AM - Between Copenhagen, PARIS & Cracow: Towards Statistical Model of the New Generation

JD

IPHC - Department of Subatomic Research, CNRS/IN_2P_3
and
University of Strasbourg, F-67037 Strasbourg, FRANCE

Monday 14th September, 2015

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$$\Delta\tau = [(2015 - 1955) \pm 0.6]\,\mathrm{y\ ago}$$

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which to a leading order are distributed as follows:

  – *Giant Dipole Resonances:* (56 ± 2) counts in the peak;
  – *Jacobi, Poincaré and other shape transitions:* (35 ± 2);
  – *Isomers and isomerism:* (30 ± 1);
  – *Super-deformation and/or hyper-deformation:* (20 ± 1)

At this point I would like to use the opportunity and most cordially wish all the best to the birth-day girl !

Sto lat Angela !! ***Sto lat [in Polish]: Hundred years***

As a good friend and collaborator
of the birthday-boy, my Good Friend and Collaborator...

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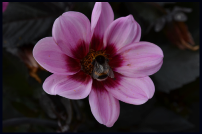
*) **O Nieba!**

Chrońcie mnie przez przyjaciółmi !!
Przed wrogami obronię się sam !!!



Here We Arrive at the Symbol of an Efficient, Hard Work

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- Therefore we will just i m p r o v i s e during the rest of this story...

Before becoming a professor,
our birthday boy,
as often happens,
had to obtain a University diploma,
and even before, oh heck! – he had to go to school !

Well - well, let us see more in detail...

All of us of *that generation*,
who happened to live in Poland,
spent over 50% of their life-time,
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**Many who have never seen Pe-Er-El
may not know about this environment.
We will recall some of its characteristics
using a few (over-)simplified illustrations.**

Part I

The Very Beginning: Times, Facts, Snap-shots from the History...

Polska Rzeczpospolita Ludowa (PRL)

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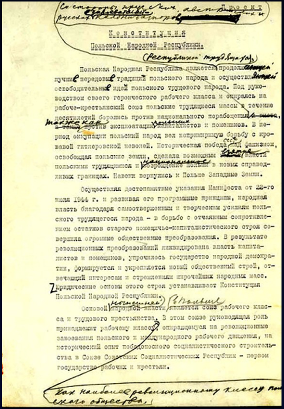

Проект

К о н с т и т у ц и я

Польской Народной Республики.

(Республики трудящихся)

Польская Народная Республика является продолжением лучших передовых традиций польского народа и осуществлением освободительных идей польского трудового народа. Под руководством своего героического рабочего класса и опираясь на рабоче-крестьянский союз польские трудящиеся массы в течение десятилетий боролись против национального порабощения, а также против эксплоатации капиталистов и помещиков. В период оккупации польский народ вел непримиримую борьбу с кровавой гитлеровской неволей. Историческая победа над фашизмом, освобождая польские земли, сделала возможным захват власти польскими трудящимися и возрождение Польши в новых справедливых границах. Навеки вернулись к Польше Западные Земли.

Осуществляя достопамятные указания Манифеста от 22-го июля 1944 г. и развивая его программные принципы, народная власть благодаря самоотверженным и творческим усилиям польского трудящегося народа – в борьбе с отчаянным сопротивлением остатков старого помещичье-капиталистического строя совершила огромные общественные преобразования. В результате революционных преобразований ликвидирована власть капиталистов и помещиков, упрочилось государство народной демократии, формируется и укрепляется новый общественный строй, отвечающий интересам и стремлениям широчайших народных масс. Юридические основы этого строя устанавливает Конституция Польской Народной Республики.

Основой народной власти является союз рабочего класса и трудового крестьянства. В этом союзе руководящая роль принадлежит рабочему классу, опирающемуся на революционные завоевания польского и международного рабочего движения, на исторический опыт победоносного социалистического строительства в Союзе Советских Социалистических Республик – первом государстве рабочих и крестьян.

On the left:

The first page of the text
of the constitution of the Pe-Er-El,
typed in Russian,
with the hand-written corrections
by J. Stalin

From WIKIPEDIA:

During the so-called socialist times in Poland, people used humour to cope with all the crazy party lies and the empty shelves in shops.

This gave rise to a huge collection of jokes about the economic crisis, the party, the Soviets and the system. Of course people had to be careful who they shared the jokes with. There was a big official competition for the best anti-Soviet joke: The prize was 5 years in Siberia.

Relax Now: Some Jokes of Those Times (2)

- Communism vs. Capitalism

Example 1

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- Capitalism is a system in which man exploits man.
- In communism exactly the opposite happens.

Relax Now: Some Jokes of Those Times (3)

- Freedom vs. Prison

Example 1: The 5 commandments for a Polish citizen

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\- *The first prisoner: "I complained about socialism* $\rightarrow$ *5 years".*
\- *The second prisoner: "I said bad things about Stalin* $\rightarrow$ *7 years".*

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- The second prisoner: "I said bad things about Stalin → 7 years".
- The third prisoner: "I didn't do anything and they sentenced me to 5 years!"

"Don't bs us. For nothing you get two years!!"

Time to Go to School

or, in other words,

The Hard Work at School

We Look for Adam

- Where is the birthday boy? Who will tell us?

Very good ... Very good ...

Let us see ...

And Now: Where Is Adam on the Two Photos?

- Please give the position: Left - 1, 2, or 3 ? Right: 1, 2, 3 or 4 ?

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LEFT. 1: Adam, 2: Witek, 3: Marek

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LEFT. 1: Adam, 2: Witek, 3: Marek

RIGHT. 1: Paul (McCartney), 2: Ringo (Starr),
3: George (Harrison), 4: John (Lennon)

As one can see

Adam was doing very well at school.

No wonder that $\rightarrow\rightarrow\rightarrow$

He Received the Professor Nomination

- from the Polish President, Lech Kaczyński, in 2006.

But before the Professor Nomination...

... he had to publish some papers (better: articles)...

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You mean to say that you know?

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... **he had to publish some papers (better: articles)...**

You mean to say that you know?

... all of them?

Do not worry!

You will be kindly invited to listen anyway!!

Part II

Nuclear Isomers: Strong Signals from Nucleonic Configurations

The First Publications: Nuclear Isomers

Z. Phys. A – Atoms and Nuclei 314, 89–95 (1983)

Zeitschrift für Physik A Atoms and Nuclei

Isomeric Transitions in ^{203}Bi and ^{205}Bi

H. Hübel, M. Guttormsen*, K.P. Blume, J. Recht, A. von Grumbkow, K. Hardt, P. Schüler, and Y.K. Agarwal**

Institut für Strahlen- und Kernphysik, Universität Bonn, Federal Republic of Germany

A. Maj***

Hahn-Meitner-Institut für Kernforschung, Berlin, Germany

The First Publications: from Berlin

The First Publications: Nuclear Isomers

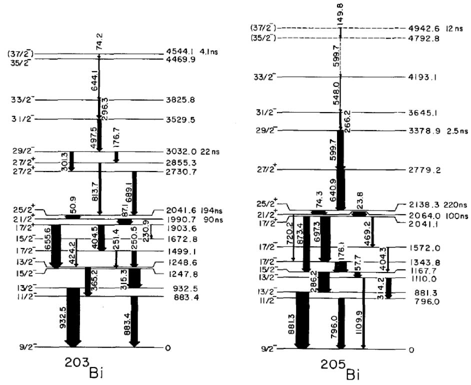
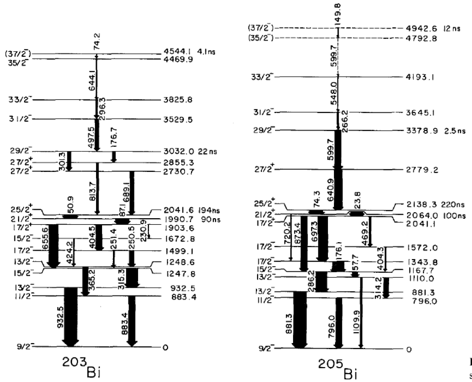


Fig. 6. Decay schemes of isomeric states in ^{203}Bi and ^{205}Bi

- Notice isomers here-and-there, of course, but also another beauty:

The First Publications: Nuclear Isomers



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- Nearly 'hidden' $\Delta I = 1\,\hbar$ doublets

The First Publications: Nuclear Isomers

Nuclear Physics **A436** (1985) 311–337

DECAY OF THE GROUND STATE AND THE $\frac{29}{2}^+$ ISOMER IN ^{217}Ac AND g-FACTOR MEASUREMENTS FROM PERTURBED α-PARTICLE ANGULAR DISTRIBUTIONS

D. J. DECMAN[†], H. GRAWE, H. KLUGE, K. H. MAIER, A. MAJ[††] and N. ROY[*]

Hahn-Meitner-Institut für Kernforschung, Berlin GmbH, Bereich Kern- und Strahlenphysik, 1000 Berlin 39, West Germany

and

Y. K. AGARWAL[**], K. P. BLUME, M. GUTTORMSEN[***], H. HÜBEL and J. RECHT

Institut für Strahlen- und Kernphysik, Universität Bonn, D-5300 Bonn, West Germany

Received 5 September 1984

The First Publications: Nuclear Isomers

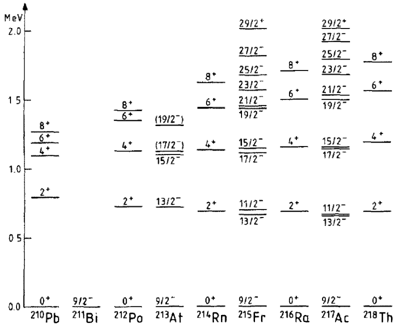

Fig. 14. Level schemes of $N = 128$ isotones as a function of Z. The data sources for each isotone are as follows: ^{210}Pb [ref. [16])], ^{212}Po [refs. [25, 26])], ^{213}At [ref. [27])], ^{214}Rn [ref. [28])], ^{215}Fr [ref. [14])], ^{216}Ra [refs. [17, 29])], ^{218}Th [refs. [30, 31])].

- This illustration summarises the systematic appearance of the doublets:

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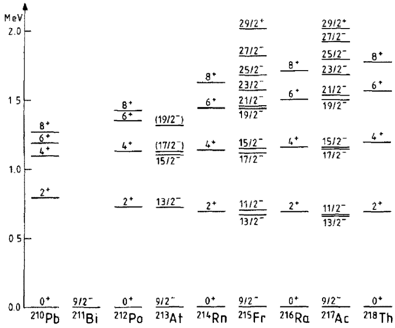

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- This illustration summarises the systematic appearance of the doublets: interpreted as the result of the coupling $I \otimes g_{9/2}$: I=0, 2, 4, …

- The preceding illustrations show in a convincing manner the validity of the "core-and-particle(s)" quantum structures, here a single neutron

Isomers and the Nuclear Mean-Field Theory

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Isomers and the Nuclear Mean-Field Theory

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• Some years earlier, Aage Bohr and Ben Mottelson suggested a generalisation: A few nucleons + core represented by the nuclear mean-field

• The approach was nick-named the *"Tilted Fermi-Surface Method"*. Following the encouragement form Aage it has been developed further within Copenhagen-Warsaw collaboration → 'Universal Woods-Saxon'

About the "Tilted Fermi Surface and Yrast Traps"

- One uses a mean-field approach and the fact that in case of an axial symmetry, say $\mathcal{O}_z$-axis we have

$$\boxed{[\hat{H}, \hat{j}_z] = 0}$$

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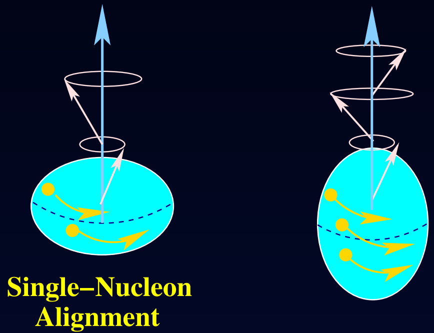
Projections of Angular Momenta Are Conserved in the Presence of Axial Symmetry



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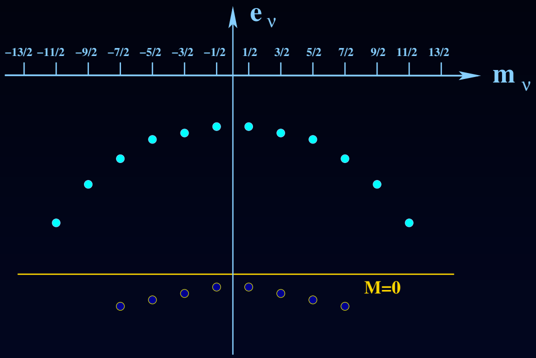
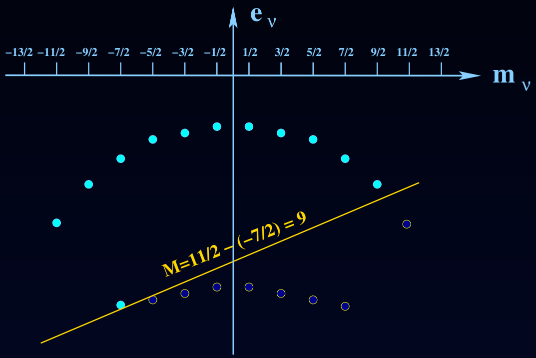


For the particle hole excited states we obtain at the same time the model energy and model spin:

$$E^* = \sum_p e_{p,m_p} - \sum_h e_{h,m_h} \quad \text{and} \quad M^* \approx Spin = \sum_p m_p - \sum_h m_h$$



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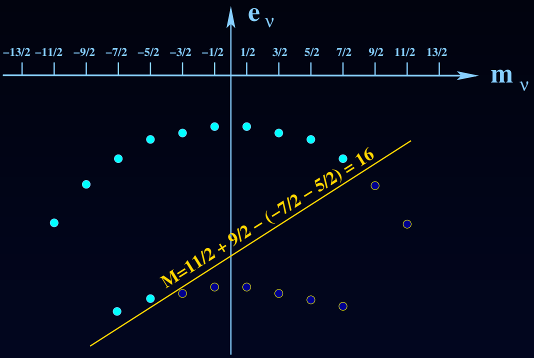

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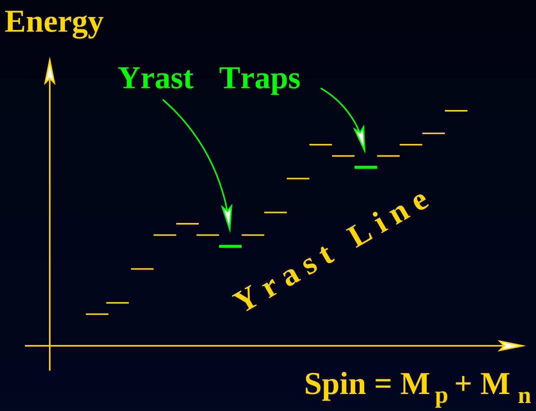


$$E^* = \sum_p e_{p,m_p} - \sum_h e_{h,m_h} \quad \text{and} \quad M^* \approx Spin = \sum_p m_p - \sum_h m_h$$

How Powerful Service the Mean-Field Offers

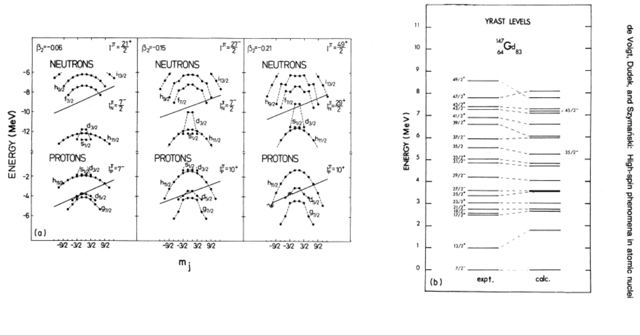


FIG. 12. (a) Tilted Fermi surfaces corresponding to the isomers observed in ^{147}Gd: 4.8 ns $I^\pi=\frac{21}{2}^+$ isomer, 27 ns $I^\pi=\frac{27}{2}^-$ isomer, and the 530 ns $I^\pi=\frac{49}{2}^+$ isomer (Dudek *et al.*, 1981). (b) Comparison between the experimental level scheme of ^{147}Gd and the calculations based on the deformed Woods-Saxon potential.

- Theoretical prediction of the isomers at $I^\pi = \frac{21}{2}^+$ [4.8 ns]; at $I^\pi = \frac{27}{2}^-$ [27 ns] and at $I^\pi = \frac{49}{2}^+$ [530 ns]

How Powerful Service... Inverted Parabolas

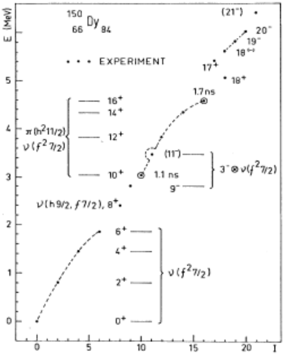


FIG. 33. Experimental high-spin excitations in ^{150}Dy (Kleinheinz, 1979). Points belonging to the same *j*-multiplet configuration are connected by dashed lines (Dudek, 1980).

- Since the single-j orbitals have inverted-parabolic energy dependence [$e_j \propto -j(j+1)$], the excitations involving such an orbital lead to inverted parabola schemes [abundant in nuclei]

PRL **99,** 132501 (2007) PHYSICAL REVIEW LETTERS week ending 28 SEPTEMBER 2007

Observation of Isomeric Decays in the *r*-Process Waiting-Point Nucleus $^{130}Cd_{82}$

A. Jungclaus,[1] L. Cáceres,[1,2] M. Górska,[2] M. Pfützner,[3] S. Pietri,[4] E. Werner-Malento,[3] H. Grawe,[2] K. Langanke,[2] G. Martínez-Pinedo,[2] F. Nowacki,[5] A. Poves,[1] J. J. Cuenca-García,[2] D. Rudolph,[6] Z. Podolyak,[4] P. H. Regan,[4] P. Detistov,[7] S. Lalkovski,[8,7] V. Modamio,[1] J. Walker,[1] P. Bednarczyk,[2,9] P. Doornenbal,[2] H. Geissel,[2] J. Gerl,[2] J. Grebosz,[2,9] I. Kojouharov,[2] N. Kurz,[2] W. Prokopowicz,[2] H. Schaffner,[2] H. J. Wollersheim,[2] K. Andgren,[10] J. Benlliure,[11] G. Benzoni,[12] A. M. Bruce,[8] E. Casarejos,[11] B. Cederwall,[10] F. C. L. Crespi,[12] B. Hadinia,[10] M. Hellström,[6] R. Hoischen,[6,2] G. Ilie,[13,14] J. Jolie,[13] A. Khaplanov,[10] M. Kmiecik,[9] R. Kumar,[15] A. Maj,[9] S. Mandal,[16] F. Montes,[2] S. Myalski,[9] G. S. Simpson,[17] S. J. Steer,[4] S. Tashenov,[2] and O. Wieland[12]

- Example of the research by a large collaboration [birthday-boy included] which can be seen as a textbook example (see below)

Inverted Parabolas Revisited

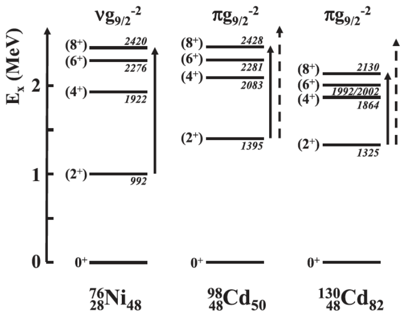


FIG. 4. Proposed level scheme of ^{130}Cd compared to the known level schemes of ^{76}Ni [29] and ^{98}Cd [13]. The solid arrows indicate the observed A^{-1} scaling, whereas the dashed arrows correspond to an $A^{-1/3}$ scaling of the $2^+ - 8^+$ energy spread.

- To notice the decreasing transition energies with increasing spin giving rise to the characteristic inverted parabola patterns [here of the j^2 (alternatively j^{-2}) configurations]

Part III

Large Nuclear Deformations as a Test-Laboratory for the Giant-Dipole Resonances

Extreme Deformations: Super-, and Hyper-defs.

ELSEVIER

Nuclear Physics A687 (2001) 237c–244c

NUCLEAR PHYSICS A

www.elsevier.nl/locate/npe

The Giant Dipole Resonance in superdeformed nuclei and the feeding of superdeformed bands

A. Bracco, F. Camera, S. Leoni, B. Million, [a]and A. Maj, M. Kmiecik [b]

[a]Dipartimento di Fisica, Universitá degli Studi di Milano and Istituto Nazionale di Fisica Nucleare, Sezione di Milano, via Celoria 16, 20133 Milano, Italy

[b] Niewodniczanski Institute of Nuclear Physics, 31-342 Krakow, Poland.

Extreme Deformations: Super-, and Hyper-defs.

ELSEVIER

Nuclear Physics A599 (1996) 123c–128c

NUCLEAR PHYSICS A

Collective Motion in Hot Superheavy Nuclei

T. S. Tveter[a,*], J. J. Gaardhøje[a], A. Maj[a,b], T. Ramsøy[a,†], A. Atac[a,‡], , J. Bacelar[c], A. Bracco[d], A. Buda[c], F. Camera[d], B. Herskind[a], W. Korten[a,§], W. Królas[b], A. Menthe[e], B. Million[d], H. Nifenecker[e], M. Pignanelli[d], J. A. Pinston[e], H. v. d. Ploeg[c], F. Schussler[e] and G. Sletten[a].

[a]Niels Bohr Institute, Tandem Accelerator Laboratory, Risø, DK-4000 Roskilde, Denmark

[b]Niewodniczanski Institute of Nuclear Physics, Radzikowskiego 152, PL-31-342 Krakow, Poland

PHYSICAL REVIEW C VOLUME 31, NUMBER 1 JANUARY 1985

Shape evolution in the transitional gadolinium, dysprosium, erbium, and ytterbium nuclei

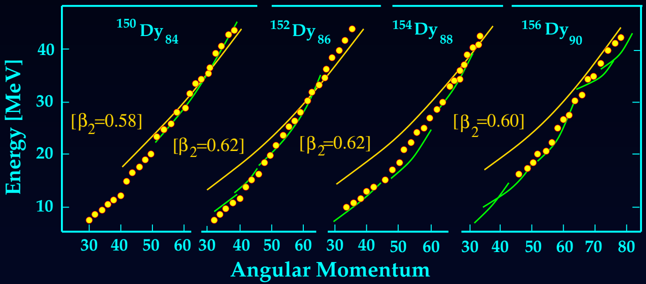
J. Dudek
Centre de Recherches Nucléaires, F-67037 Strasbourg Cedex, France

W. Nazarewicz*
Department of Mathematical Physics, Lund Institute of Technology
S-22007 Lund, Sweden
(Received 25 June 1984)

Shape evolution in $I \geq 30\,\hbar$ high-spin states of $^{144-150}$Gd, $^{150-156}$Dy, $^{152-158}$Er and $^{154-160}$Yb is predicted theoretically within the cranking approximation using the generalised Strutinsky method. A comparison with available experimental data is provided.

Whereas Adam Is Travelling: Berlin ↔ Bonn

- One of four original figures predicting the existence of an island of super-deformed Gadolinium, Dysprosium, Erbium as well as Ytterbium nuclei – in competition with normal-deformed ones.



- Predicted competition between the super-deformed, together with normal-deformed (in particular triaxial) and non-collective states, the latter marked with circles.

VOLUME 57, No. 7 PHYSICAL REVIEW LETTERS AUGUST 1986

Observation of a Discrete-Line Superdeformed Band up 60ħ in ^{152}Dy

P. J. Twin, B. M. Nyakó, A. H. Nelson, J. Simpson, M. A. Bentley, H. W. Cranmer-Gordon, P. D. Forsyth, D. Howe, A. R. Mokhtar, J. D. Morrison, J. F. Sharpey-Schafer, and G. Sletten

A rotational band of nineteen transitions with a moment of inertia Jband(2) of $84\hbar^2$ MeV^{-1} has been observed in ^{152}Dy. The band feeds into the oblate yrast states between 19^- and 25^- and it is proposed that the lowest member of the band has a spin of 22^+ and thus the band extends up to 60ħ. It is identified as the yrast superdeformed band and its intensity accounts for the whole of the ridge structure seen previously in continuum E_γ-E_γ correlations.

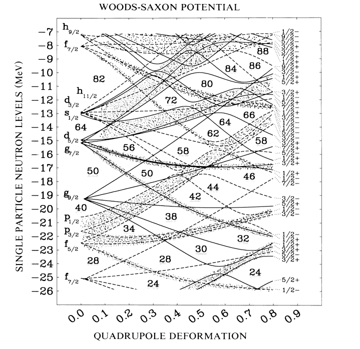
The first SD Band is in our hands. It is 1986.

Whereas Adam Is Travelling: Berlin ↔ Cracow

VOLUME 57, No. 7 PHYSICAL REVIEW LETTERS SEPTEMBER 1987

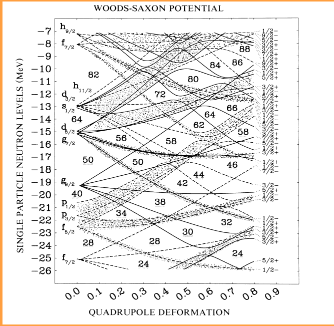
Abundance and systematics of nuclear superdeformed states; relation to the pseudospin and pseudo-SU(3) symmetries

J. Dudek, W. Nazarewicz, Z. Szymański and G. A. Leander



Read the Figure - and Write in Words What It Says

SU(3) Multiplets



Theoretical Predictions for SD's

1. Existence Z=28, 30, 32
2. Absence Z=34, 36

3. Existence Z=38, 40, 42, 44, 46
4. Absence Z=48, 50, 52, 54, 56

5. Existence Z=58, 60, 62, 64, 66
6. Absence Z=68, 70

7. Existence Z=72
8. Absence Z=74, 76, 78

9. Existence Z=80, 82, ... Actinide

- This diagram is published at the time when only one SD band is known experimentally, using the no-fit 'Universal Woods-Saxon'

Comparison: Theory-Experiment, Data of 2008

Experimental Situation

Z=28, Ni, N=30
Z=30, Zn, N=30, 32, 32, 34 absent, 38 (!)

Z=32, 34, 36, absent

Z=38, Sr, N=44
Z=40, Zr, N=44, 46
Z=42, Mo, N=46
Z=44, Cd , absent
Z=46, Pd, N=58, 60

Z=48, 50, 52, 54, 56, absent

Z=58, Ce, N=72, 74
Z=60, Nd, N=72, 74, 76
Z=62, Sm, N=74, 76, 78 absent, 80
Z=64, Gd, N=80, 82, 84, 86
Z=66, Dy, N=86, 88
Z=68, Er, N=86

Z=70, Yb, absent

Z=72, Hf, N=96

Z=74, 76, 78, absent

Z=80, Hg, N=110, 112, 114
Z=82, Pb, N=112, 114, 116

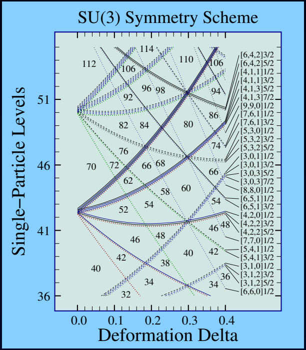
Theoretical Predictions

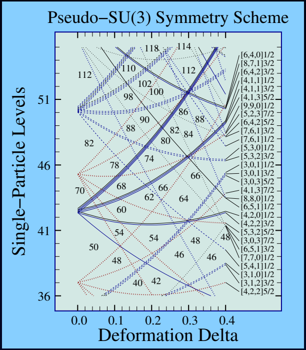
1. Existence Z=28, 30, 32
2. Absence Z=34, 36
3. Existence Z=38, 40, 42, 44, 46
4. Absence Z=48, 50, 52, 54, 56
5. Existence Z=58, 60, 62, 64, 66
6. Absence Z=68, 70
7. Existence Z=72
8. Absence Z=74, 76, 78
9. Existence Z=80, 82, ...
10. Actinide

- This comparison illustrates the ‘predictive power’ over the stretch of about 20 years – ahead of time: Prediction is prediction

Level Degeneracies and Underlying Symmetries

- The key factor in obtaining the large gaps are degeneracies
- The above scheme of shell structures has been fully confirmed by the super-deformations studies 1985 - to date





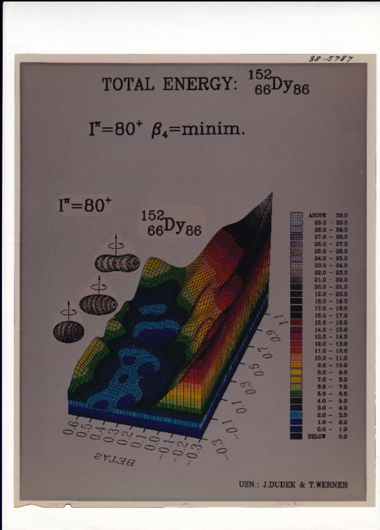
- In the jargon of theorists this mechanism is associated with the so-called SU(3) [pseudo-SU(3)] symmetries of nuclear mean-field

Prediction of the Nuclear Hyperdeformation

• Some years later, using similar techniques, the prediction of the existence of the super- and hyper-deformation mechanisms has been formulated.

• This nostalgic/historical diagram (right) was made in Strasbourg, France, and printed in Oak-Ridge, USA.

• The figure was the cover illustration of the Document: Scientific Motivation for the US-American Germanium detector Gammasphere.



Vol. 36 (2005) *ACTA PHYSICA POLONICA B* No 4

SEARCH FOR HYPERDEFORMATION IN LIGHT Xe NUCLEI*

B.M. Nyakó[a], F. Papp[a†], J. Gál[a], J. Molnár[a], J. Timár[a], A. Algora[a]
Zs. Dombrádi[a], G. Kalinka[a], L. Zolnai[a], K. Juhász[b], A.K. Singh[c], H. Hübel[c]
A. Al-Khatib[c], P. Bringel[c], A. Bürger[c], A. Neusser[c], G. Schönwasser[c]
B. Herskind[d], G.B. Hagemann[d], C.R. Hansen[d], G. Sletten[d], J.N. Scheurer[e]
F. Hannachi[e], M. Kmiecik[f], A. Maj[f], J. Styczeń[f], K. Zuber[f], K. Hauschild[g]
A. Korichi[g], A. Lopez-Martens[g], J. Roccaz[g], S. Siem[g], P. Bednarczyk[h]
Th. Byrski[h], D. Curien[h], O. Dorvaux[h], G. Duchêne[h], B. Gall[h]
F. Khalfallah[h], I. Piqueras[h], J. Robin[h], S.B. Patel[i], A.O. Evans[j]
G. Rainovski[j], A. Airoldi[k], G. Benzoni[k], A. Bracco[k], F. Camera[k]
B. Million[k], P. Mason[k], A. Paleni[k], R. Sacchi[k], O. Wieland[k], G. La Rana[l]
R. Moro[l], C.M. Petrache[m], D. Petrache[m], G. De Angelis[n], P. Fallon[o]
I.-Y. Lee[o], J.C. Lisle[p], B. Cederwall[q], K. Lagergren[q], R.M. Lieder[r]
E. Podsvirova[r], W. Gast[r], H. Jäger[r], N. Redon[s] and A. Görgen[t]

Extreme Deformations: “Super- and Hyper-defs.”

Vol. 34 (2003) *ACTA PHYSICA POLONICA B* No 4

HUNTING GROUNDS FOR JACOBI TRANSITIONS AND HYPERDEFORMATIONS*

B. Herskind[a], G. Benzoni[b], J.N. Wilson[a], T. Døssing[a]
G.B. Hagemann[a], G. Sletten[a], C. Rønn Hansen[a], D.R. Jensen[a]
A. Bracco[b], F. Camera[b], S. Leoni[b], P. Mason[b], O. Wieland[b]
A. Maj[c], M. Brekiesz[c], M. Kmiecik[c], H. Hübel[d], P. Bringel[d]
A. Neusser[d], A.K. Singh[d], R.M. Diamond[e], R.M. Clark[e]
M. Cromaz[e], P. Fallon[e], A. Görgen[e], I.Y. Lee[e]
A.O. Macchiavelli[e], D. Ward[e], F. Hannachi[f], A. Korichi[f]
A. Lopez-Martens[f], T. Byrski[g], D. Curien[g], P. Bednarczyk[c,g]
J. Dudek[g], H. Amro[h], W.C. Ma[h], J. Lisle[i], S. Ødegård[j]
C. Petrache[k], D. Petrache[k], T. Steinhardt[l], and O. Thelen[l]

Before proceeding further
towards the physics of high temperature,
shape transitions and GDR

Before proceeding further

towards the physics of high temperature,

shape transitions and GDR

let us stop at PARIS

PARIS Project

• It is difficult to under-estimate the importance for the nuclear structure physics, of the γ-calorimeter capable of measuring the γ-energies between 100 keV and 50 MeV

• PARIS, the detector under construction, will allow studying the decay of compound nuclei with the angular momentum up to $I_{\text{max.}} \approx 100\,\hbar$, or so

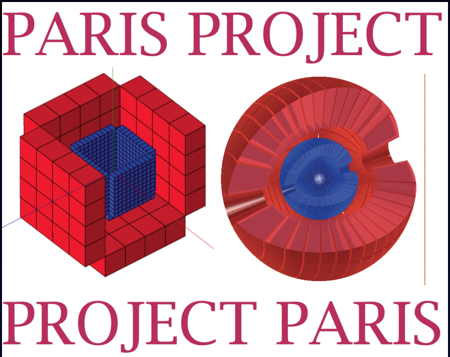
• The physics phenomena discussed today, such as symmetry breaking involved during the nuclear shape transitions, the high temperature phenomena, specific effect of the coherence in the nucleonic motion: Giant Resonances (e.g. dipole), the collective rotation at very high temperatures and spins, super-deformation and hyper-deformation*) – and others – will greatly profit from PARIS

*) *If the spin window under control, ask me if it interests you!*

Many Thanks Adam for the Engagement in the PARIS!

Many Thanks Adam for the Engagement in the PARIS!

Many Thanks Adam for the Engagement in the PARIS!



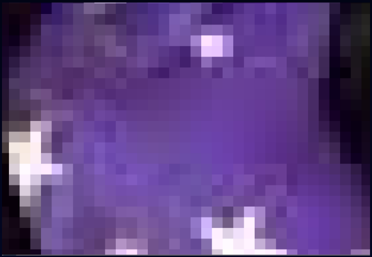
By the way:

Do you remember enlargement of this picture?

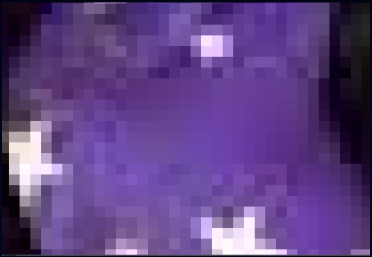
How about enlarging this one, Adam?

- Weeel, since you seem interested, let us compare:

- Weeel, since you seem interested, let us compare:



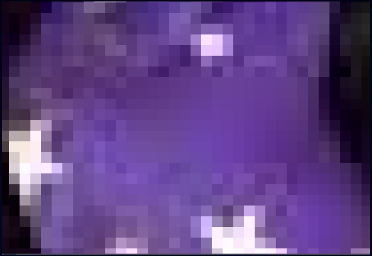
- Weeel, since you seem interested, let us compare:



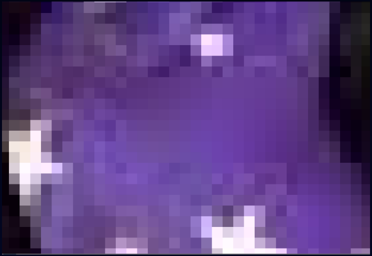
- Question:

What is the fundamental (technical) difference between the two photos?

- Adam! Please tell us!!



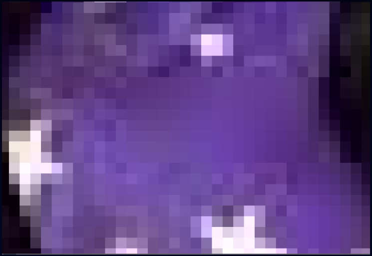
- Adam! Please tell us!!

- Good answer Adam:

You got it!! I took only one of them!!!

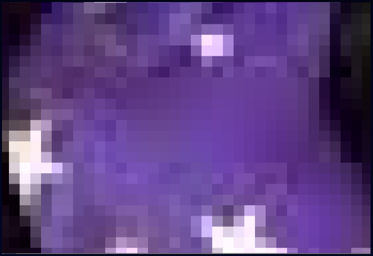
- Adam! Please tell us!!



- Good answer Adam:

You got it!! I took only one of them!!! Which one?

- Adam! Please tell us!!



- Good answer Adam:

You got it!! I took only one of them!!! Which one?
Of course the bee, Adam, of course the bee!

Greetings...

Greetings... More greetings...

Greetings... More greetings... Congratulations for Adam (for Paris)...

Greetings... More greetings... Congratulations for Adam (for Paris)... Not Paris: PARIS...

Greetings... More greetings... Congratulations for Adam (for Paris)... Not Paris: PARIS... ???...

Greetings... More greetings... Congratulations for Adam (for Paris)... Not Paris: PARIS... ???... PARIS? Hm... Congratulations anyway...

Greetings... More greetings... Congratulations for Adam (for Paris)... Not Paris: PARIS... ???... PARIS? Hm... Congratulations anyway... Et, passez les excelentes Emmerdeuses pour Adam!...

Greetings... More greetings... Congratulations for Adam (for Paris)... Not Paris: PARIS... ???... PARIS? Hm... Congratulations anyway... Et, passez les excelentes Emmerdeuses pour Adam!... Mr le President : You mean these... ladies???


Les Emmerdeuses

Les Emmerdeuses...

Les Emmerdeuses... These are not these ladies you know and I know...

Les Emmerdeuses... These are not these ladies you know and I know...
No! These ladies are already forgotten...

Les Emmerdeuses... These are not these ladies you know and I know...
No! These ladies are already forgotten... I mean t h e bottle!!!

Les Emmerdeuses... These are not these ladies you know and I know... No! These ladies are already forgotten... I mean t h e bottle!!! It is excellent!

Les Emmerdeuses... These are not these ladies you know and I know... No! These ladies are already forgotten... I mean t h e bottle!!! It is excellent! Yes, I know this wine...

Les Emmerdeuses... These are not these ladies you know and I know... No! These ladies are already forgotten... I mean t h e bottle!!! It is excellent! Yes, I know this wine... Indeed...

Les Emmerdeuses... These are not these ladies you know and I know... No! These ladies are already forgotten... I mean t h e bottle!!! It is excellent! Yes, I know this wine... Indeed... Au revoir Mr le President!

Back to Physics: Jacobi and Poincaré Transitions

ELSEVIER

Nuclear Physics A731 (2004) 319–326

NUCLEAR PHYSICS A

www.elsevier.com/locate/npe

Evidence for the Jacobi shape transition in hot ^{46}Ti

A. Maj[a], M. Kmiecik[a], A. Bracco[b], F. Camera[b], P. Bednarczyk[ac], B. Herskind[d], S. Brambilla[b], G. Benzoni[b], M. Brekiesz[a], D. Curien[c], G. De Angelis[e], E. Farnea[f], J. Grębosz[a], M. Kicińska-Habior[g], S. Leoni[b], W. Męczyński[a], B. Million[b], D.R. Napoli[e], J. Nyberg[h], C.M. Petrache[i], J. Styczeń[a], O. Wieland[b], M. Ziębliński[a], K. Zuber[a], N. Dubray[c], J. Dudek[c] and K. Pomorski[j]

Bundeskanzlei?...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker... Ja, ja, I will pass my congratulations...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker... Ja, ja, I will pass my congratulations... Transmit a bottle of "Schloss von Staufenberg"?...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker... Ja, ja, I will pass my congratulations... Transmit a bottle of "Schloss von Staufenberg"?... Ja, ja, I know, von Markgraf von Baden...

Schloss von Staufenberg, Baden Würtemberg

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker... Ja, ja, I will pass my congratulations... Transmit a bottle of "Schloss von Staufenberg"?...

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Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker... Ja, ja, I will pass my congratulations... Transmit a bottle of "Schloss von Staufenberg"?... Ja, ja, I know, von Markgraf von Baden... From Angela to Angela?...

Bundeskanzlei?... Frau Bundeskanzlerin? Ja, Guten Tag... Frau Professor Angela Bracco?... Ja, ja, she is working on the Jakobi transitions... Jakobi? Natürlich, ein Deutcher Mathematiker... Ja, ja, I will pass my congratulations... Transmit a bottle of "Schloss von Staufenberg"?... Ja, ja, I know, von Markgraf von Baden... From Angela to Angela?... Sehr net!! With the greatest pleasure!!

Examples of Some Articles: Physics Behind

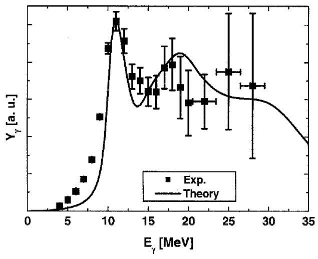

Figure 4. The full drawn line shows the theoretical prediction (at $< T > \approx 2$ MeV and in the spin region 28–34 $\hbar$) of the GDR lineshape in ^{46}Ti obtained from the thermal shape fluctuation model based on free energies from the LSD model calculations [2]. The filled squares are the experimental data shown also in the right panel of Figure 2.

• The present work on the GDR γ-decay in the hot rotating nucleus, ^{46}Ti, shows evidence for the expected Jacobi shape transition.

• It is based on the observation of two particular features:

- The presence of a high energy component related to large deformations;

- The appearance of a GDR component at $\approx$10 MeV (in region where the statistics is very high), identified for the first time in the present experiment

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must first sharpen his tools"
[Confucius: 551 BC - 479 BC]

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must learn about tri-axiality"

[Dudecius: Follower, 2.5×10^3 y later]

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The sharpening of the tools

took place a while ago

through preparation of the new product

called LSD

Adam! Please answer (Yes/No) the Following:

What does the term “LSD” stand for?

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A. Photon Array for studies with Radioactive Ion and Stable Beams

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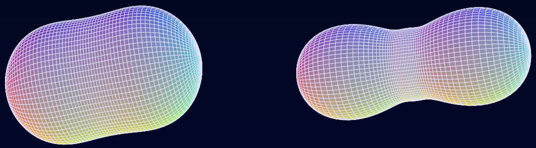
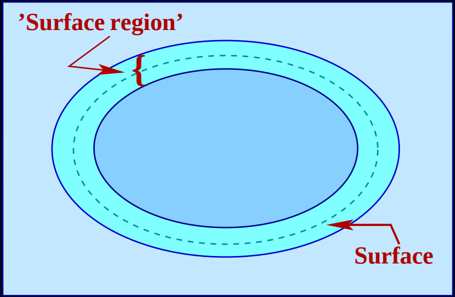
Yes! You are the winner!!
Lublin-Strasbourg Drop (LSD)
is a nickname of a realistic nuclear-energy expression taking into account the curvature of the nuclear surface
[K. Pomorski and JD, PRC 67, 044316 2003]

Lublin-Strasbourg Drop (LSD):
The Principle



Geometry and the Surface Energy Contribution

• The nuclear surface energy comes from the nuclear matter contained in a surface region determined by its diffusivity



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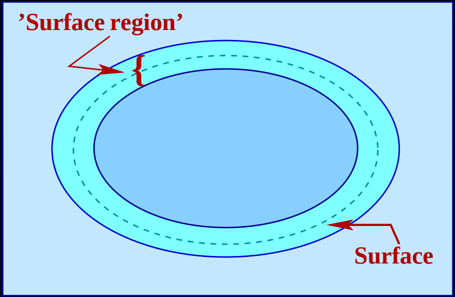

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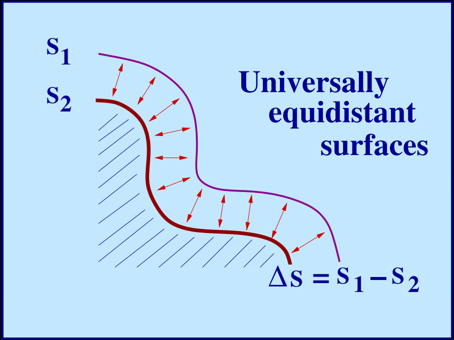
- A mathematical comment about universally-equidistant surfaces



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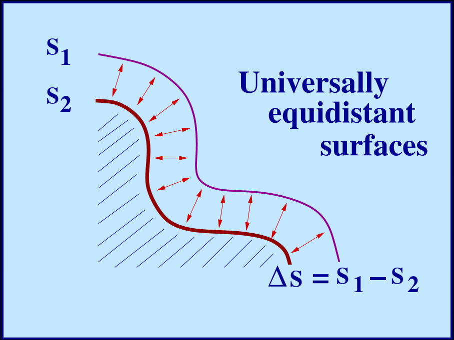

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Nuclear Surface Energy with Curvature Terms

- Denote the two principal radii of the nuclear surface by R_1 and R_2. The local curvature is:

$$K \equiv \frac{1}{R_1} + \frac{1}{R_2}$$

- Then the volume $\mathcal{V}$, the surface area $\mathcal{S}$ and the average curvature $\mathcal{L}$ are expressible with the help of the surface Σ:

$$\mathcal{V} \equiv \frac{1}{3}\int_\Sigma \vec{n} \cdot d\vec{S}; \quad \mathcal{S} \equiv \int_\Sigma dS; \quad \mathcal{L} \equiv \int_\Sigma dS\left(\frac{1}{R_1} + \frac{1}{R_2}\right),$$

- They satisfy:

$$\mathcal{L}(s) = \frac{d\mathcal{S}}{ds} = \frac{d^2\mathcal{V}}{ds^2}$$

- Therefore the volume and the surface satisfy

$$\mathcal{V}(s) = \mathcal{V}_0 + \mathcal{S}_0\, s + \tfrac{1}{2}\mathcal{L}_0\, s^2 + \ \dots; \ \ \mathcal{S}(s) = \mathcal{S}_0 + \mathcal{L}_0\, s + \dots,$$

Origin of the Curvature Energy - thus the LSD

- The energy associated with the volume of the skin region is:

$$\mathcal{E}_{surf} \sim \mathcal{V}_S \sim \int_{s_1}^{s_2} \mathcal{S}(s) ds \sim \int_{s_1}^{s_2} [\mathcal{S}_0 + \mathcal{L}_0 s] \, ds$$

- Given the fact that Taylor expansion 'constants' vary with Z & N

$$\mathcal{E}_{surf} \sim \mathcal{S}_0 \underbrace{(s_2 - s_1)}_{\mathcal{C}_S(Z,N)} + \mathcal{L}_0 \underbrace{(s_2^2 - s_1^2)}_{\mathcal{C}_L(Z,N)}$$

- It then follows that

$$\mathcal{L}(s) = \frac{d\mathcal{S}}{ds} = \frac{d^2\mathcal{V}}{ds^2}$$

- Therefore the surface energy contribution satisfies:

$$\boxed{\mathcal{E}_{surf} = \mathcal{C}_S(Z,N) \cdot \mathcal{S}_0 + \mathcal{C}_L(Z,N) \cdot \mathcal{L}_0}$$

- The nuclear surface energy can be decomposed using two surface terms whose A-dependences are different: $A^{2/3}$ and $A^{1/3}$
- At *the surface areas* $\mathcal{S}_0$ *equal*, two nuclei differing in terms of the average curvatures $\mathcal{L}_0$ and $\mathcal{L}_0'$, will have *different surface energies*
- The final deformation energy is

$$\boxed{\begin{aligned} E(Z,N;\mathrm{def}) \quad &\sim \quad b_{\mathrm{area}}\,(1-\kappa_{\mathrm{area}}\,I^2\,)\,A^{2/3}B_{\mathrm{area}}(\mathrm{def}) \\ &+ \quad b_{\mathrm{curv}}\,(1-\kappa_{\mathrm{cur1}}\,I^2\,)\,A^{1/3}B_{\mathrm{curv}}(\mathrm{def}) \\ &+ \quad \tfrac{3}{5}\,e^2\,\frac{Z^2}{r_0^{ch}\,A^{1/3}}\,B_{\mathrm{Coul}}(\mathrm{def}) + E_{\mathrm{cong}}(Z,N) \end{aligned}}$$

- By refitting parameters of the LSD-energy expression to nearly 3000 nuclear masses we obtain $\chi^2 = 0.72$ MeV
- The errors of the fission barriers 'automatically' (no fit to barriers) decrease by up to the factor of 4 (!). The final improvements come from the deformation-dependent congruence-energy term

LSD Macroscopic Energy - Final Comments

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LSD Macroscopic Energy - Final Comments

Table : Comparison of the barrier heights: Experimental values [Exp], LSD-model results with no congruence [LSD No C], Congruence from Myers and Świątecki [C. M.-S.], and LSD with deformation-dependent congruence-energy term.

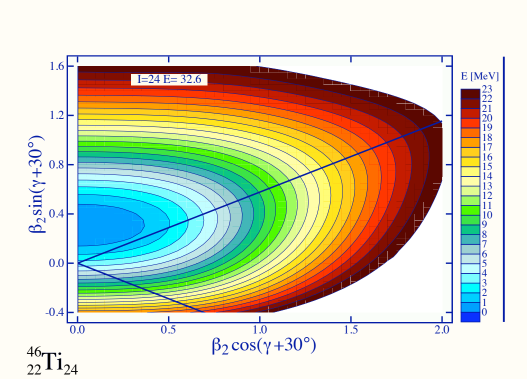
Nucleus	Exp	Ref	LSD No C.	C. M.-S.	LSD-Cong.
^{70}Se	**39.4**	[1]	50.61	43.33	**40.39**
^{76}Se	**44.5**	[1]	54.32	49.62	**45.08**
^{75}Br	**41.0**	[2]	52.60	47.06	**43.41**
^{90}Mo	**42.0**	[3]	50.89	45.51	**42.30**
^{98}Mo	**46.0**	[3]	54.57	50.65	**47.44**
^{173}Lu	**29.0**	[4]	28.70	25.63	**26.79**
^{228}Ra	**6.3**	[4]	6.20	6.013	**6.18**

• With this agreement with the experimental data, we believe, the evolution of barrier heights with spin and deformation as well as the shape transitions have good chances to be realistic.

[K. Mazurek, JD, A. Maj and D. Rouvel, Phys. Rev. C 91, 034301 (2015)]

Jacobi Transitions - Illustrations for ^{46}Ti

- Let us consider an example of the Jacobi shape transition: ^{46}Ti; energy obtained by minimising over nonaxial α_{22} deformation



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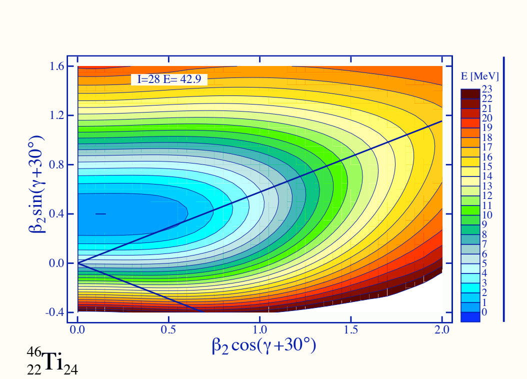

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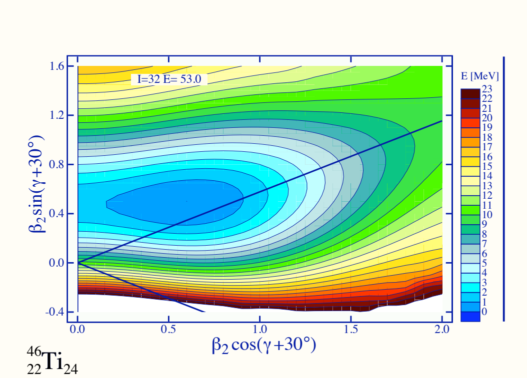
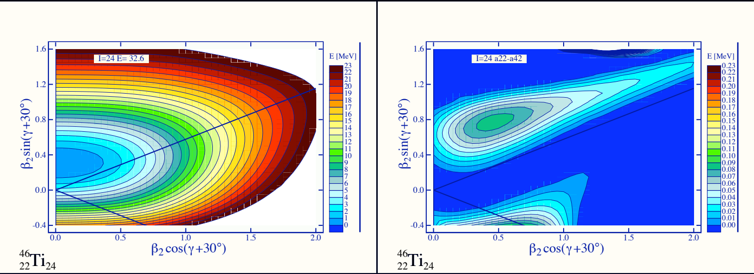


Jacobi Transitions - Higher Order Triaxiality [1]

- Let us add an extra tri-axial deformation, α_{42}, while minimising
- Let us subtract the energy surfaces: $E_{22+42} - E_{22}$ and compare



- Observation: The maximum difference of $\sim$180 keV superposes with the total energy at the level of 6 MeV.

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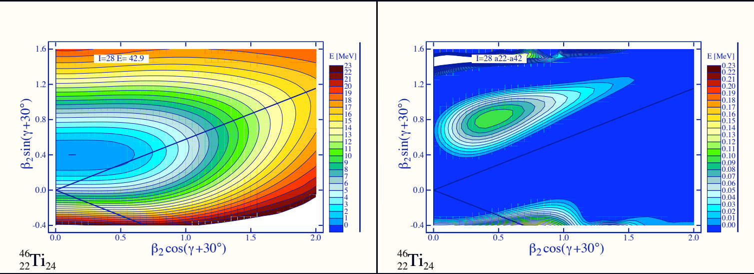

- Observation: The maximum difference of ~ 100 keV superposes with the total energy at the level of 6 MeV.

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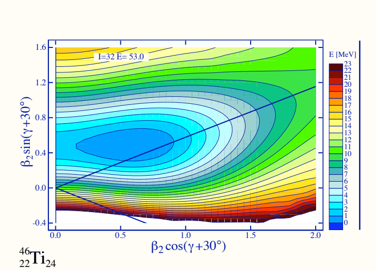

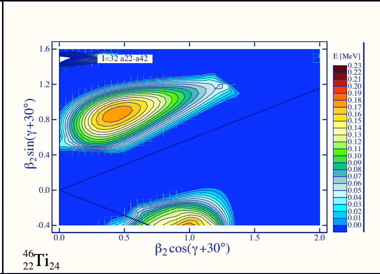

- Observation: The maximum difference of ∼180 keV superposes with the total energy at the level of ∼4 MeV.

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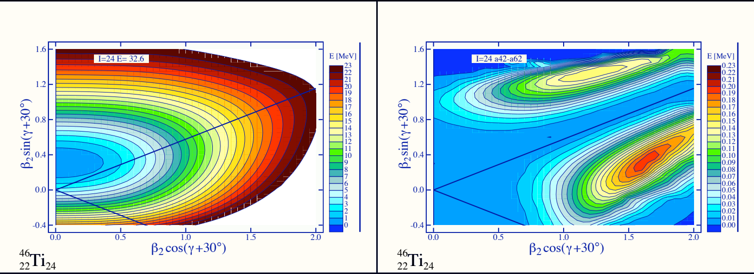

- Observation: The maximum difference of $\sim$200 keV superposes with the total energy at the level of $\sim$17 MeV.

Jacobi Transitions - Higher Order Triaxiality [2]

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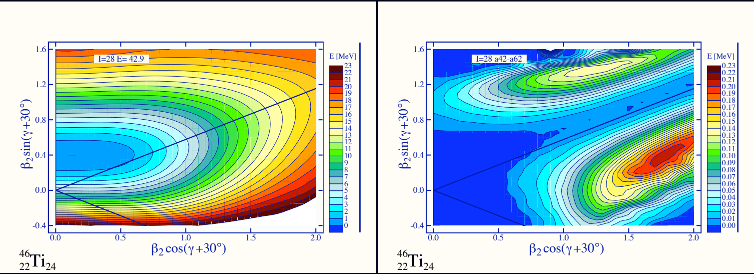

- Observation: The maximum difference of $\sim$200 keV superposes with the total energy at the level of $\sim$16 MeV.

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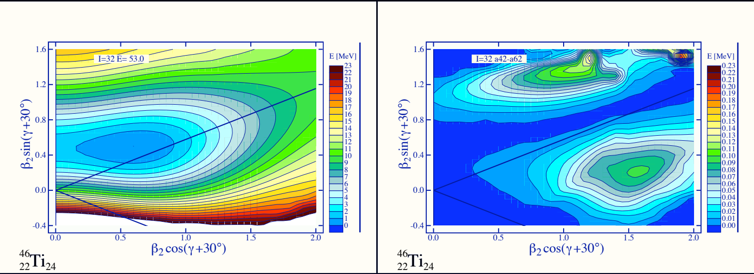

- Observation: The maximum difference of ∼100 keV superposes with the total energy at the level of ∼10 MeV.

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Triaxiality Stability Tests - Conclusions

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- Higher order tri-axiality multipoles ($\alpha_{\lambda,2}$ with $\lambda \geq 4$) are not essential for the calculations of the Jacobi transitions

The telephone connection does not seem very clear, strange noises...

He loves really big things...

He loves really big things...
Grandioso...

He loves really big things...
Grandioso... Super-big...

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And after all: Giant Resonance...

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I should pass regards to Adam...

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... and a bottle of vodka: "Donskaya"...

Ouufff!!

Back to physics of nuclei

Posing the Problem of Large Amplitude Motion

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  – The intrinsic occupancy of nucleonic orbitals changes dramatically
  – And yet, the total nuclear energy varies by a few hundreds of keV only – a typical energy of a vibrational state

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- Consequently, we propose to solve quantum mechanical problem of the nuclear collective motion, find the wave functions and the most probable deformations, with clear-cut interpretation in the context!

• Despite the fact that *model* used here to parametrize the nuclear energy is classical – the *physical nuclear system* is of course quantum

Posing the Problem of Large Amplitude Motion

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- The corresponding Schrödinger equation has a usual general from

$$\boxed{[\hat{T} + V(\alpha)]\,\Psi_n(\alpha) = E_n\,\Psi_n(\alpha) \quad \text{with} \quad V(\alpha) \leftrightarrow V_{LSD}(\alpha)}$$

Posing the Problem of Large Amplitude Motion

- Despite the fact that *model* used here to parametrize the nuclear energy is classical – the *physical nuclear system* is of course quantum
- The corresponding Schrödinger equation has a usual general from

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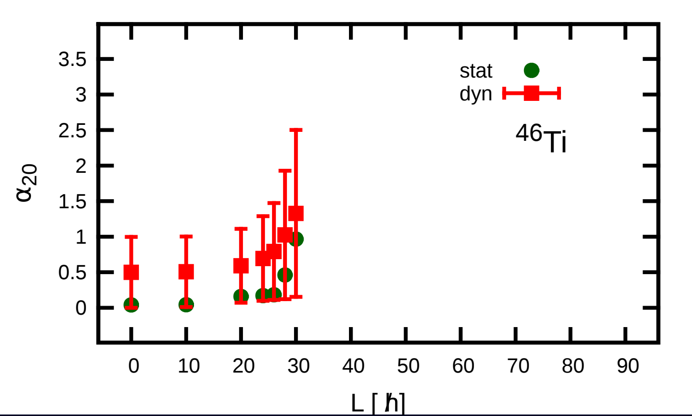
- Knowing solutions we can calculate the expected value $\bar{\alpha}_{\lambda\mu}$ taken as a measure of the most probable deformation can be obtained as:

$$\langle \alpha^2_{\lambda\mu} \rangle \equiv \int d\alpha\,\Psi^*_n(\alpha)\,\alpha^2_{\lambda\mu}\Psi_n(\alpha) \;\rightarrow\; \bar{\alpha}_{\lambda\mu} = \sqrt{\langle \alpha^2_{\lambda\mu} \rangle}$$

- In this way we obtain two, different and non-equivalent realisations of the description of physical deformations: static and dynamical:

$$(\alpha_{20}, \alpha_{22})_{stat.} \quad \text{and} \quad (\bar{\alpha}_{20}, \bar{\alpha}_{22})_{dyn.}$$

- Results of calculations obtained by solving Schrödinger equation



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• Although many building blocks of this project have been prepared in Cracow and Strasbourg, combining them is still ahead of us;

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