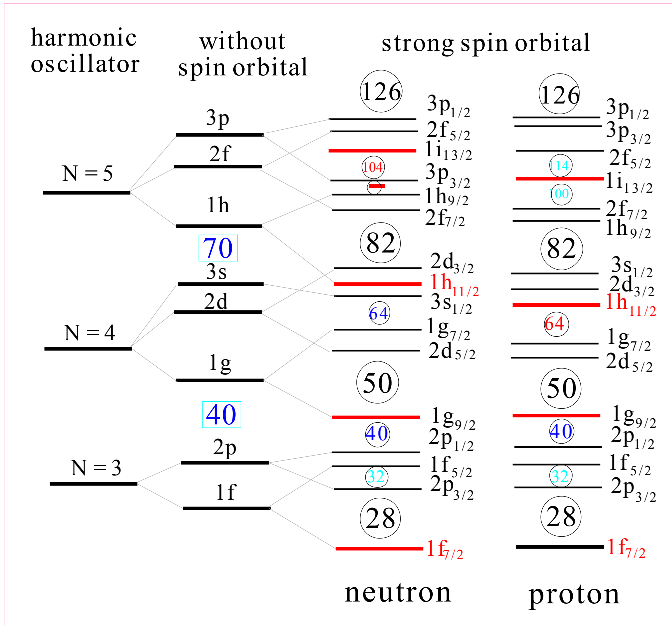

Ni Zn Ge Se Kr Sr Zr Mo Ru Pd Cd Sn
2+
Energy (keV)
0
-500
-1000
-1500
-2000
28 30 32 34 36 38 40 42 44 46 48 50
Proton Number
N44
N46
N48
N50
N52
N54
N56
N58
N60
N62
N64
N66


Ni Zn Ge Se Kr Sr Zr Mo Ru Pd Cd Sn
R : E(4+)/E(2+)
3.0
2.5
2.0
1.5
N=60
28 30 32 34 36 38 40 42 44 46 48 50
Proton Number
N44
N46
N48
N50
N52
N54
N56
N58
N60
N62
N64
N66
N68
N70

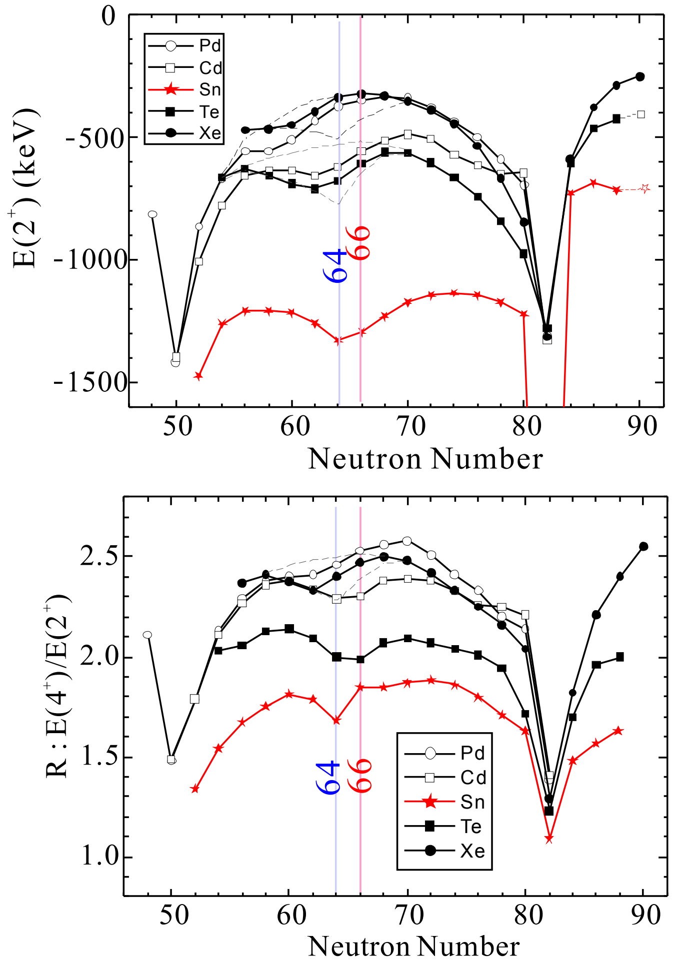
2. 시작점

Nuclear shapes and their phases

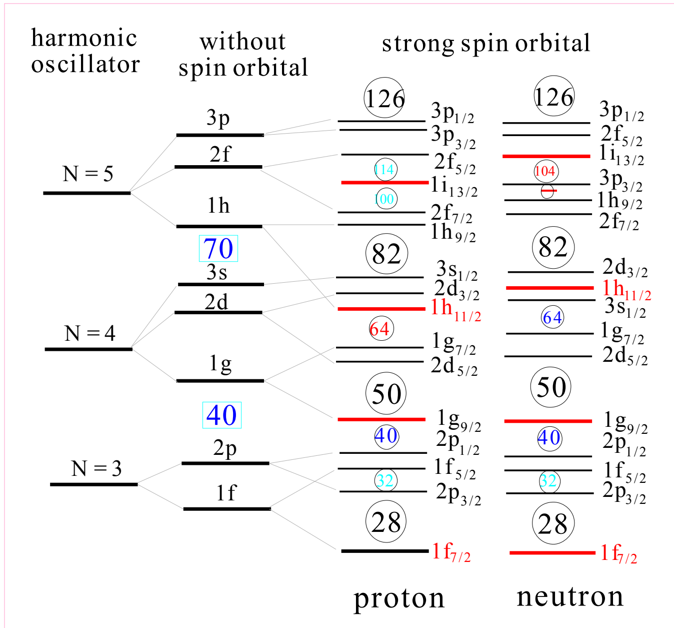
Atomic nuclei have a shell structure under which have favored configurations

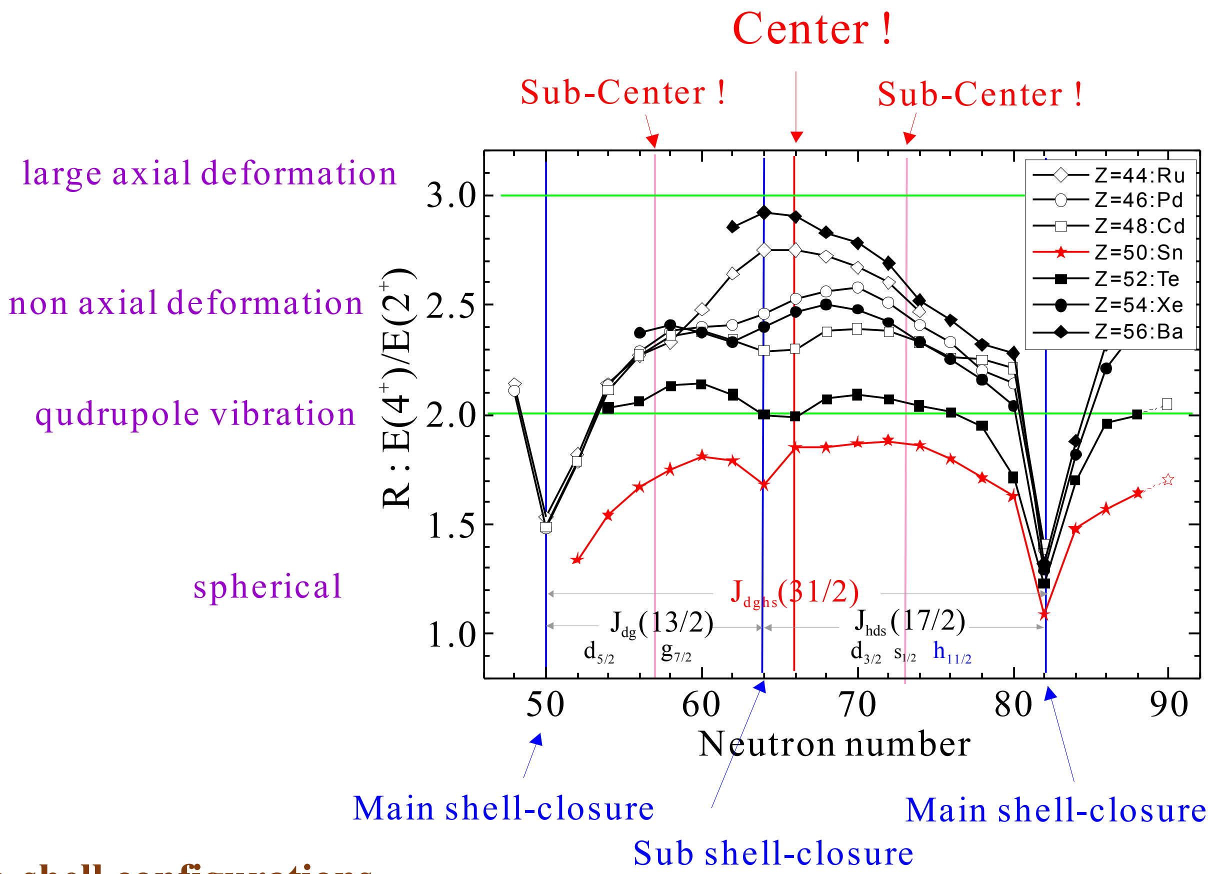


What a similarity between energy and shape



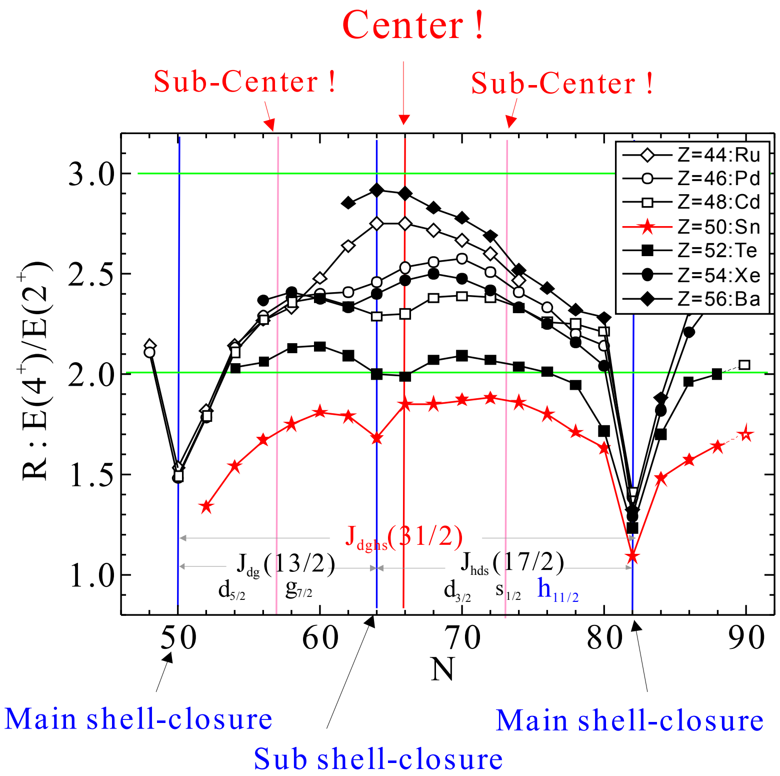
Reinforcing deformations

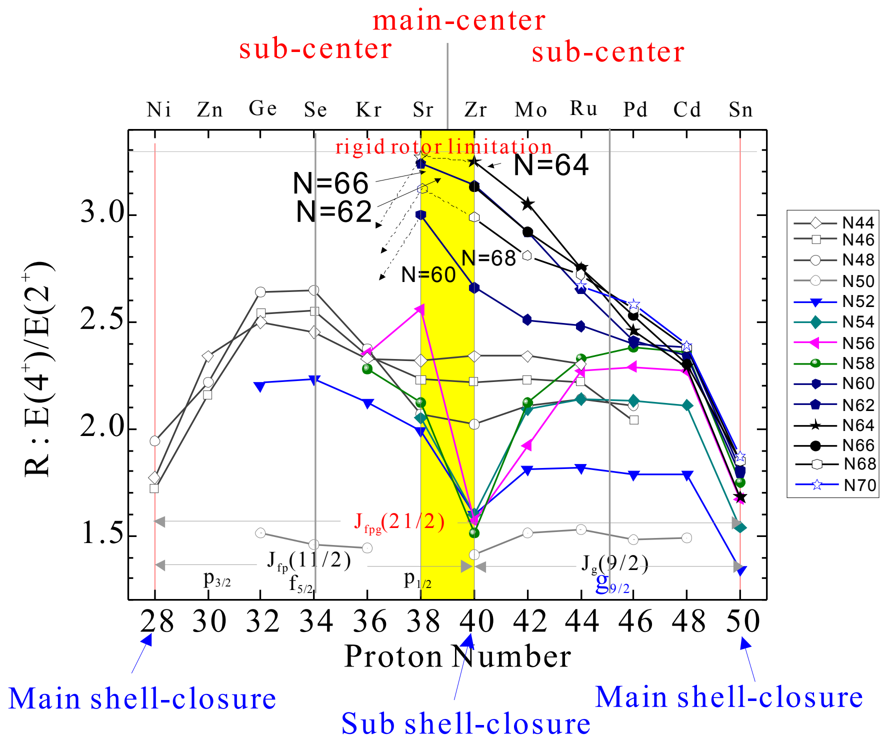




Pseudo-shell configurations

Networking between neutrons and protons





3. 출발선에 선 우리들의 핵종들

아궁이와 불쏘시개

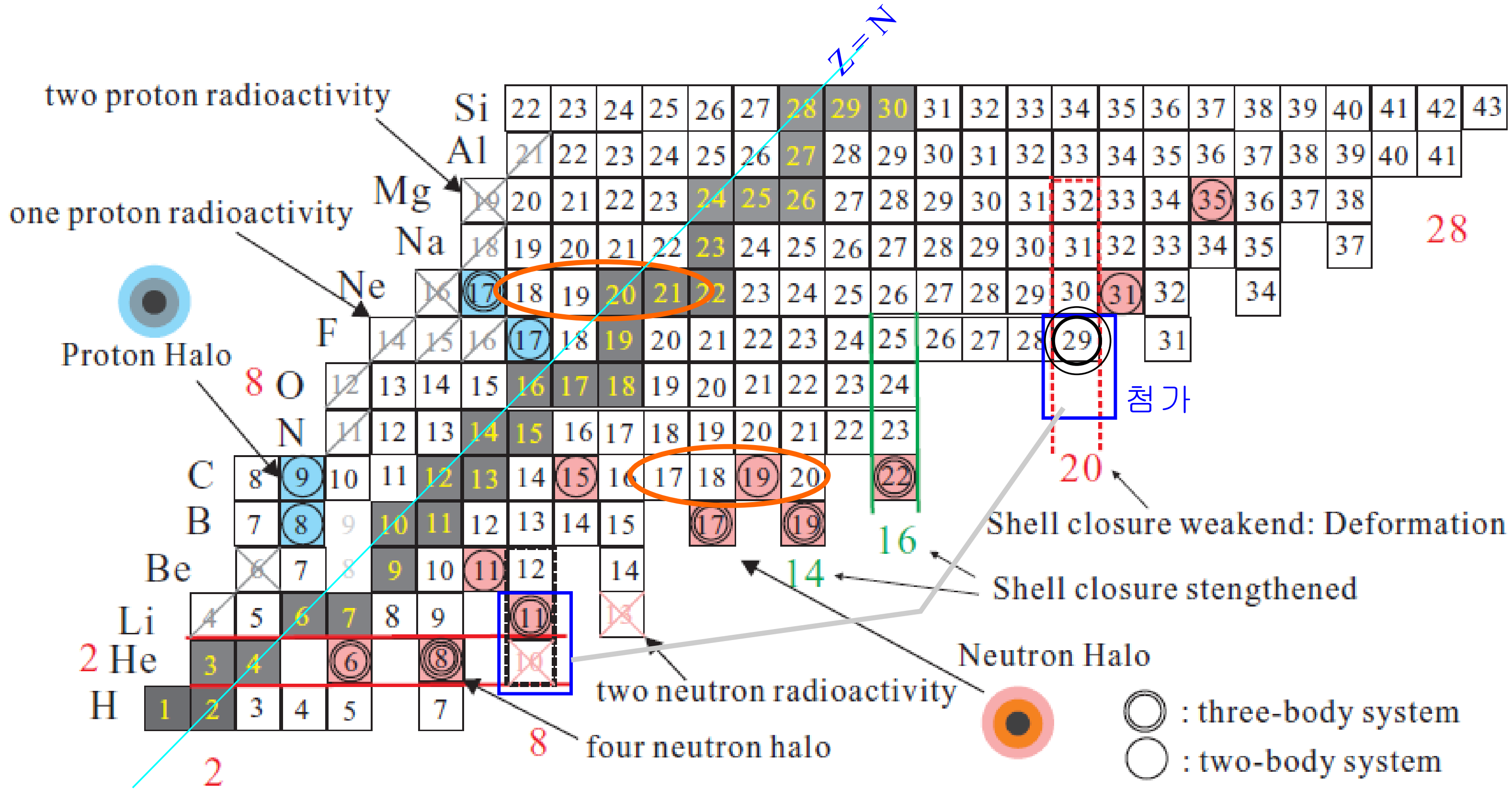


FIG. 3. Section of the chart of the nuclides showing the shell structure evolution. Some exotic nuclei with nuclear halos and skins are denoted.[10] The proton unbound nuclei of interest are also shown.

Measurement of ^{77,79}Se(d, p)^{78,80}Se reactions as a surrogate for ^{79}Se(n,γ)^{80}Se reaction

N. Imai,[*1] M. Dozono,[*1] S. Michimasa,[*1] T. Sumikama,[*2] S. Ota,[*1] S. Hayakawa,[*1] K. Iribe,[*3] C. Iwamoto,[*1] S. Kawase,[*4] K. Kawata,[*1,*2] N. Kitamura,[*1] S. Masuoka,[*1] K. Nakano,[*4] P. Schrock,[*1] D. Suzuki,[*2] R. Tsunoda,[*1] K. Wimmer,[*5] D.S. Ahn,[*2] O. Beliuskina,[*1] N. Chiga,[*2] N. Fukuda,[*2] E. Ideguchi,[*6] K. Kusaka,[*2] H. Miki,[*7] H. Miyatake,[*8] D. Nagae,[*2] M. Nakano,[*9] S. Ohmika,[*2] M. Ohtake,[*2] H. Otsu,[*2] H.J Ong,[*6] S. Sato,[*9] H. Shimizu,[*1] Y. Shimizu,[*2] H. Sakurai,[*2,*5] X. Sun,[*2] H. Suzuki,[*2] M. Takaki,[*1] H. Takeda,[*2] S. Takeuchi,[*7] T. Teranishi,[*3] Y. Watanabe,[*4] Y.X. Watanabe,[*8] H. Yamada,[*7] H. Yamaguchi,[*1] L. Yang,[*1] R. Yanagihara,[*6] K. Yoshida,[*2] Y. Yanagisawa,[*2] and S. Shimoura[*1]

To design a facility for decommissioning the spent fuel from nuclear power plants containing long-lived fission products (LLFPs), more nuclear reaction data is needed. Within the ImPACT program, thus far several nuclear reactions of LLFPs produced by BigRIPS impinging on nuclear and proton targets have been measured.[1)] Because of the longer mean free path, the transmutation with neutrons can be applied more efficiently. However, since both the neutron and the LLFPs are unstable, the measurement of the neutron-induced cross section requires a neutron facility, in addition to enriched radioactive targets. Instead, the reaction cross-section can be determined in an indirect way employing a surrogate reaction.

PTEP

Prog. Theor. Exp. Phys. **2019**, 043D02 (11 pages)
DOI: 10.1093/ptep/ptz028

Angle-tunable wedge degrader for an energy-degrading RI beamline

Jongwon Hwang[1,*], Shin'ichiro Michimasa[1], Shinsuke Ota[1], Masanori Dozono[1], Nobuaki Imai[1], Koichi Yoshida[2], Yoshiyuki Yanagisawa[2], Kensuke Kusaka[2], Masao Ohtake[2], Deuk Soon Ahn[2], Olga Beliuskina[1], Naoki Fukuda[2], Chihiro Iwamoto[1], Shoichiro Kawase[3], Keita Kawata[1], Noritaka Kitamura[1], Shoichiro Masuoka[1], Hideaki Otsu[2], Hiroyoshi Sakurai[2], Philipp Schrock[1], Toshiyuki Sumikama[2], Hiroshi Suzuki[2], Motonobu Takaki[1], Hiroyuki Takeda[2], Rieko Tsunoda[1], Kathrin Wimmer[4], Kentaro Yako[1], and Susumu Shimoura[1]

중이온가속기 KoRIA와 천체핵물리학

한국물리학회지 “새물리”, Volume 60, Number 8, 2010년 8월

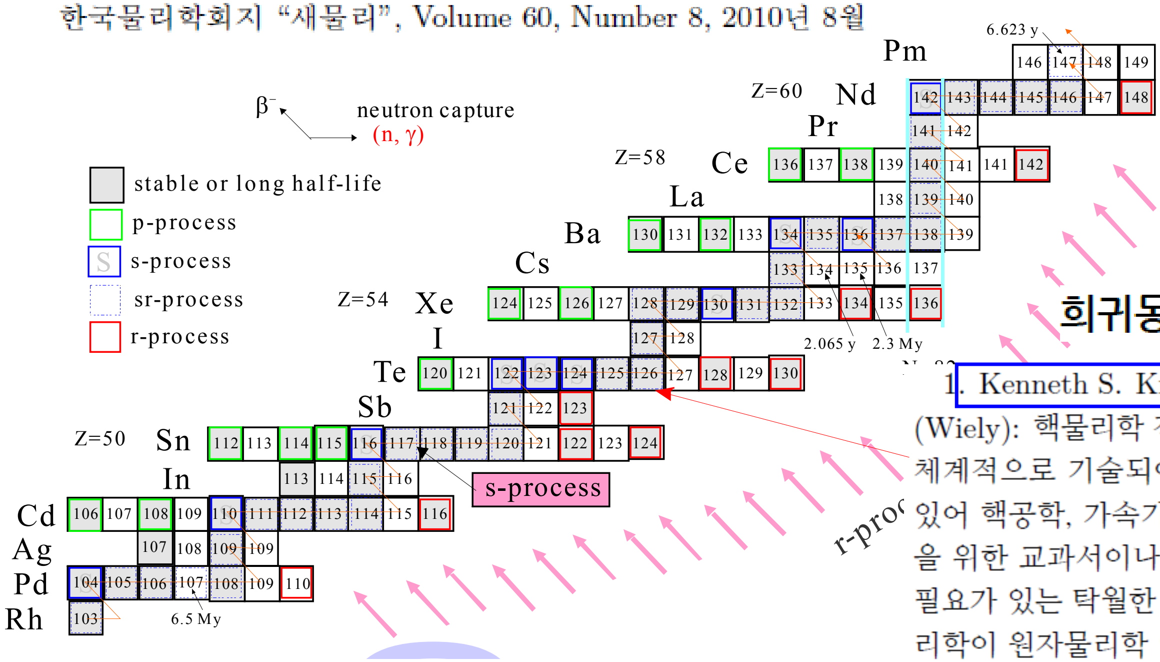


Fig. 17. The s-process path through the elements from Rh to Pm [1]. Notice that like ^{107}Pd, ^{135}Cs, and ^{147}Pm.

희귀동위원소 가속기와 핵과학

1. Kenneth S. Krane, “Introductory Nuclear Physics” (Wiely): 핵물리학 전반에 걸친 이론과 실험 그리고 개념이 체계적으로 기술되어 있음. 핵물리 응용분야까지 다루고 있어 핵공학, 가속기 물리학자들에게도 추천함. 학부과정을 위한 교과서이나 최고의 핵물리학 전문가도 정독을 할 필요가 있는 탁월한 참고서적임. 특히 응용편 16장은 핵물리학이 원자물리학 연구에 어떻게 연결되는지를 아름답게 설명하고 있음.

New Physics: Sae Mulli,
Vol. 66, No. 12, December 2016, pp. 1480~1490
http://dx.doi.org/10.3938/NPSM.66.1480

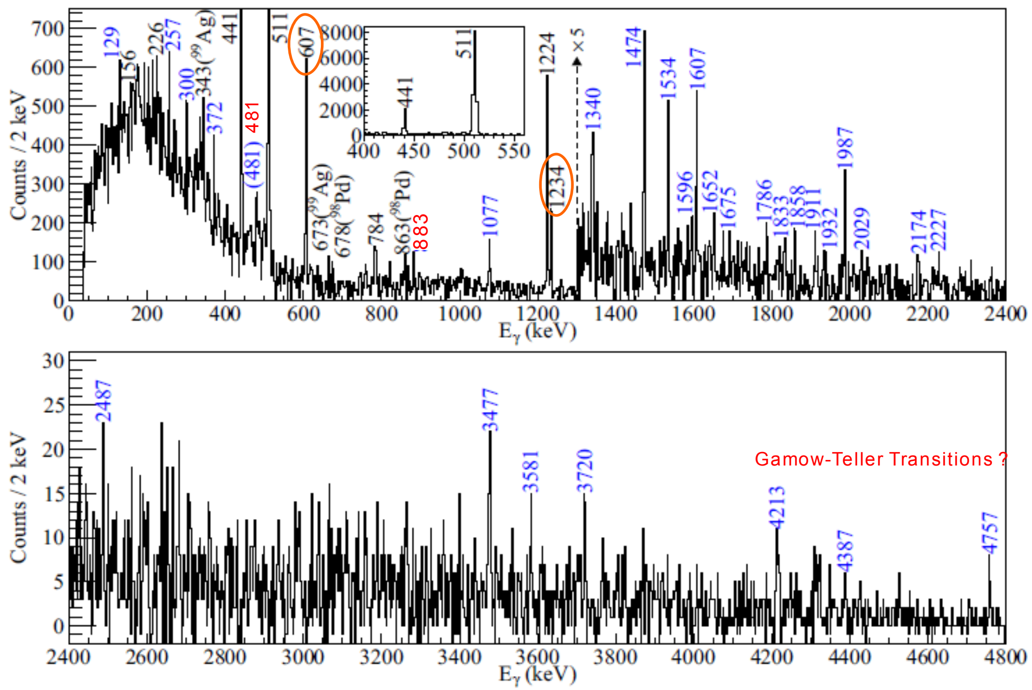


FIG. 2. Background-subtracted γ-ray spectra of β-decay events correlated between 0 and 5 s after ^{99}In implantation. The peaks labeled in black correspond to the previously observed γ rays in ^{99}Cd [8] and other background contaminants as labeled. New transitions from this decay

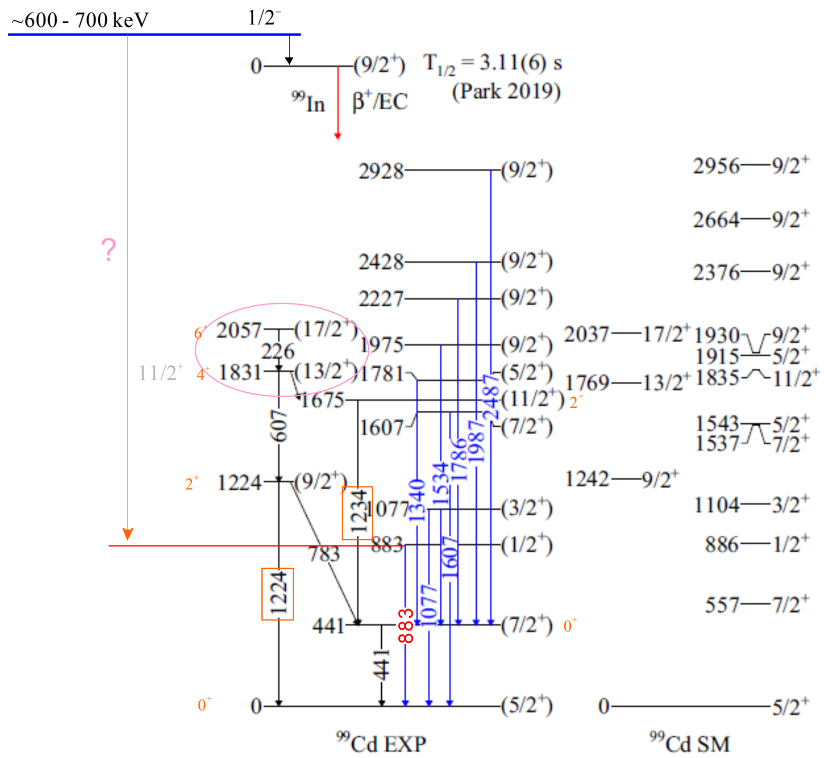


FIG. 4. Level schemes of ^{99}Cd from the $\beta\gamma$ spectroscopy of ^{99}In.

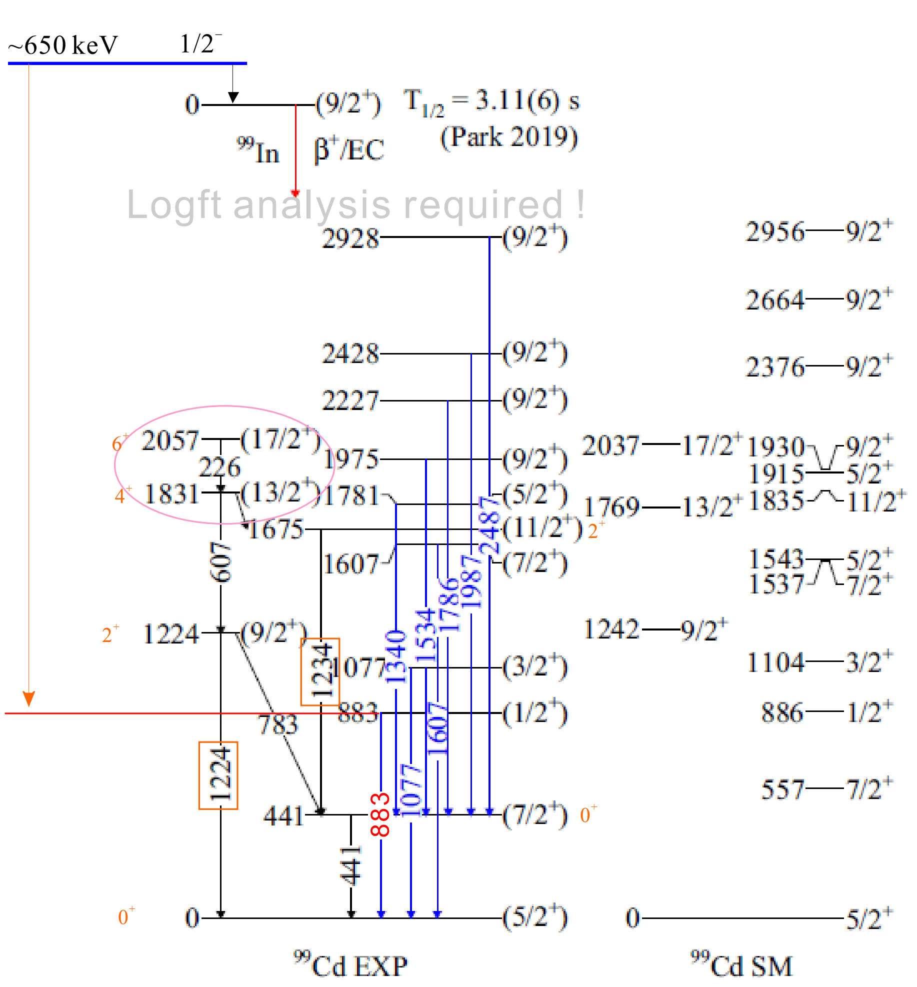
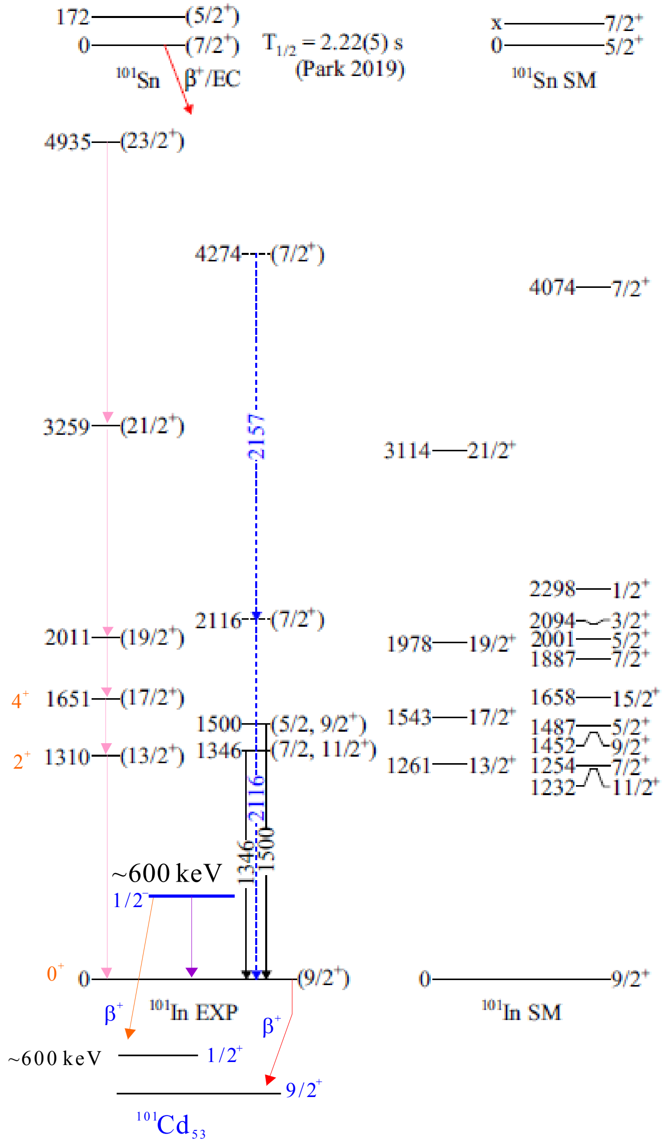
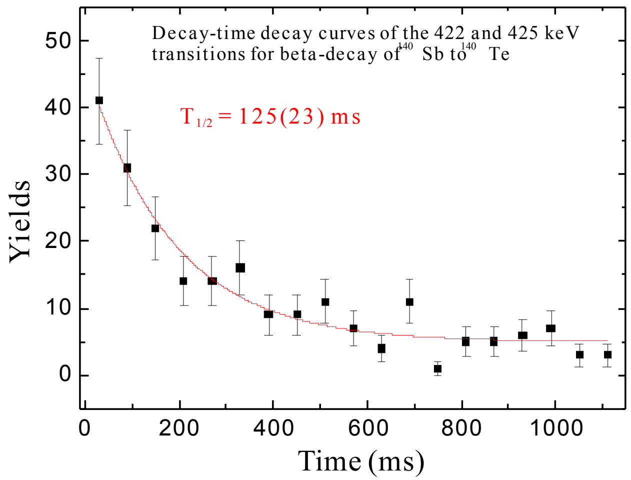
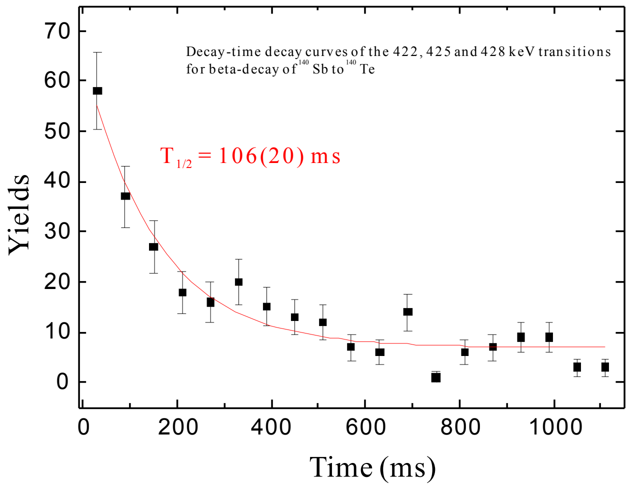


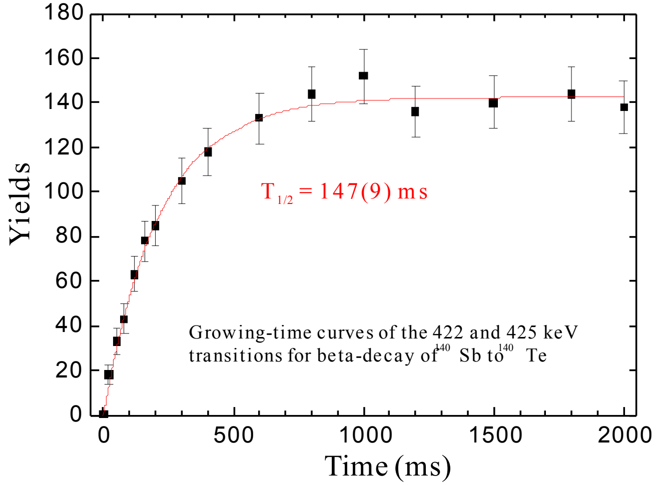
FIG. 4. Level schemes of ^{99}Cd from the $\beta\gamma$ spectroscopy of ^{99}In.

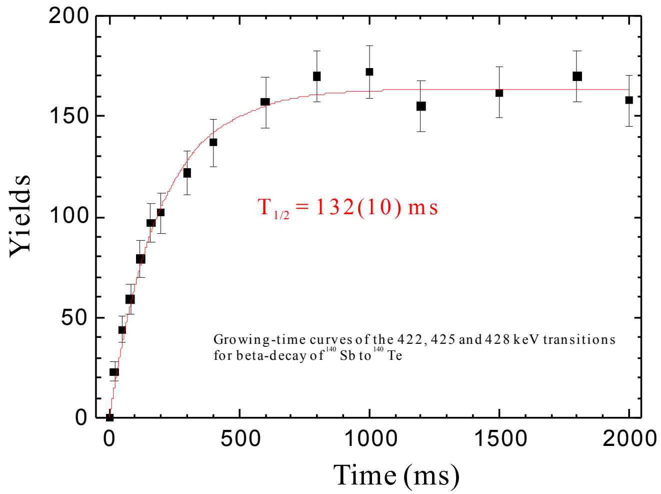


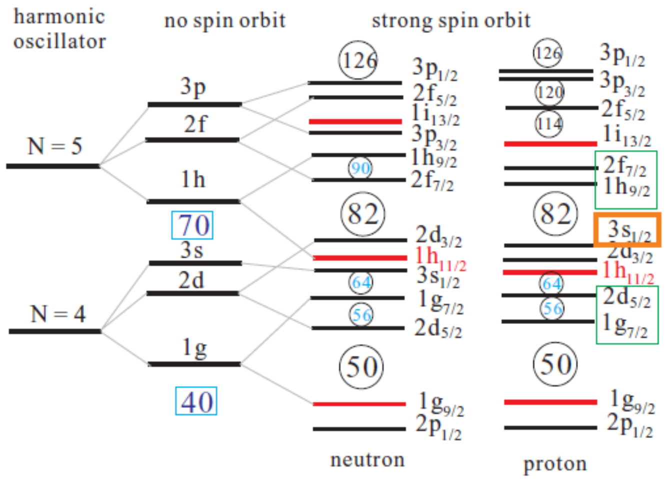
Moon@2015.10.21.











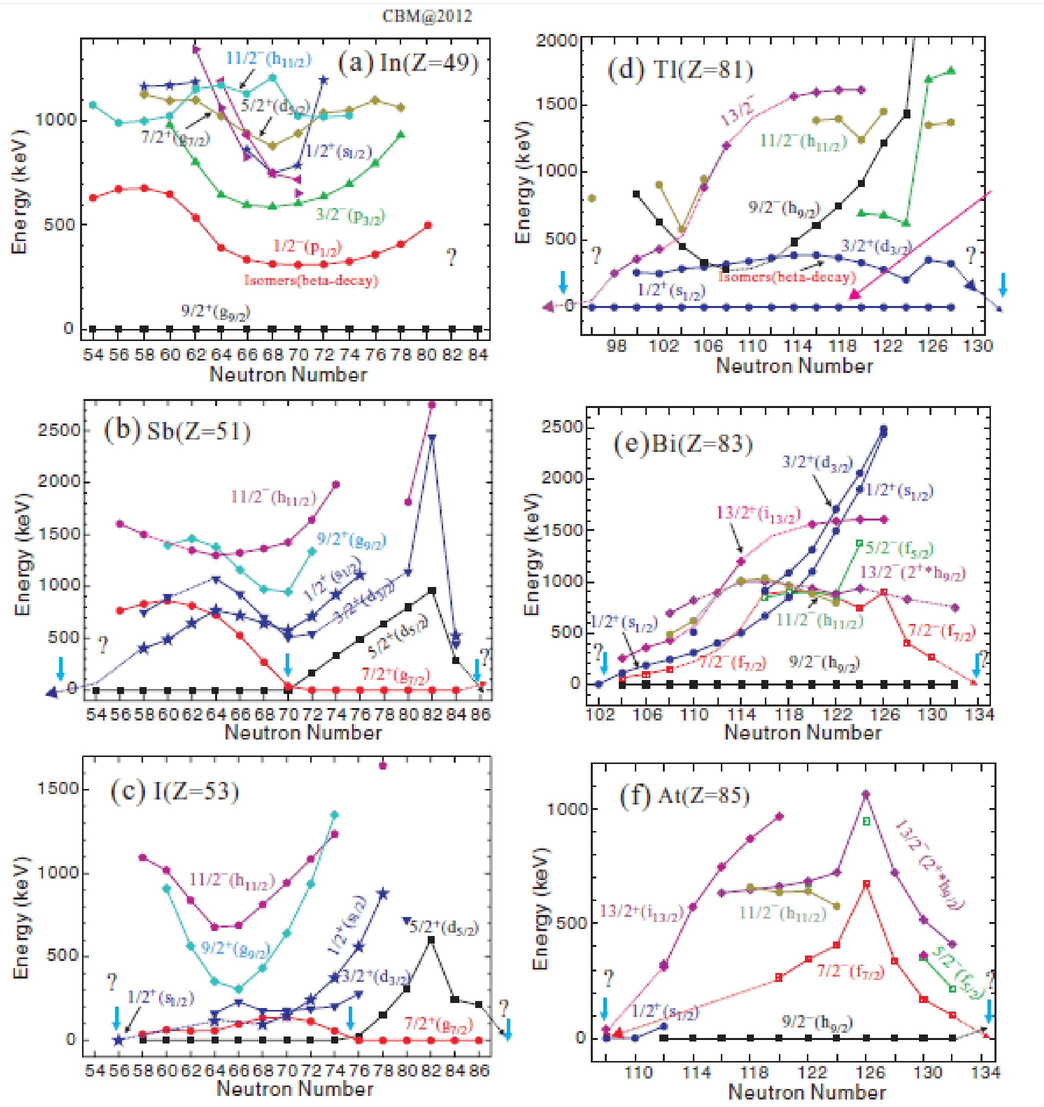
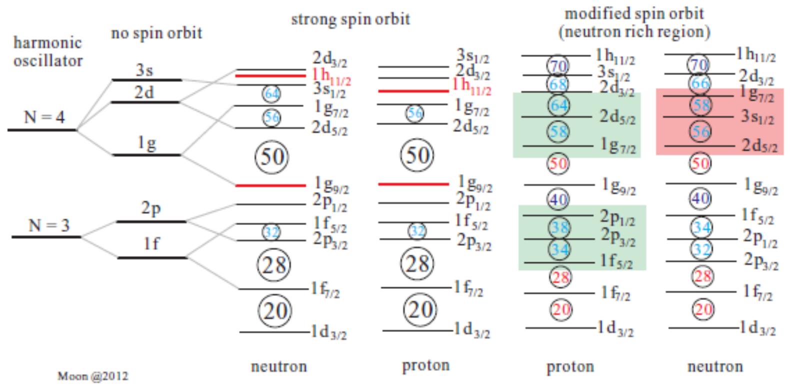


FIG. 6. Systematics of ground and low-lying states for the odd-mass nuclei; (a) Indium, (b) Antimony, and (c) Iodine around ^{132}Sn and (d) Thallium, (e) Bismuth, and (f) Astatine around ^{208}Pb as a function of neutron numbers. The expected level crossings on the basis of the systematic trends are denoted by the arrows. Data are from NNDC.[22]



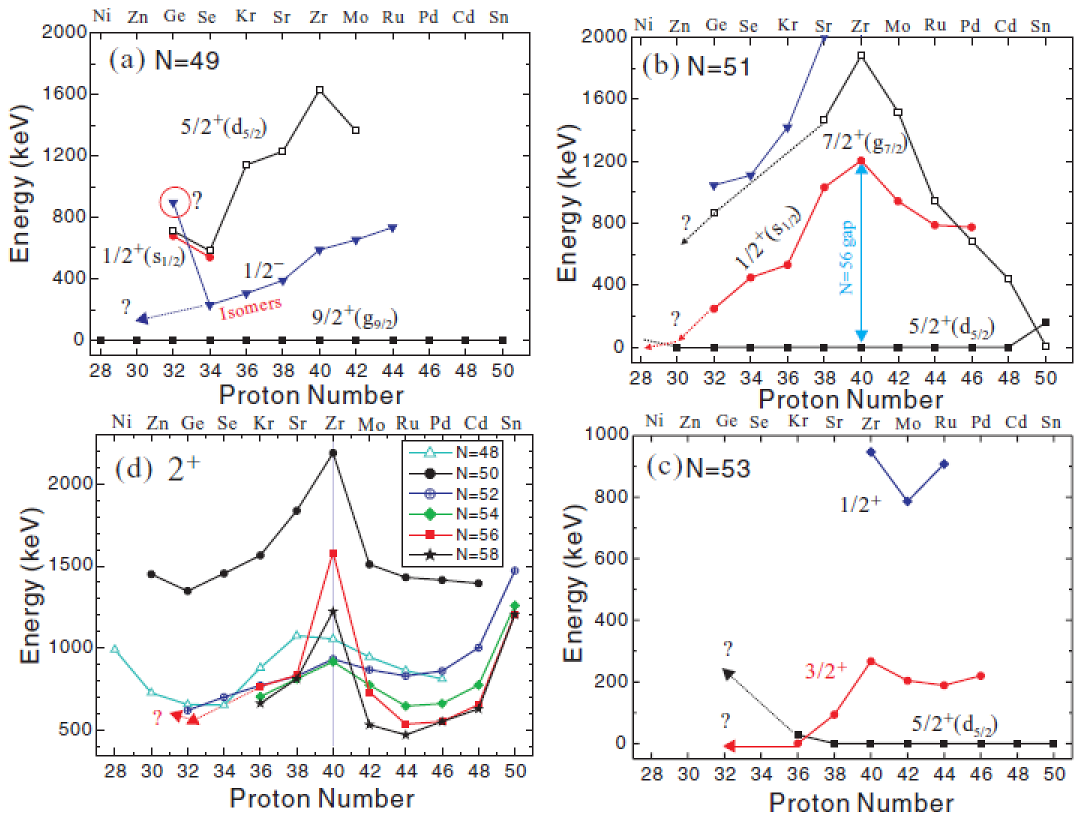
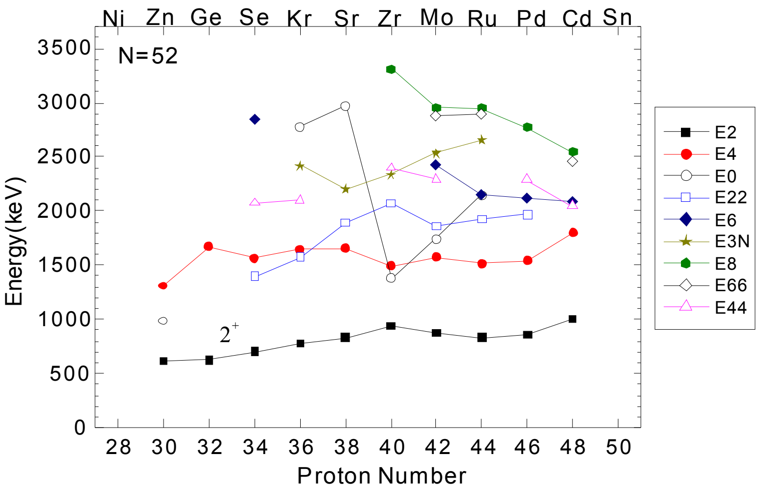
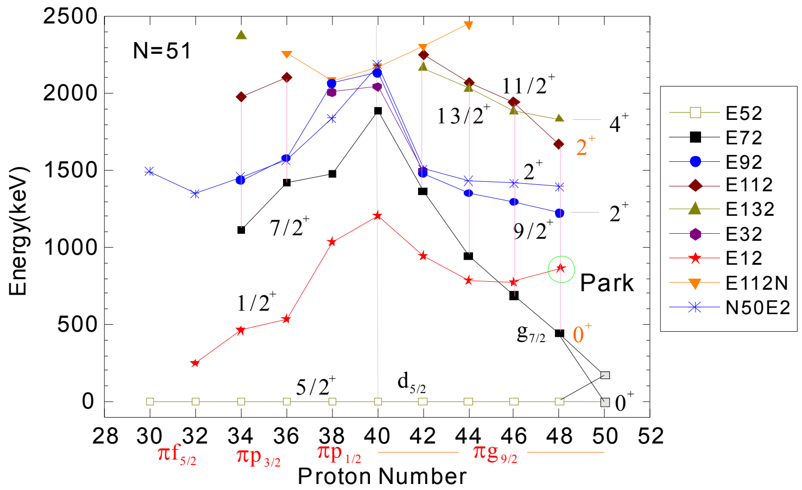
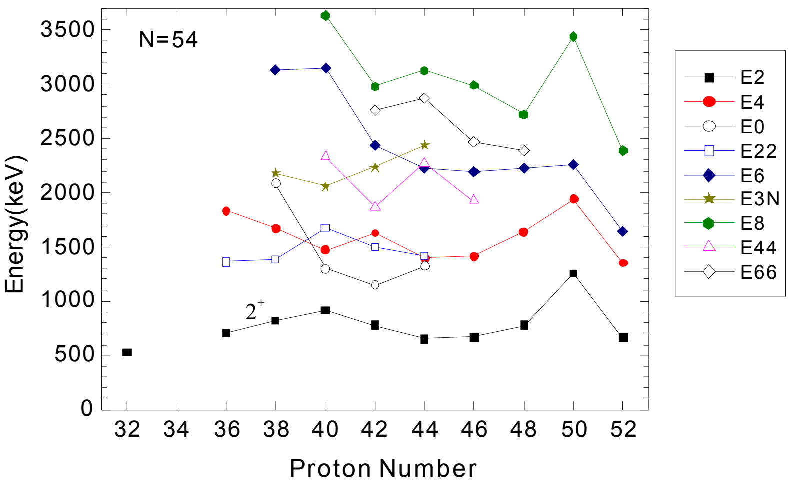


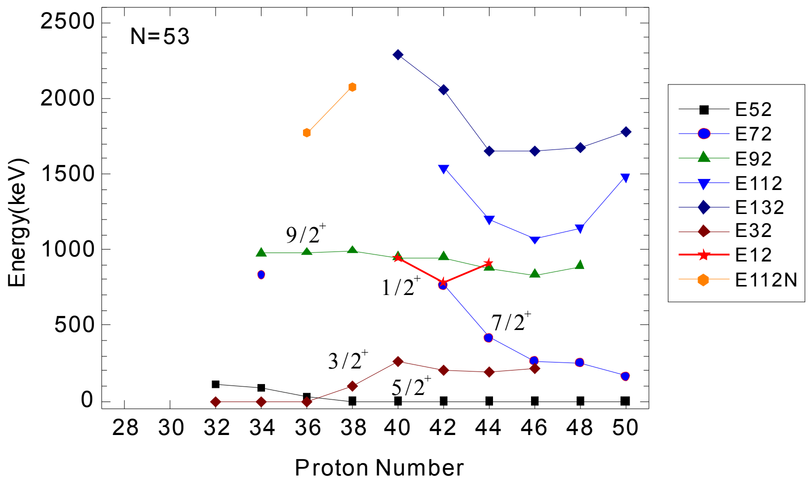
FIG. 22. Systematics of the ground and the excited states of interest in odd N = 49, 51, and 53 nuclei as a function of proton number. For comparison and discussion, the associated systematics of the first 2^+ states in even-even nuclei is also included.

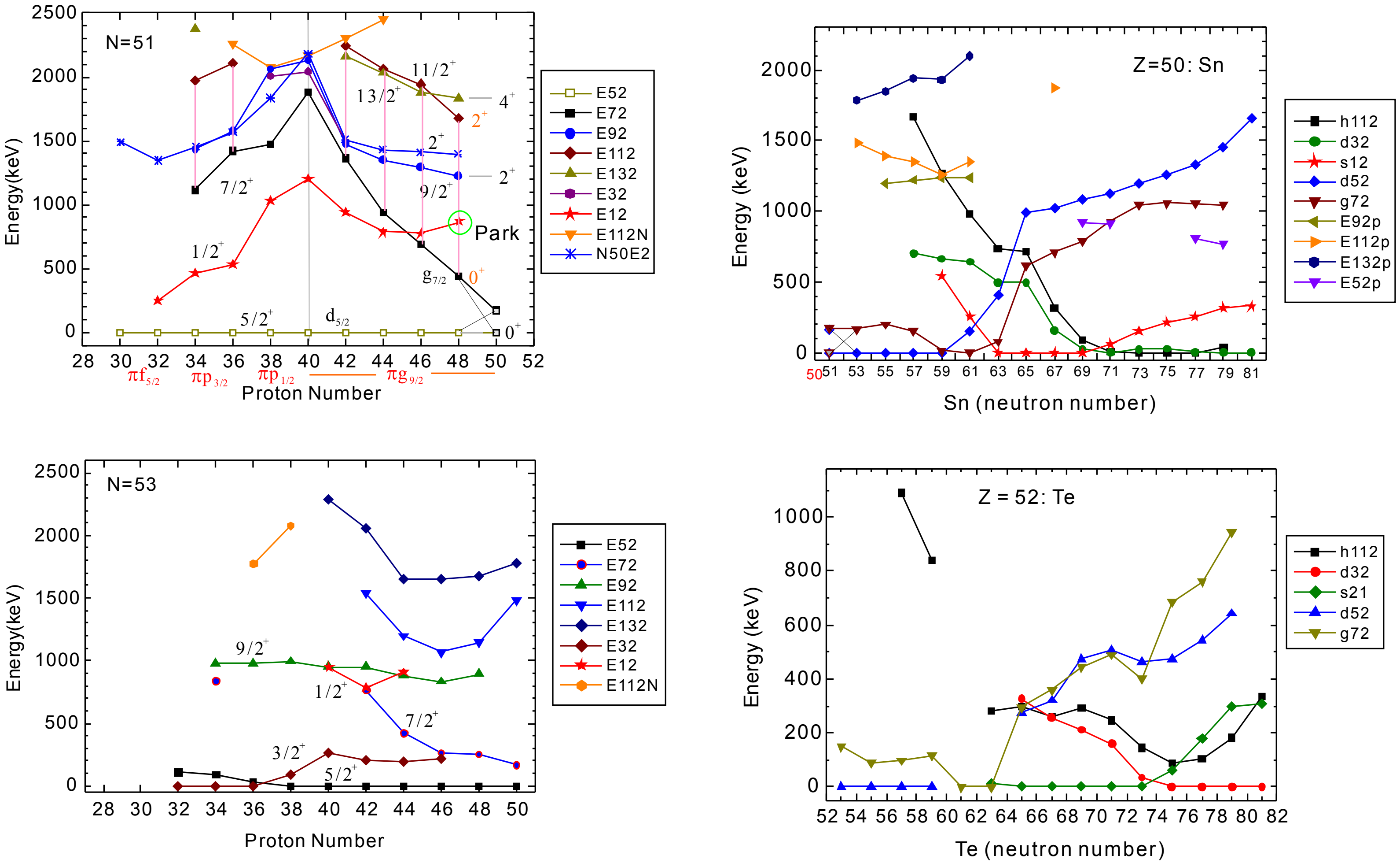
2020. 6. 8.

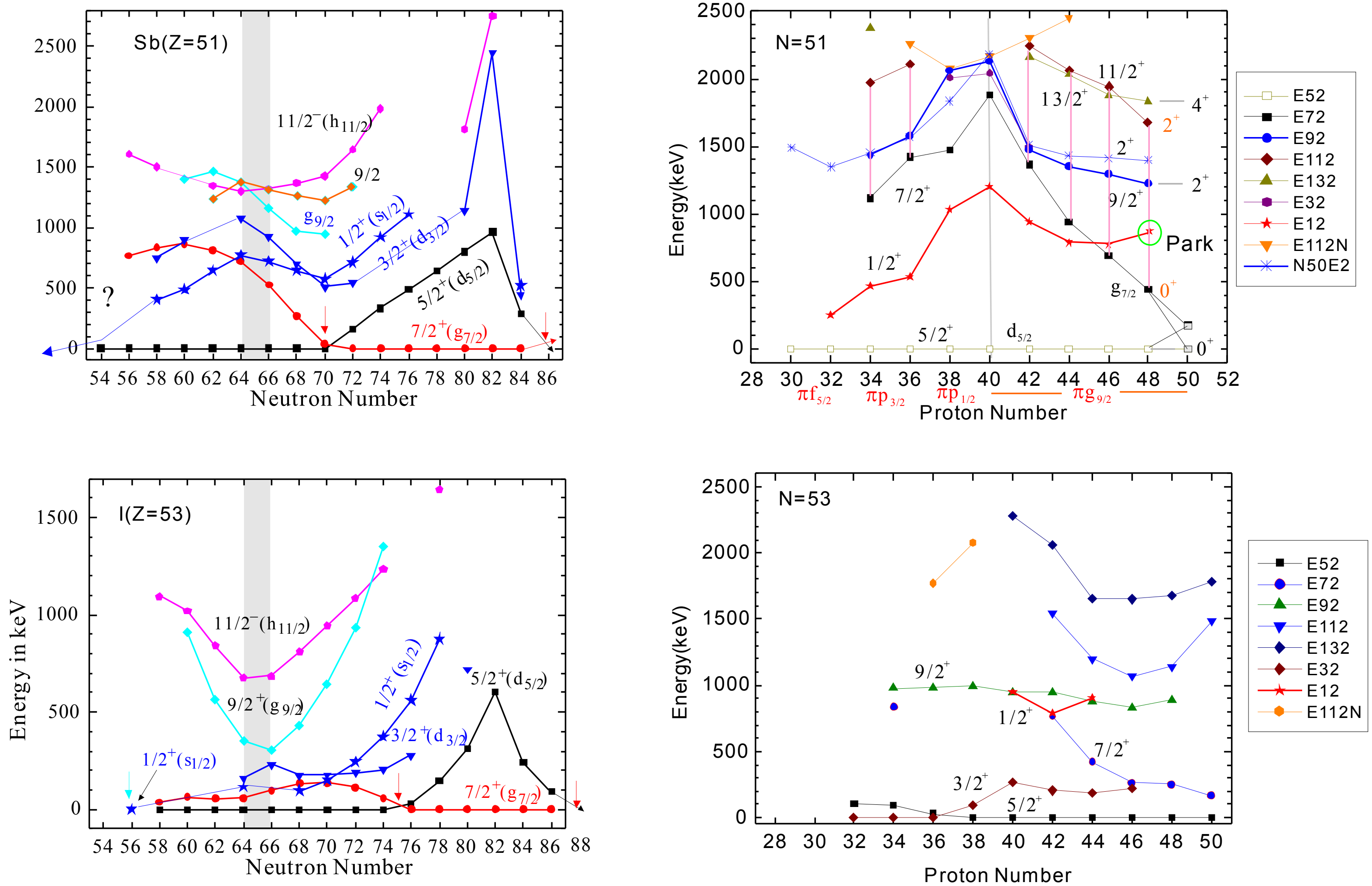

N=52
Ni Zn Ge Se Kr Sr Zr Mo Ru Pd Cd Sn
Energy(keV)
Proton Number
2+
E2
E4
E0
E22
E6
E3N
E8
E66
E44


N=51
Energy(keV)
Proton Number
πf5/2
πp3/2
πp1/2
πg9/2
11/2+
13/2+
4+
2+
2+
7/2+
9/2+
2+
1/2+
Park
g7/2
0+
5/2+
d5/2
0+
E52
E72
E92
E112
E132
E32
E12
E112N
N50E2


N=54
Energy(keV)
Proton Number
2+
E2
E4
E0
E22
E6
E3N
E8
E44
E66

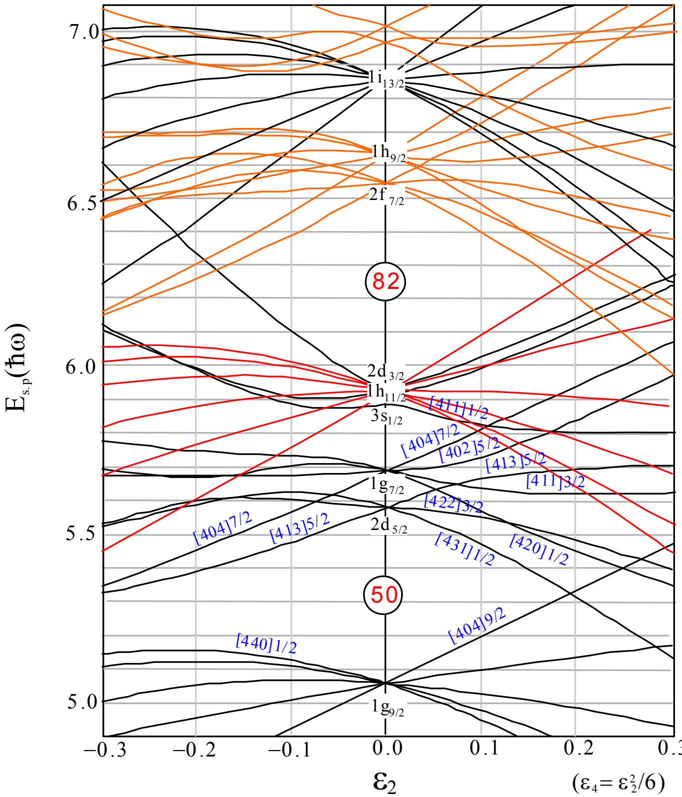

N=53
Energy(keV)
Proton Number
9/2+
1/2+
7/2+
3/2+
5/2+
E52
E72
E92
E112
E132
E32
E12
E112N


N=51
Energy(keV)
Proton Number
E52
E72
E92
E112
E132
E32
E12
E112N
N50E2
Park
1/2+
5/2+
7/2+
9/2+
11/2+
13/2+
2+
4+
0+
$d_{5/2}$
$g_{7/2}$
$\pi f_{5/2}$
$\pi p_{3/2}$
$\pi p_{1/2}$
$\pi g_{9/2}$
Z=50: Sn
Energy (keV)
Sn (neutron number)
h112
d32
s12
d52
g72
E92p
E112p
E132p
E52p
N=53
Energy(keV)
Proton Number
E52
E72
E92
E112
E132
E32
E12
E112N
9/2+
1/2+
7/2+
3/2+
5/2+
Z = 52: Te
Energy (keV)
Te (neutron number)
h112
d32
s21
d52
g72

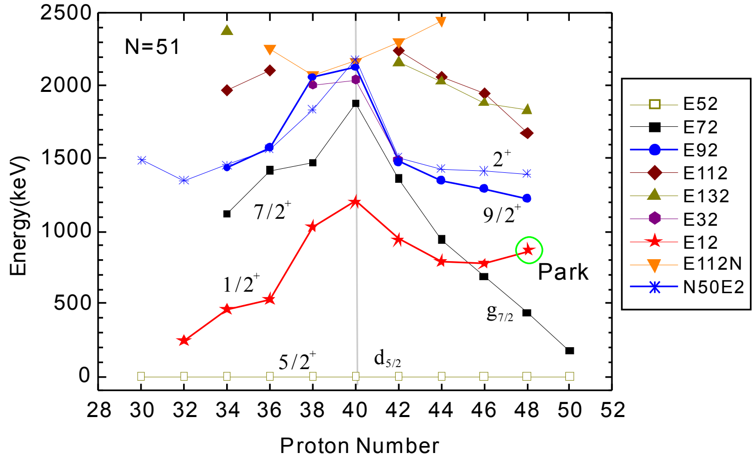


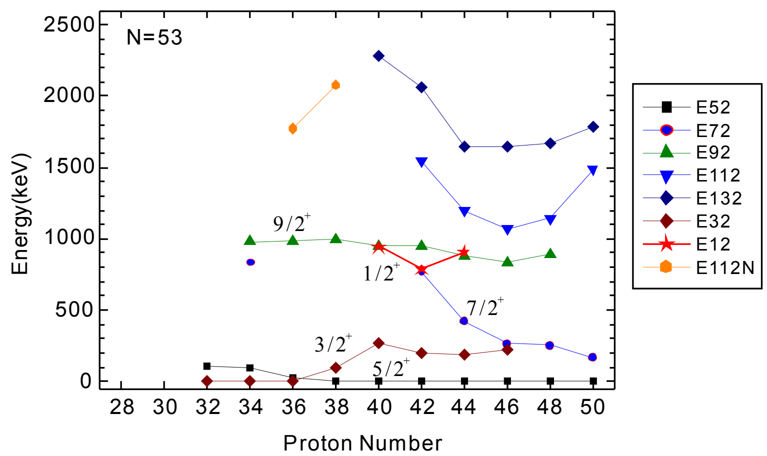
Sb(Z=51)
2500
2000
1500
1000
500
0
11/2⁻(h11/2)
9/2
g9/2
1/2⁺(s1/2)
3/2⁺(d3/2)
5/2⁺(d5/2)
7/2⁺(g7/2)
?
54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86
Neutron Number
N=51
Energy(keV)
11/2⁺
13/2⁺
4⁺
2⁺
2⁺
2⁺
7/2⁺
9/2⁺
1/2⁺
Park
g7/2
0⁺
5/2⁺
d5/2
0⁺
28 30 32 34 36 38 40 42 44 46 48 50 52
πf5/2
πp3/2
πp1/2
πg9/2
Proton Number
E52
E72
E92
E112
E132
E32
E12
E112N
N50E2
I(Z=53)
Energy in keV
1500
1000
500
0
11/2⁻(h11/2)
9/2⁺(g9/2)
1/2⁺(s1/2)
3/2⁺(d3/2)
5/2⁺(d5/2)
1/2⁺(s1/2)
7/2⁺(g7/2)
54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88
Neutron Number
N=53
Energy(keV)
9/2⁺
1/2⁺
7/2⁺
3/2⁺
5/2⁺
28 30 32 34 36 38 40 42 44 46 48 50
Proton Number
E52
E72
E92
E112
E132
E32
E12
E112N

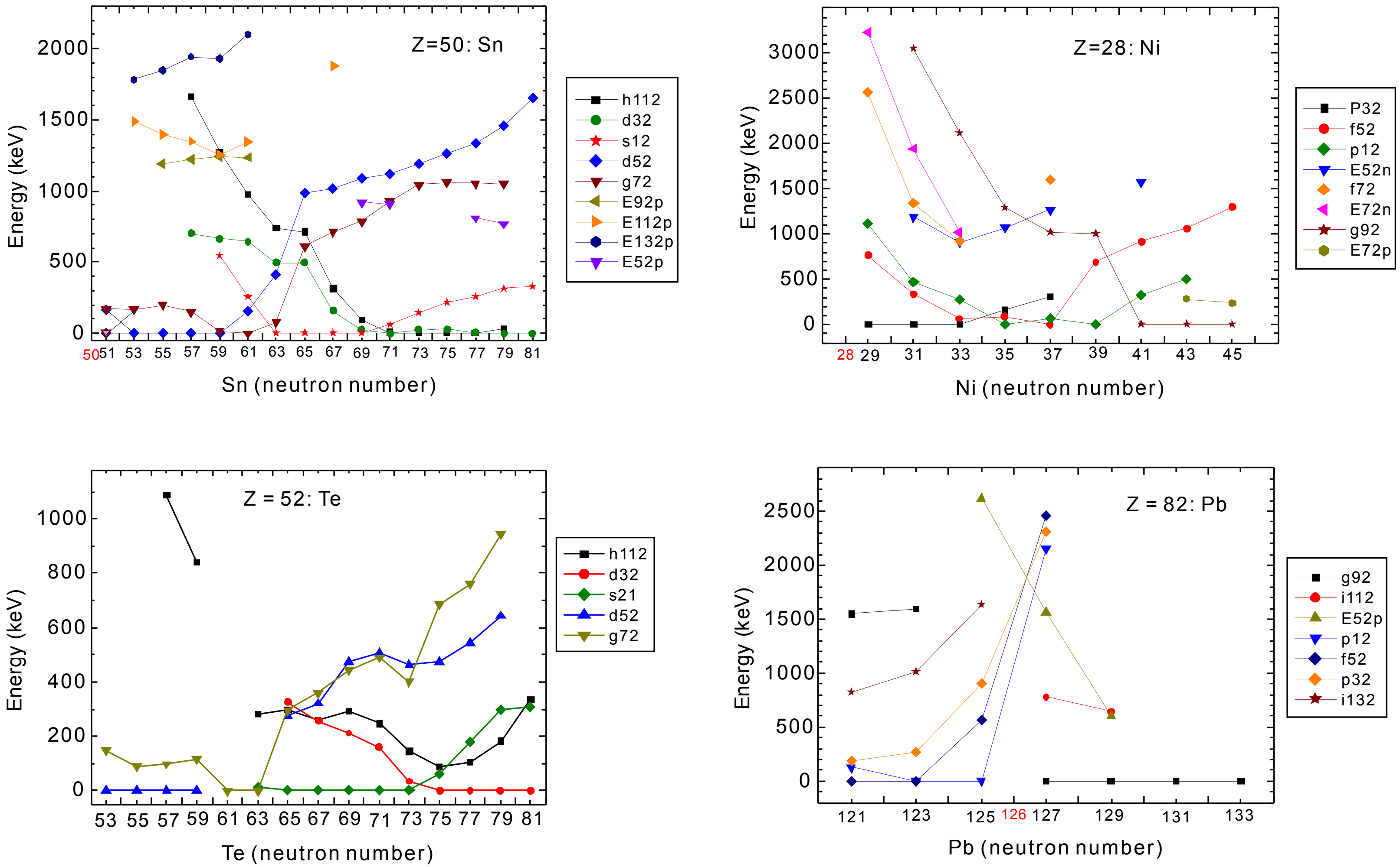
유행하는 spherical shell model이 다가 아니다



Nilsson diagram for neutrons







Z=50: Sn
Energy (keV)
Sn (neutron number)
h112
d32
s12
d52
g72
E92p
E112p
E132p
E52p
Z=28: Ni
Ni (neutron number)
P32
f52
p12
E52n
f72
E72n
g92
E72p
Z = 52: Te
Te (neutron number)
h112
d32
s21
d52
g72
Z = 82: Pb
Pb (neutron number)
g92
i112
E52p
p12
f52
p32
i132

Variety of nuclear structures for Z = 48 to 56, 50 < N < 82

1 Z = 53 (I)

Doublet collective states
Shape coexistence

$\pi h_{11/2}$ $\pi h_{11/2}$ $\nu h_{11/2}$

2 Z = 52 (Te)

Structure of two valence protons
: a big puzzle to be solved

$\pi g_{7/2}$ $\pi d_{5/2}$

3 Z = 51 (Sb) Isomers

$\pi h_{11/2}$ $\nu h_{11/2}$

Z = 54 (Xe)

Triaxial shape ?
Gamma soft(unstable) shape ?

Doublet states $\nu h_{11/2}$

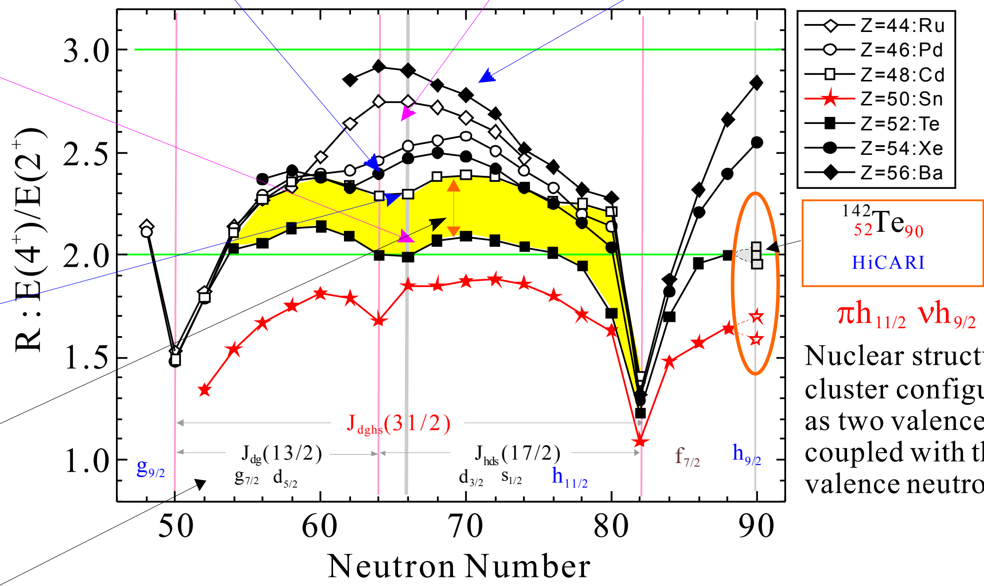
Z = 55 (Cs)

Doublet collective states
Geometrical handedness:
Chirality

$\pi h_{11/2}$ $\nu h_{11/2}$

Z = 56 (Ba)

Dynamic octapole collectivity
Static octapole ?



$^{142}_{52}Te_{90}$
HiCARI

$\pi h_{11/2}$ $\nu h_{9/2}$

Nuclear structure by two-proton cluster configurations described as two valence particles, Z>50, coupled with the number of valence neutrons, N > 82.

Z = 48 (Cd)

Collectivity still uncleared
:Triaxial rotator or vibrator ?

$\pi g_{9/2}$ $\nu h_{11/2}$

Notice a large difference between Z = 48 and Z = 52

pseudo-shell concept
l=2, l=4 => $\tilde{l}$= 3
: doublet shell structure

4. 갈 길

A3 Foresight Program: 2019 Northeastern Asian Symposium on Nuclear Physics in the 21st Century, 2019. 12. 6-7. RIKEN Kobe campus .

Don't stay a particular ridge of your own interest, but look at other domains in nuclear many-body quantum systems, even at different branches; chemistry and biology.

I hope the presentation make you feel free to extrapolate and to speculate about where you go next.

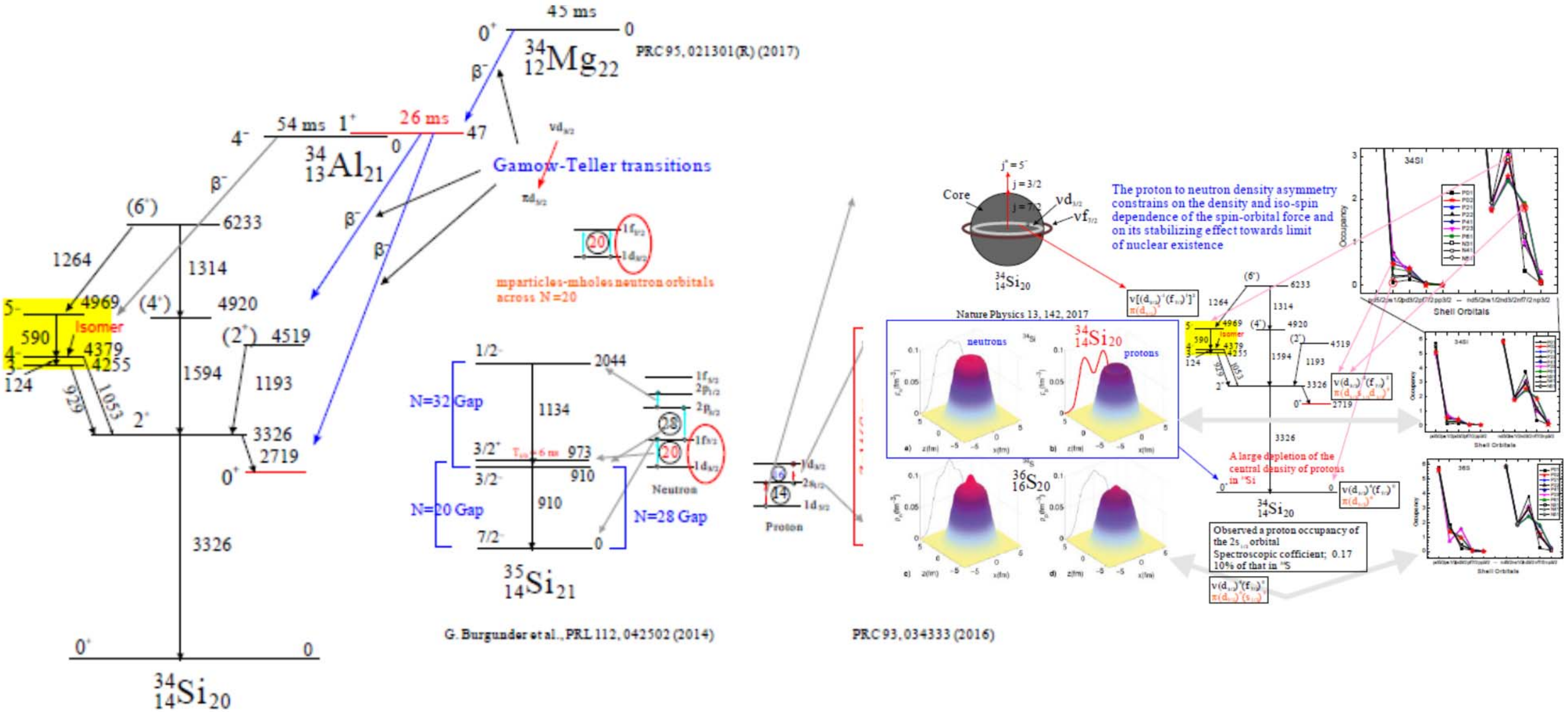
Foresight ? but also backsight !
Background ? but also foreground !
Forecast ? but also backcast !

The author shows how our **personalities** reflect the biological mechanisms underlying thought and emotion and how **behavioral eccentricities** may be traced to abnormalities in an individual brain.
–mapping the mind-

An Episode

A3 Foresight Program: 2018 20th Northeastern Asian Symposium on Nuclear Physics in the 21st century
18-20 September 2018, Hilton Nagoya, Nagoya, Japan.

Exotic facets in the Z(proton) = 14 and N(neutron) = 20 system: ^{34}Si



International Nuclear Physics Conference 2010 (INPC2010)
Journal of Physics: Conference Series **312** (2011) 092050

The deformed 0^+ state in ^{34}Si

S Paschalis[1], P Fallon[1], A O Macchiavelli[1], M Petri[1], P C Bender[2], M P Carpenter[3], X Chen[4], C J Chiara[3,5], R M Clark[1], M Cromaz[1], S Gros[1], L Hamilton[2], C R Hoffman[2], R V F Janssens[3], T Lauritsen[3], I Y Lee[1], C J Lister[3], E A McCutchan[3], L Phair[1], W Reviol[4], D G Sarantites[4], D Seweryniak[3], S L Tabor[2], Y Toh[3,6], M Wiedeking[7] and S Zhu[3]

[1] Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
[2] Florida State University, Tallahassee, FL 32306, USA
[3] Argonne National Laboratory, Argonne, IL 60439, USA
[4] Washington University, St. Louis, MO 63130, USA
[5] University of Maryland, College Park, MD 20742, USA
[6] Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan
[7] Lawrence Livermore National Laboratory, Livermore, CA 94551, USA

Failed

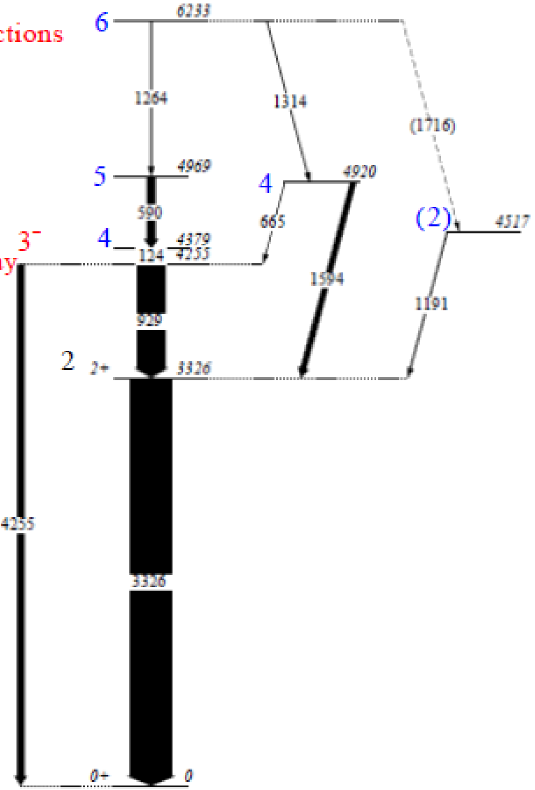
Conversion electron measurements should have made

Abstract. The energy of the lowest deformed 2-particle 2-hole (2p2h) 0^+ state in even-even N = 20 nuclei is a key observable directly related to the size of the neutron N = 20 shell closure. ^{34}Si, with 14 protons and 20 neutrons, lies at the boundary of the "island of inversion", where the deformed 2p2h 0^+ state is the ground state in even-A nuclei. In ^{34}Si, the 2p2h 0^+ state is expected to be particularly low lying - in some theories it is even predicted to lie below the first 2^+ state. While there have been a number of attempts, using various techniques, no experiment to date has been able to firmly locate the ^{34}Si 2p2h 0^+ state although a number of candidates have been suggested. Here we present, for the first time, data obtained from a fusion-evaporation reaction ^{18}O(^{18}O, 2p) to produce ^{34}Si. Gammasphere and Microball were used to detect γ-γ coincidences and charged particles (two protons), respectively. The increased sensitivity of this experiment using γ-γ coincidences and a high charged-particle detection efficiency helped to exclude previously reported candidates and provided a stringent limit on the anticipated γ decay from the first 2^+ state to the 2p2h 0^+ state.

Fusion-evaporation reactions produce mainly

Yrast states

determined by beta decay



Level structure of the double-shell closure system with Z = 14 and N = 20: ^{34}Si

Chang-Bum Moon[1]* and Cenxi Yuan[2]†
[1] *Faculty of Science, Hoseo University, Asan, Chung-Nam 31499, Republic of Korea*
[2] *Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-Sen University, Zhuhai 519-082, China*
(Dated: January 2, 2019)

Level structure of the double-magic nucleus ^{34}Si (Z = 14, N = 20) has been investigated by evaluating the available data. On the basis of experimental results from the beta-decay and fusion-evaporation reactions, we have established the level scheme as assigning spin-parities up to 6_1^+ at 6233 keV. The energy ratio of the first 4^+ state to the first 2^+ state, $E(4^+/2^+)$ turns out to be 1.48, which is consistent with values of the double-magic nuclei such as ^{68}Ni (Z = 28, N = 40), 1.55. This nucleus, for a long time, has attracted much attention because of, on one side, a proton bubble structure at the ground state and, on the other side, a deformation at the second 0^+ state, 0_2^+. By a comparison of the constructed level scheme with the shell model calculations, we describe the emerging structures in the ground 0^+, second 0^+, and negative-parity 3^- states within the framework of shell model context. We propose a deformed rotational band with the cascading $6_2^+ - 4_1^+ - 2_1^+$ transitions built on the 0_2^+ state.

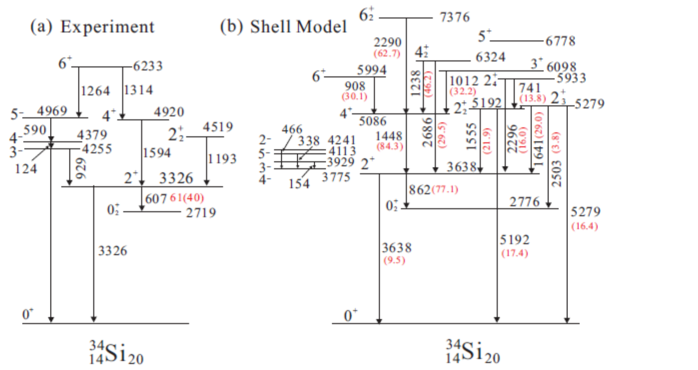


FIG. 3: (Color online) (a) Level scheme of ^{34}Si proposed by the present work. (b) The predicted level scheme of ^{34}Si by the large-scale shell-model calculations over the space of $d_{5/2}$, $s_{1/2}$, $d_{3/2}$, $f_{7/2}$, and $p_{3/2}$ for both protons and neutrons. Numbers in parentheses are the expected electric quadrupole transition strengths, $B(E2; J+2 \rightarrow J)$, in e^2fm^4. The experimental value in (a) is from [4].

Physics Letters B 772 (2017) 529–533

Contents lists available at ScienceDirect

Physics Letters B

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Northern boundary of the "island of inversion" and triaxiality in ^{34}Si

R. Han[a], X.Q. Li[a,1], W.G. Jiang[a], Z.H. Li[a,*], H. Hua[a,*], S.Q. Zhang[a], C.X. Yuan[b], D.X. Jiang[a], Y.L. Ye[a], J. Li[a], Z.H. Li[a], F.R. Xu[a], Q.B. Chen[a], J. Meng[a], J.S. Wang[c], C. Xu[a], Y.L. Sun[a], C.G. Wang[a], H.Y. Wu[a], C.Y. Niu[a], C.G. Li[a], C. He[a], W. Jiang[a], P.J. Li[a], H.L. Zang[a], J. Feng[a], S.D. Chen[a], Q. Liu[a], X.C. Chen[a], H.S. Xu[c], Z.G. Hu[c], Y.Y. Yang[c], P. Ma[c], J.B. Ma[c], S.L. Jin[c], Z. Bai[c], M.R. Huang[c], Y.J. Zhou[c], W.H. Ma[c], Y. Li[c], X.H. Zhou[c], Y.H. Zhang[c], G.Q. Xiao[c], W.L. Zhan[c]

Normal and intruder configurations in ^{34}Si populated in the β^- decay of ^{34}Mg and ^{34}Al

R. Lică,[1,2] F. Rotaru,[1] M. J. G. Borge,[2,3] S. Grévy,[4,5] F. Negoiţă,[1] A. Poves,[6,7] O. Sorlin,[4] A. N. Andreyev,[8] R. Borcea,[1] C. Costache,[1] H. De Witte,[9] L. M. Fraile,[10] P. T. Greenlees,[11,12] M. Huyse,[9] A. Ionescu,[1,13] S. Kisyov,[14,1] J. Konki,[11,12,2] Lazarus,[15] M. Madurga,[2] N. Mărginean,[1] R. Mărginean,[1] C. Mihai,[1] R. E. Mihai,[1] A. Negret,[1] F. Nowacki,[16,17] R. D. Page,[18] Pakarinen,[11,12] V. Pucknell,[15] P. Rahkila,[11,12] E. Rapisarda,[2,19] A. Şerban,[1] C. O. Sotty,[1] L. Stan,[1] M. Stănoiu,[1] O. Tengblad,[3] . Turturică,[1] P. Van Duppen,[9] N. Warr,[20] Ph. Dessagne,[21] T. Stora,[22] C. Borcea,[1] S. Călinescu,[1] J. M. Daugas,[23] D. Filipescu,[1] I. Kuti,[24] S. Franchoo,[25] I. Gheorghe,[1] P. Morfouace,[25,23] P. Morel,[23] J. Mrazek,[26] D. Pietreanu,[1] D. Sohler,[27] I. Stefan,[25] R. Şuvăilă,[1] S. Toma,[1] and C. A. Ur[1,28]
(IDS Collaboration)

(Received 26 February 2019; revised manuscript received 29 March 2019; published 11 September 2019)

F. Triaxiality in ^{34}Si?

A recent study [20] claimed evidence of triaxiality in ^{34}Si based on the decay pattern of the 2_2^+ state at 4519 keV to the 0_2^+ level by a 1800-keV γ-ray transition, in addition to its already known decays to the 0_1^+ and 2_1^+ states. Unfortunately,

The present paper concludes that (1) the present experimental and theoretical results do not support the presence of triaxially deformed structures in ^{34}Si, being consistent with two estimates, based on different theory approaches, which point to a pronounced γ softness, in line with the potential energy surface (PES) calculations discussed in Ref. [20]; (2) more precise Coulomb excitation measurements are required in order to lower the uncertainty for the known $B(E2)$ values and to determine the ones corresponding to the newly identified 2^+ states in ^{34}Si.

보낸사람	Physics Letters B <em@editorialmanager.com> 주소록추가 | 수신거부 | 불량메일신고
받는사람	ChangbumMoon<cbmoon@hoseo.edu> 주소록추가
보낸날짜	2020-08-04 23:33:43

CC: geesaman@anl.gov

Ms. No.: PLB-D-19-00005
Level structure of the double-shell closure system with Z = 14 and N = 20: 34Si

Dear Professor Changbum Moon,

I am writing to you in regard to your above-referenced manuscript which we invited you to revise and resubmit for continued publication consideration at Physics Letters B.

I regret to have to inform you that the deadline set for the revision of your manuscript has long passed and we have not received any update on the status of your manuscript.

At this point, there are three options:

1) If you wish to submit a revised version of your manuscript, please do so within two weeks. After the two weeks have passed if we have not received the revised manuscript, your manuscript will be withdrawn and its record in the online system will be closed.

2) If you do NOT plan to submit the revised paper, please tell us by logging into the system as an author, click on your 'Submissions Needing Revision' folder and then click on 'Decline to revise' under the available action items. This action will remove your manuscript's record from our system.

3) If you want to submit a revised version of the paper after the deadline above has passed, then it would have to be sent as a new manuscript. Your manuscript will then be given a new reference number and a new received date.

To do any of these actions, please log in as an author at https://www.editorialmanager.com/plb/.

Your username is: cbmoon@hoseo.edu.

We hope you will revise and resubmit your paper soon and we appreciate you helping us update our records.

Yours sincerely,

Viviana Letizia
Managing Editor
Physics Letters B

For confirming our suggestion, the second 6^+ state will be identified by an experiment. *Interestingly, we find a γ-ray peak near 1940 keV on Figure 2 in [5] where the coincidence γ-ray spectra gated on the 3326-keV and 929-keV transitions are displayed. We suggest that this peak might be the γ-ray transition of 6_2^+ state, leading to the 6860-keV level, to the 4^+ state at 4920 keV.* It is also worthwhile to know a close resemblance between the collective bands, the 6_2^+ - 4_1^+ - 2_1^+ - 0_2^+ sequence in ^{34}Si and the 6_2^+- 4_1^+ - 2_2^+ - 0_2^+ sequence in ^{38}Ar.

Finally, let us notice a recent paper published during the revision. This paper supports our result and is certainly consistent with our discussion. We include this paper as a note added in proof, which is put in a reference number, 17. Here we would not like to any response to the insistence, such as a tri-axial shape, raised by the authors in Ref. 9. Instead, we are very glad to see conclusions made by the authors in Ref. 17.

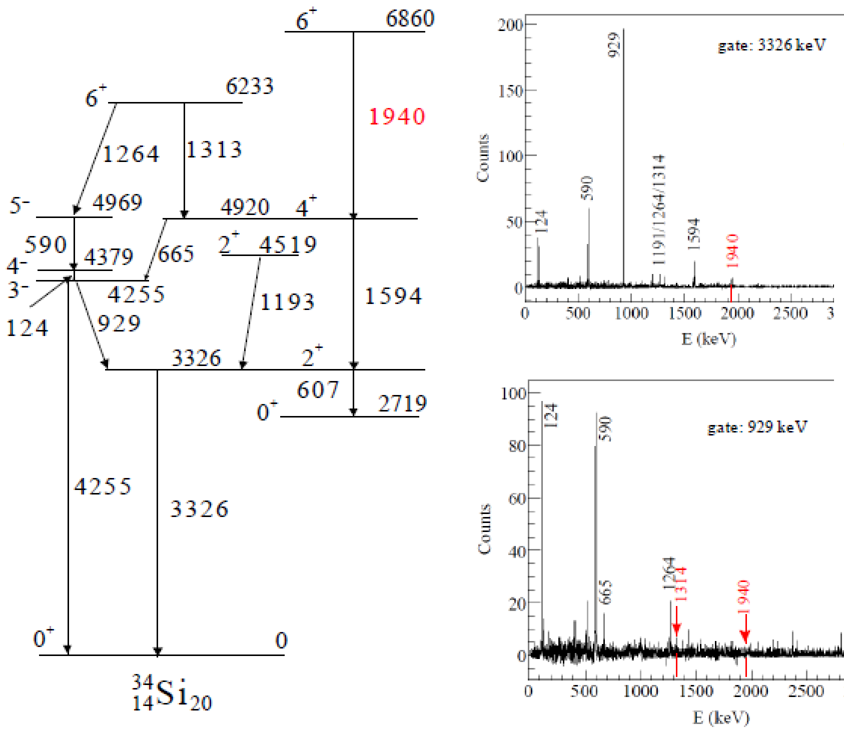

Figure 2. Proposed level scheme by considering the 1940-keV transition in ref. 5.

Manuscript for Physics Letters B: D-19-00005.

Level structure of the double-shell closure system with Z = 14 and N = 20: ^{34}Si

Chang-Bum Moon[1, 2,*1], Cenxi Yuan[3,*2]

[1]*Faculty of Science, Hoseo University, Chung-Nam 31499, Republic of Korea*
[2]*Center for Exotic Nuclear Studies, The Institute for Basic Science, Daejeon 34126, Republic of Korea*
[3]*Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-Sen University, Zhuhai 519-082, China*

(Submit; 2 January 2019, Resubmit; 12 August 2020)

Level structure of the double-magic nucleus ^{34}Si (Z = 14, N = 20) has been investigated by evaluating the available data. On the basis of experimental results from the beta-decay and fusion-evaporation reactions, we have established the level scheme as assigning spin-parities up to 6_1^+ at 6233 keV. The energy ratio of the first 4^+ state to the first 2^+ state, $E(4^+/2^+)$ turns out to be 1.48, which is consistent with values of the double-magic nuclei such as ^{68}Ni (Z = 28, N = 40), 1.55. This nucleus, for a long time, has attracted much attention because of, on one side, a proton bubble structure at the ground state and, on the other side, a deformation at the second 0^+ state, 0_2^+. By a comparison of the constructed level scheme with the shell model calculations, we describe the emerging structures in the ground 0^+, second 0^+, and negative-parity 3^- states within the frame work of shell model context. We propose a deformed rotational band with the cascading $6_2^+ - 4_1^+ - 2_1^+$ transitions built on the 0_2^+ state.