Beta decay of deformed halos

A. O. Macchiavelli, Physics Division – ORNL

Contribution to the Nuclear Structure and Reaction Theory Working Group
2022 NSAC Long-Range Plan Town Hall Meeting

Rotational Motion
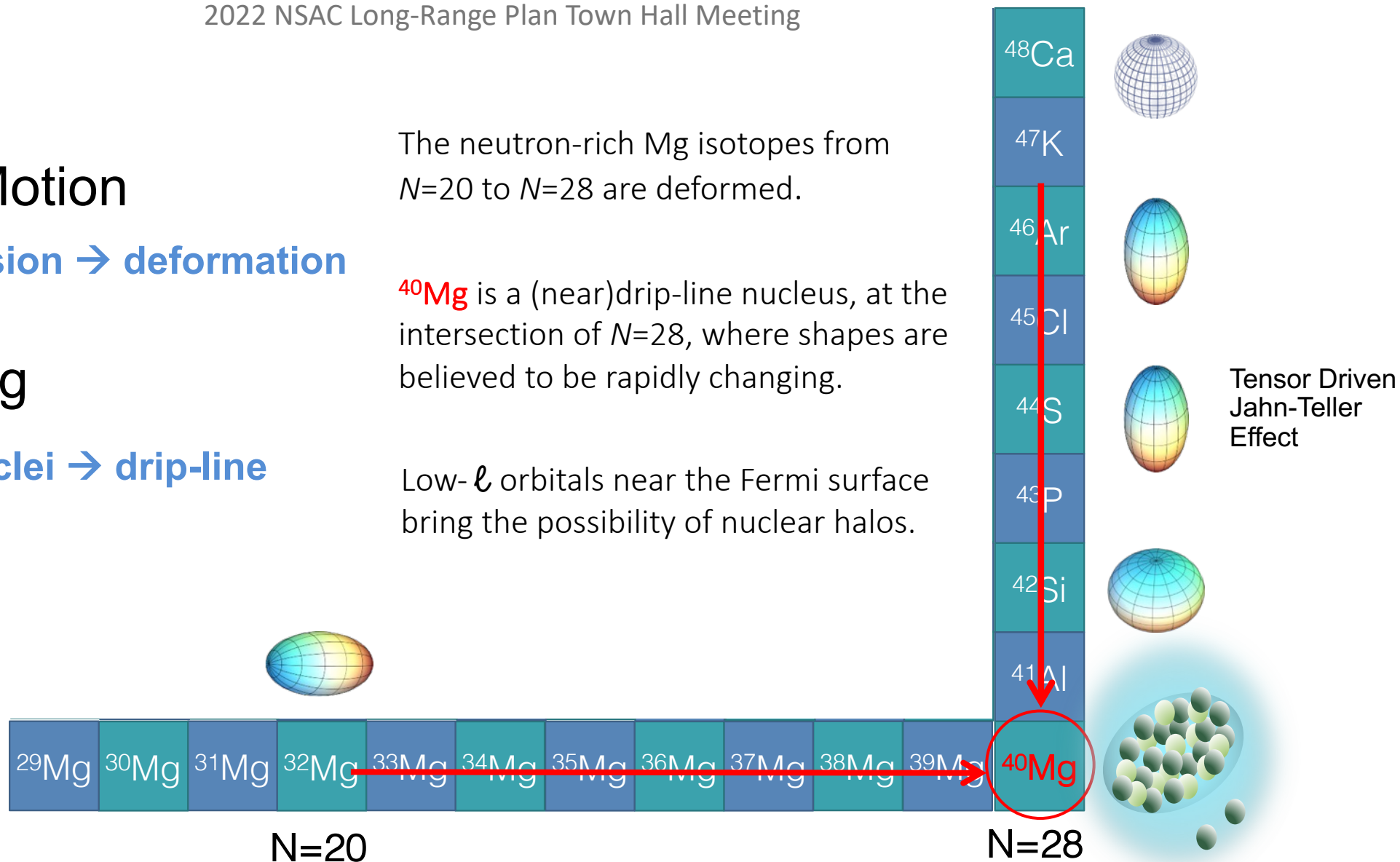
Islands of Inversion → deformation

Weak binding

Neutron-rich nuclei → drip-line

The neutron-rich Mg isotopes from $N=20$ to $N=28$ are deformed.

^{40}**Mg** is a (near)drip-line nucleus, at the intersection of $N=28$, where shapes are believed to be rapidly changing.

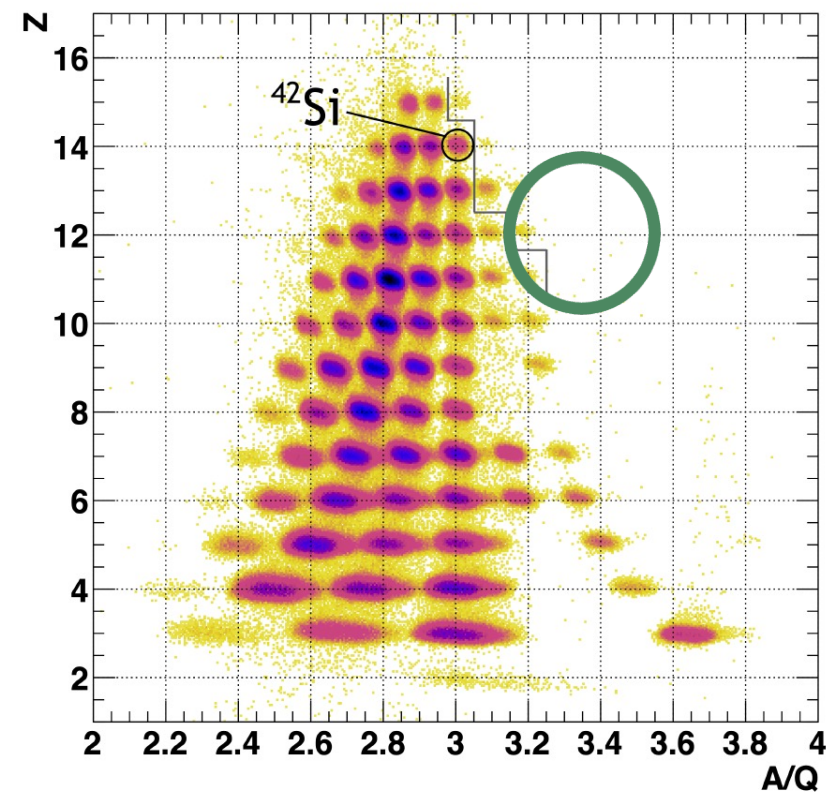Low-ℓ orbitals near the Fermi surface bring the possibility of nuclear halos.

Tensor Driven Jahn-Teller Effect

| ^{48}Ca |
| ^{47}K |
| ^{46}Ar |
| ^{45}Cl |
| ^{44}S |
| ^{43}P |
| ^{42}Si |
| ^{41}Al |
| ^{40}Mg |

| ^{29}Mg | ^{30}Mg | ^{31}Mg | ^{32}Mg | ^{33}Mg | ^{34}Mg | ^{35}Mg | ^{36}Mg | ^{37}Mg | ^{38}Mg | ^{39}Mg | ^{40}Mg |

N=20

N=28

OAK RIDGE
National Laboratory

2

First Spectroscopy of the Near Drip-line Nucleus ^{40}Mg

H. L. Crawford,[1,*] P. Fallon,[1] A. O. Macchiavelli,[1] P. Doornenbal,[2] N. Aoi,[3] F. Browne,[2] C. M. Campbell,[1]
S. Chen,[2] R. M. Clark,[1] M. L. Cortés,[2] M. Cromaz,[1] E. Ideguchi,[3] M. D. Jones,[1,†] R. Kanungo,[4,5]
M. MacCormick,[6] S. Momiyama,[7] I. Murray,[6] M. Niikura,[7] S. Paschalis,[8] M. Petri,[8] H. Sakurai,[2,7]
M. Salathe,[1] P. Schrock,[9] D. Steppenbeck,[9] S. Takeuchi,[2,10] Y. K. Tanaka,[11]
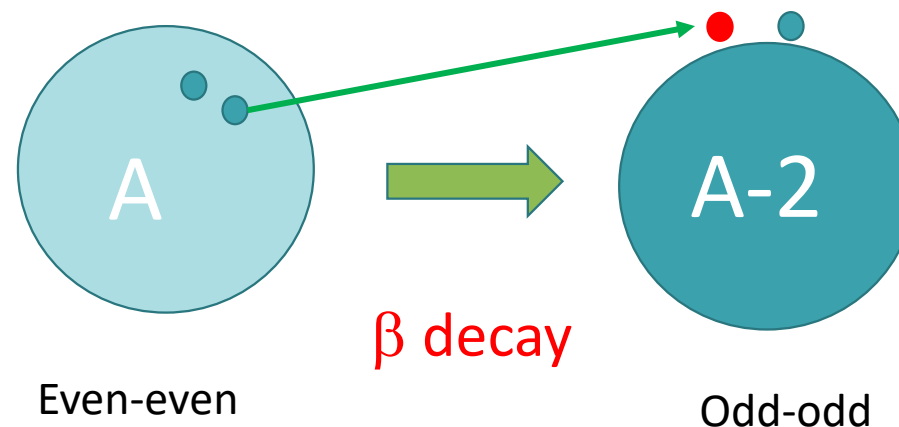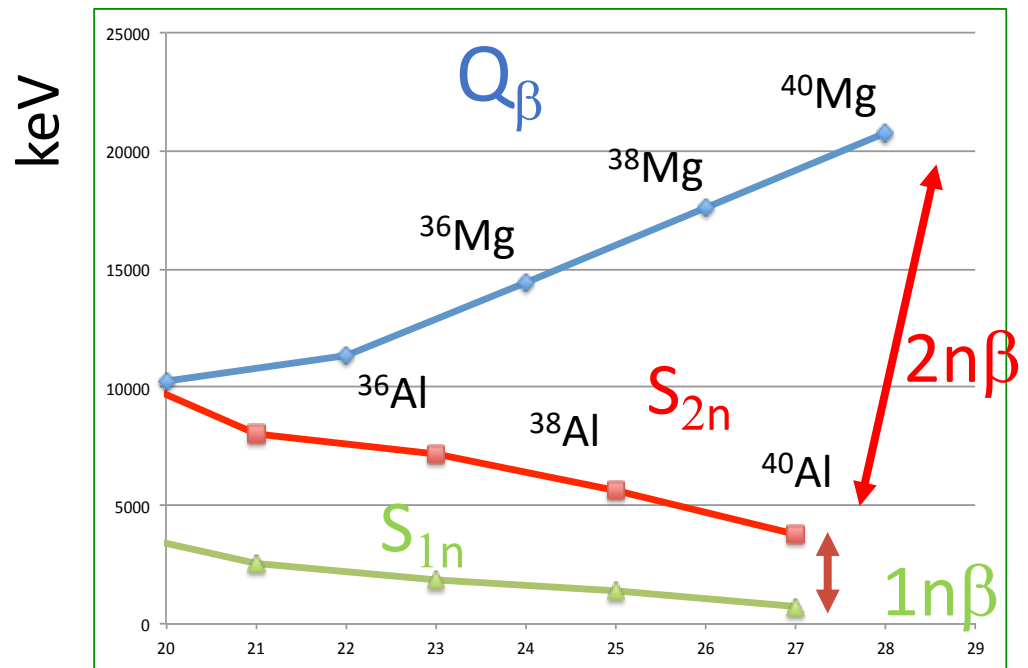R. Taniuchi,[7] H. Wang,[2] and K. Wimmer[7]
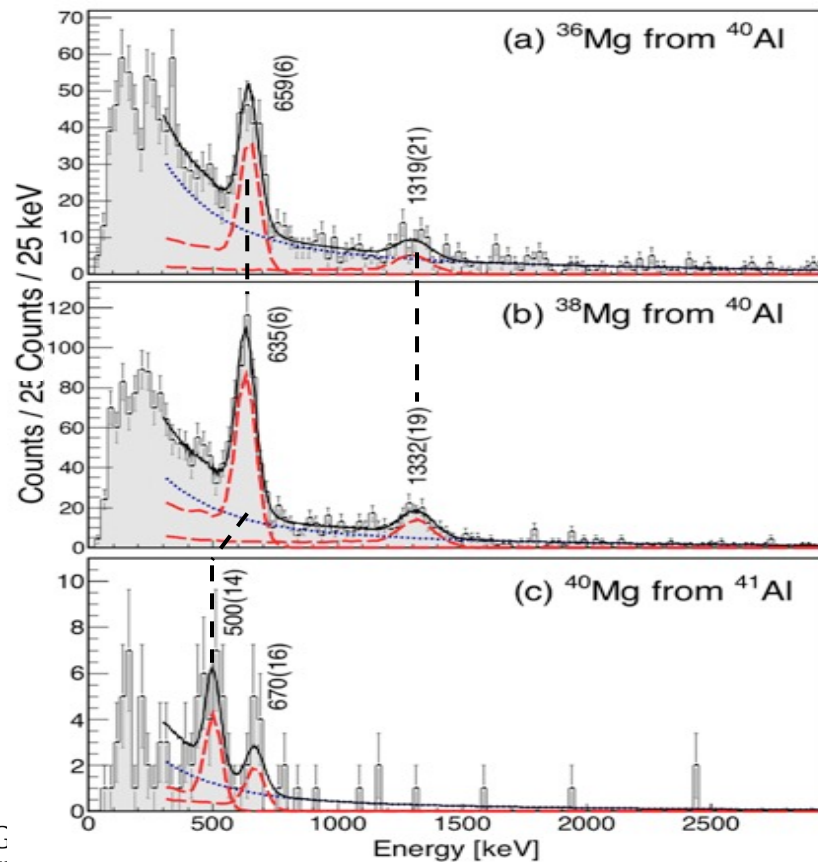
Crossing $N = 28$ Toward the Neutron Drip Line: First Measurement of Half-Lives at FRIB
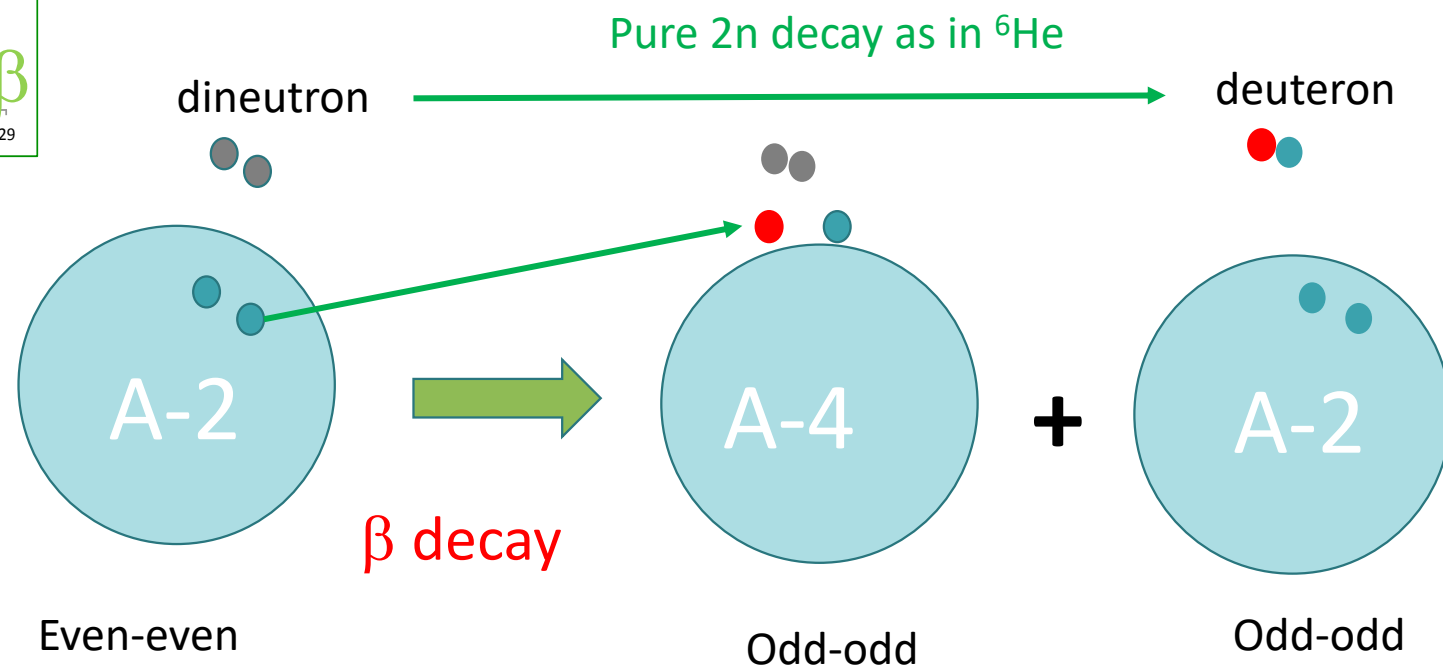
H. L. Crawford,[1,*] V. Tripathi,[2] J. M. Allmond,[3] B. P. Crider,[4] R. Grzywacz,[5] S. N. Liddick,[6,7] A. Andalib,[6,8] E. Argo,[6,8]
C. Benetti,[2] S. Bhattacharya,[2] C. M. Campbell,[1] M. P. Carpenter,[9] J. Chan,[5] A. Chester,[6] J. Christie,[5] B. R. Clark,[4] I. Cox,[5]
A. A. Doetsch,[6,8] J. Dopfer,[6,8] J. G. Duarte,[10] P. Fallon,[1] A. Frotscher,[1] T. Gaballah,[4] T. J. Gray,[3] J. T. Harke,[10] J. Heideman,[5]
H. Heugen,[5] R. Jain,[6,8] T. T. King,[3] N. Kitamura,[5] K. Kolos,[10] F. G. Kondev,[9] A. Laminack,[3] B. Longfellow,[10] R. S. Lubna,[6]
S. Luitel,[4] M. Madurga,[5] R. Mahajan,[6] M. J. Mogannam,[6,7] C. Morse,[11] S. Neupane,[5] A. Nowicki,[5] T. H. Ogunbeku,[4,6]
W.-J. Ong,[10] C. Porzio,[1] C. J. Prokop,[12] B. C. Rasco,[3] E. K. Ronning,[6,7] E. Rubino,[6] T. J. Ruland,[13] K. P. Rykaczewski,[3]
L. Schaedig,[6,8] D. Seweryniak,[9] K. Siegl,[5] M. Singh,[5] S. L. Tabor,[2] T. L. Tang,[2] T. Wheeler,[6,8] J. A. Winger,[4] and Z. Xu[5]

OAK RIDGE National Laboratory

^{40}Mg beta decay

Q_β

^{40}Mg

^{38}Mg

^{36}Mg

^{36}Al

S_{2n}

^{38}Al

$2n\beta$

^{40}Al

keV

S_{1n}

$1n\beta$

For example, ^{36,38}Mg

β decay

Even-even

Odd-odd

A

A-2

Pure 2n decay as in ^{6}He

dineutron

deuteron

A-2

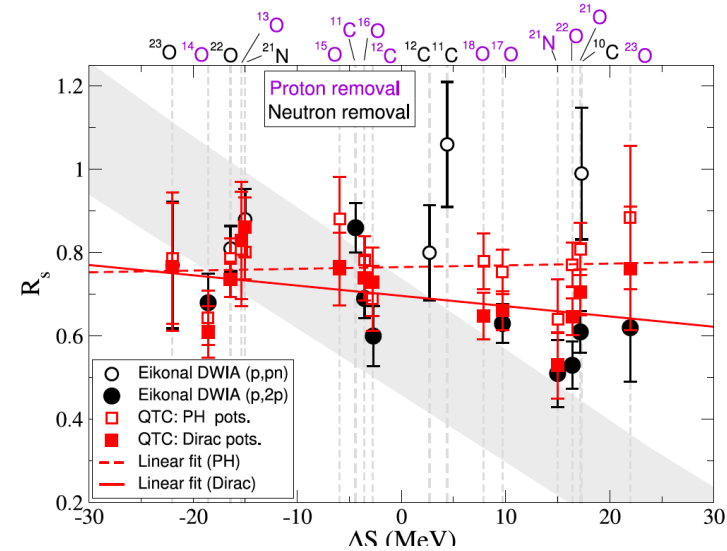A-4

A-2

β decay

Even-even

Odd-odd

Odd-odd

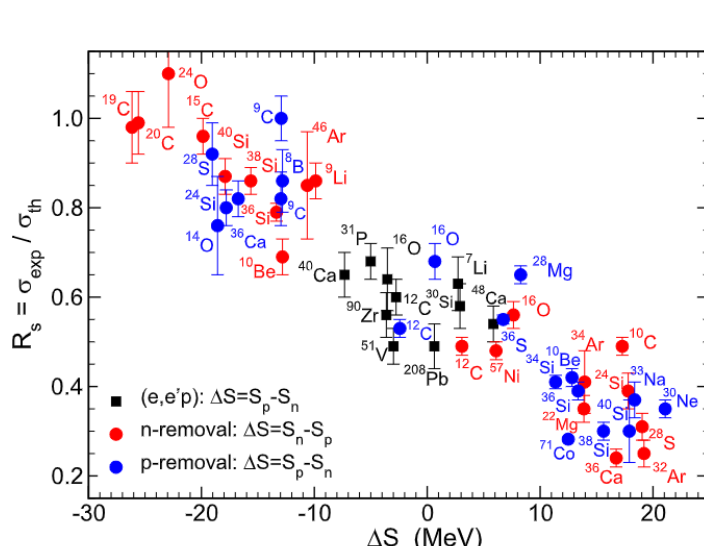**OAK RIDGE** National Laboratory

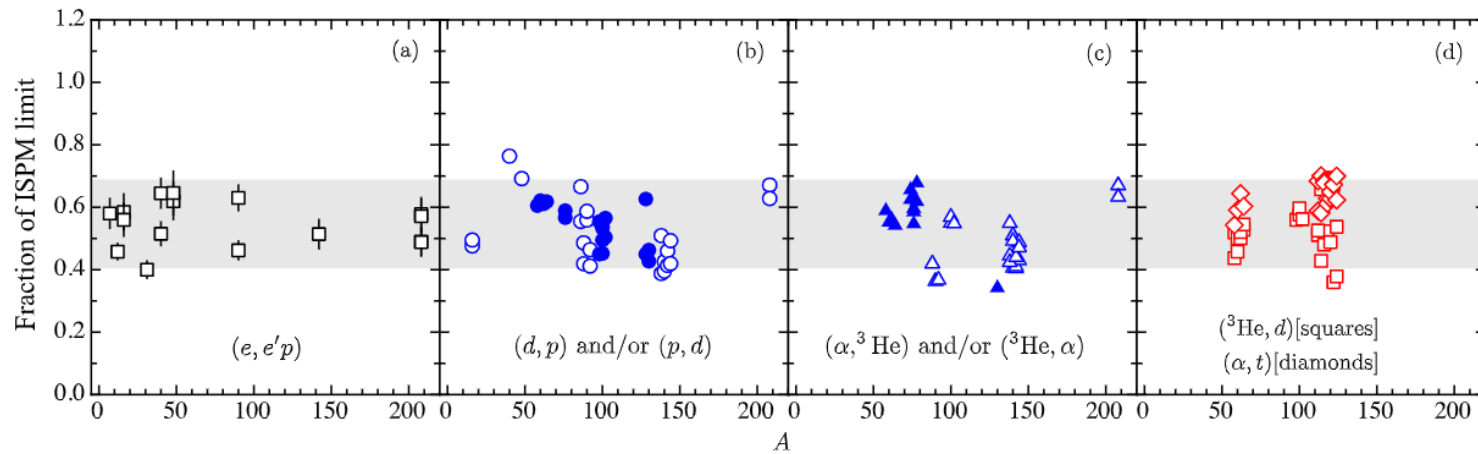# The relation of single-particle SF's quenching and that of TNA's ?

A. O. Macchiavelli, Physics Division – ORNL

Contribution to the Nuclear Structure and Reaction Theory Working Group
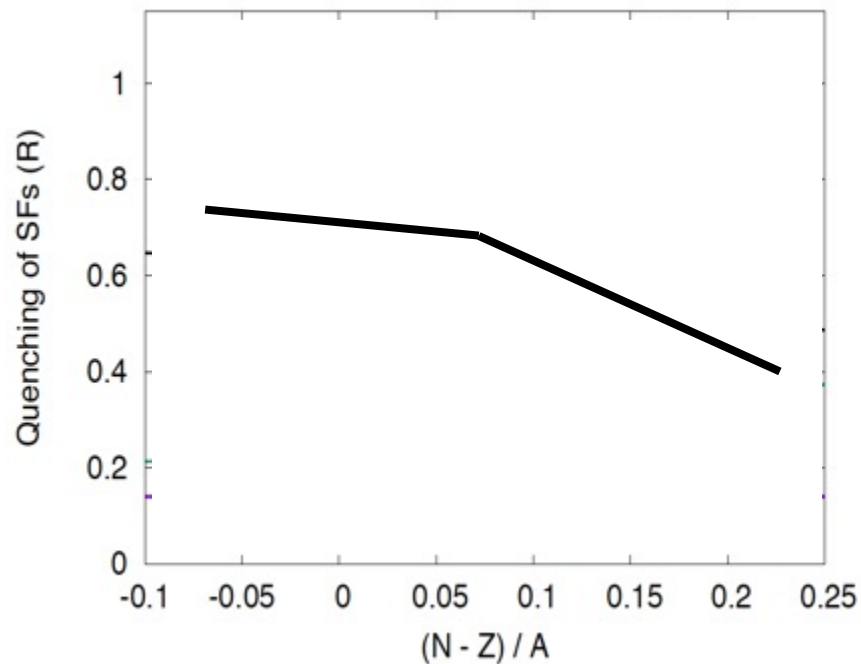2022 NSAC Long-Range Plan Town Hall Meeting

LRC, SRC, Reaction

Two nucleon direct reactions where 2 neutrons are deposited or picked up at the same point in space provide an specific tool to probe the amplitude of pairing collectivity (PV, BCS, BEC)

The transition operators $\langle f|a^+a^+|i\rangle$, $\langle f|aa|i\rangle$ are the analogous to the transition probabilities BE2′s on the quadrupole case.

?????

One-nucleon direct reaction   Two-nucleon direct reaction

OAK RIDGE
National Laboratory