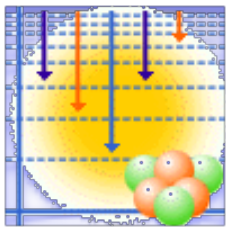
B(E3) Evaluation Update



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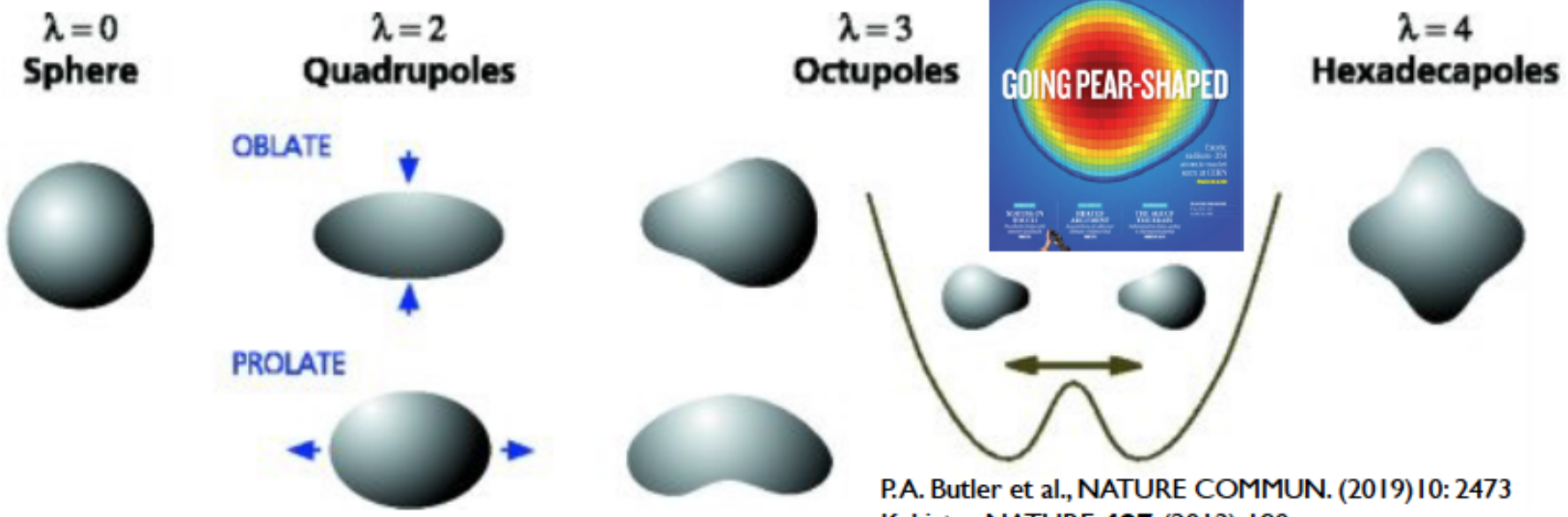
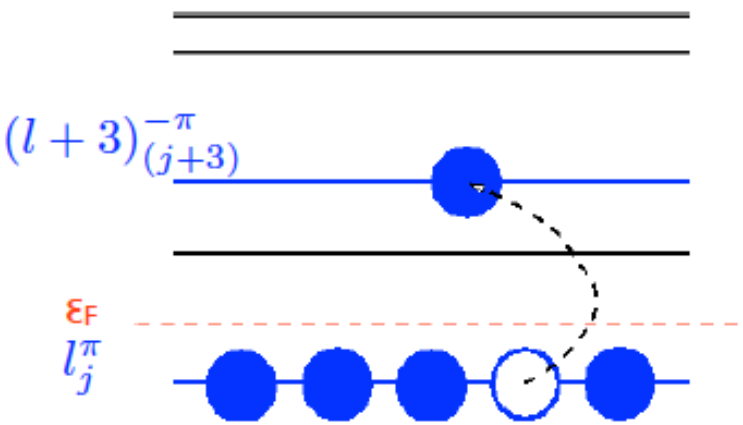
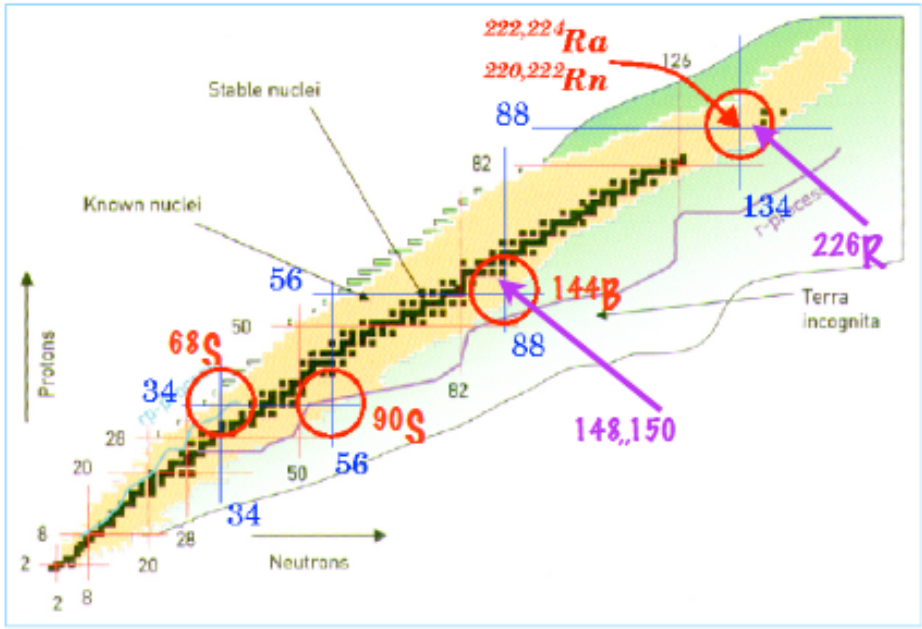
P.A. Butler and W. Nazarewicz,, Rev. Mod. Phys. **68** (1996) 349



P.A. Butler et al., NATURE COMMUN. (2019)10: 2473
K. Lister, NATURE **497** (2013) 190
L.P. Gaffney et al., NATURE **497** (2013) 199

Intruder orbitals of opposite parity and ΔJ, ΔL = 3 close to the Fermi level





Octupole Collectivity

Macroscopically...

Nuclei take on a "pear" shape

- β_3-vibration
- β_2-deformation + β_3-softness
- static β_3-deformation?

Signatures...

- Odd-even staggering, π=-
- Parity doublets in odd-*A* nuclei
- Enhanced E1 transitions
- Large E3 strength

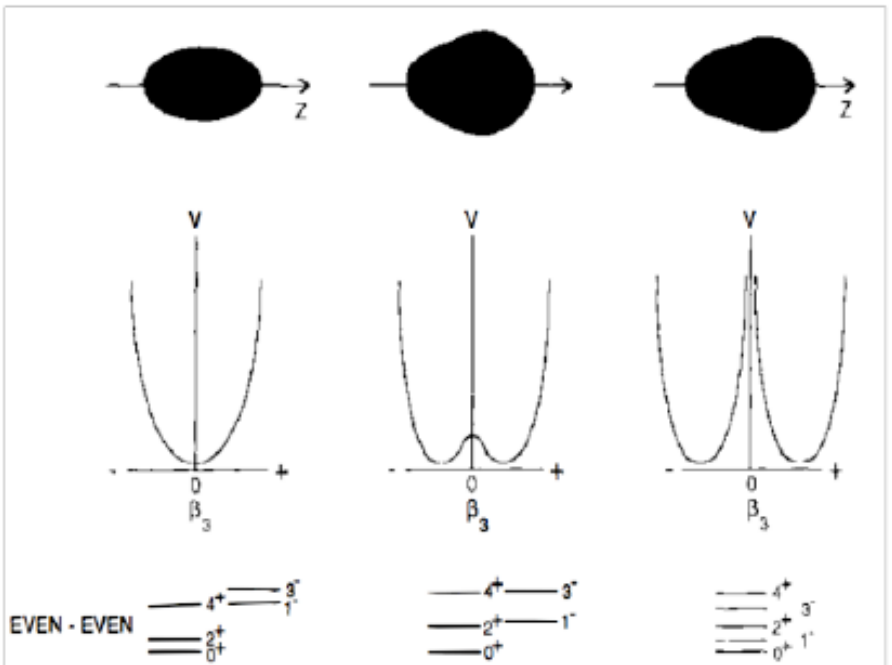


Image: I.Ahmed and P.A. Butler, Ann. Rev. Nucl. Part. Sci (1993) **43**

$$B(E3;0^+ \rightarrow 3^-) \propto < 0^+ || E3 || 3^- >^2$$

$$\tau_{E3}[s] = 0.012264 \times E_{3_1^-}^{-7} \times [B(E3)\uparrow]^{-1}$$

$$E_{3_1^-}[MeV]; B(E3)\uparrow [e^2 fm^6]$$

$$\beta_3 = \frac{4\pi}{ZR^3}\sqrt{\frac{B(E3)\uparrow}{e^2}}$$

Previous B(E3) Evaluations

Ray Spear
1933-2018

Precision [%]	Nuclides
<2	1
[2:5]	8
[5:10]	41
[10:25]	70
>25	45
Total	**165**

- R.H. Spear, ADNDT **42** (1989) 55
- T. Kibédi and R.H. Spear, ADNDT **80** (2002) 35

Experimental procedures

a) **Coulomb Excitation** - model independent
   - Bombarding energy need to be low to avoid higher order effects (reorientation, interference, virtual excitations)

b) **Lifetime measurements** - model independent

c) **Inelastic electron scattering** - model dependent

d) **Deformation parameters (β_3) from inelastic scattering of nucleons and light ions** - highly model dependent

e) Miscellaneous procedures – low reliability

Updated B(E3) Evaluation

Collaboration between ANU & ANL
endorsed at the Workshop on Octupole Degree of Freedom (preceded INPC2019)

- Review new data; close to 200 publications with "B(E3)" key words since 2000;

  many on B(E3, $0^+_1 \rightarrow 3^-_1$)

  - ^{96}Zr (2019Is03): B(E3)=42(3) W.u.; was 53(6) W.u.; theoretical description is no longer a puzzle
  - ^{144}Ba (2016Bu02): B(E3)=48 (+25-34) W.u.; strong octupole correlation in A<200; 6 neutrons away from stable ^{138}Ba
  - ^{146}Gd (2016Or06): observation of multi-phonon excitations of the octupole type
  - ^{24}Mg & ^{28}Si (2009Ch33): new lower B(E3) from ^{6}Li elastic/inelastic scattering

- Extend the scope
  - include odd N(Z) and odd-odd nuclei
  - include isomeric states