

Aspects of ‚Empirical Aspects...‘



TECHNISCHE
UNIVERSITÄT
DARMSTADT

Norbert Pietralla, TU Darmstadt

10th Int'l workshop on Quantum Phase Transitions in Nuclei and Many-Body Systems

Thank you, Dario & team !



- Structure of Session
- 10th Workshop: Anniversary!
- A few ‚historical‘ remarks

"Session 2: Empirical aspects of quantum phase transitions in nuclei"

Conveners: N.P. & Rick Casten



14 junior researchers presenting **experimental data** relevant for nuclear shape phase transition

Data presentation distributed over the sessions

Varying structure of workshops over the time

2004: Berkeley

2005: Camerino

2006: Athens

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2018: Padova

2021: Dubrovnik

...and another anniversary:

Rick Casten turned 80 !

10th edition



Rick's 60th

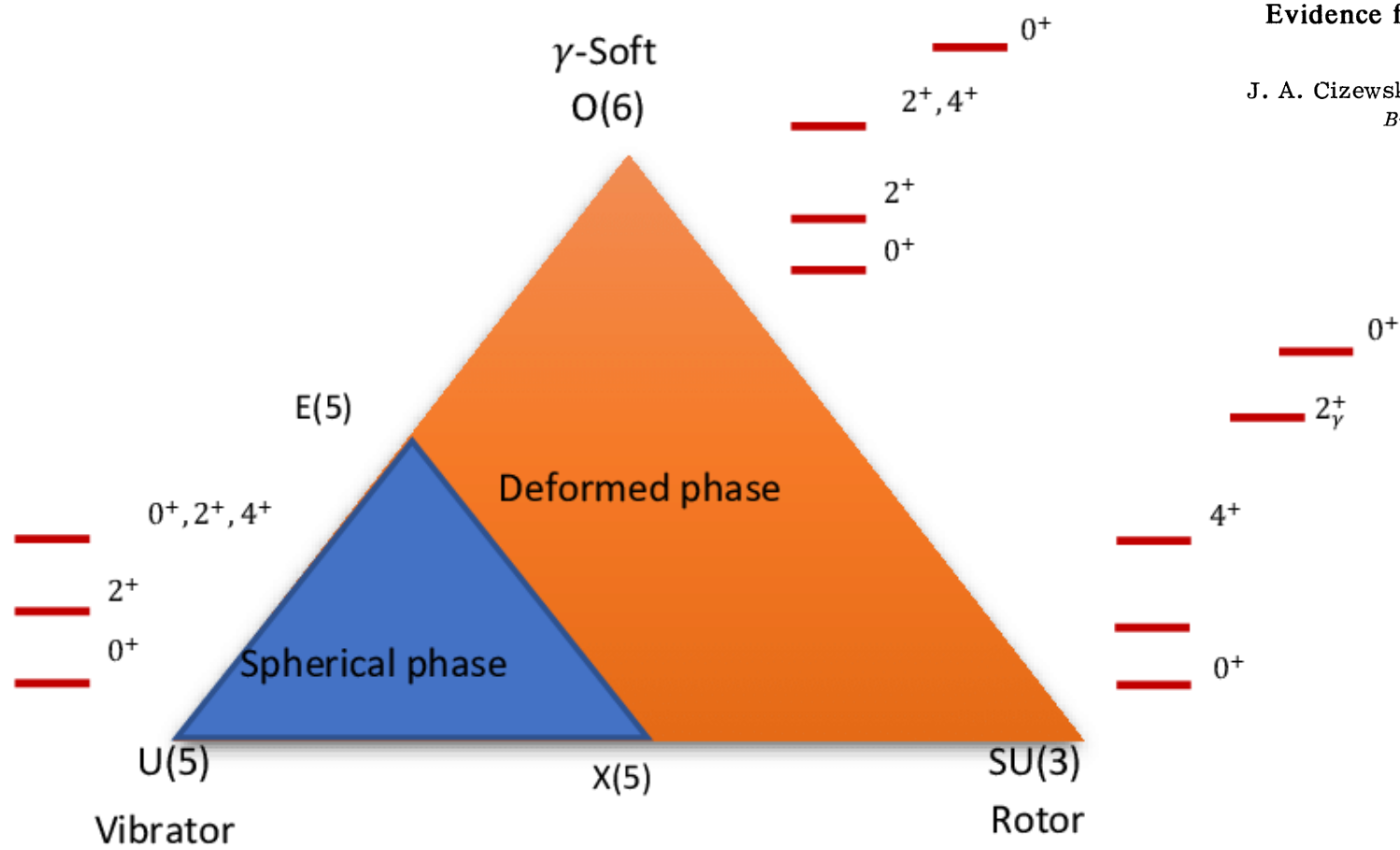
*„Mapping the
Triangle“*

Grand Teton
WY,

May 2002

a few words on Rick's role in establishment of QPT workshops

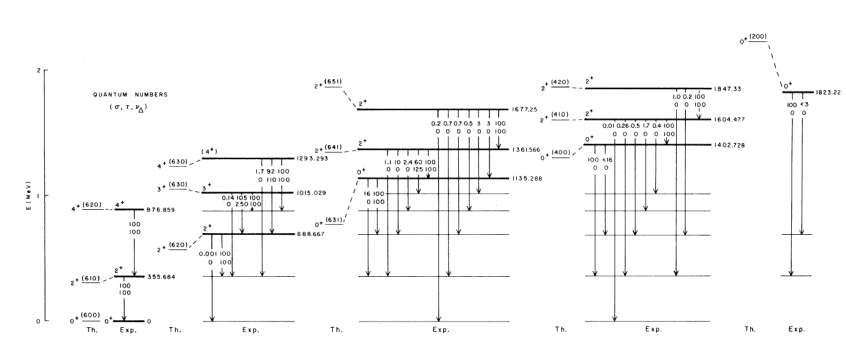
O(6) and the 'Casten Triangle' (of Franco's Solutions)



Evidence for a New Symmetry in Nuclei: The Structure of ¹⁹⁶Pt and the O(6) Limit

J. A. Cizewski,^(a) R. F. Casten, G. J. Smith, M. L. Stelts, and W. R. Kane
Brookhaven National Laboratory, Upton, New York 11973

and
 H. G. Börner^(b) and W. F. Davidson
Institut Laue-Langevin, 38042 Grenoble, France
 (Received 18 November 1977)



O(6) and the 'Casten Triangle'

Volume 152, number 1,2

PHYSICS LETTERS

28 February 1985

AN EXTENSIVE REGION OF O(6)-LIKE NUCLEI NEAR $A = 130$

R. F. CASTEN

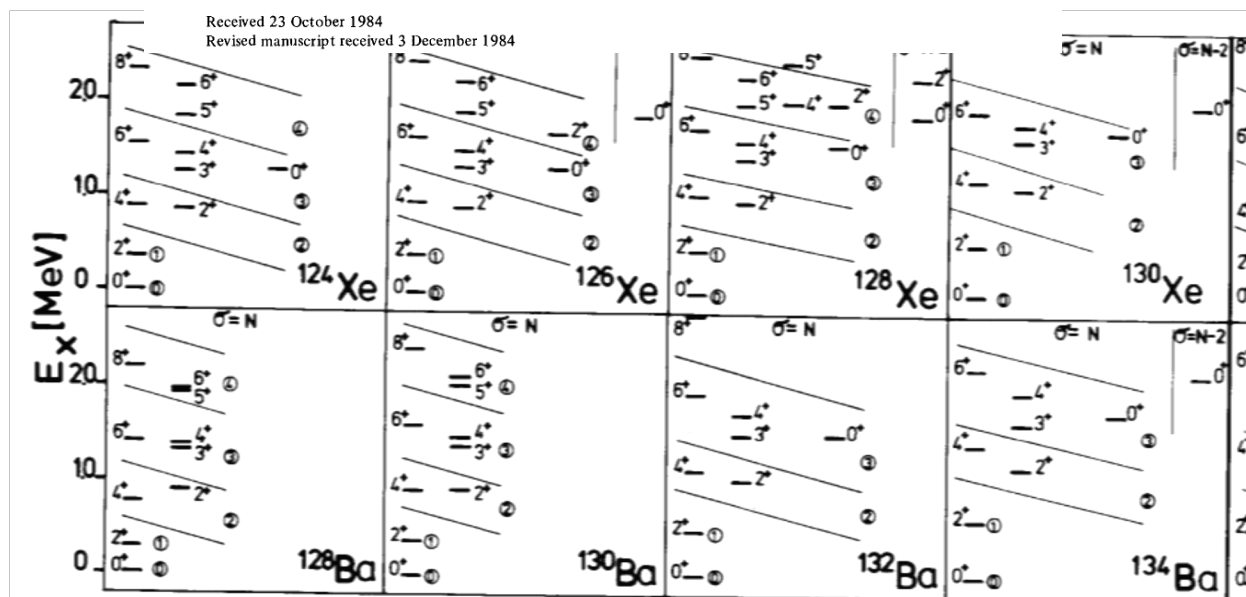
Brookhaven National Laboratory, Upton, NY 11973, USA
and Institut für Kernphysik, University of Köln, Cologne, West Germany

and

P. VON BRENTANO

Institut für Kernphysik, University of Köln, Cologne, West Germany

Received 23 October 1984
Revised manuscript received 3 December 1984



The interacting boson approximation

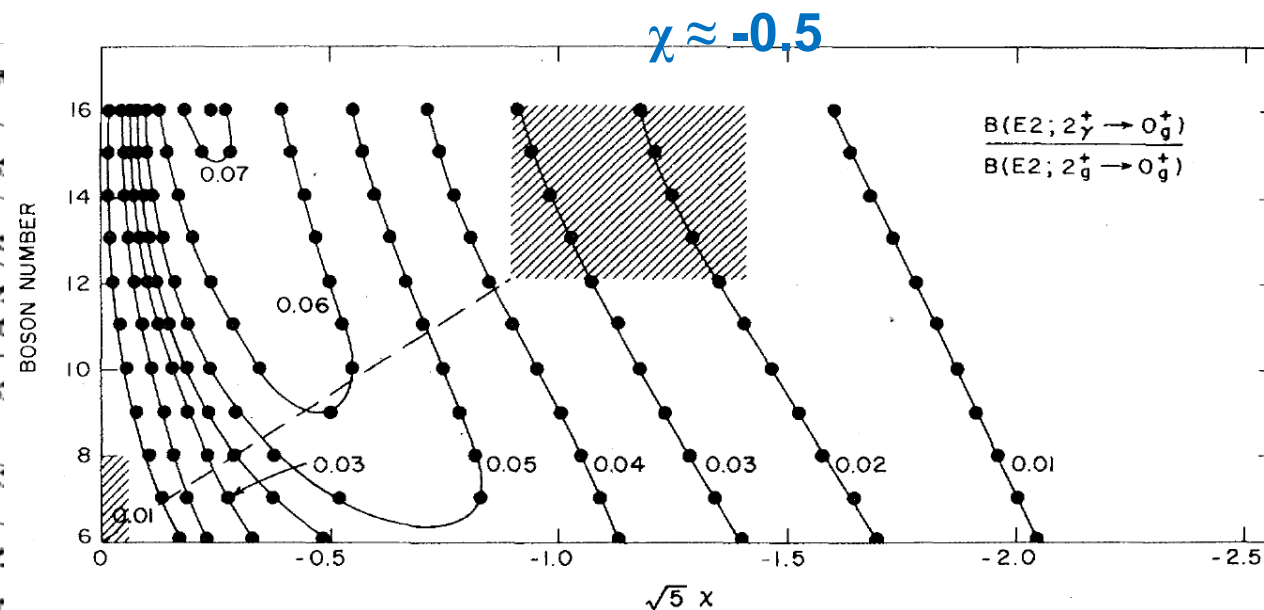
Rev.Mod.Phys. (1988)

R. F. Casten

Brookhaven National Laboratory, Upton, New York 11973
and Institut für Kernphysik der Universität zu Köln, 5000 Köln 41, West Germany

D. D. Warner

Science and Engineering Research Council Daresbury Laboratory, Warrington WA4 4AD, England
and Brookhaven National Laboratory, Upton, New York 11973



O(6) and the Q-phonon scheme

Multiple quadrupole “phonon” excitations in ^{130}Ba

G. Siems, U. Neuneyer, I. Wiedenhöver, S. Albers, M. Eschenauer, R. Wirowski, A. Gelberg,
P. von Brentano

Institut für Kernphysik, Universität zu Köln, Zùlpicher Str. 77, W-50937 Köln, Germany

and

T. Otsuka

Dept. of Physics, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113, Japan

Received 10 August 1993; revised manuscript received 9 November 1993

$$\begin{aligned}
 &|I^\pi, \tau, \nu_A\rangle \\
 &|0_1^+, 0, 0\rangle \propto |0\rangle \\
 &|2_1^+, 1, 0\rangle \propto Q|0\rangle \\
 &|4_1^+, 2, 0\rangle \propto [QQ]^{(4)}|0\rangle \propto [Q|2_1^+\rangle]^{(4)} \\
 &|6_1^+, 3, 0\rangle \propto [QQQ]^{(6)}|0\rangle \propto [Q|4_1^+\rangle]^{(6)} \\
 &|2_2^+, 2, 0\rangle \propto [QQ]^{(2)}|0\rangle \propto [Q|2_1^+\rangle]^{(2)} \\
 &|4_2^+, 3, 0\rangle \propto [QQQ]^{(4)}|0\rangle \propto [Q|2_2^+\rangle]^{(4)} \\
 &|3_1^+, 3, 0\rangle \propto [QQQ]^{(3)}|0\rangle \propto [Q|2_2^+\rangle]^{(3)} \\
 &|5_1^+, 4, 0\rangle \propto [QQQQ]^{(5)}|0\rangle \propto [Q|3_1^+\rangle]^{(5)} \\
 &|0_2^+, 3, 1\rangle \propto [QQQ]^{(0)}|0\rangle \propto [Q|2_2^+\rangle]^{(0)} \\
 &|2_3^+, 4, 1\rangle \propto \alpha([QQ]^{(2)}[QQ]^{(2)})^{(2)}|0\rangle + \beta[QQ]^{(2)}|0\rangle \\
 &|4_3^+, 4, 0\rangle \propto \alpha'([QQ]^{(2)}[QQ]^{(2)})^{(4)}|0\rangle + \beta'[QQ]^{(4)}|0\rangle
 \end{aligned}$$

Distribution of Low-Lying Quadrupole Phonon Strength in Nuclei

N. Pietralla,¹ P. von Brentano,¹ R. F. Casten,^{1,2} T. Otsuka,³ and N. V. Zamfir^{2,4,5}

¹*Institut für Kernphysik, Universität zu Köln, D-50937 Köln, Germany*

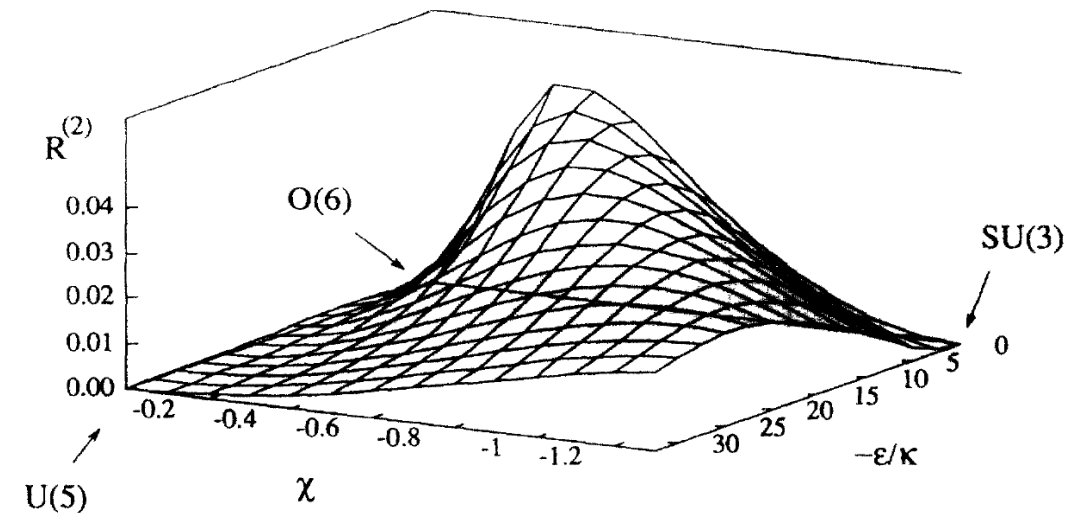
²*Brookhaven National Laboratory, Upton, New York 11973*

³*Department of Physics, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113, Japan*

⁴*Clark University, Worcester, Massachusetts 01610*

⁵*Institute of Atomic Physics, Bucharest-Magurele, Romania*

(Received 29 April 1994)



0⁺ as a phonon on the gamma-band and discussion

RAPID COMMUNICATIONS

PHYSICAL REVIEW C

VOLUME 50, NUMBER 3

SEPTEMBER 1994

comments

New interpretation of the lowest $K=0$ collective excitation of def

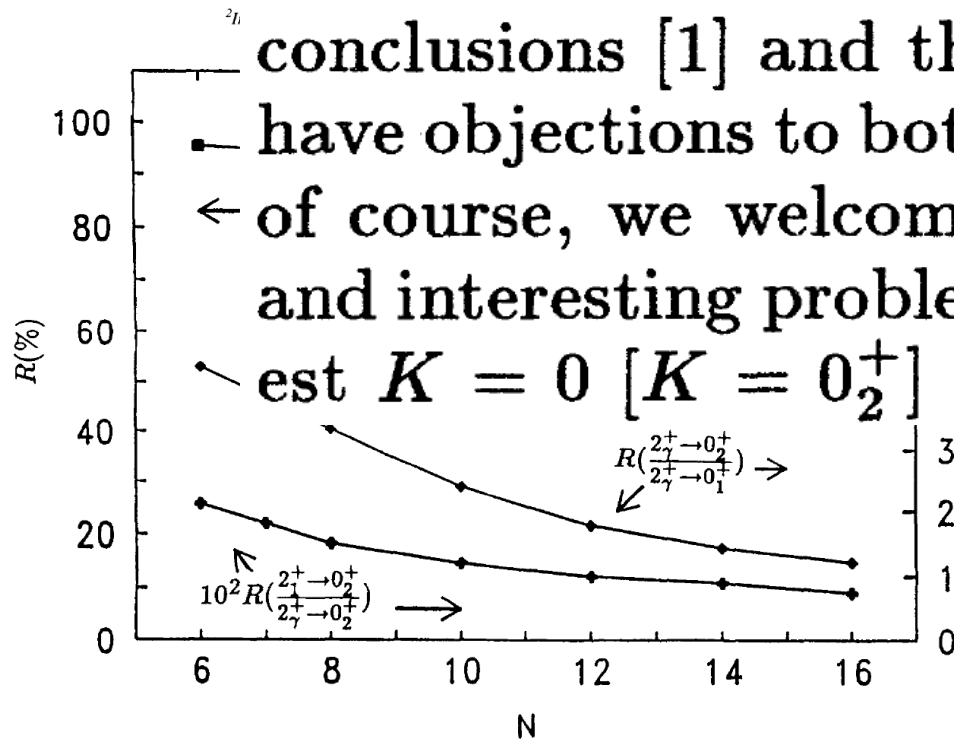
[1] D. G. Burke and P. C. Sood, Phys. Rev. C **51**, 3525

One Comment claims that we are premature in our conclusions [1] and the other [2] that he did it first. We have objections to both, which we will present below, but, of course, we welcome a discussion of this fundamental and interesting problem concerning the nature of the lowest $K = 0$ [$K = 0_2^+$] excitations in deformed nuclei. We

AUGUST 1996

citation

n raised in



PHYSICAL REVIEW C

VOLUME 51, NUMBER 6

JUNE 1995

Reply to "Comments on 'New interpretation of the lowest $K = 0$ collective excitation of deformed nuclei as a phonon excitation of the γ band'"

R. F. Casten^{1,2} and P. von Brentano²

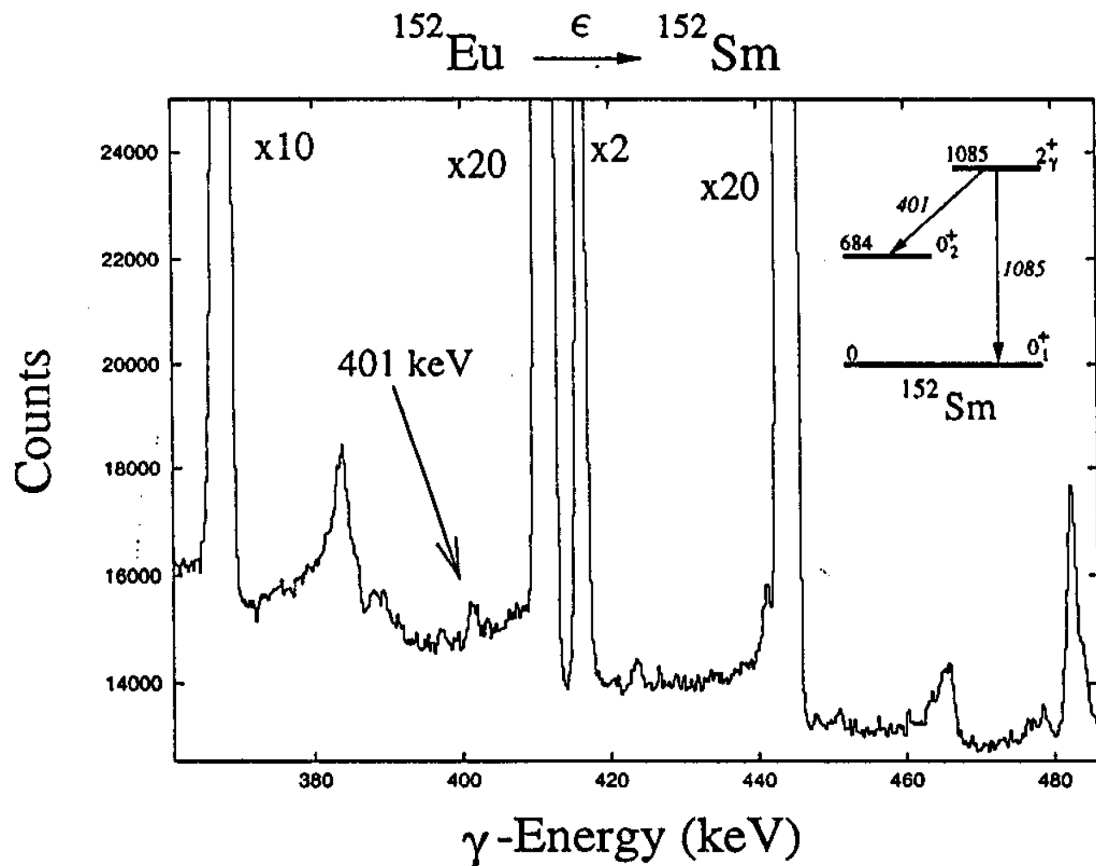
¹Brookhaven National Laboratory, Upton, New York 11973

²Institut für Kernphysik, Universität Köln, D-50937 Köln, Germany

(Received 21 December 1994)

This is a reply to the preceding Comments.

Surprising Data on the 0^+_2 State of ^{152}Sm : The "Pocket"



THIRD SERIES, VOLUME 57, NUMBER 4

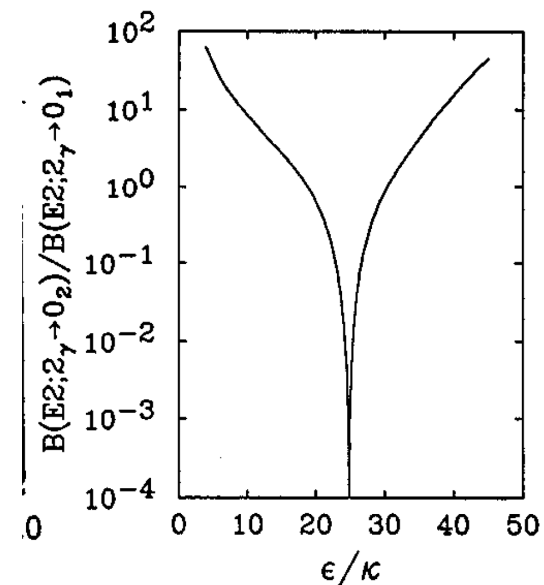
APRIL 1998

RAPID COMMUNICATIONS

The Rapid Communications section is intended for the accelerated publication of important new results. Manuscripts submitted to this section are given priority in handling in the editorial office and in production. A Rapid Communication in *Physical Review C* may be no longer than five printed pages and must be accompanied by an abstract. Page proofs are sent to authors.

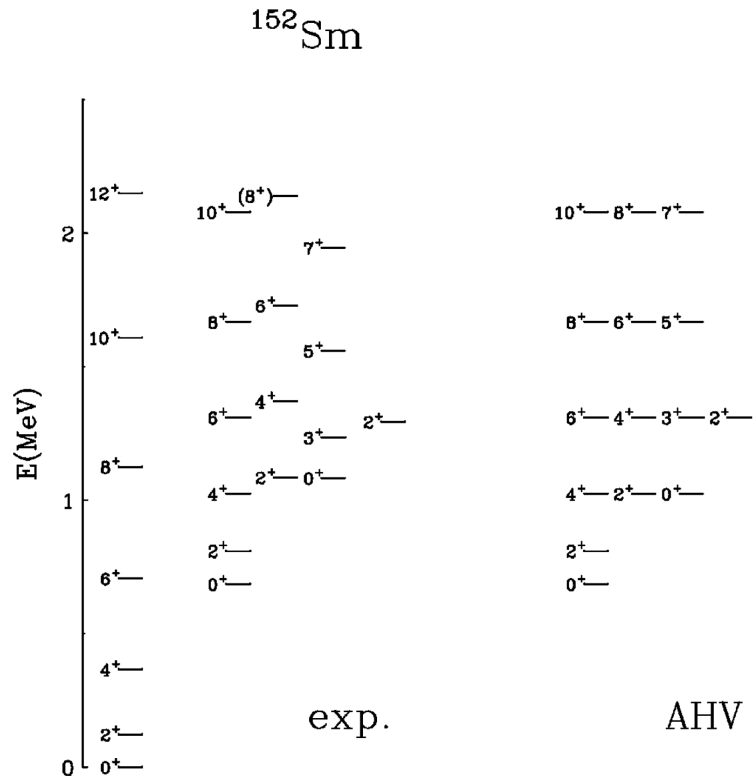
The first excited 0^+ state in ^{152}Sm

R. F. Casten,¹ M. Wilhelm,^{1,2} E. Radermacher,² N. V. Zamfir,^{1,3,4,5} and P. von Brentano²



Pre-X(5) Shape-Coexistence Interpretation

PHYSICAL REVIEW C, VOLUME 60, 054312



$B(E2)$ values and phase coexistence in ^{152}Sm

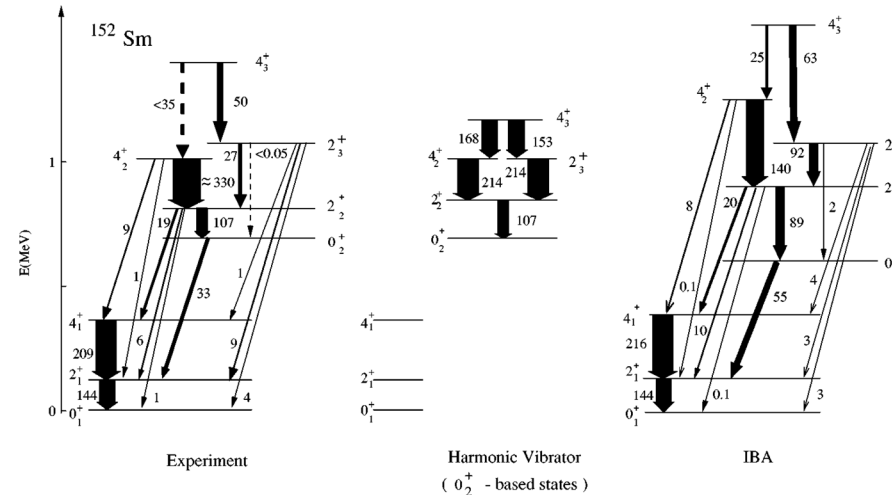
N. V. Zamfir,^{1,2} R. F. Casten,¹ M. A. Caprio,¹ C. W. Beausang,¹ R. Krücken,¹ J. R. Novak,¹ J. R. Cooper,¹
G. Cata-Danil,^{1,3} and C. J. Barton²

¹Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520

²Clark University, Worcester, Massachusetts 01610

³National Institute for Physics and Nuclear Engineering, Bucharest-Magurele, Romania

(Received 13 May 1999; published 4 October 1999)



^{152}Sm as First Example for X(5)

VOLUME 87, NUMBER 5

PHYSICAL REVIEW LETTERS

30 JULY 2001

Empirical Realization of a Critical Point Description in Atomic Nuclei

R. F. Casten¹ and N. V. Zamfir^{1,2,3}

¹Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520-8,

²Clark University, Worcester, Massachusetts 01610

³National Institute for Physics and Nuclear Engineering, Bucharest-Magurele, Romania

(Received 12 December 2000; published 12 July 2001)

back-to-back-PRL with Franco's X(5)

VOLUME 87, NUMBER 5

PHYSICAL REVIEW LETTERS

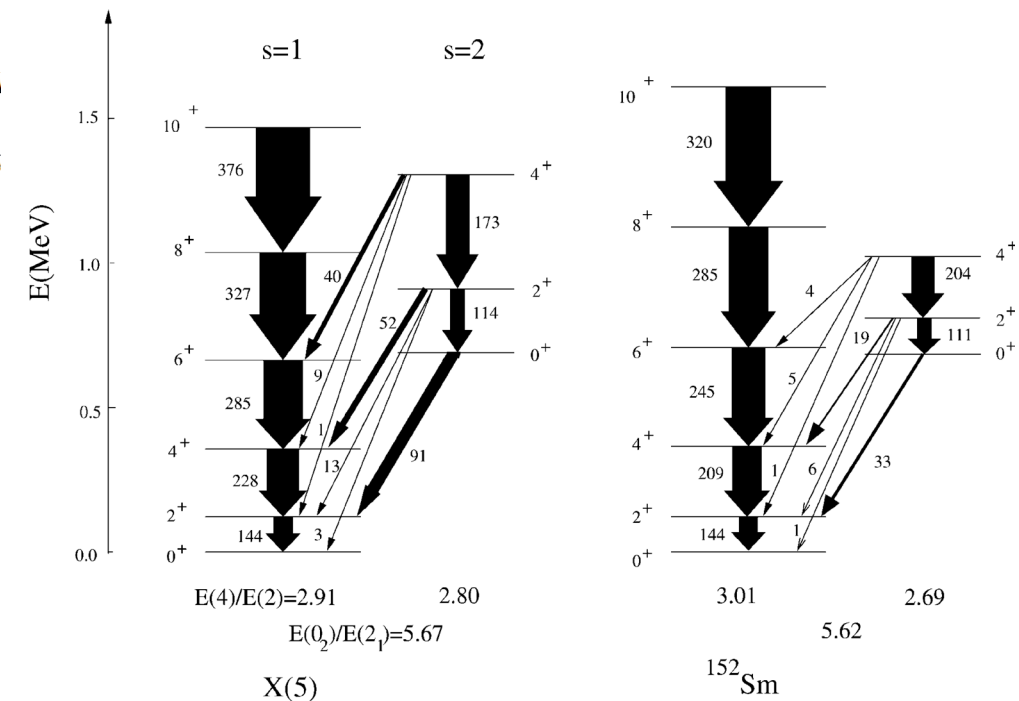
30 JULY 2001

Analytic Description of Critical Point Nuclei in a Spherical-Axially Deformed Shape Phase Transition

F. Iachello

Center for Theoretical Physics, Sloane Physics Laboratory, Yale University, New Haven, Connecticut 06520-8120

(Received 12 December 2000; published 12 July 2001)



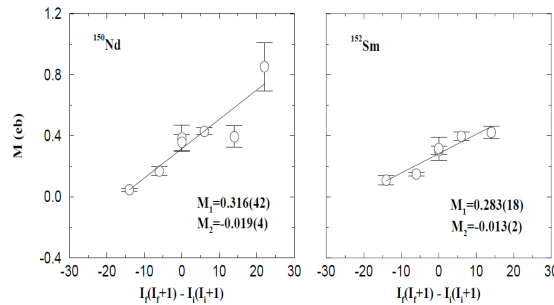
PHYSICAL REVIEW C **67**, 041302(R) (2003)

Reexamination of the $N=90$ transitional nuclei ^{150}Nd and ^{152}Sm

R. M. Clark, M. Cromaz, M. A. Deleplanque, R. M. Diamond, P. Fallon, A. Görgen, I. Y. Lee, A. O. Macchiavelli, F. S. Stephens, and D. Ward

Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720

(Received 21 January 2003; published 28 April 2003)

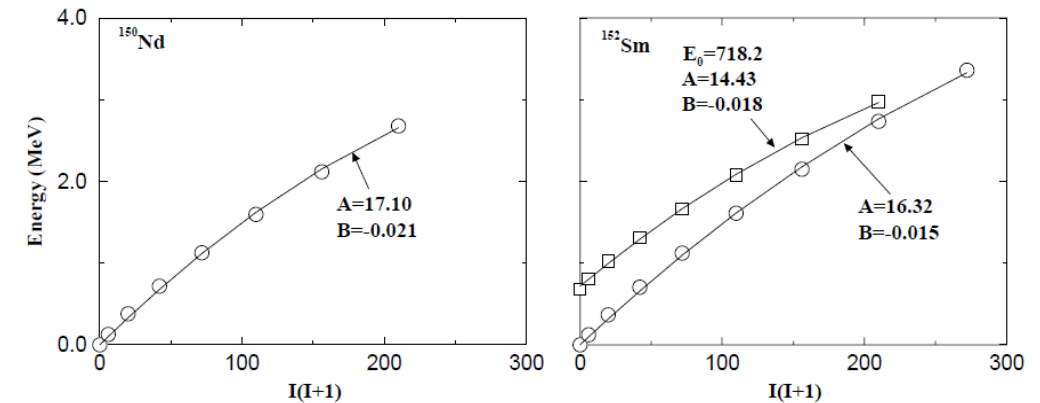


This mixing will affect the $E2$ transition strengths between the bands such that they obey the relationship

$$B(E2; I_i \rightarrow I_f) = \langle I_i 0 2 0 | I_f 0 \rangle^2 \times \{M_1 + M_2 [I_i(I_i+1) - I_f(I_f+1)]\}^2, \quad (9)$$

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Claim (in short):
bandmixing of rigid-rotor like structures or the pairing-plus-quadrupole model account for $N=90$ spectra well enough



PHYSICAL REVIEW C **68**, 059801 (2003)

Comment on “Reexamination of the $N=90$ transitional nuclei ^{150}Nd and ^{152}Sm ”

R. F. Casten,^{1,2} N. V. Zamfir,^{1,3} and R. Krücken⁴

¹*Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520-8124, USA*

²*Institut für Kernphysik, Universität zu Köln, D-50937 Köln, Germany*

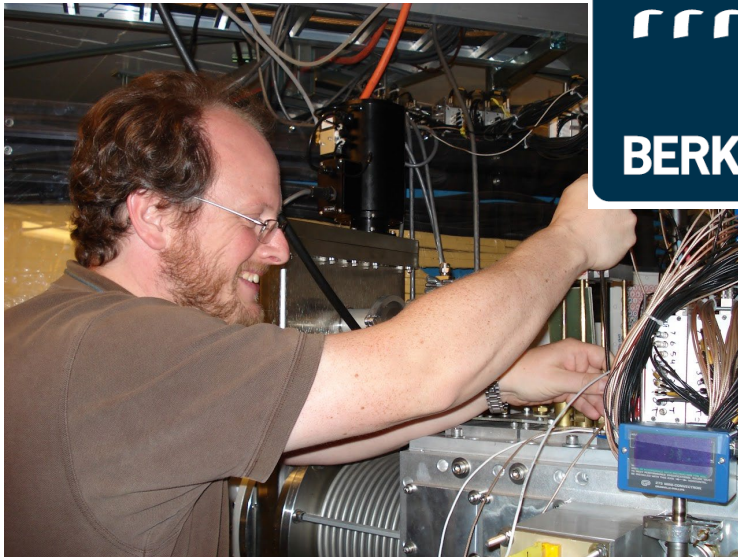
³*Clark University, Worcester, Massachusetts 01610, USA*

⁴*Physik Department E12, Technische Universität München, D-85748 Garching, Germany*

(Received 16 July 2003; published 21 November 2003)

We show that, contrary to a recent paper, the new, analytic, critical point symmetry $X(5)$, which is parameter-free (except for scale), reproduces the data in ^{152}Sm and ^{150}Nd quite well, and better than multiparameter models based on bandmixing of pure rotor states.

...i.e., "We need to talk!"



2004: Berkeley

2005: Camerino

2006: Athens

2007: Sofia

2009: Istanbul

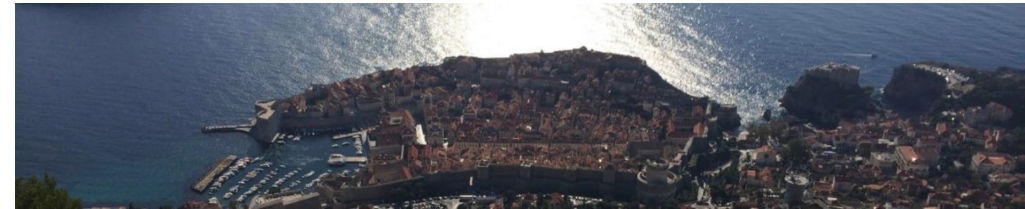
2012: Darmstadt

2014: Sevilla

2016: Prague

2018: Padova

2021: Dubrovnik



Ami L.: *„It doesn't matter so much whether the statement [on the nature of the 0^+_2 state] was right or wrong; what matters is that there were new measurements with new precise data, and new deeper insight.“*

Rick Casten (and Rod Clark) were the driving forces behind the establishment of this workshop series.

It was meant for ample discussions of surprising observations!

Incl. the „Empirical Aspects of Nuclear Shape Phase Transitions“

Congratulations Rick Casten!

"Session 2: Empirical aspects of quantum phase transitions in nuclei"

Conveners: N.P. & Rick Casten



Tuesday morning July 12, 09:00-13:30

Empirical Aspects of QPTs (N. Pietralla, R.F. Casten)

09:00-11:00 Session

PIETRALLA, Norbert (Darmstadt) *Aspects of "Empirical Aspects"* [15+5]

GARRETT, Paul Edward (Guelph) *Nuclei with multiple shape coexistence* [20+10]

BEUSCHLEIN, Maïke (Darmstadt) *Investigation of the $B(E2; 0^+_1 \rightarrow 2^+_1)$ value of ^{116}Sn* [8+7]

MAHESHWARI, Bhoomika (Zagreb) *Evolution of nuclear structure in and around semi-magic nuclei* [15+5] ↔ Bruno Olaizola

STETZ, Tim (Darmstadt) *M1 Transition strength of the mixed-symmetry 2^+ state of ^{132}Te* [8+7]

WERNER, Volker (Darmstadt) *Boundaries of the QPT and evolution of deformation in rare earth nuclei* [8+7]

11:30-13:30 Session

BUTLER, Peter (Liverpool) *Studies of pear-shaped nuclei* [20+10]

BECK, Tobias (FRIB, MSU) $\Delta K = 1$ *Coriolis mixing of 1^+ states of ^{164}Dy* [8+7]

PRILL, Sarah (Cologne) *Lifetime measurements around $A=100$ with py -coincidence DSAM* [15+10]

ESMAYLZADEH, Arwin (Koeln) *Investigation of shape coexistence and γ -softness in the neutron rich $A \approx 100$ region using lifetime measurements* [15+5]

VON SPEE, Franziskus (Koeln, IKP) *Signs of shape coexistence in mid-shell Te isotopes* [15+5]



One Slide for Discussion

Why is the 2^+_{1+} state of Nd isotopes the lowest in the entire Rare Earths ?

