Compilation/Evaluation near Z~ 10 to 12 and N~20: “Island of Inversion”

Shamsu Basunia, LBNL

Balraj Singh, Chris Ouellet and Scott Geraedts
McMaster University

Boris Pritychenko, BNL

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Brief History

- From $^{26\text{-}32}$Na mass measurements: C. Thibault *et al.* (PRC **12**, 1975, 644) reported higher binding energies for ^{31}Na and ^{32}Na than expected from theoretical predictions. They suggested a strong deformed region near N~20
- Measuring first 2+ state of ^{32}Mg at 885 keV (PRC **19**, 1979, 164) and later deducing mass excess for ^{31}Mg and ^{32}Mg (Nucl. Phys. **A394**, 1983, 378): C. Détraz *et al.* provided additional experimental support for the deformed region near N~20
- E. K. Warburton *et al.* (PRC **41**, 1990, 1147) used the term "Island of Inversion" for nuclei Z ≅ 10-12 and N ≅ 18-22 with further evidence from binding energy calculations
- K. Heyde and J. L. Wood (J. Phys. G. **17**, 1991, 135) also came to the conclusion of low-lying 0^+ intruder states and related shape co-existence in the neutron-rich N=20 nuclei from an independent review on binding energies

Experimental facility

- New experimental (RIB) facilities have allowed spectroscopic studies of these exotic neutron-rich nuclides in recent years
- Main experimental facilities:
  - NSCL, MSU, USA
  - GANIL, France
  - ISOLDE/CERN, Switzerland
  - RIKEN, Japan
  - GSI, Germany

Experiment

- Production and spectroscopy involves:
  - Fragmentation of primary beam
  - Separation and acceleration of the secondary beam, and
  - Finally further fragmentation or knock-out reactions using a secondary target
  - Gamma ray detection by large γ-ray detector array and particles by 4π particle detector

Properties include:

- Large anomalous binding energy
- Intruder ground state or mixing
- Prolate deformation

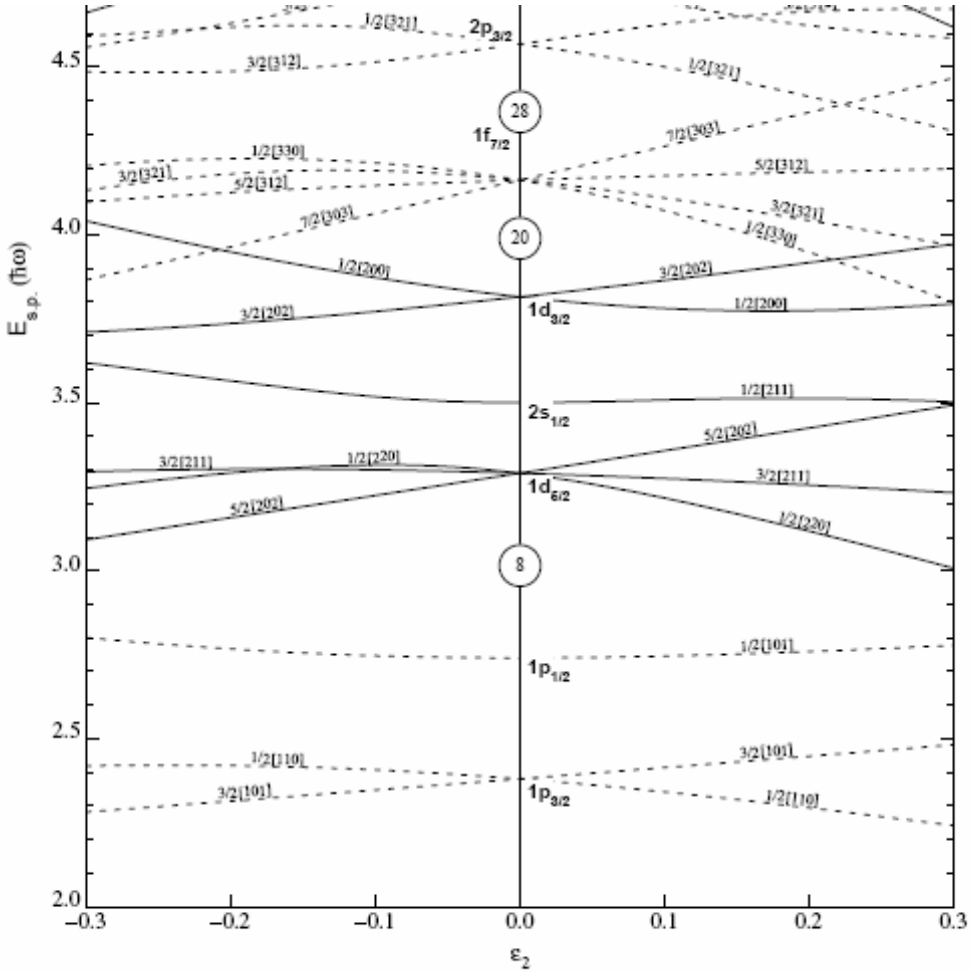
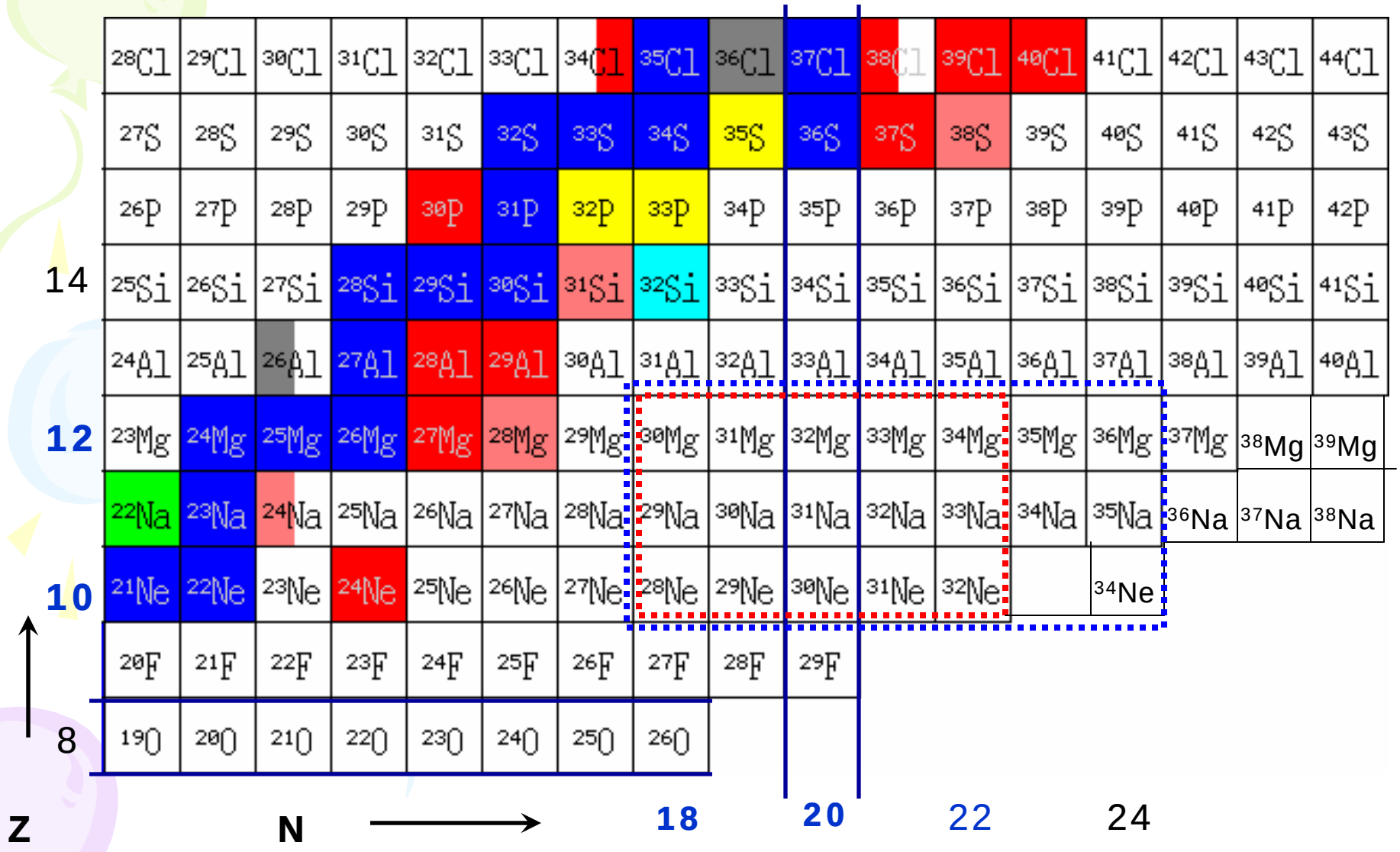


Figure 4. Nilsson diagram for protons or neutrons, Z or N ≤ 50 (ε_4 = 0).

- Spectroscopic studies include:
  - Excited state energies (Large γ-detector arrays)
  - Ground-state spins and parities
  - Precision mass measurements (Penning-trap)
  - Cross sections for population of levels
  - Transition Probabilities, Log *ft* values
  - Static Magnetic and Quadrupole moments etc.
  - Ground State nuclear radius

- Focus: Study of nuclear properties and boundary/edge of the “Island of Inversion”


28Cl 29Cl 30Cl 31Cl 32Cl 33Cl 34Cl 35Cl 36Cl 37Cl 38Cl 39Cl 40Cl 41Cl 42Cl 43Cl 44Cl
27S 28S 29S 30S 31S 32S 33S 34S 35S 36S 37S 38S 39S 40S 41S 42S 43S
26P 27P 28P 29P 30P 31P 32P 33P 34P 35P 36P 37P 38P 39P 40P 41P 42P
14
25Si 26Si 27Si 28Si 29Si 30Si 31Si 32Si 33Si 34Si 35Si 36Si 37Si 38Si 39Si 40Si 41Si
24Al 25Al 26Al 27Al 28Al 29Al 30Al 31Al 32Al 33Al 34Al 35Al 36Al 37Al 38Al 39Al 40Al
12
23Mg 24Mg 25Mg 26Mg 27Mg 28Mg 29Mg 30Mg 31Mg 32Mg 33Mg 34Mg 35Mg 36Mg 37Mg 38Mg 39Mg
22Na 23Na 24Na 25Na 26Na 27Na 28Na 29Na 30Na 31Na 32Na 33Na 34Na 35Na 36Na 37Na 38Na
10
21Ne 22Ne 23Ne 24Ne 25Ne 26Ne 27Ne 28Ne 29Ne 30Ne 31Ne 32Ne 34Ne
20F 21F 22F 23F 24F 25F 26F 27F 28F 29F
8
19O 20O 21O 22O 23O 24O 25O 26O
Z
N
18
20
22
24

Current ENSDF Status

^{30}Mg Jan,99	^{31}Mg **To be Submitted**	^{32}Mg Mar,04	^{33}Mg Feb,07	^{34}Mg **To be Submitted**	^{35}Mg Jan,99	^{36}Mg Sep,07
^{29}Na Jan,99	^{30}Na Jan,99	^{31}Na Oct,06	^{32}Na Jan,99	^{33}Na Jan,99	^{34}Na Jan,99	^{35}Na Jan,99
^{28}Ne Jan,99	^{29}Ne Jan,99	^{30}Ne Dec,06	^{31}Ne Oct,06	^{32}Ne Jan,99		^{34}Ne Oct,06

Importance

- A current subject of interest

RAPID COMMUNICATIONS

PHYSICAL REVIEW C, VOLUME 65, 061304(R)

Structure of the "island of inversion" nucleus ^{33}Mg

B. V. Pritychenko,[1,2]* T. Glasmacher,[1,2] P. D. Cottle,[3] R. W. Ibbotson,[1,†] K. W. Kemper,[3] L. A. Riley,[4] A. Sakharuk,[1,‡] H. Scheit,[1,2,§] M. Steiner,[1] and V. Zelevinsky[1,2]

[1]*National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824*

[2]*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824*

[3]*Department of Physics, Florida State University, Tallahassee, Florida 32306*

[4]*Department of Physics and Astronomy, Earlham College, Richmond, Indiana 47374*

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The excitation of the 485-keV state of the neutron-rich "island of inversion" nucleus ^{33}Mg was measured in intermediate-energy Coulomb excitation. The result of the present experiment suggests that the 485-keV state is a rotational excitation built on the ground state, not a state with different intrinsic structure as proposed previously. If the 485-keV state is indeed a rotational excitation, then the deformation of ^{33}Mg is similar to that of other nuclei in the island of inversion.

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The "island of inversion" in the neutron-rich isotopes near ^{32}Mg is a spectacular example of shape coexistence in nuclei, a severe test of our understanding of the mechanism of this phenomenon, and an important challenge for experi-

other nuclei in the island of inversion. A recent β-decay study of ^{33}Mg [17] has suggested that the 485-keV excited state has a different intrinsic structure from the ground state. In this latter study the ground state of $N=21$ ^{33}Mg is as-

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Structure of Exotic Nuclei and Nuclear Forces

Transition to the Island of Inversion: Study of Excited States in $^{28-30}$Ne

P. Fallon[1], E. Rodriguez-Vieitez[1,2], D. Bazin[3], C. M. Campbell[3,4], J. M. Cook[3,4], R.M. Clark[1], D.-C. Dinca[3,4], A. Gade[3,4], T. Glasmacher[3,4], I-Y. Lee,[1] A. O. Macchiavelli[1], W. F. Mueller[3], S. G. Prussin[2], M. Wiedeking[1], K. Yoneda[3,4]

[1]Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

[2]Department of Nuclear Engineering, University of California, Berkeley, CA 94720, USA

[3]National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824, USA

[4]Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA

pfallon@lbl.gov

Abstract. An experiment was conducted at the National Superconducting Cyclotron Laboratory (MSU) to study N~20 Ne and Na nuclei. A 140 MeV/A ^{48}Ca primary beam

PRL 99, 072502 (2007) PHYSICAL REVIEW LETTERS week ending 17 AUGUST 2007

Spectroscopy of ^{36}Mg: Interplay of Normal and Intruder Configurations at the Neutron-Rich Boundary of the "Island of Inversion"

A. Gade,[1,2] P. Adrich,[1] D. Bazin,[1] M. D. Bowen,[1,2] B. A. Brown,[1,2] C. M. Campbell,[1,2] J. M. Cook,[1,2] S. Ettenauer,[1] T. Glasmacher,[1,2] K. W. Kemper,[3] S. McDaniel,[1,2] A. Obertelli,[1] T. Otsuka,[4,5] A. Ratkiewicz,[1,2] K. Siwek,[1,2] J. R. Terry,[1,2] J. A. Tostevin,[6] Y. Utsuno,[7] and D. Weisshaar[1]

[1]*National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824, USA*
[2]*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824, USA*
[3]*Department of Physics, Florida State University, Tallahassee, Florida 32306, USA*
[4]*Department of Physics and Center for Nuclear Study, University of Tokyo, Hongo, Tokyo 113-0033, Japan*
[5]*RIKEN, Hirosawa, Wako-shi, Saitama 351-0198, Japan*
[6]*Department of Physics, School of Electronics and Physical Sciences, University of Surrey, Guildford, Surrey GU2 7XH, United Kingdom*
[7]*Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan*
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Compilation/Evaluation

- Horizontal/Nuclide?

- Process, work plan:
  - Evaluation procedures: as for ENSDF
  - Review: continuous or one-year cycle for relevant nuclei
  - Include Author comments of the measured quantity and calculation relevant to the properties of the “Island of Inversion”
  - Consider relevant theory papers?

Compilation/Evaluation and Dissemination

- Evaluation - LBNL and McMaster
  - Current responsibility in this mass region:
    - LBNL: A = 21-30: expect to finish relevant nuclei by March, 2008
    - McMaster: A = 31- 44: expect to finish relevant nuclei by December, 2007
- Dissemination:
    - Web base: NNDC