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XIV. International Conference On Nuclear Structure Properties

We are pleased to announce the XIV. International Conference on Nuclear Structure Properties, NSP2021 to be held as online meeting on 2-4 June 2021 in Selcuk University, Konya, TURKEY.

2- 4 June 2021

Conference web page: http://nsp2021.selcuk.edu.tr

XIV INTERNATIONAL CONFERENCE ON NUCLEAR STRUCTURE PROPERTIES
2 – 4 JUNE 2021
SELCUK UNIVERSITY, KONYA ,TURKEY

Role of nuclear tensor force within Skyrme mean-field approach on deformed magic numbers in rare earth region

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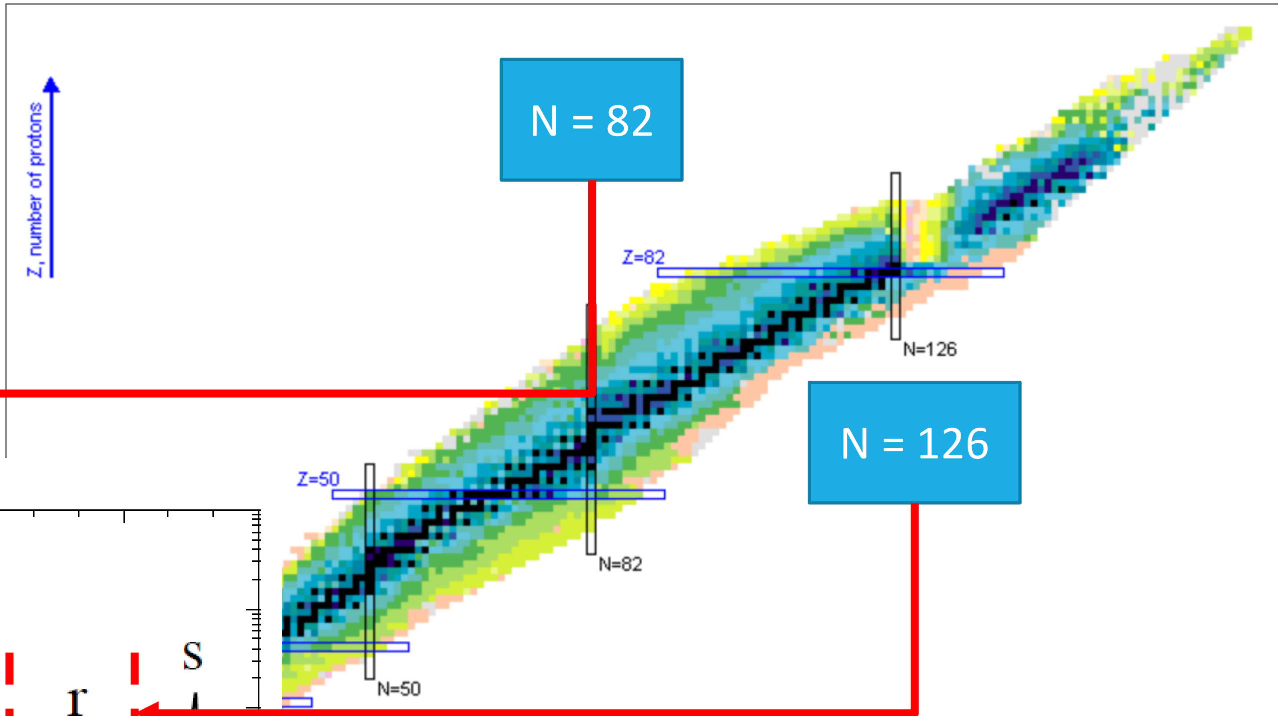
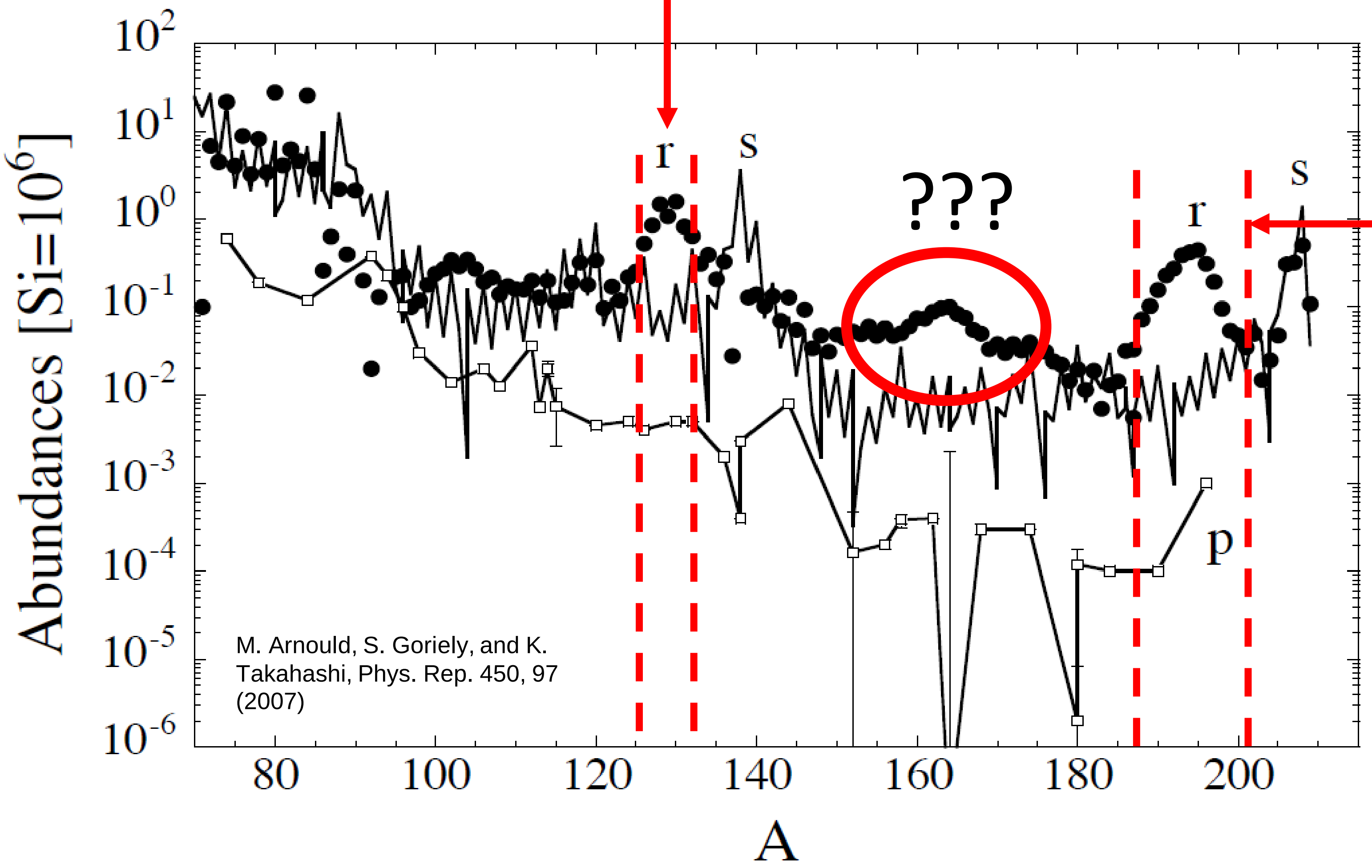
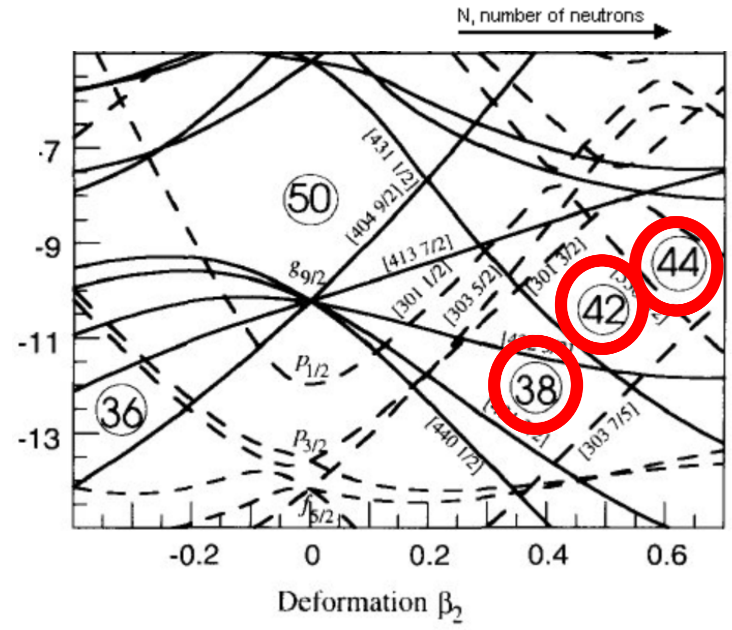
Solar abundancy around mass number 165

Abundancy of elements due to neutron shell closures







Studies on deformed magic numbers

BRIEF ACCOUNT OF EXPERİMENTAL WORK

Progress on the experimental side

PHYSICAL REVIEW C VOLUME 59, NUMBER 6 JUNE 1999

β-decay half-lives of new neutron-rich isotopes ^{167,168}Tb and levels in ^{167,168}Dy

M. Asai,[1,*] S. Ichikawa,[1] K. Tsukada,[1] M. Sakama,[2] M. Shibata,[3] Y. Kojima,[3] A. Osa,[4] I. Nishinaka,[1] Y. Nagame,[1]
K. Kawade,[3] and T. Tachibana[5]
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[2]*Department ... 2-0364, Japan*
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[4]*Department of Materi... Gunma 370-1292, Japan*
[5]*Advanced Research Ins... Tokyo 169-8555, Japan*
(Received 19 January 1999)

N = 98 around ^{164}Dy

PRL **113,** 262502 (2014) PHYSICAL REVIEW LETTERS week ending 31 DECEMBER 2014

Isomer Decay Spectroscopy of ^{164}Sm and ^{166}Gd: Midshell Collectivity Around $N = 100$

Z. Patel,[1,2] P.-A. Söderström,[2] Zs. Podolyák,[1] P. H. Regan,[1,3] P. M. Walker,[1] H. Watanabe,[2,4,5] E. Ideguchi,[6,7] G. S. Simpson,[8]
H. L. Liu,[9] S. N... L. Sinclair,[2,12]
T. Sumikama,[1... ...o,[7] Y. Fang,[7]
N. Fukuda,[2] C... ...Kobayashi,[17]
T. Komatsub... ...chimasa,[17]
C.-B. Moon,[25] H. Nishibata,[7] I. Nishizuka,[13] A. Odahara,[7] E. Şahin,[15] H. Sakurai,[2,14] H. Schaffner,[22] H. Suzuki,[2]
H. Takeda,[2] M. Tanaka,[7] J. Taprogge,[26,27] Zs. Vajta,[23] A. Yagi,[7] and R. Yokoyama[28]

N = 100 shell gap for $Z \leq 66$

PRL **118,** 072701 (2017) PHYSICAL REVIEW LETTERS week ending 17 FEBRUARY 2017

94 β-Decay Half-Lives of Neutron-Rich $_{55}$Cs to $_{67}$Ho: Experimental Feedback and Evaluation of the r-Process Rare-Earth Peak Formation

No *N* = 100 deformed subshell gap

A. Gottardo, C. J. Griffin, H. Kanaoka, T. Kojouharov, F. G. Kondev, S. Kubono, N. Kurz, I. Kuti,
S. Lalkovski,[4] G. J. Lane,[30] E. J. Lee,[24] T. Lokotko,[11] G. Lotay,[4] C.-B. Moon,[31] H. Nishibata,[14] I. Nishizuka,[32]
C. R. Nita,[13,33] A. Odahara,[14] Zs. Podolyák,[4] O. J. Roberts,[34] H. Schaffner,[28] C. Shand,[4] J. Taprogge,[35,36]

PHYSICAL REVIEW LETTERS **120,** 182502 (2018)

Masses and β-Decay Spectroscopy of Neutron-Rich Odd-Odd ^{160,162}Eu Nuclei: Evidence for a Subshell Gap with Large Deformation at $N = 98$

D. J. Hartley,[1] F. G. Kondev,[2] R. Orford,[2,3] J. A. Clark,[2,4] G. Savard,[2,5] A. D. Ayangeakaa,[2,*]
S. Bottoni,[2,†] F. Buchinger,[3] M. T. Burkey,[2,5] M. P. Carpenter,[2] P. Copp,[2,6] D. A. Gorelov,[2,4]
K. Hicks,[1] C. R. Hoffman,[2] C. Hu,[7] R. V. F. Janssens,[2,‡] J. W. Klimes,[2] T. Lauritsen,[2] J. Sethi,[2,8]
...
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Existence of a deformed subshell gap at N = 98

Eur. Phys. J. A (2019) **55**: 19
DOI 10.1140/epja/i2019-12677-6
THE EUROPEAN PHYSICAL JOURNAL A

Review

Nuclear decay studies of rare isotopes

Overview of decay spectroscopy at RIBF

Hiroshi Watanabe[1]
[1] IRCNPC, School ...
[2] RIKEN Nishina C...

Emergence of a deformed sub-shell gap at N = 108 for heavier rare earth

Skyrme force with and without tensor

Skyrme Hamiltonian density

Many-body Hamiltonian → $\hat{H} = \hat{K} + \hat{V}$

Effective nucleon-nucleon interaction

Approximated by the Skyrme force

$$V(\mathbf{r}_1,\mathbf{r}_2) = V_c(\mathbf{r}_1,\mathbf{r}_2) + V_{DD}(\mathbf{r}_1,\mathbf{r}_2) + V_{s.o}(\mathbf{r}_1,\mathbf{r}_2)$$

Central potential | **Density dependent potential** | **Spin-orbit potential**

$+ V_{\text{tensor}}$

$$\begin{aligned}\mathcal{H} =& B_1\,\rho^2 + B_3\,(\rho\tau - \mathbf{j}^2) + B_5\,\rho\Delta\rho + B_7\,\rho^{2+\alpha} \\ &+ B_9\,(\rho\nabla\cdot\mathbf{J} + \mathbf{j}\cdot\nabla\times\mathbf{s}) + B_{10}\,\mathbf{s}^2 + B_{12}\,\rho^\alpha\mathbf{s}^2 \\ &+ B_{14}\Big(\sum_{\mu,\nu=x}^{z}\mathbf{J}_{\mu\nu}\mathbf{J}_{\mu\nu} - \mathbf{s}\cdot\mathbf{T}\Big) \\ &+ B_{16}\Big[\Big(\sum_{\mu=x}^{z}\mathbf{J}_{\mu\mu}\Big)^2 + \Big(\sum_{\mu,\nu=x}^{z}\mathbf{J}_{\mu\nu}\mathbf{J}_{\nu\mu} - 2\,\mathbf{s}\cdot\mathbf{F}\Big)\Big] \\ &+ B_{18}\,\mathbf{s}\cdot\Delta\mathbf{s} + B_{20}\,(\nabla\cdot\mathbf{s})^2\end{aligned}$$

$$\begin{aligned}\mathcal{H}_q =& B_2\,\rho_q^2 + B_4\,(\rho_q\tau_q - \mathbf{j}_q^2) + B_6\,\rho_q\Delta\rho_q + B_8\,\rho_0^\alpha\rho_q^2 \\ &+ B_{9_q}(\rho_q\nabla\cdot\mathbf{J}_q + \mathbf{j}_q\cdot\nabla\times\mathbf{s}_q) + B_{11}\,\mathbf{s}_q^2 + B_{13}\,\rho^\alpha\mathbf{s}_q^2 \\ &+ B_{15}\Big(\sum_{\mu,\nu=x}^{z}\mathbf{J}_{q,\mu\nu}\mathbf{J}_{q,\mu\nu} - \mathbf{s}_q\cdot\mathbf{T}_q\Big) \\ &+ B_{17}\Big[\Big(\sum_{\mu=x}^{z}\mathbf{J}_{q,\mu\mu}\Big)^2 + \Big(\sum_{\mu,\nu=x}^{z}\mathbf{J}_{q,\mu\nu}\mathbf{J}_{q,\nu\mu} - 2\,\mathbf{s}_q\cdot\mathbf{F}_q\Big)\Big] \\ &+ B_{19}\,\mathbf{s}_q\cdot\Delta\mathbf{s}_q + B_{21}\,(\nabla\cdot\mathbf{s}_q)^2\end{aligned}$$

Skyrme Hamiltonian density

$$\mathcal{H} = B_1\,\rho^2 + B_3\,(\rho\tau - \mathbf{j}^2) + B_5\,\rho\Delta\rho + B_7\,\rho^{2+\alpha}$$
$$+ B_9\,(\rho\nabla\cdot\mathbf{J} + \mathbf{j}\cdot\nabla\times\mathbf{s}) + B_{10}\,\mathbf{s}^2 + B_{12}\,\rho^\alpha\mathbf{s}^2$$
$$+ B_{14}\Big(\sum_{\mu,\nu=x}^{z}\mathbf{J}_{\mu\nu}\mathbf{J}_{\mu\nu} - \mathbf{s}\cdot\mathbf{T}\Big)$$
$$+ B_{16}\Big[\Big(\sum_{\mu=x}^{z}\mathbf{J}_{\mu\mu}\Big)^2 + \Big(\sum_{\mu,\nu=x}^{z}\mathbf{J}_{\mu\nu}\mathbf{J}_{\nu\mu} - 2\,\mathbf{s}\cdot\mathbf{F}\Big)\Big]$$
$$+ B_{18}\,\mathbf{s}\cdot\Delta\mathbf{s} + B_{20}\,(\nabla\cdot\mathbf{s})^2$$

$$B_{14} = -\frac{t_1x_1 + t_2x_2}{8} + \frac{1}{4}(t_e + t_o)$$

Central components

Tensor components

$$B_{16} = -\frac{3}{8}(t_e + t_o)$$

Tensor only

Skyrme forces with tensor

Perturbative fit

Original Skyrme parameters
+
Fit of two tensor parameters

SIII + T

Volume 68B, number 2 — PHYSICS LETTERS — 23 May 19..

THE TENSOR PART OF SKYRME'S INTERACTION

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and

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PHYSICAL REVIEW C **97**, 064304 (2018)

Skyrme density functional description of the double magic ^{78}Ni nucleus

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[2] *University of Liège, Institute of Physics, B.5, Sart Tilman, B-4000 Liège 1, Belgium*

(Received 29 March 2018; published 6 June 2018)

We calculate the single-particle spectrum of the double magic nucleus ^{78}Ni in a Hartree-Fock approach using the Skyrme density-dependent effective interaction containing central, spin-orbit, and tensor parts. We show that the tensor part has an important effect on the spin-orbit splitting of the proton $1f$ orbit that may explain the survival of magicity so far from the stability valley. We confirm the inversion of the $1f5/2$ and $2p3/2$ levels at the neutron number 48 in the Ni isotopic chain expected from previous Monte Carlo shell-model calculations and supported by experimental observation.

SLy5 + T

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ScienceDirect
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PHYSICS LETTERS B
Physics Letters B 646 (2007) 227–231
www.elsevier.com/locate/physletb

Spin–orbit splitting and the tensor component of the Skyrme interaction

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Available online 3 February 2007
Editor: J.-P. Blaizot

Skyrme forces with tensor

Full refit

Refit of all original 10 parameters
+
2 tensor parameters

PHYSICAL REVIEW C **76**, 014312 (2007)

Tensor part of the Skyrme energy density functional: Spherical nuclei

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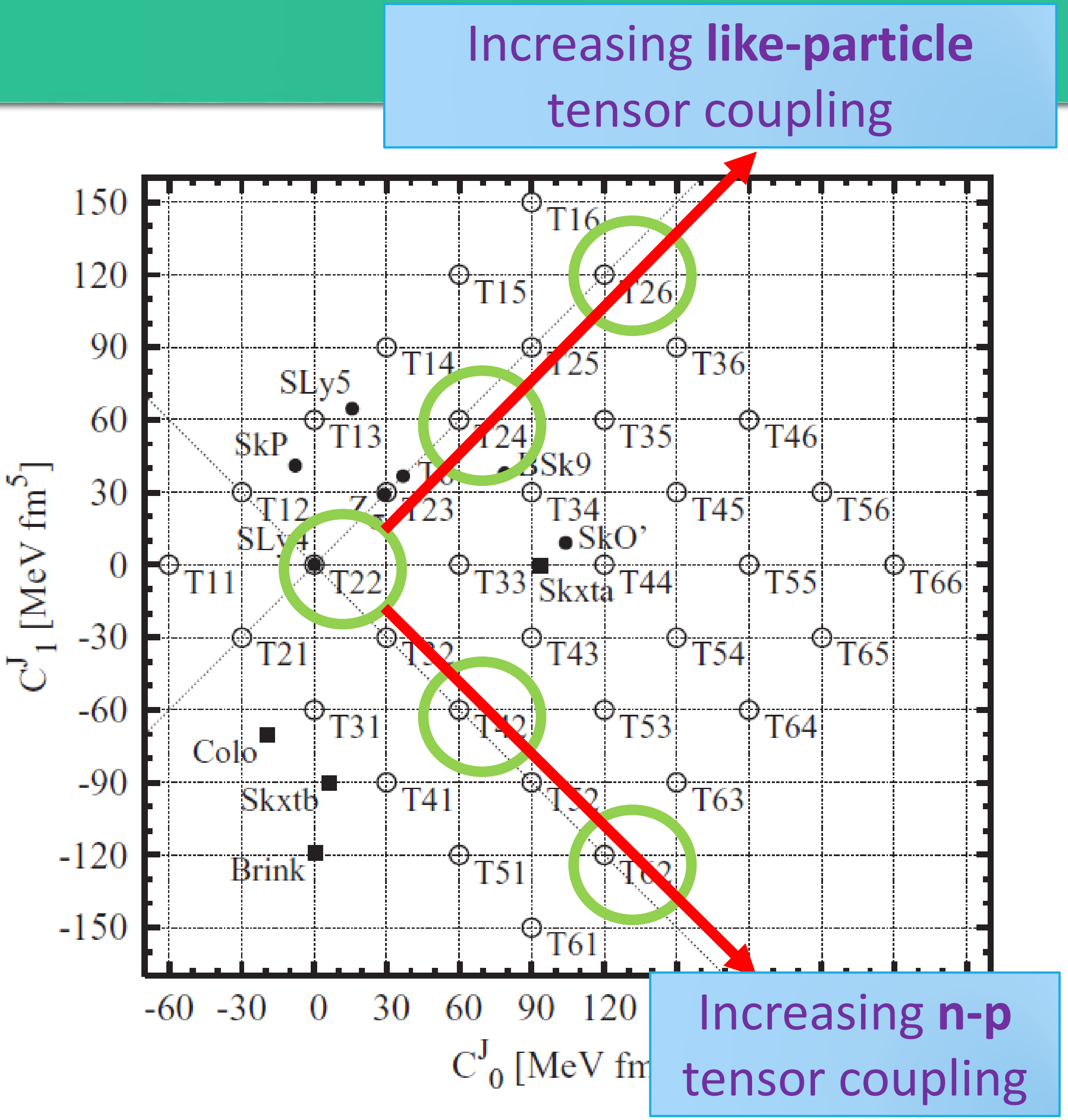
TIJ

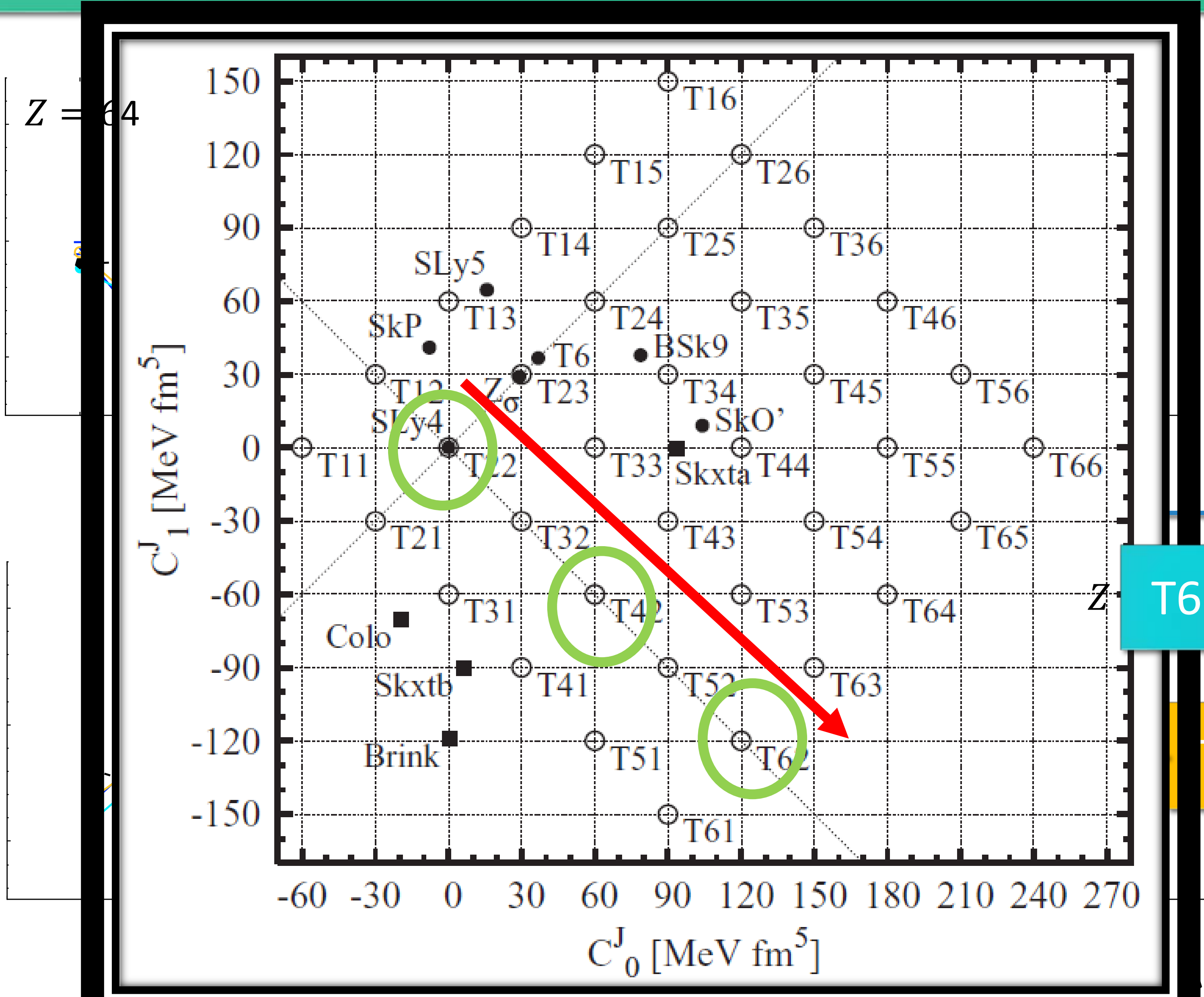


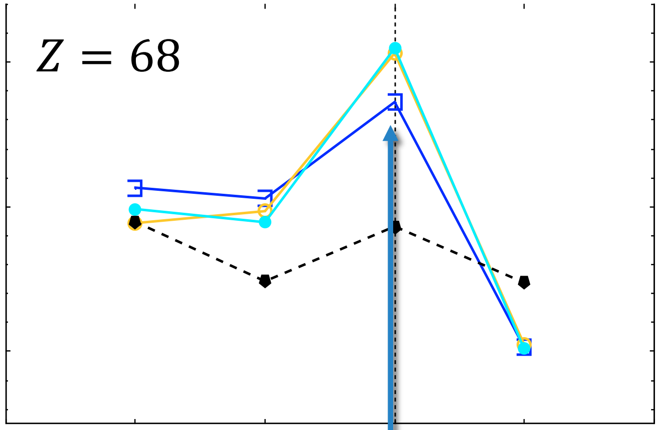
Two-neutron separation energy differential

RESULTS

Experimental two-neutron separation energy differential

Two-neutron separation energy differential - Increasing np tensor coupling





T62

T42

What we learnt?

- T22 reproduce some experimental peaks
- Strong np tensor reinforce the peaks obtained by T22 at N = 104 in heavier RE

Two-neutron separation energy differential - Increasing nn and pp tensor coupling

Extracting the tensor contribution

RESULTS

Contribution of tensor and non-tensor EDF terms to S2n differential T26 vs T22 vs T62 (Experimental peak at N = 104)

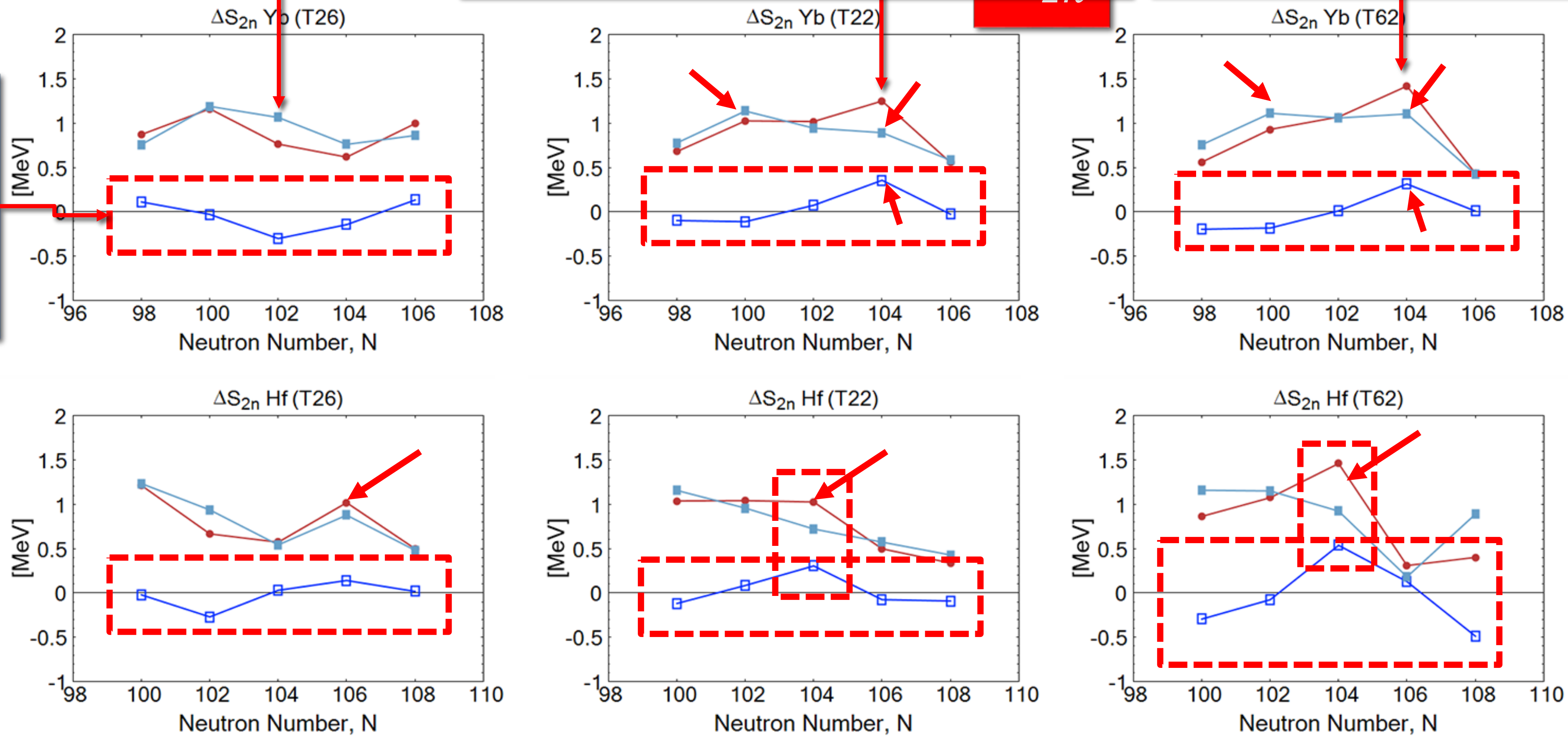
Central contr.

Tensor contr.

$E^T_{B_{14}} + E^T_{B_{15}}$
$+ E_{B_{16}}$
$+ E_{B_{17}}$

Reflects the need for nuclear tensor.
Note: Combinations of T22 tensor terms in the EDF cancels one another.

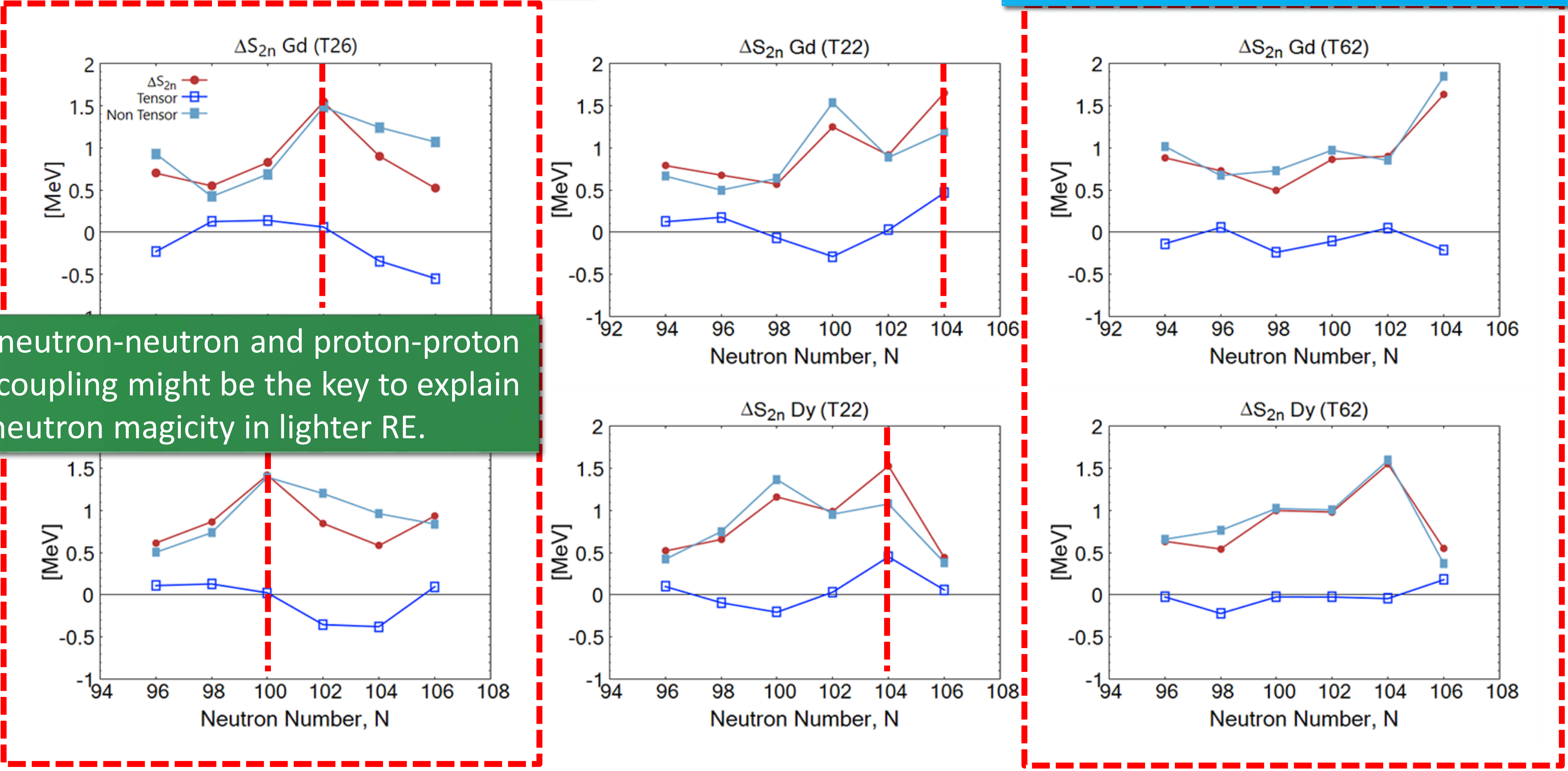
Neutron-proton tensor coupling enhance the peak at N = 104.



Contribution of tensor and non-tensor EDF terms to S2n differential T26 vs T22 vs T62 (Lighter RE at N = 98 and N = 102)

Peak at N = 104 is removed. Only a peak at N = 100.

No peak appearing at N = 98 and N = 102 with strong n-p tensor coupling.



Strong neutron-neutron and proton-proton tensor coupling might be the key to explain neutron magicity in lighter RE.

Summary

ROLE OF NUCLEAR TENSOR ON DEFORMED NUMBERS İN RARE EARTH NUCLEİ

Key message to take home…

1. Neutron magicity in heavy rare earth nuclei ($Z > 66$) – Strong neutron-proton tensor coupling is needed

2. Light rare earth nuclei ($Z \leq 66$)
   a) Magicity at $N = 98$ and $N = 102$ is not reproduced, but …
   b) Increasing like-particle (nn and pp) tensor coupling might be the key ingredient

3. More experimental data are needed for example in
   a. lighter ($Z \leq 62$) and heavier ($Z \geq 72$)
   b. the whole RE region in general – to verify sometimes conflicting data (BE, half-life, excitation energy levels)

Questions or comments?