Coulomb Excitation of Pear-shaped Nuclei

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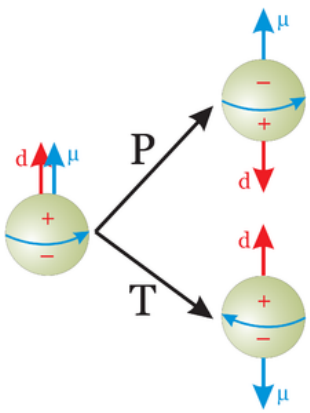
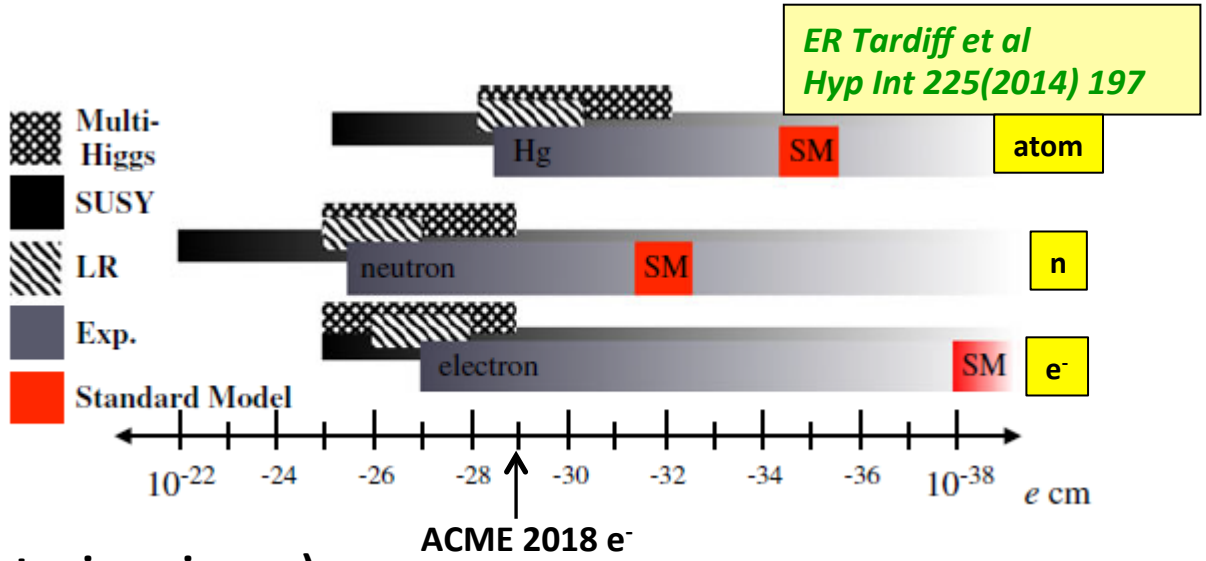
Measure level schemes in ^{224,226}Rn
- unknown so far.
Relevant to EDM searches

Measure B(E3)s in ^{222,224}Rn, ^{222,228}Ra
(previously measured ^{220}Rn, ^{224,226}Ra)
Search for other cases of static octupole deformation

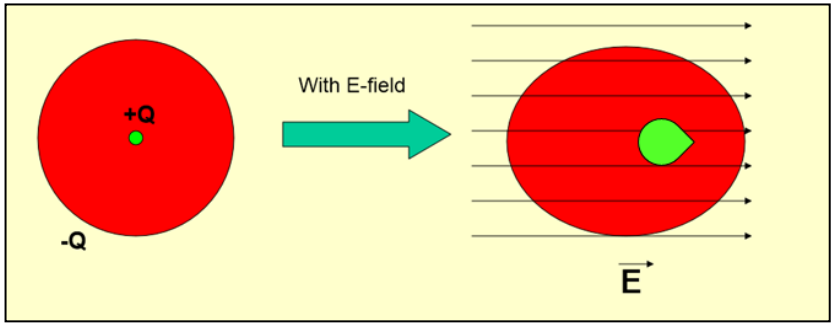
Pear-shapes and EDMs





CP-violation
(matter-antimatter asymmetry in universe)

atomic EDM



^{225}Ra [Argonne]

ΔE ~ 50 keV
Q_3 known for ^{224,226}Ra

^{223}Rn [TRIUMF]

ΔE *not known*
Q_3 known for ^{220}Rn

Schiff Moment

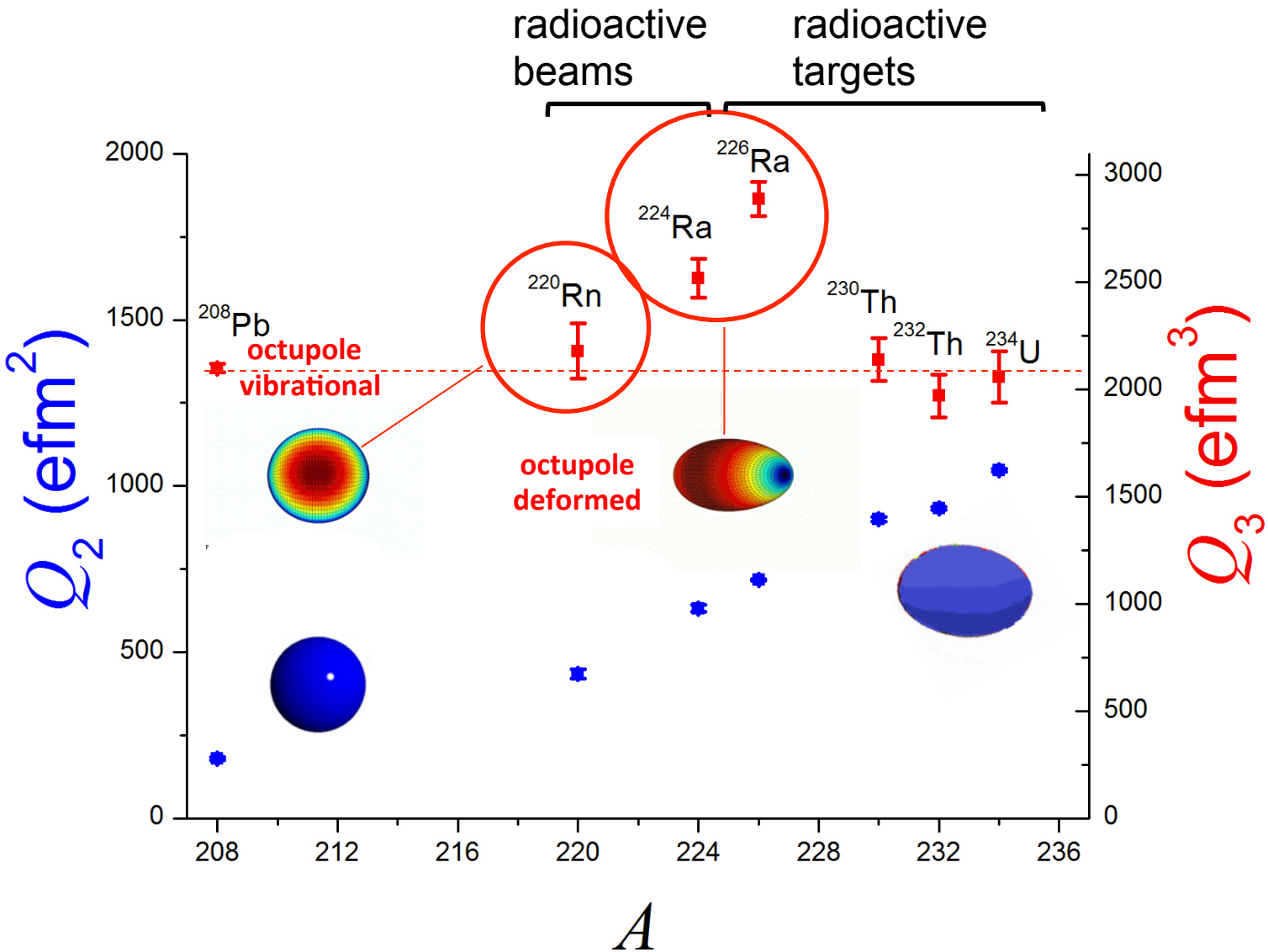
$$S = -2\frac{J}{J+1}\frac{\langle \hat{S}_z \rangle \langle \hat{V}_{PT} \rangle}{\Delta E}$$

related to Q_3 — P,T-violating interaction — energy splitting of parity doublet

E2 and E3 moments for heavy nuclei

LP Gaffney et al ^{220}Rn, ^{224}Ra
Nature 497 (2013) 199

HJ Wollersheim et al ^{226}Ra
NP A556 (1993) 261



Some experimental details: beams

HIE-ISOLDE + MINIBALL+CD July-August 2018

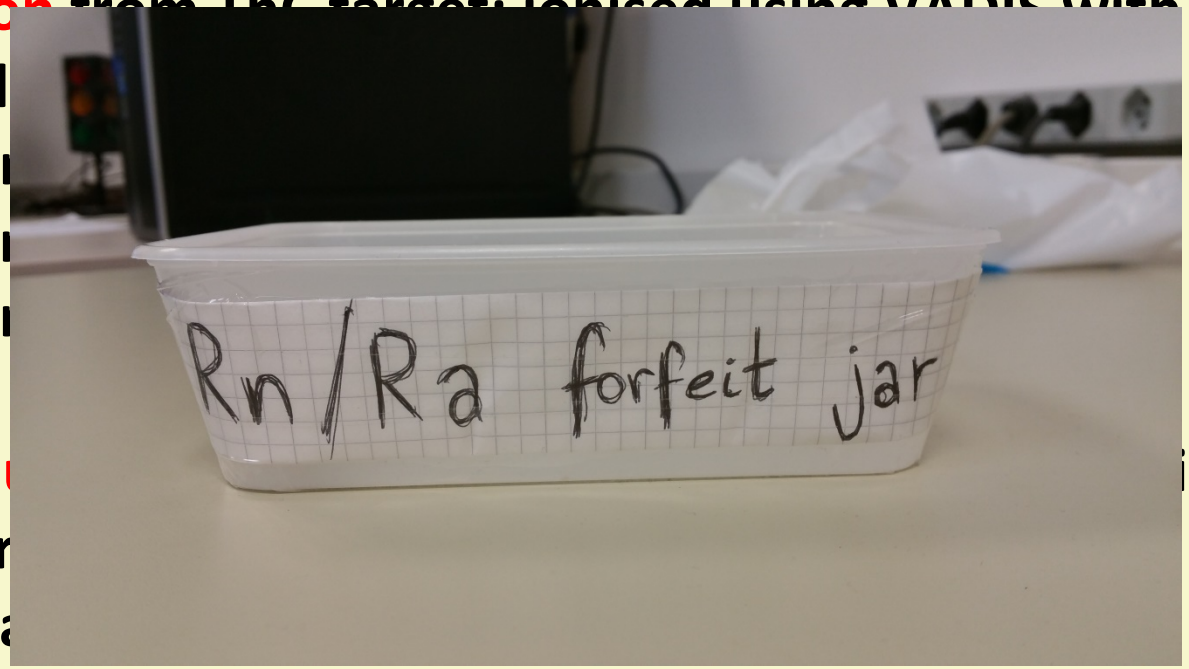
rado

cool

^{222}R

^{224}R

^{226}R



radi **ion**

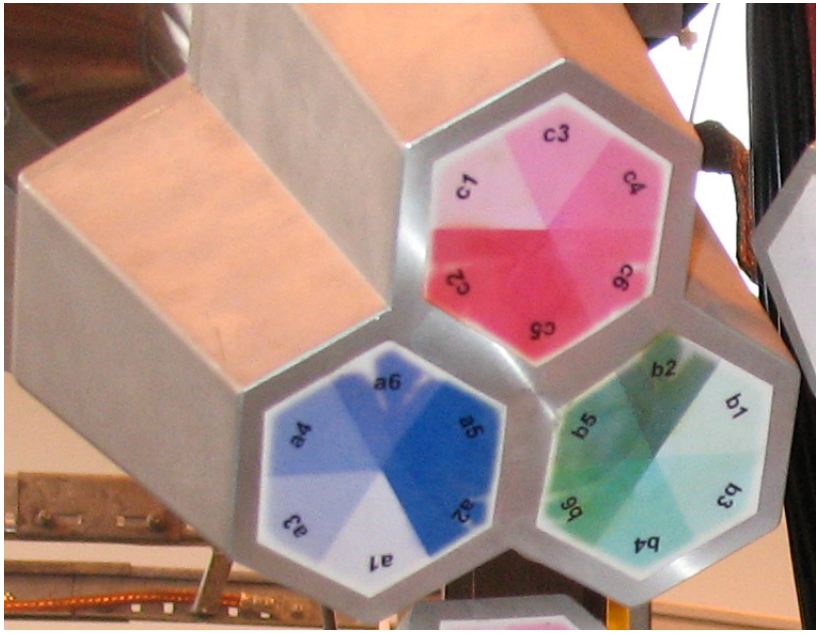
sour

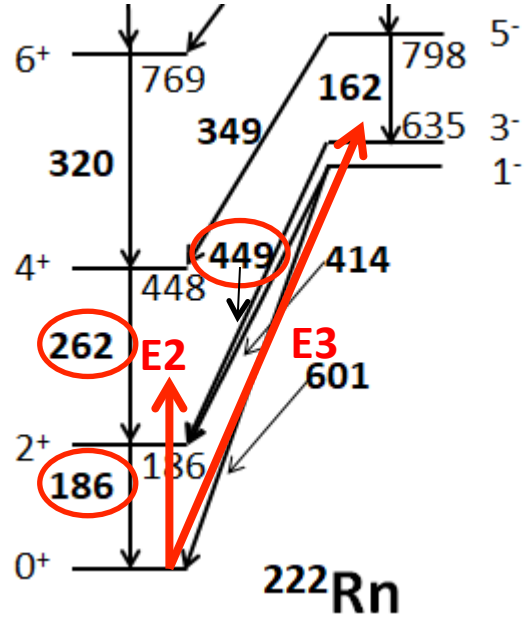
^{222}Ra

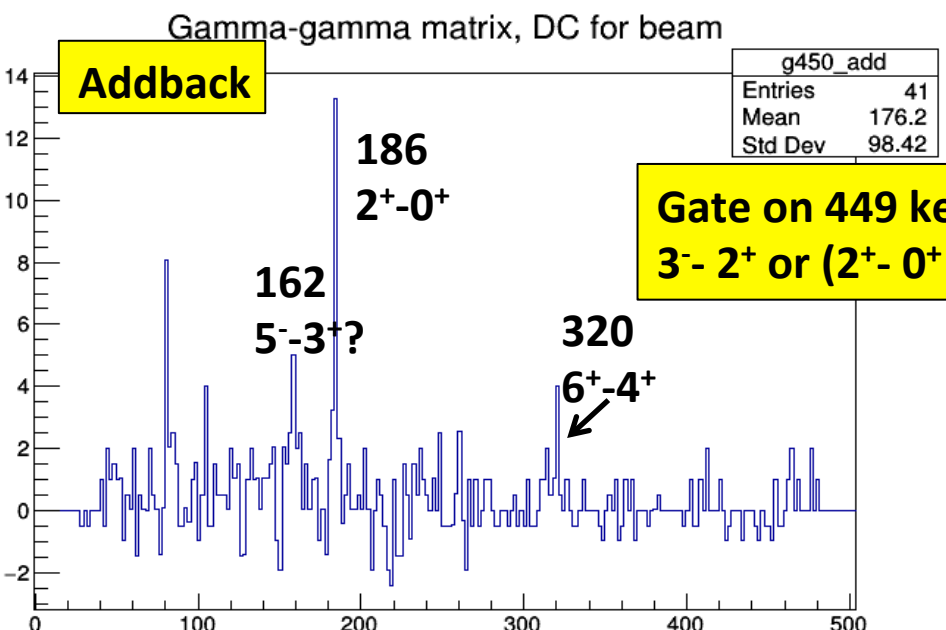
^{228}Ra 53^+ 4.31 MeV/u $6 \cdot 10^5$ /s

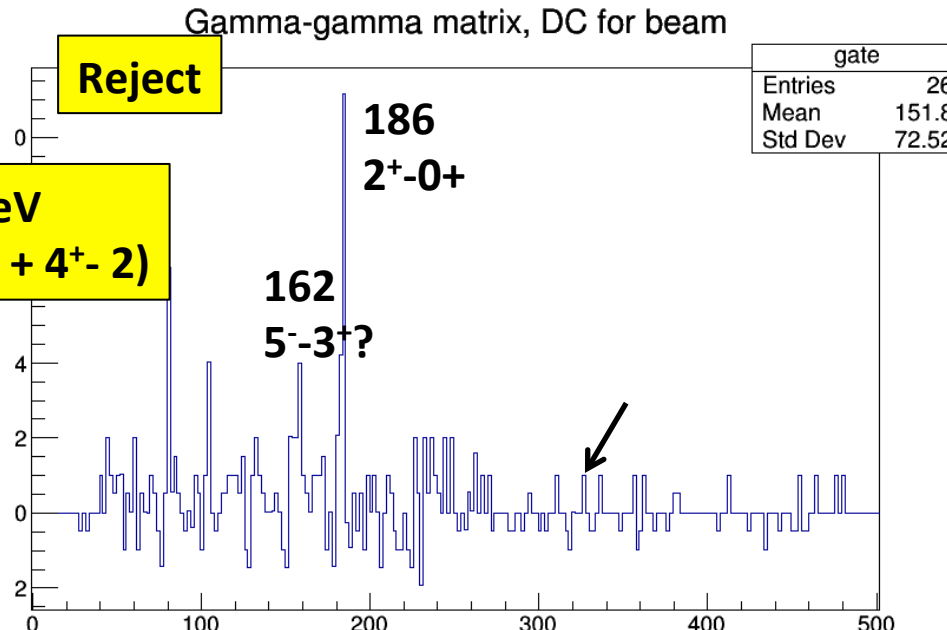
EBIS breeding time 500-700 ms

Some experimental details: Miniball operation

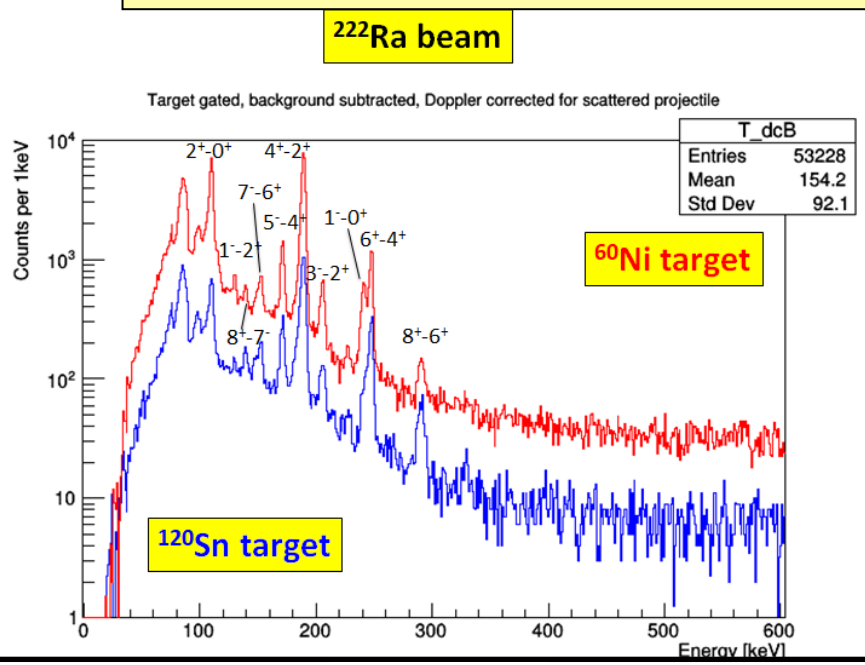


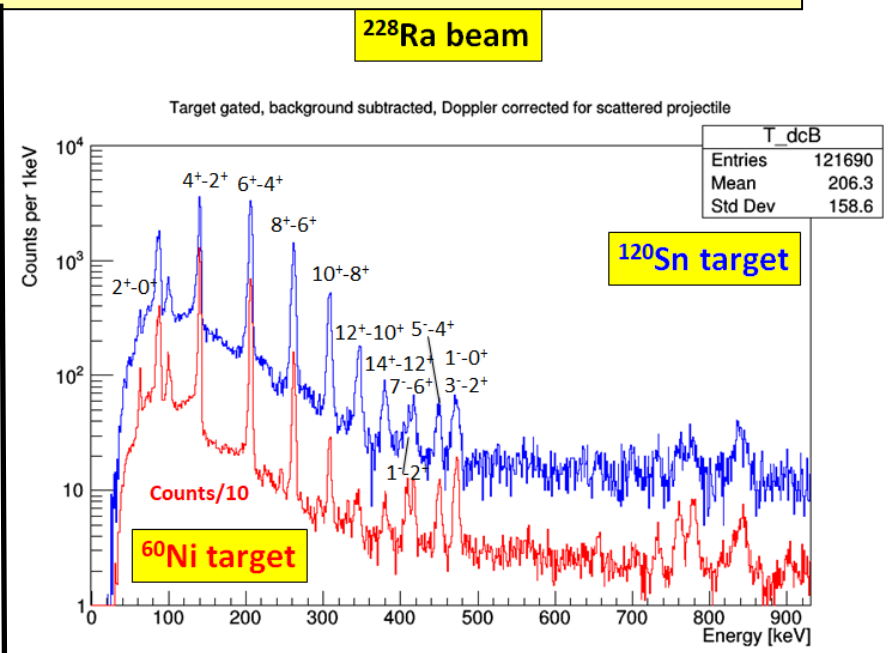


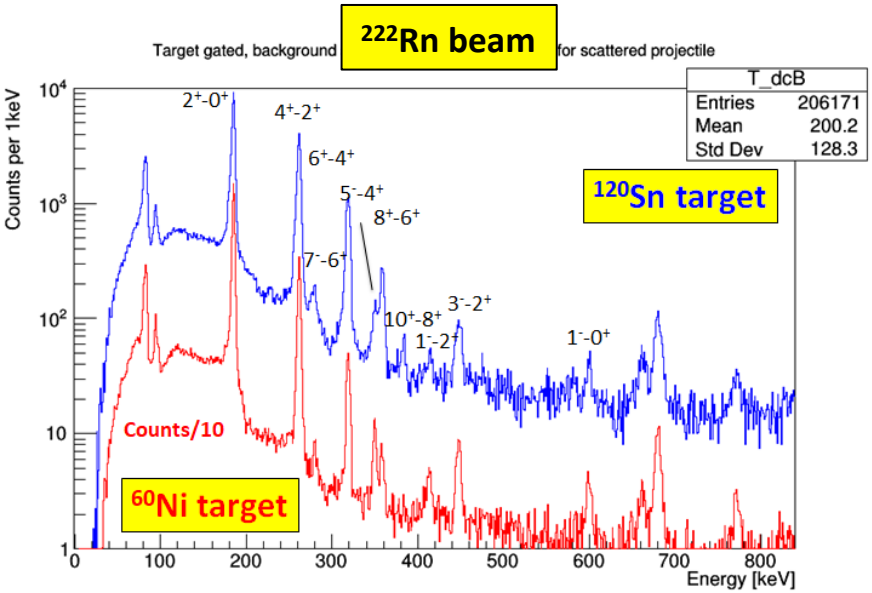


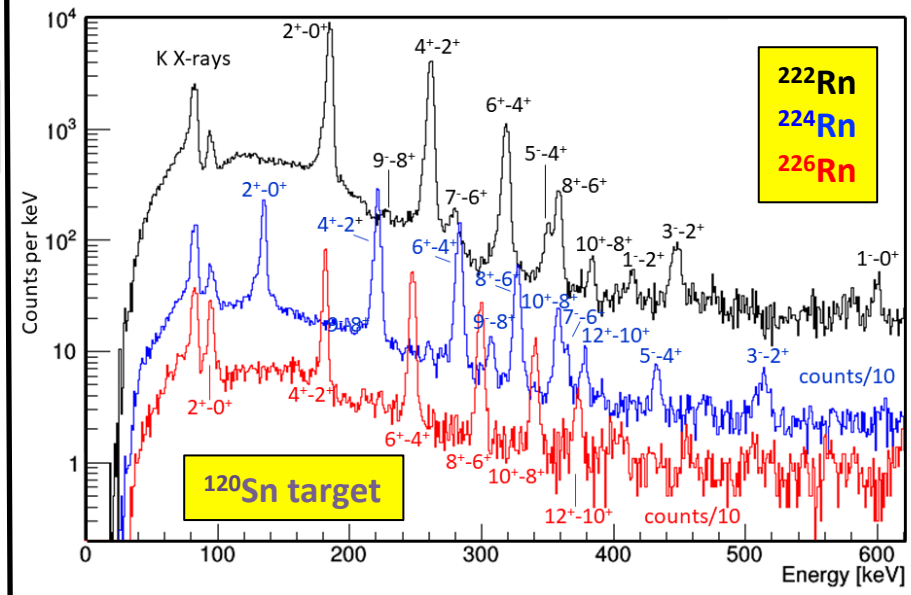


γ-ray spectra: Coulex of ^{222,224,226}Rn, ^{222,228}Ra

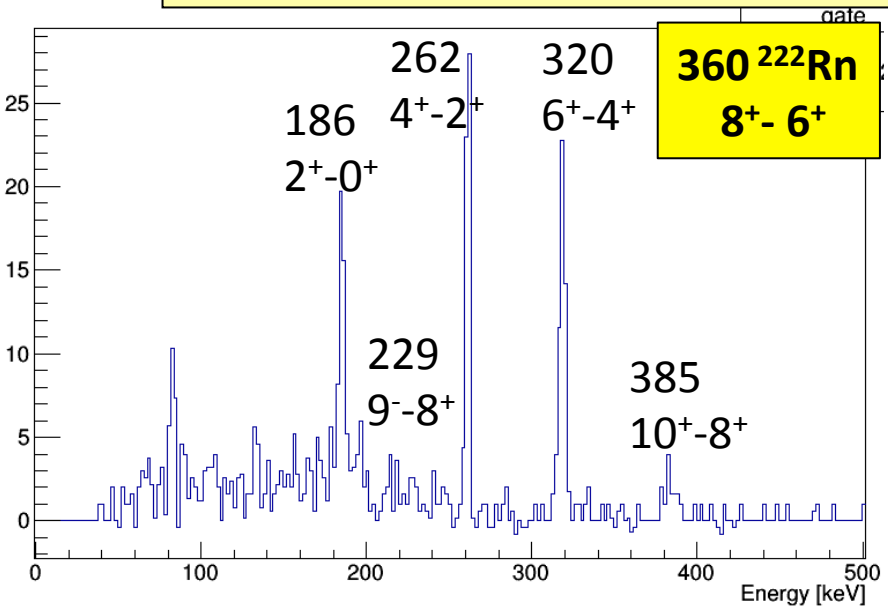


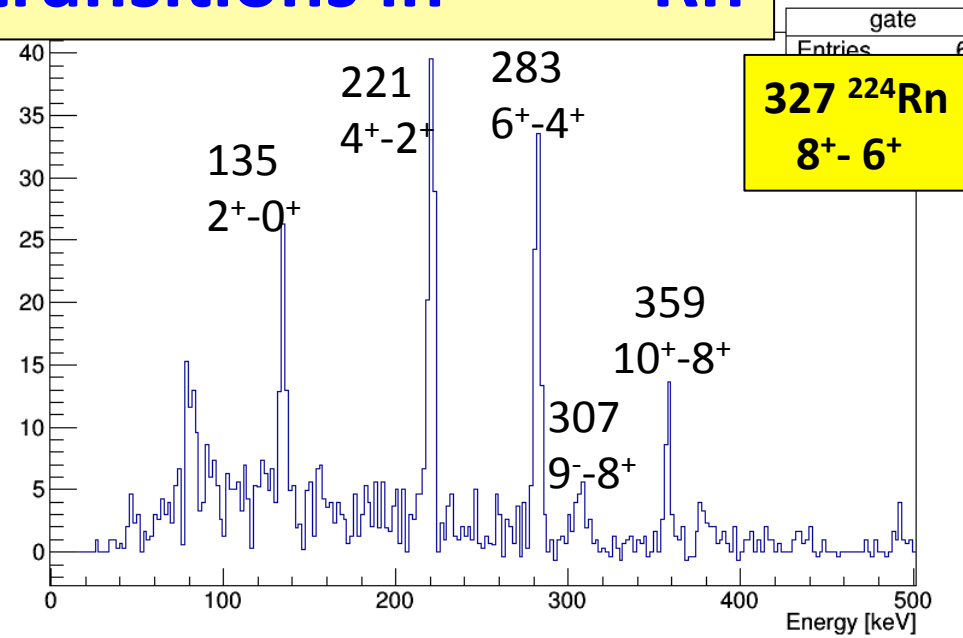


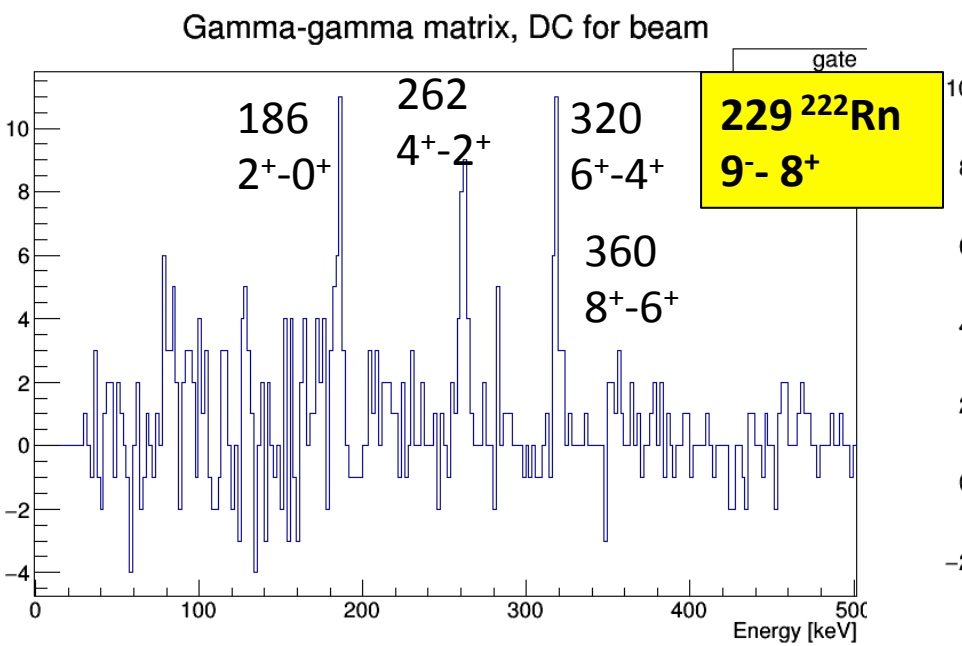


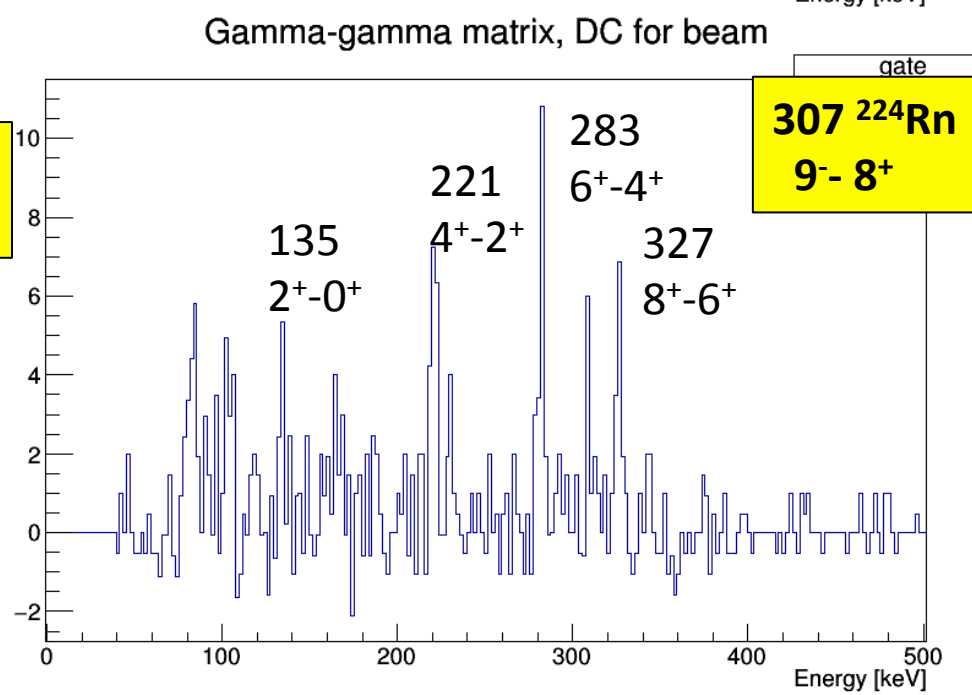


γ-γ spectra: gates on transitions in ^{222,224}Rn

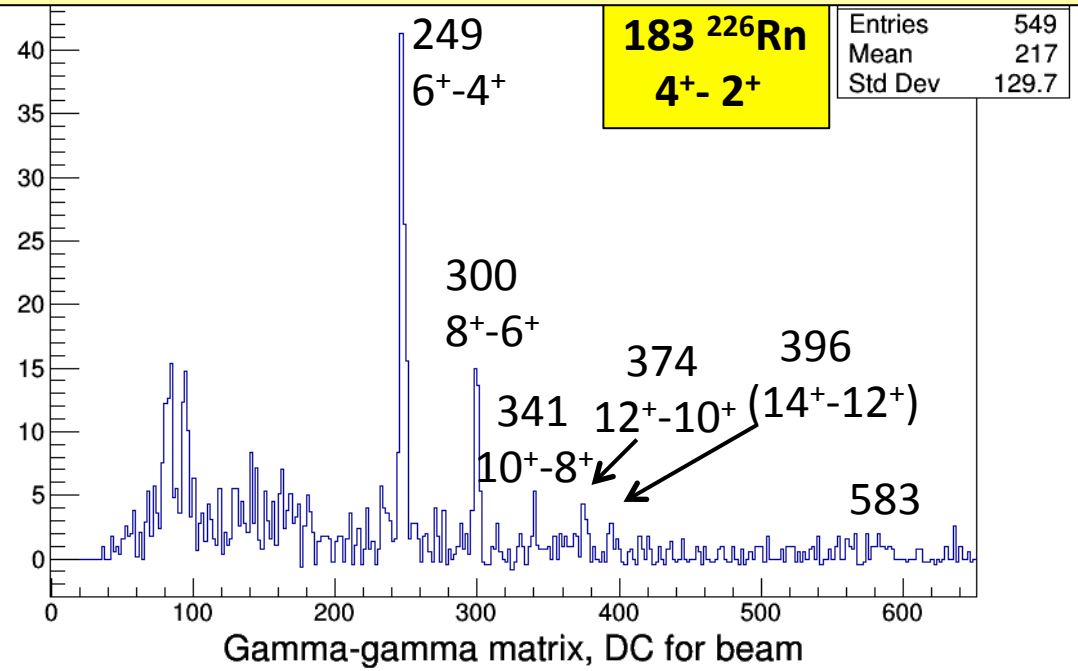


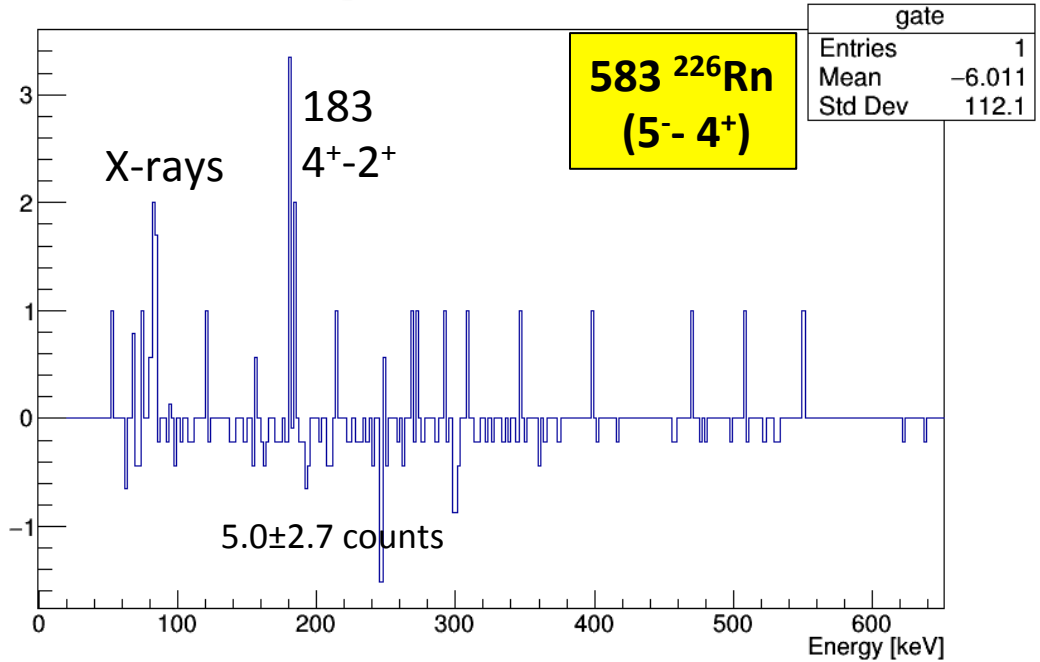






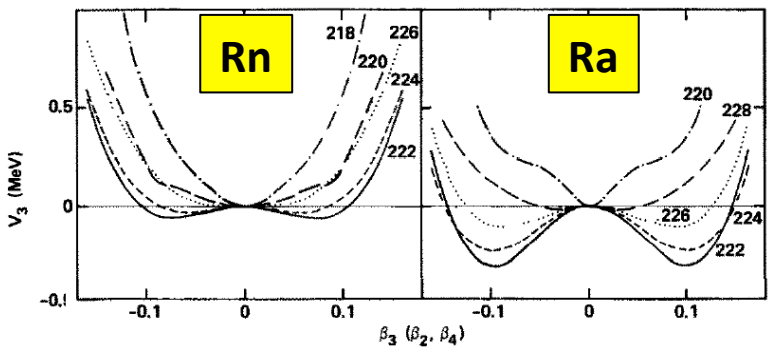
γ-γ spectra: gates on transitions in ^{226}Rn



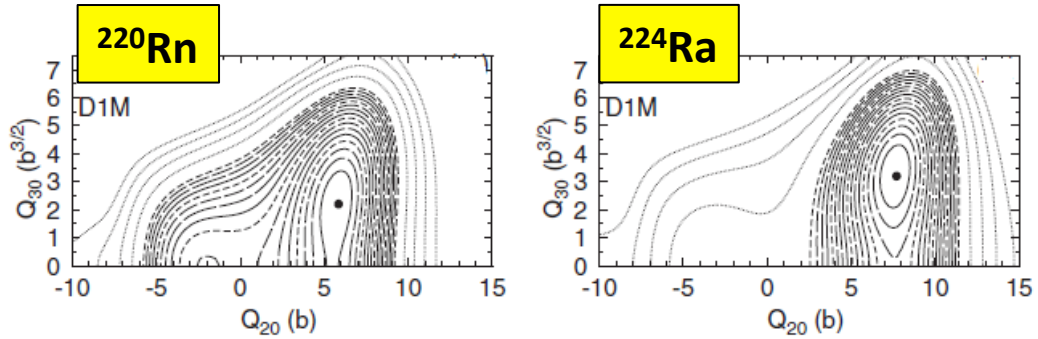


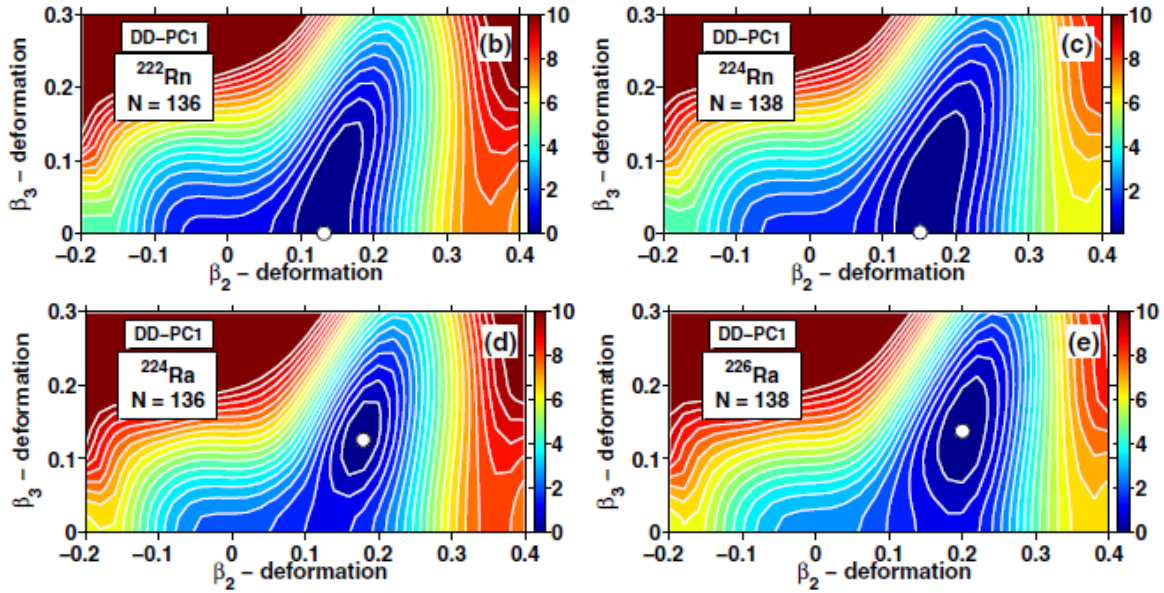
Theory

Nazarewicz et al. Strut. WS
NP A429 (1984) 269



Robledo & Butler HFB Gogny
PRC 88 (2013) 051302





Agbemava et al. Rel. HFB
PRC 93 (2016) 044304

Conclusions

Radon even-even nuclei are octupole vibrational, minimum around ^{222}Rn

Very unlikely that parity doublets will be observed for odd-A Rn

Schiff moment for candidate EDM search ^{223}Rn will not have the same enhancement as for ^{225}Ra.

Future analysis:

B(E3)s will be deduced for ^{222,228}Ra and ^{222,224}Rn

Acknowledgements

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