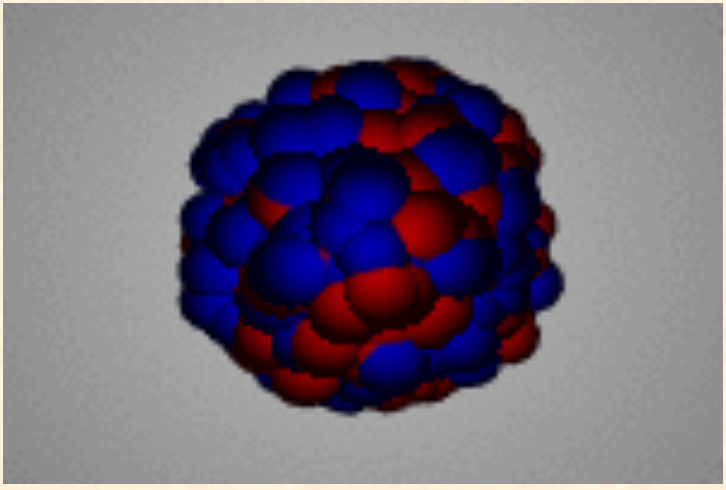
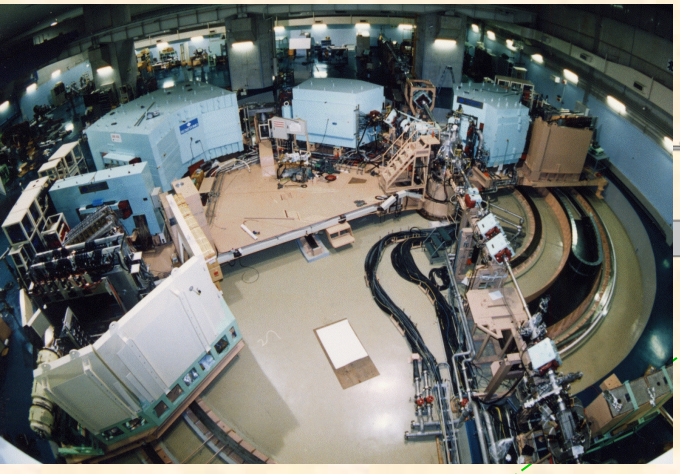
GMR in Stable (and some Unstable) Nuclei: What's New?

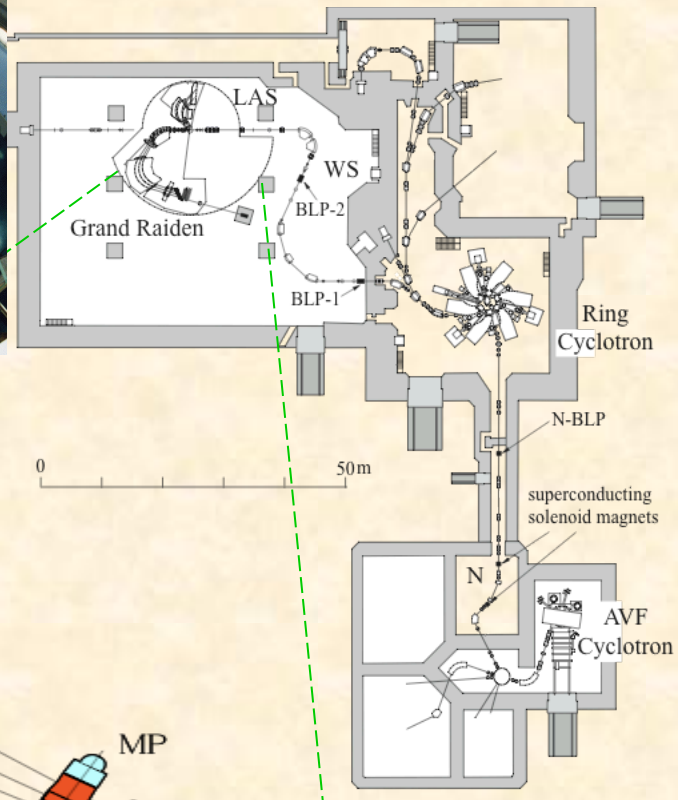


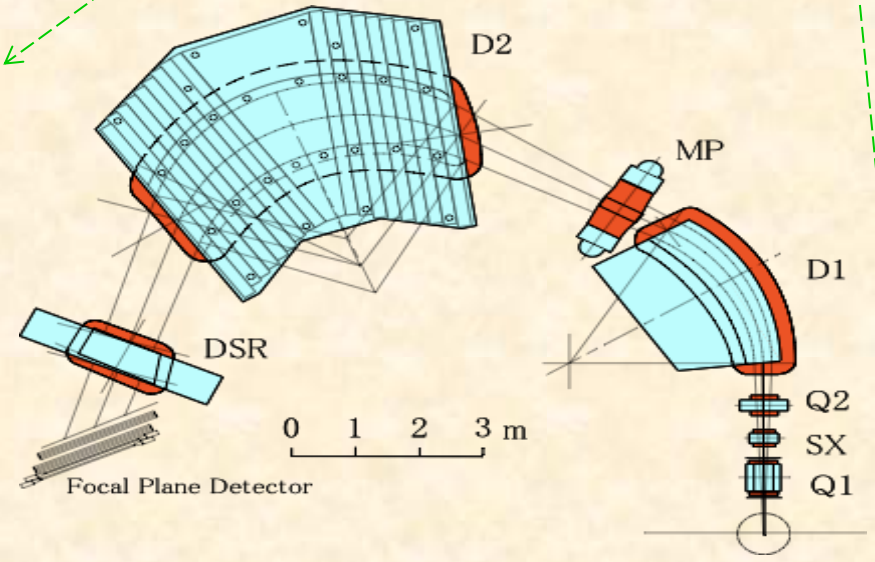
U. Garg
University of Notre Dame

Supported in part by the National Science Foundation

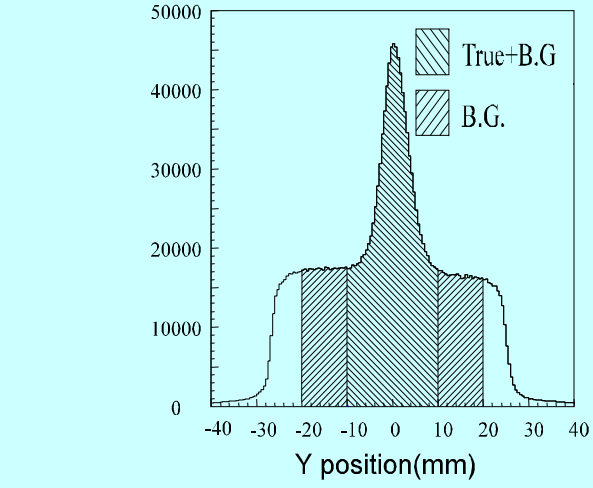
GDR Resanet: GMR Workshop, Orsay, November 25, 2020

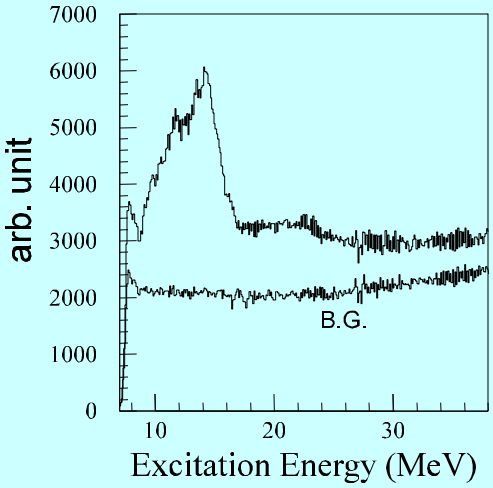


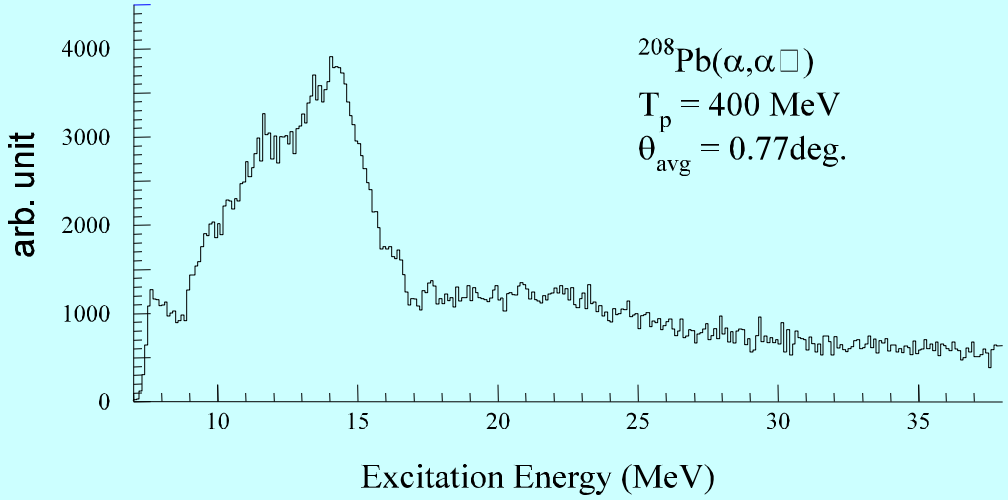

LAS
WS
BLP-2
BLP-1
Grand Raiden
Ring
Cyclotron
N-BLP
0
50m
superconducting
solenoid magnets
N
AVF
Cyclotron


D2
MP
D1
DSR
Q2
SX
Q1
0 1 2 3 m
Focal Plane Detector

386 MeV (α,α')



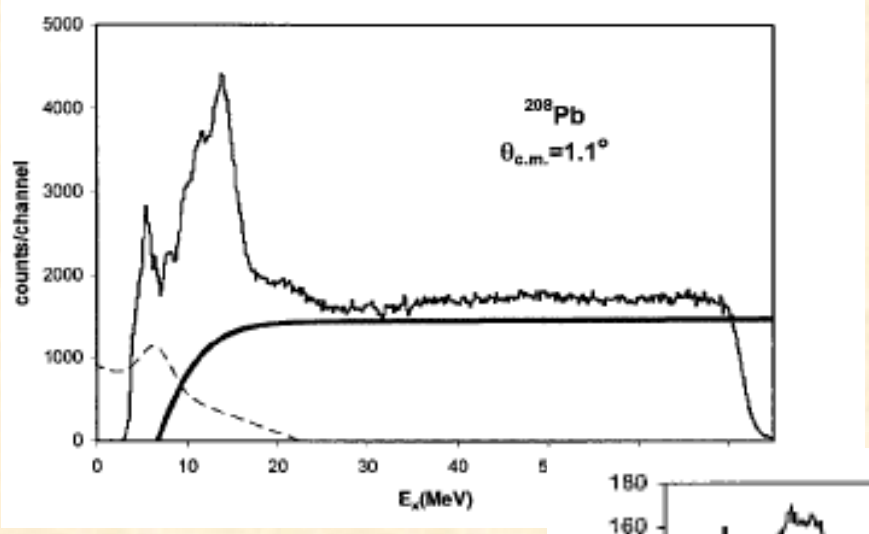


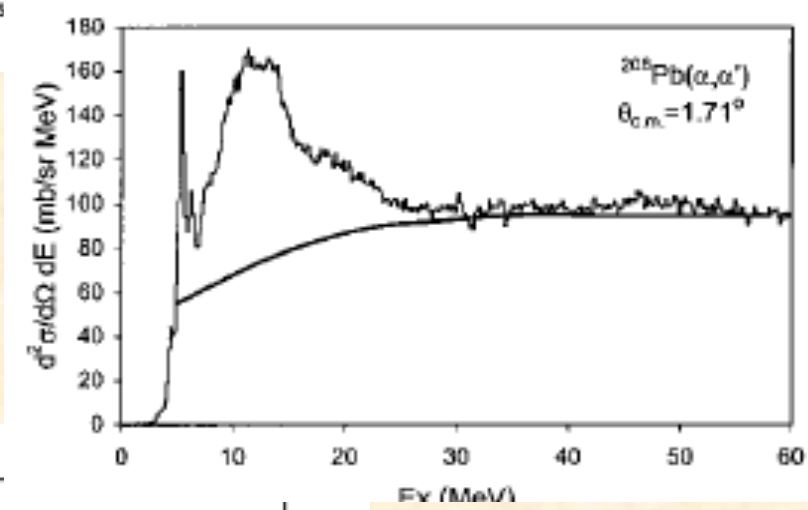


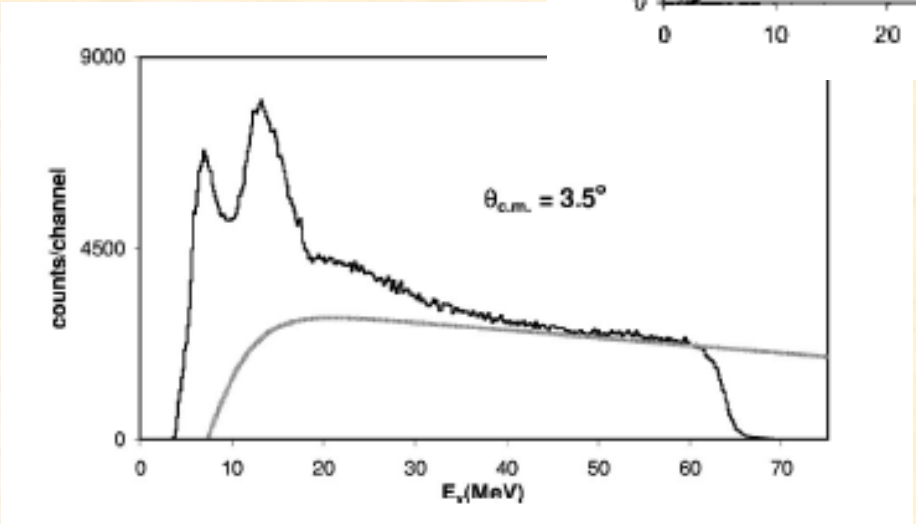
$^{208}Pb(\alpha,\alpha\square)$

$T_p = 400$ MeV

$\theta_{avg} = 0.77$deg.







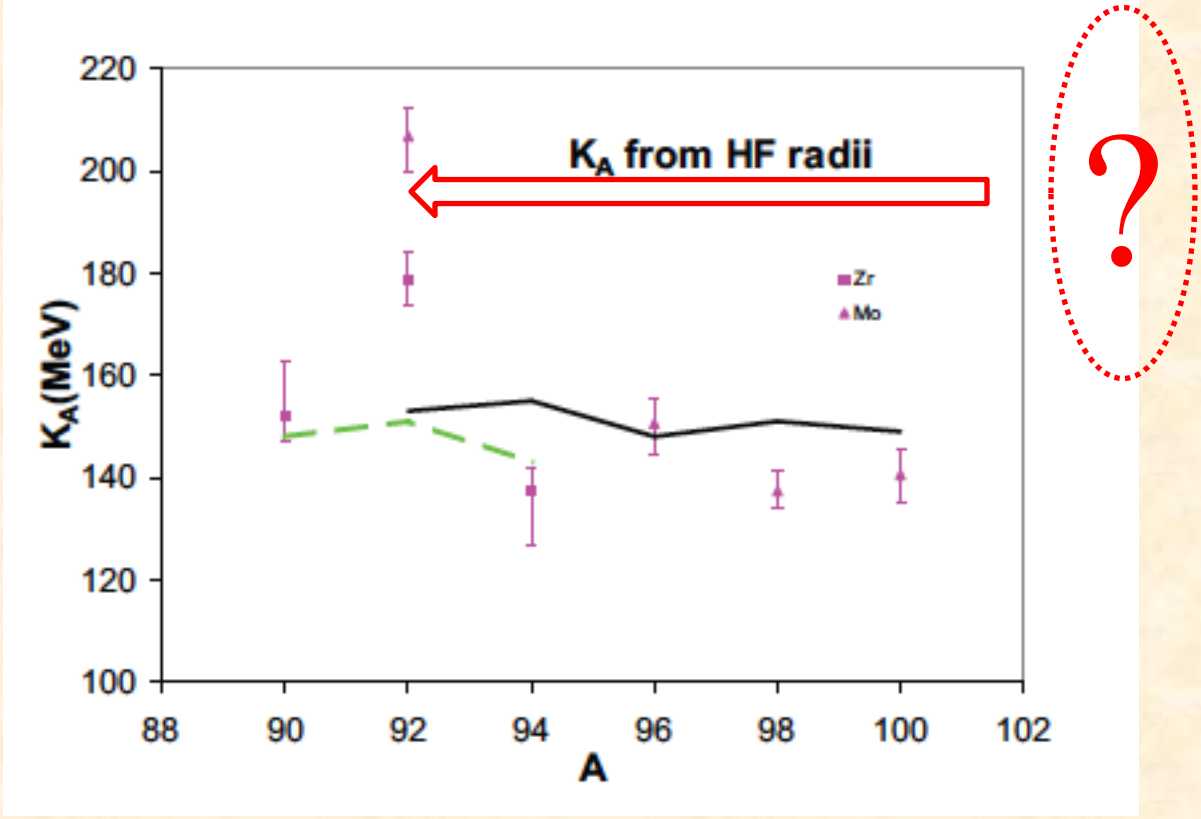
240 MeV (α,α') [Texas A & M]

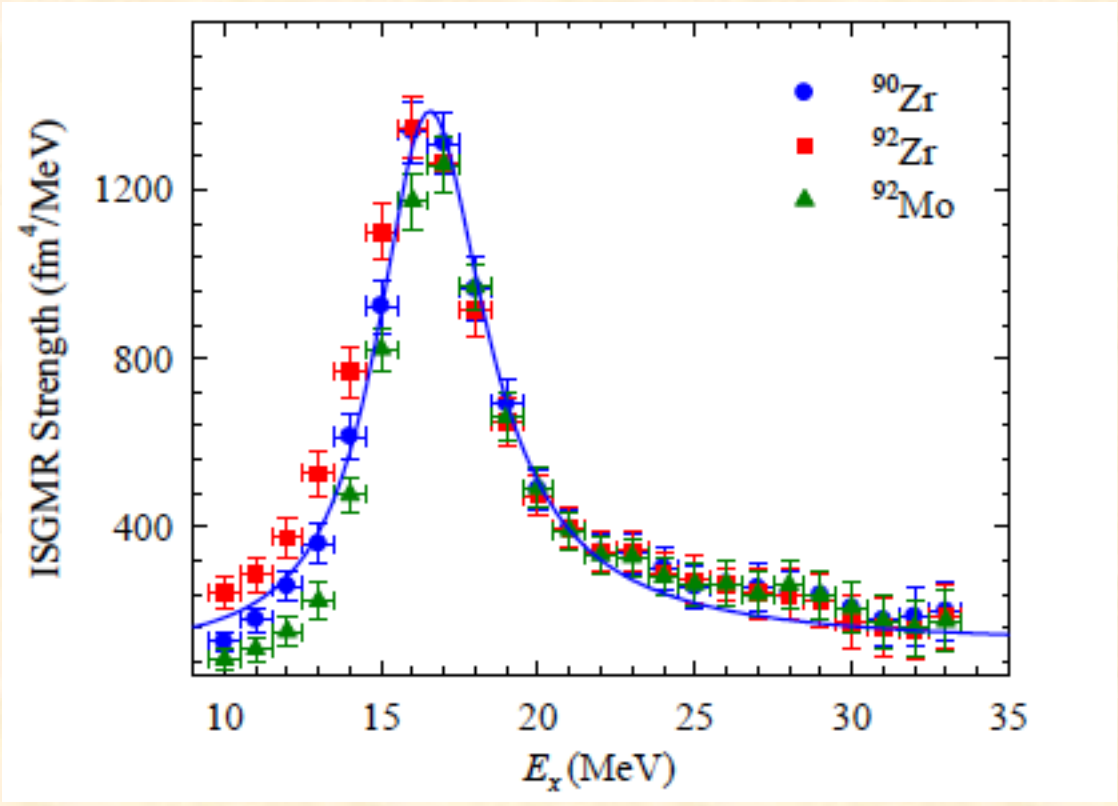
PHYSICAL REVIEW C **88**, 021301(R) (2013)

Unexpected characteristics of the isoscalar monopole resonance in the $A \approx 90$ region: Implications for nuclear incompressibility

D. H. Youngblood,[1] Y.-W. Lui,[1] Krishichayan,[1,2] J. Button,[1] M. R. Anders,[1] M. L. Gorelik,[3] M. H. Urin,[3] and S. Shlomo[1]

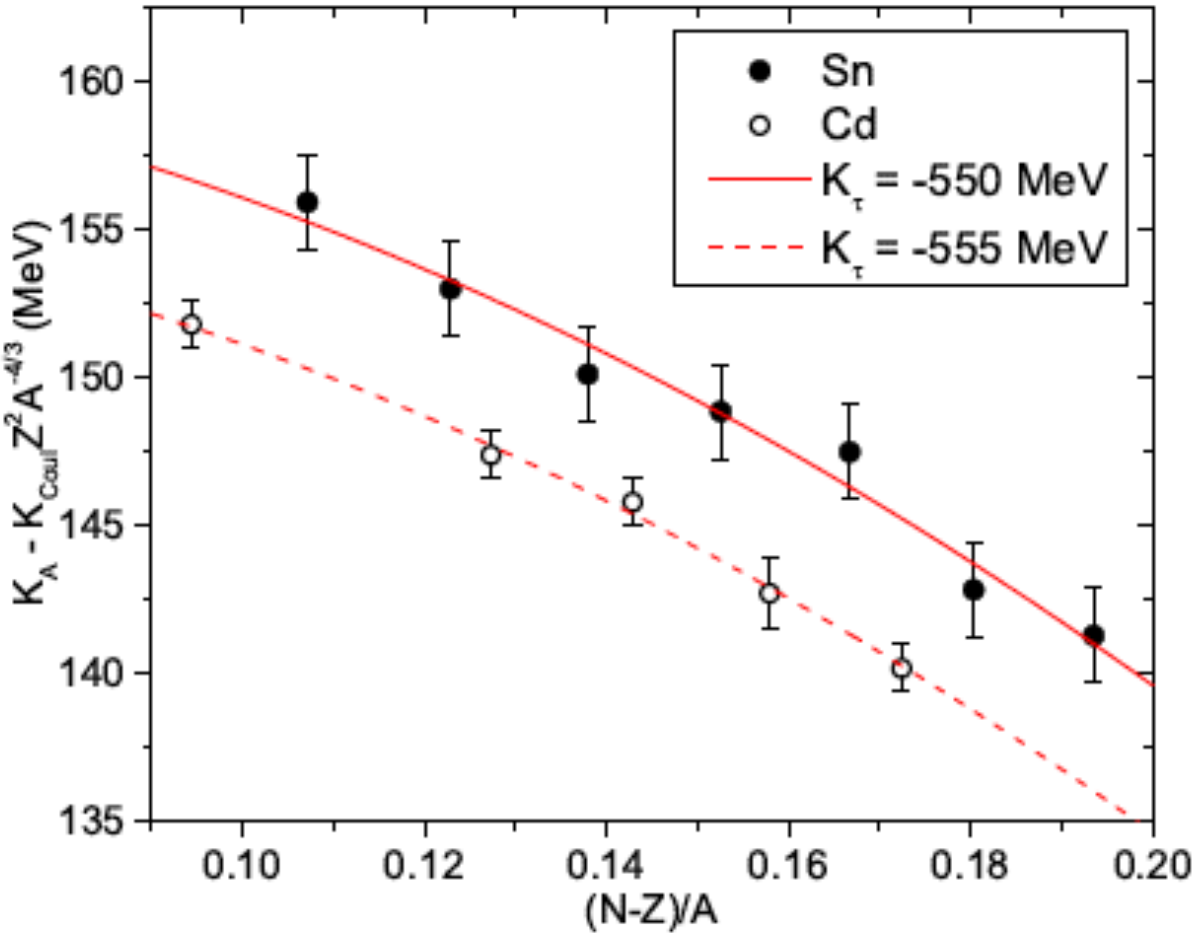
[1]*Cyclotron Institute, Texas A&M University, College Station, Texas 77843, USA*





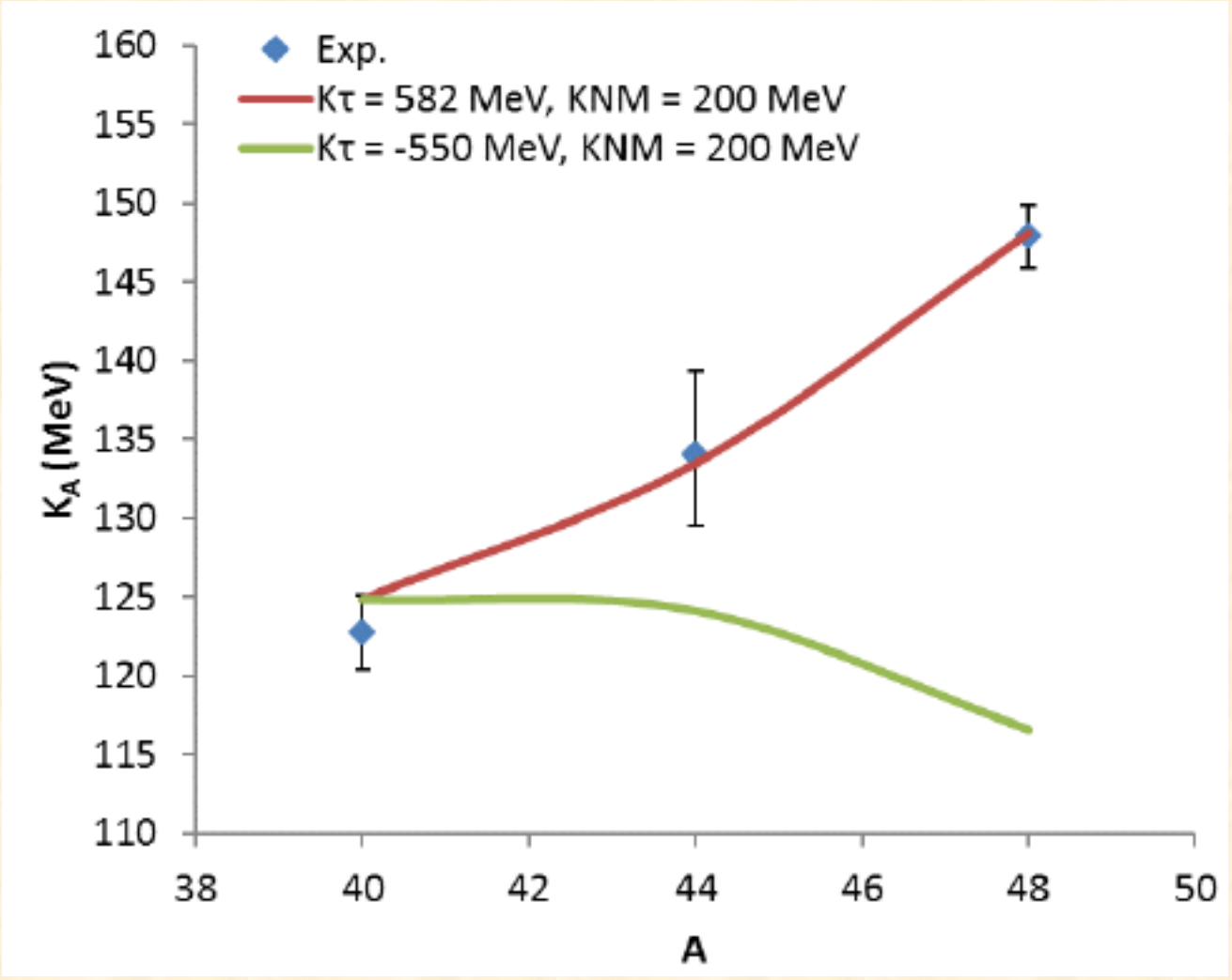
Nucleus	E_m (MeV)	Γ (MeV)
^{90}Zr	16.55 ± 0.08	4.2 ± 0.3
^{92}Zr	16.12 ± 0.04	4.5 ± 0.2
^{92}Mo	16.79 ± 0.11	4.2 ± 0.4

Y. K. Gupta *et al.*, Phys. Lett. B **760**, 482 (2016)

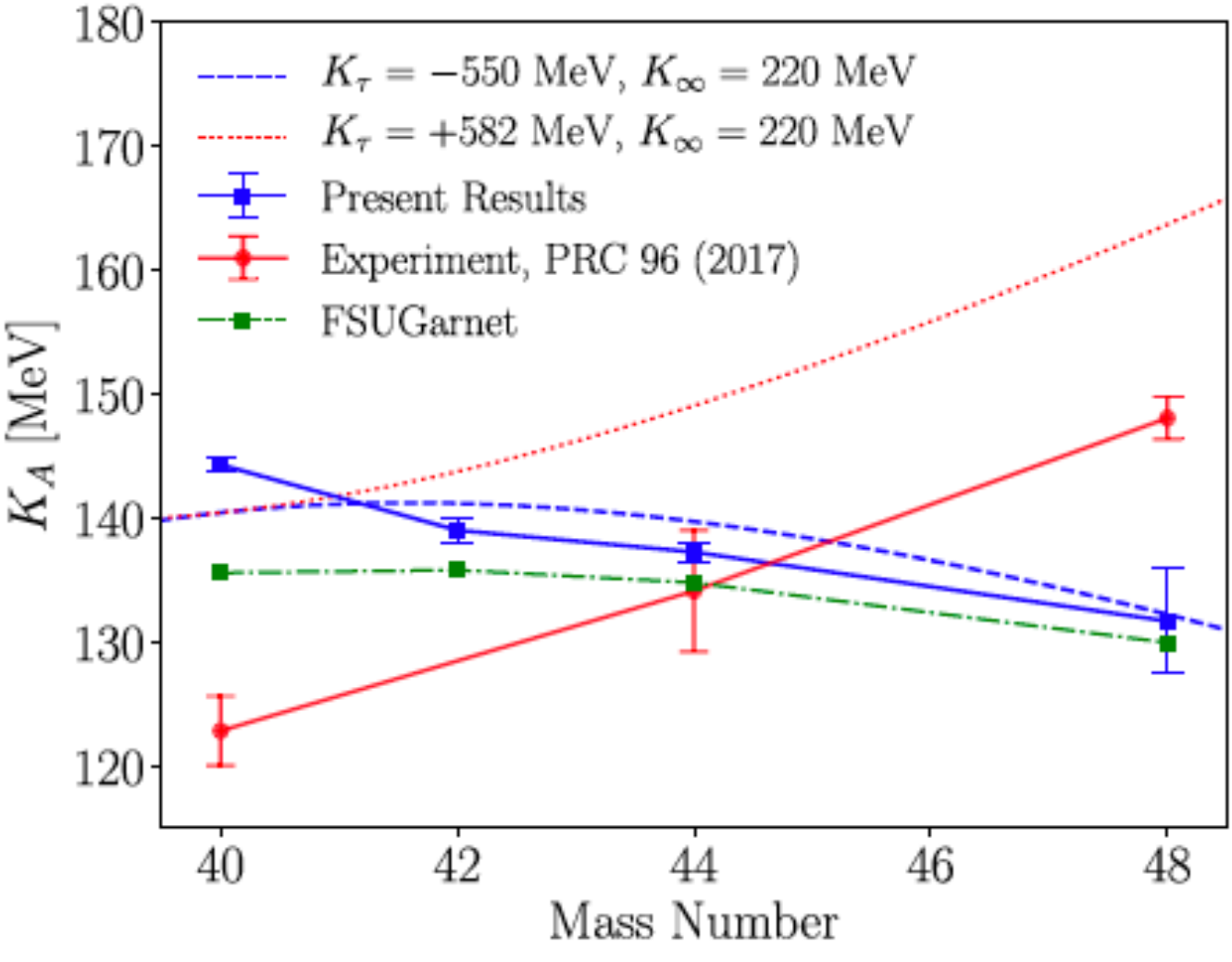


$$K_\tau = -550 \pm 100 \text{ MeV}$$

$$K_\tau = K_{sym} - 6L - Q_0 L/K_\infty$$



J. Button et al., Phys. Rev. C **96**, 054330 (2017)

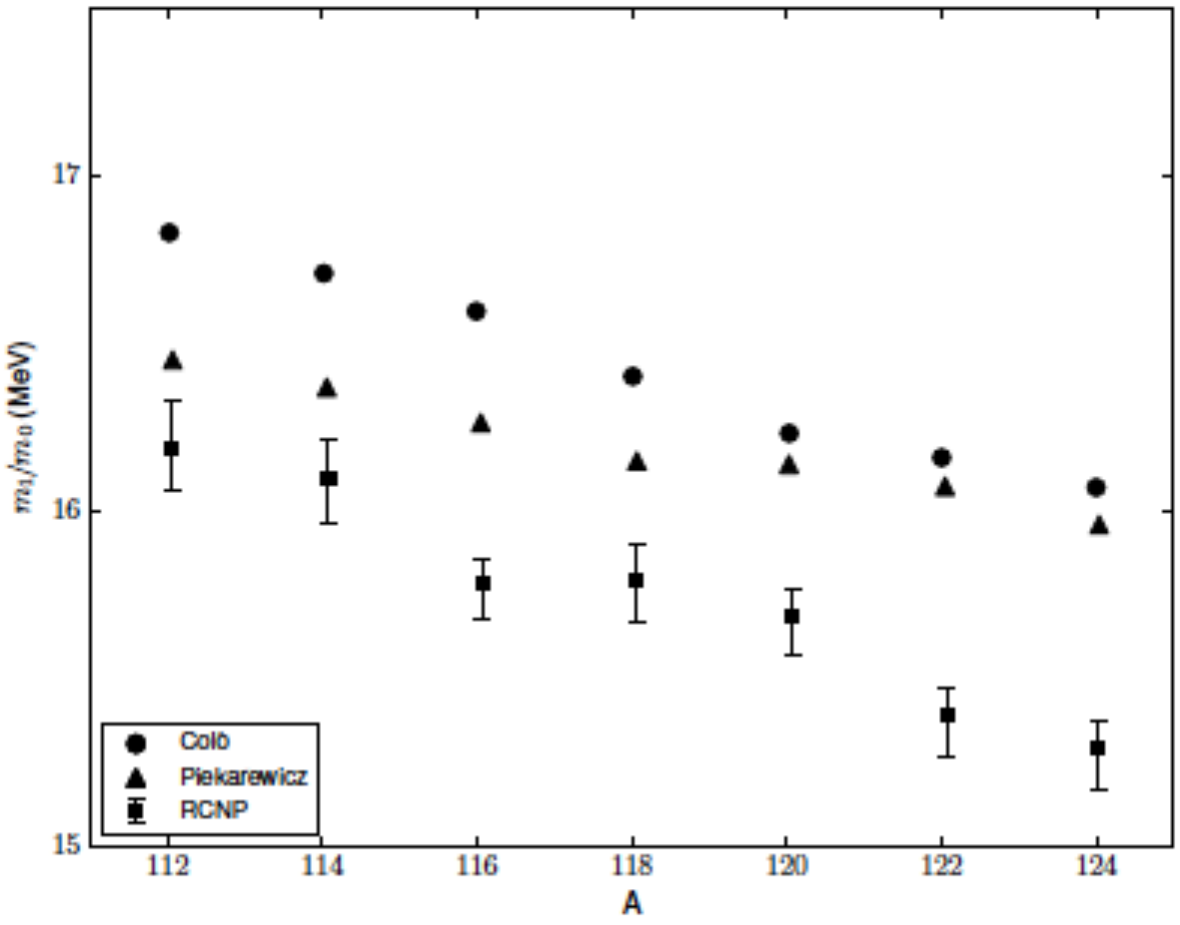


K. B. Howard et al., Phys. Lett. B **801**, 135185 (2020)

From GMR data on ^{208}Pb and ^{90}Zr

$K_\infty = 240 \pm 20$ MeV

This number is consistent with both GMR and ISGDR data and with non-relativistic and relativistic calculations



Why are tins so "Fluffy"?

T. Li *et al.*, Phys. Rev. Lett. **99**, 162503 (2007)

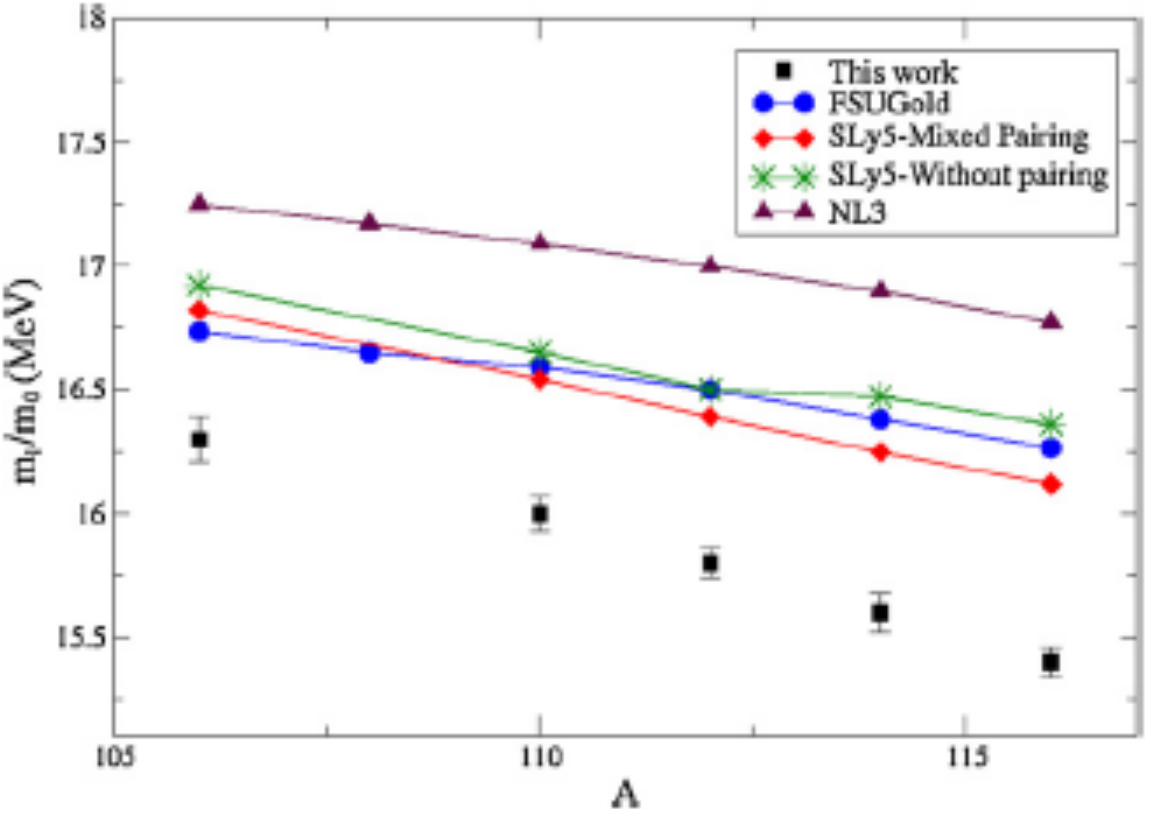
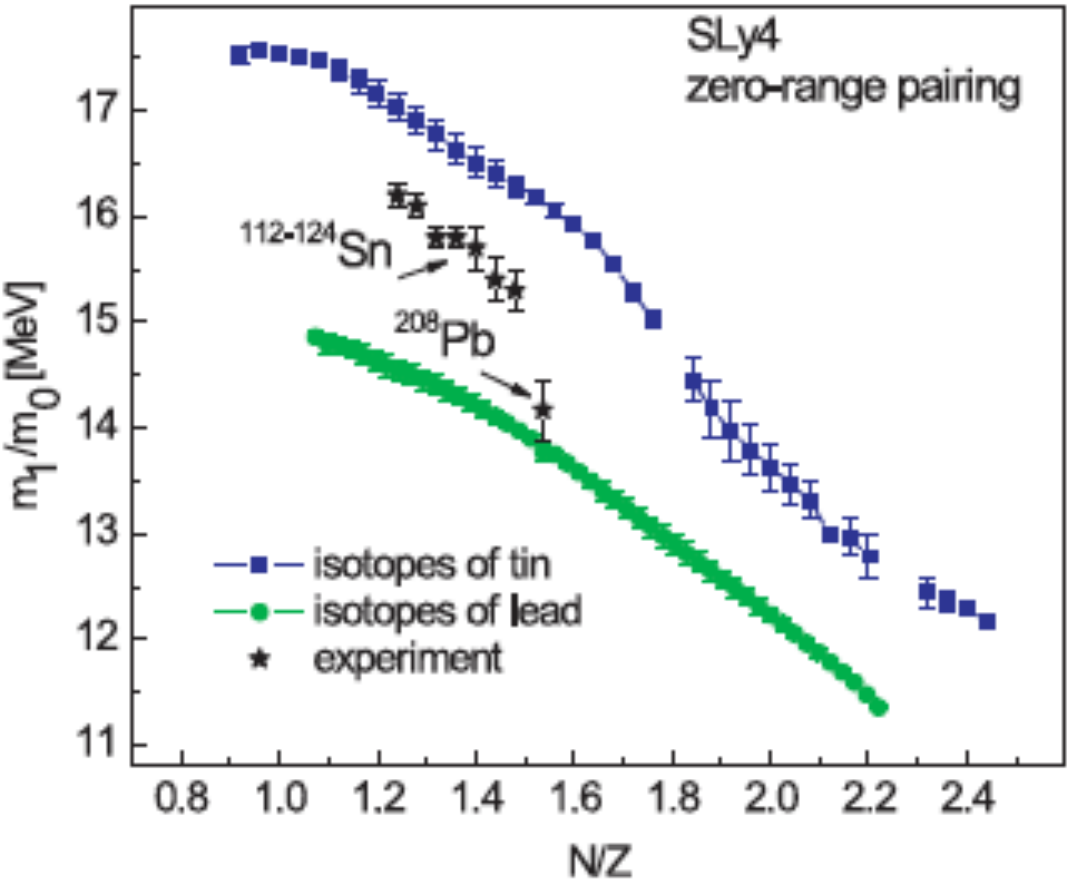
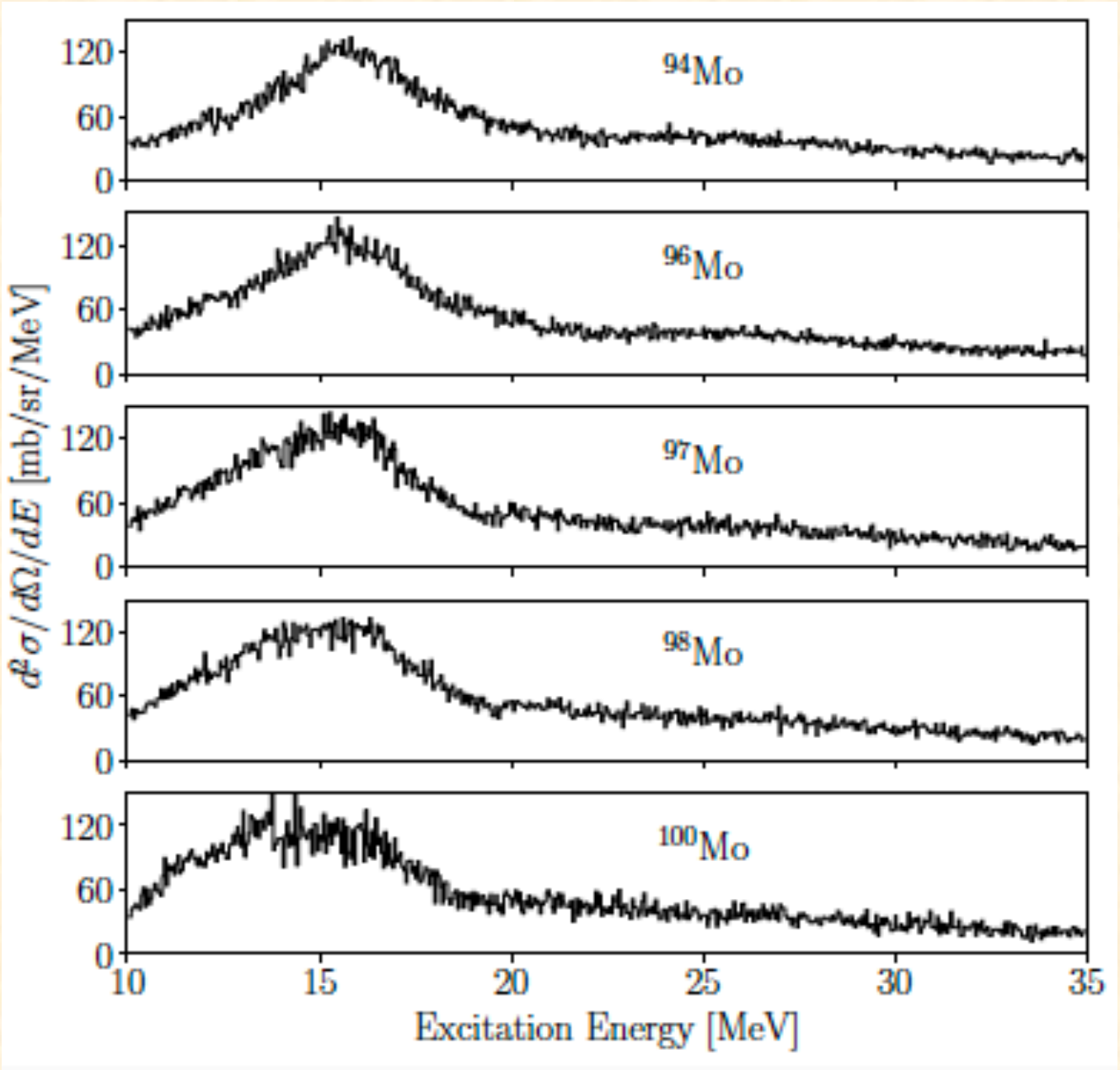


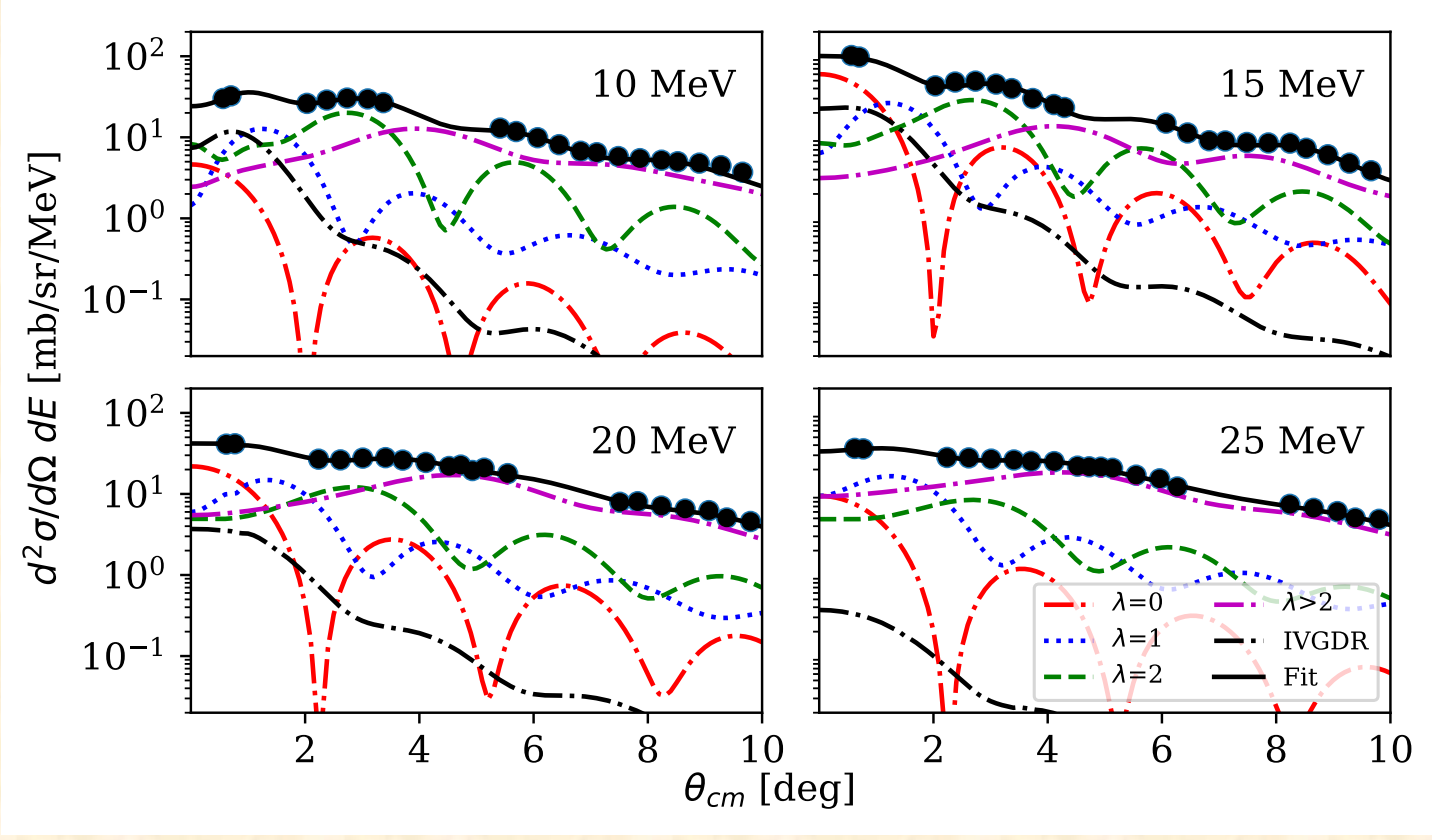
Fig. 3. (Color online.) Systematics of the moment ratio, m_1/m_0 for the ISGMR strength distributions in the Cd isotopes investigated in this work. The experimental results (squares) are compared with relativistic calculations performed using the FSUGold (circles) and NL3 (triangles) effective interactions. Also presented are results from non-relativistic calculations performed using the Sly5 parameter set in the HF-BCS + QRPA formalism with and without the mixed pairing interaction (diamonds and stars, respectively) [36]. The solid lines are to guide the eye.

D. Patel *et al.*, Phys. Lett. B **718**, 447 (2012)

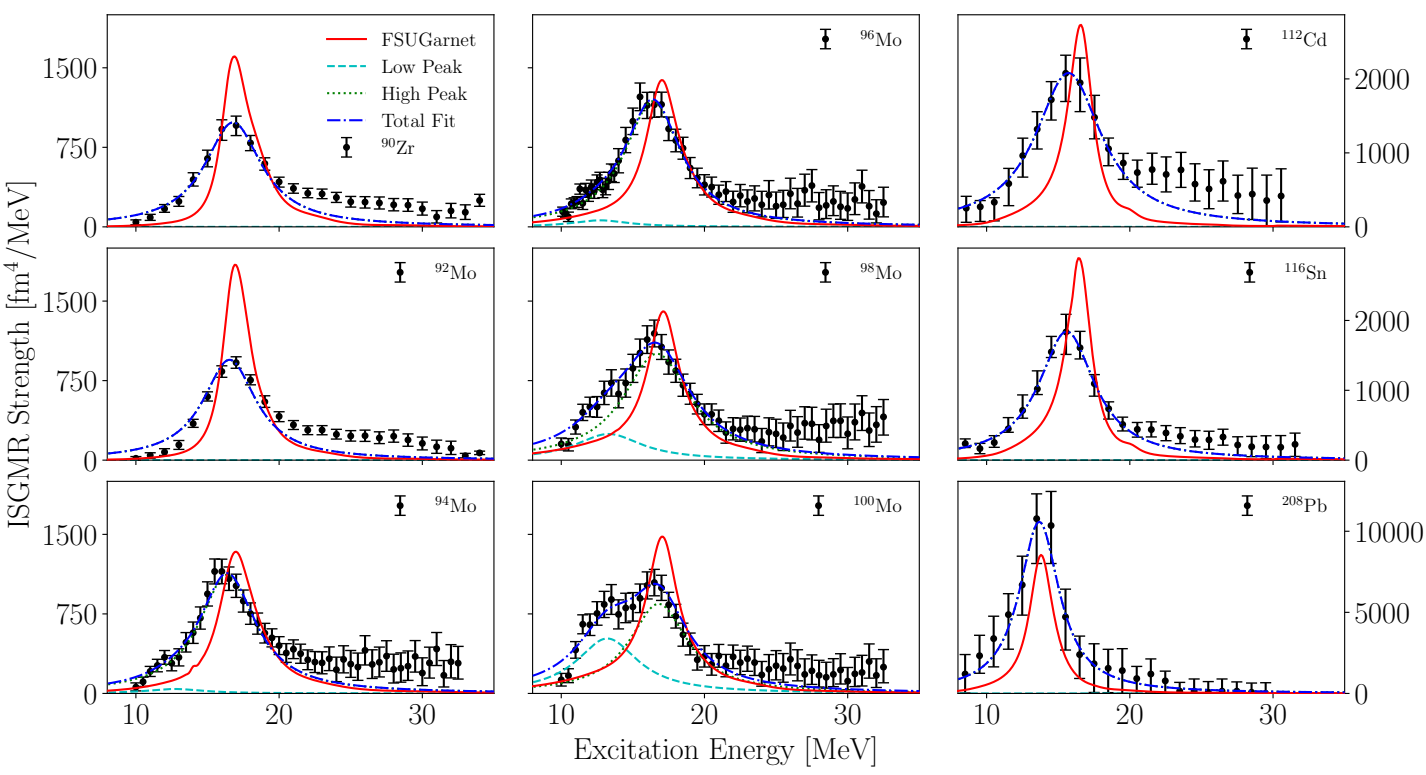


P. Vesely *et al.*, Phys. Rev. C 86, 024303 (2012)

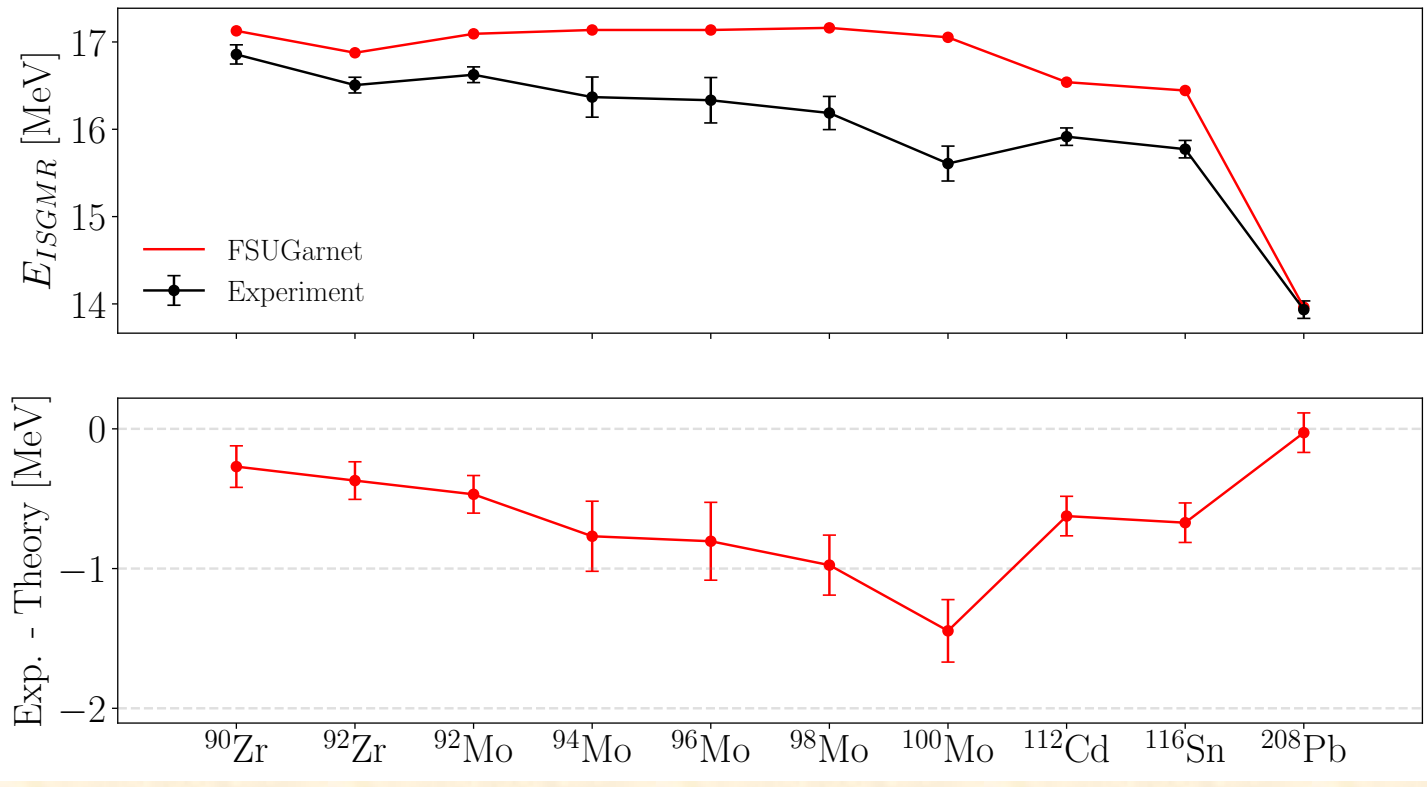

120
60
0
^{94}Mo
^{96}Mo
^{97}Mo
^{98}Mo
^{100}Mo
$d^2\sigma/d\Omega/dE$ [mb/sr/MeV]
10
15
20
25
30
35
Excitation Energy [MeV]

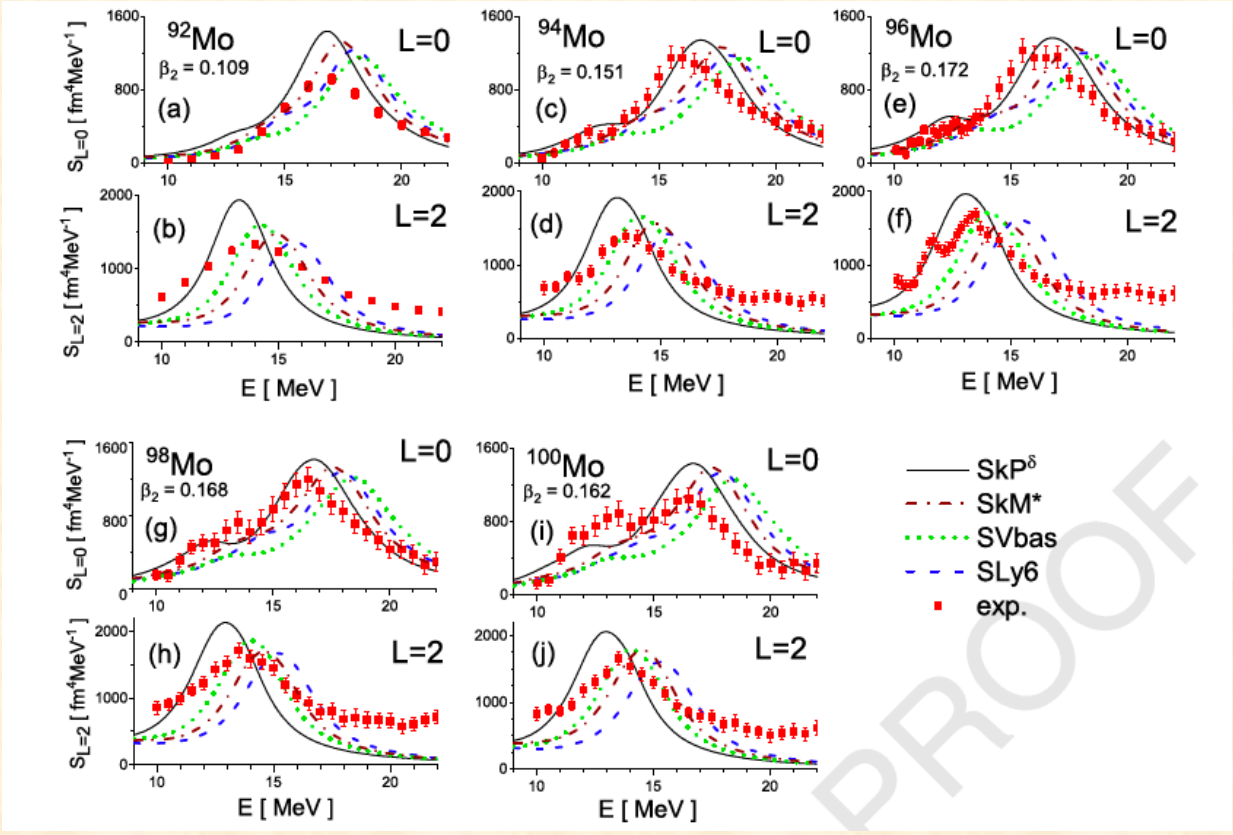

10 MeV
15 MeV
20 MeV
25 MeV
$d^2\sigma/d\Omega\, dE$ [mb/sr/MeV]
θ_{cm} [deg]
λ=0
λ=1
λ=2
λ>2
IVGDR
Fit

^{94}Mo



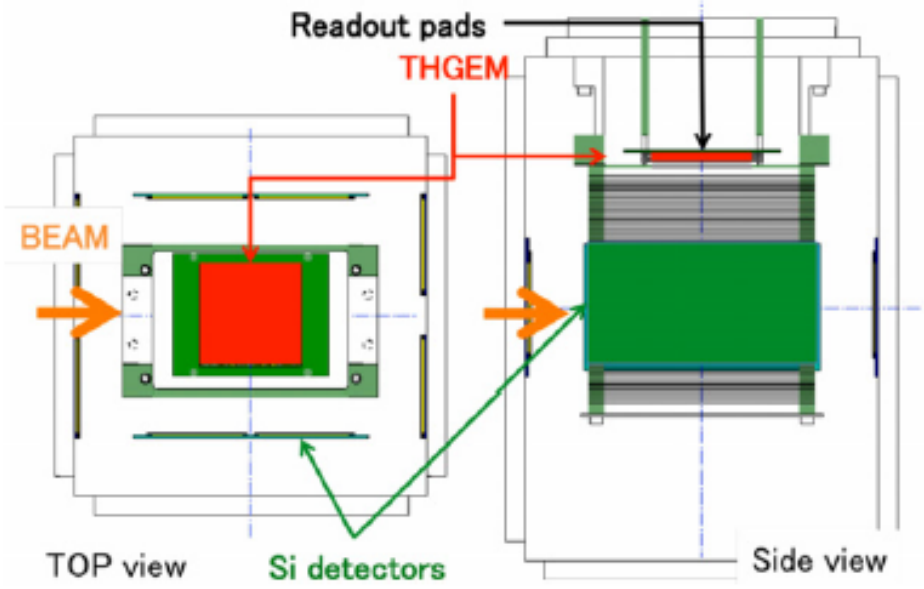
K. B. Howard et al., Phys. Lett. B **807**, 135608 (2020)


E_{ISGMR} [MeV]
17
16
15
14
FSUGarnet
Experiment
Exp. - Theory [MeV]
0
−1
−2
^{90}Zr
^{92}Zr
^{92}Mo
^{94}Mo
^{96}Mo
^{98}Mo
^{100}Mo
^{112}Cd
^{116}Sn
^{208}Pb



the connection between the line shape of the monopole strength ISGMR and the deformation-induced coupling between the ISGMR and the K = 0 branch of the ISGQR. The ISGMR is best described by the force SkP$^{\delta}$, having a low incompressibility K_{∞} = 202 MeV.

Gianluca Colò et al., Phys. Lett. B (2020), *to appear*

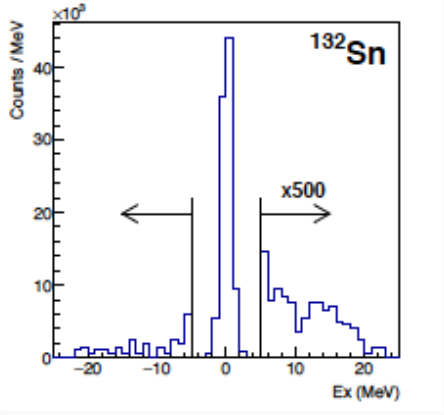


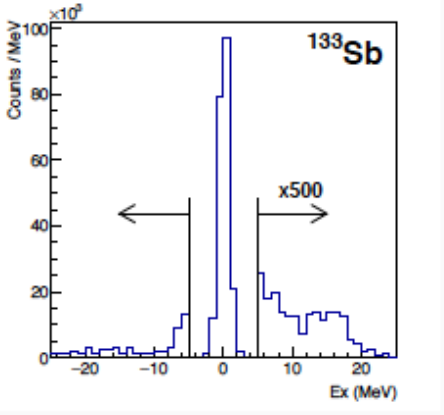
RIBF 113

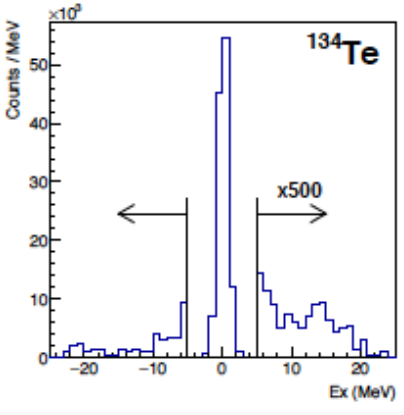
$^{132}Sn + {}^{2}H$
100 MeV/A
>50 kHz ^{132}Sn

Preliminary uncorrected energy spectra for ^{132}Sn, ^{133}Sb, and ^{134}Te.

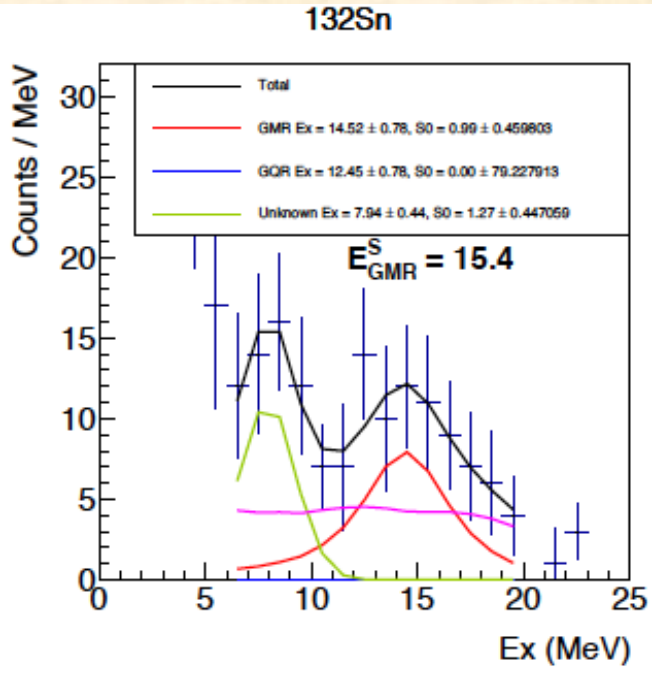
Particle identifications of beam and recoil particles have been done.

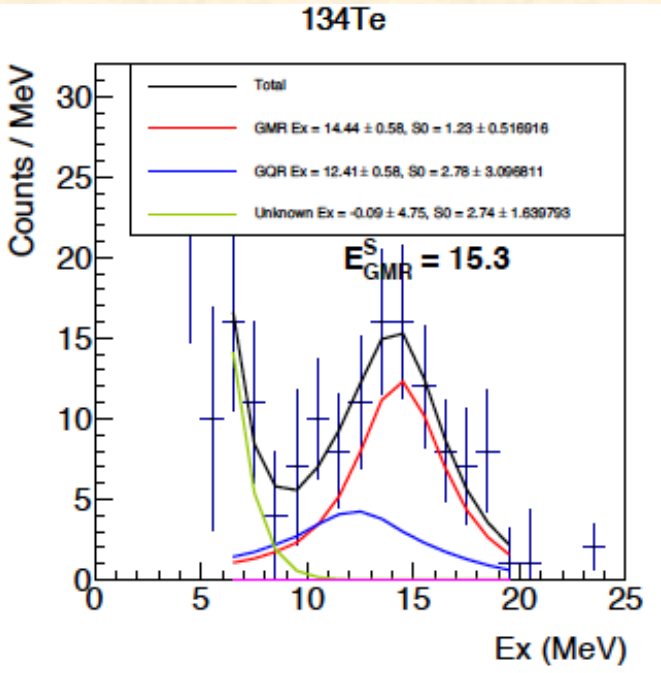


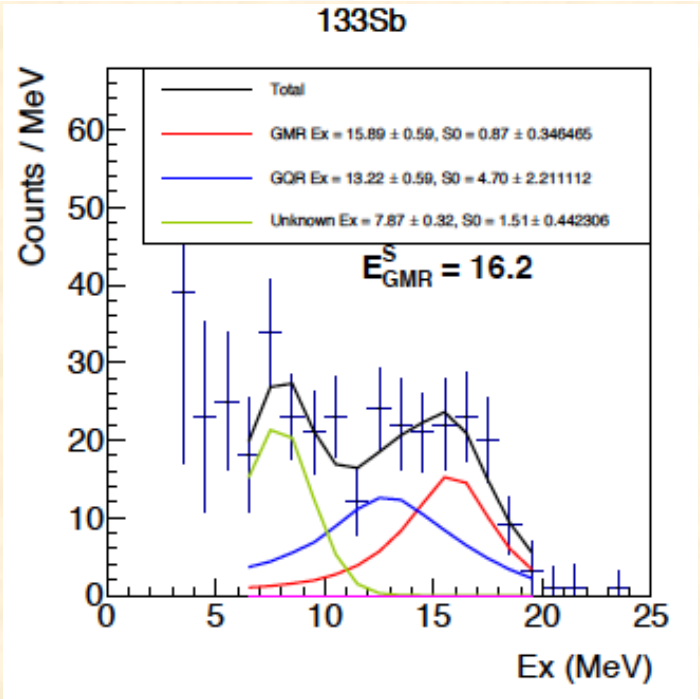




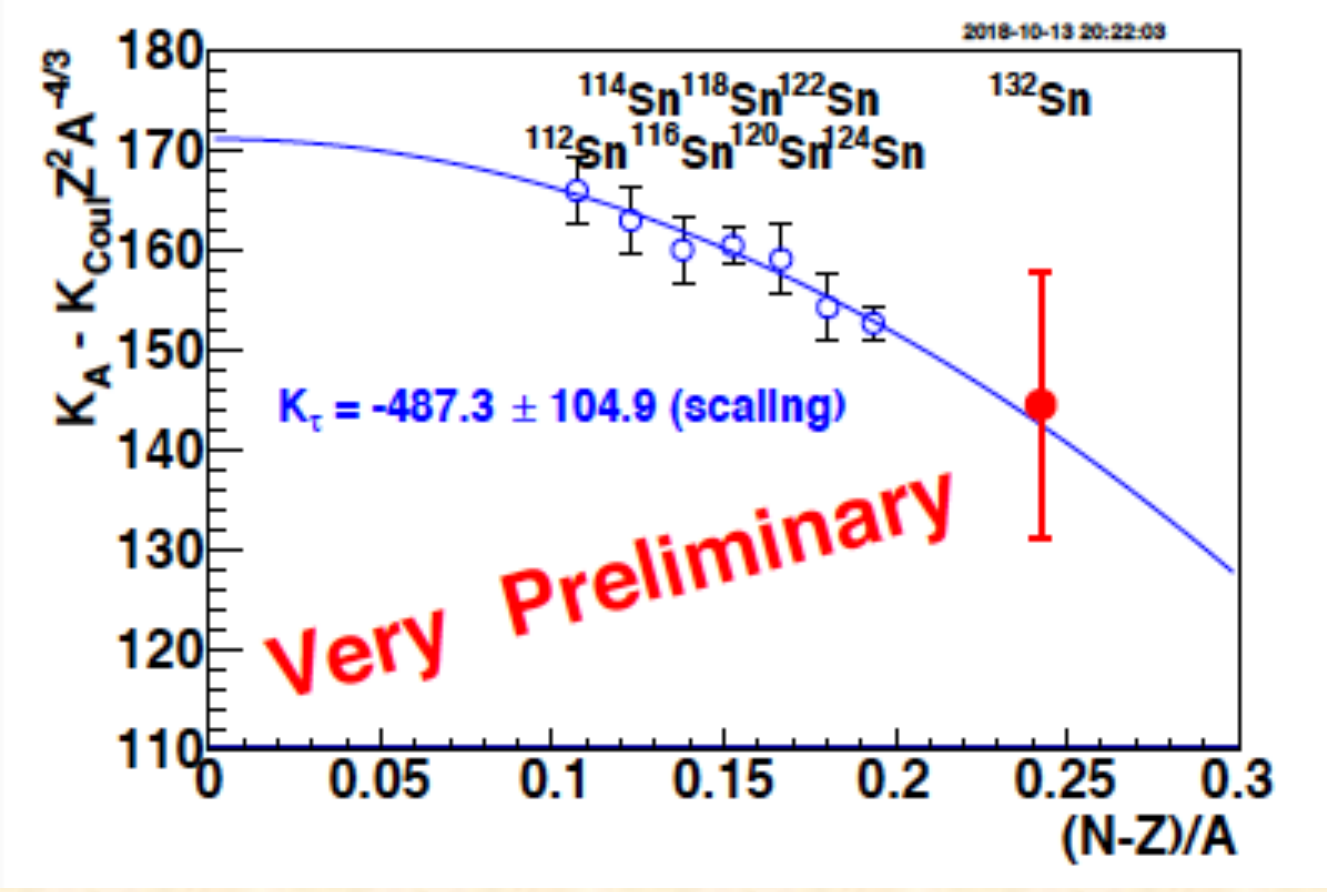
Preliminary results from RIKEN *d*(^{132}Sn, ^{132}Sn')*d* experiment





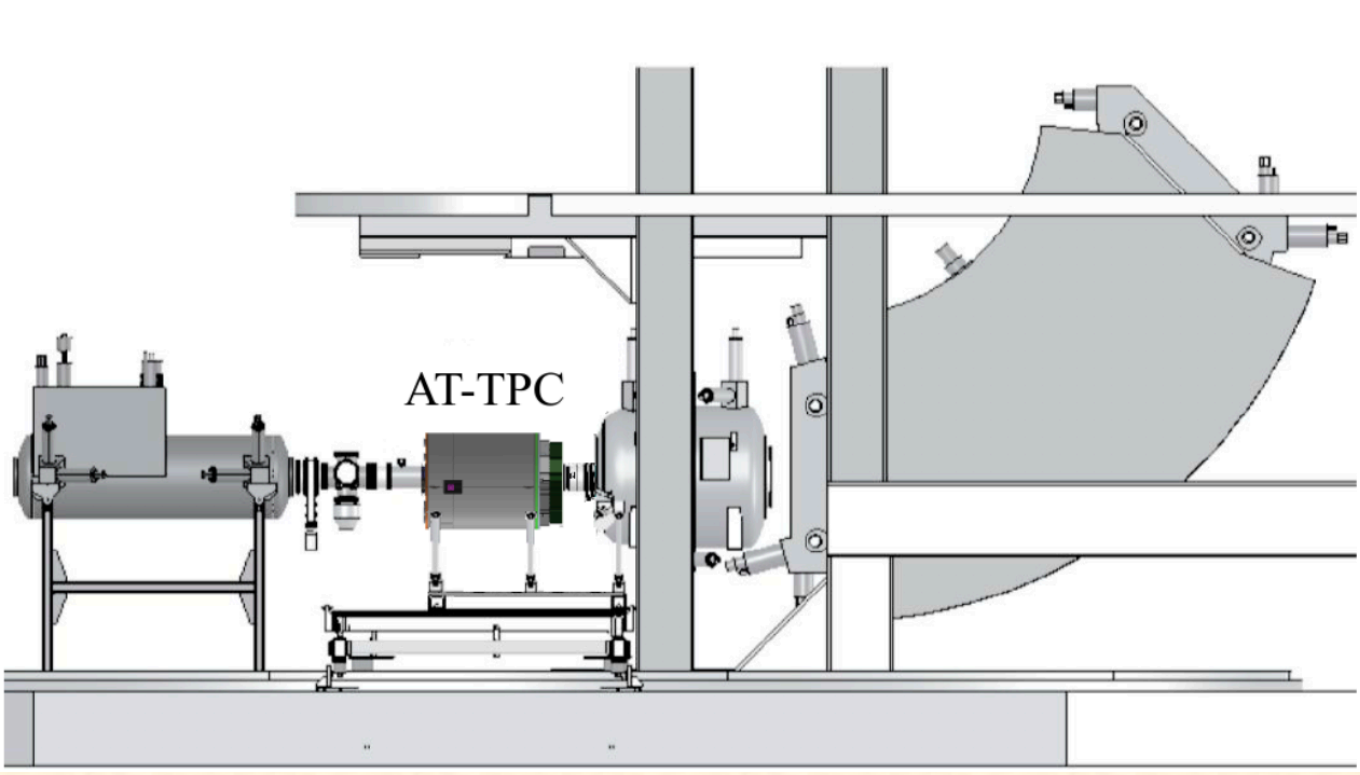


Preliminary results from RIKEN *d*(^{132}Sn, ^{132}Sn')*d* experiment



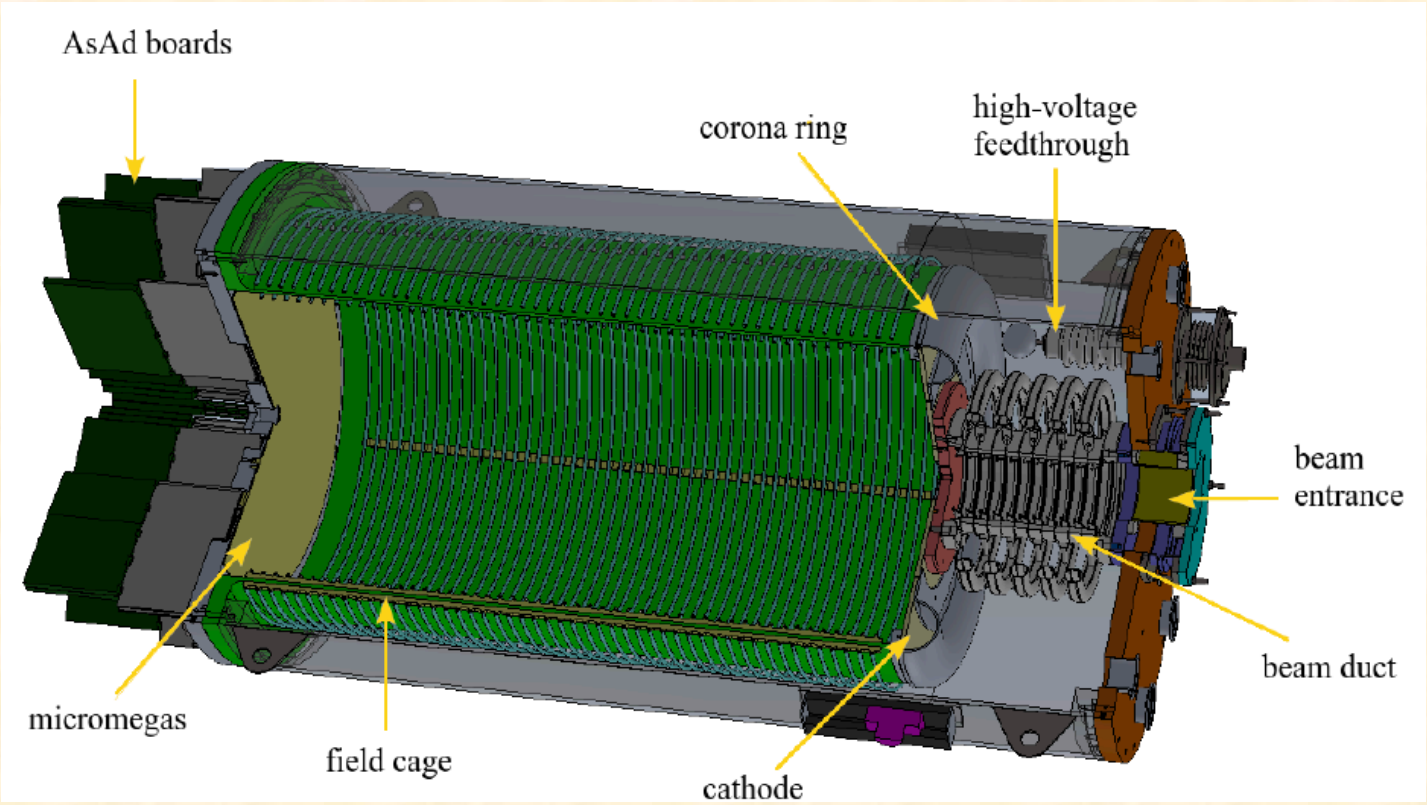
Preliminary results from RIKEN $d(^{132}\mathrm{Sn}, ^{132}\mathrm{Sn}')d$ experiment

$^{4}He(^{70}Ni, ^{70}Ni')^{4}He$ @ NSCL

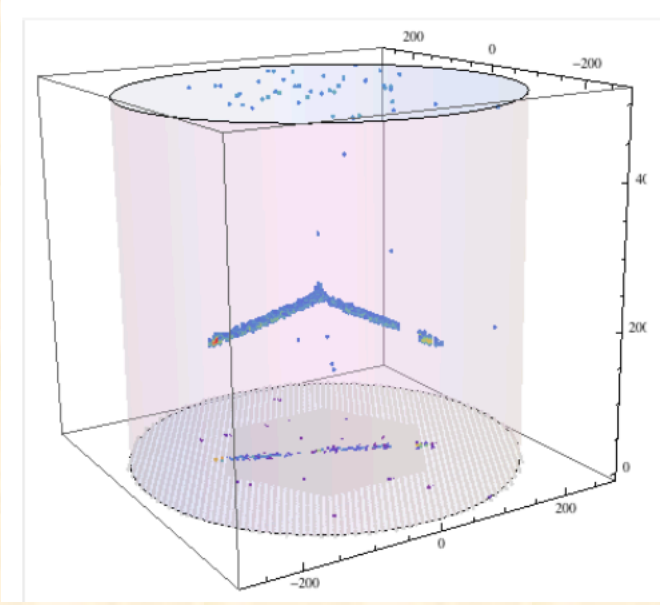


82 MeV/A; ~20k pps

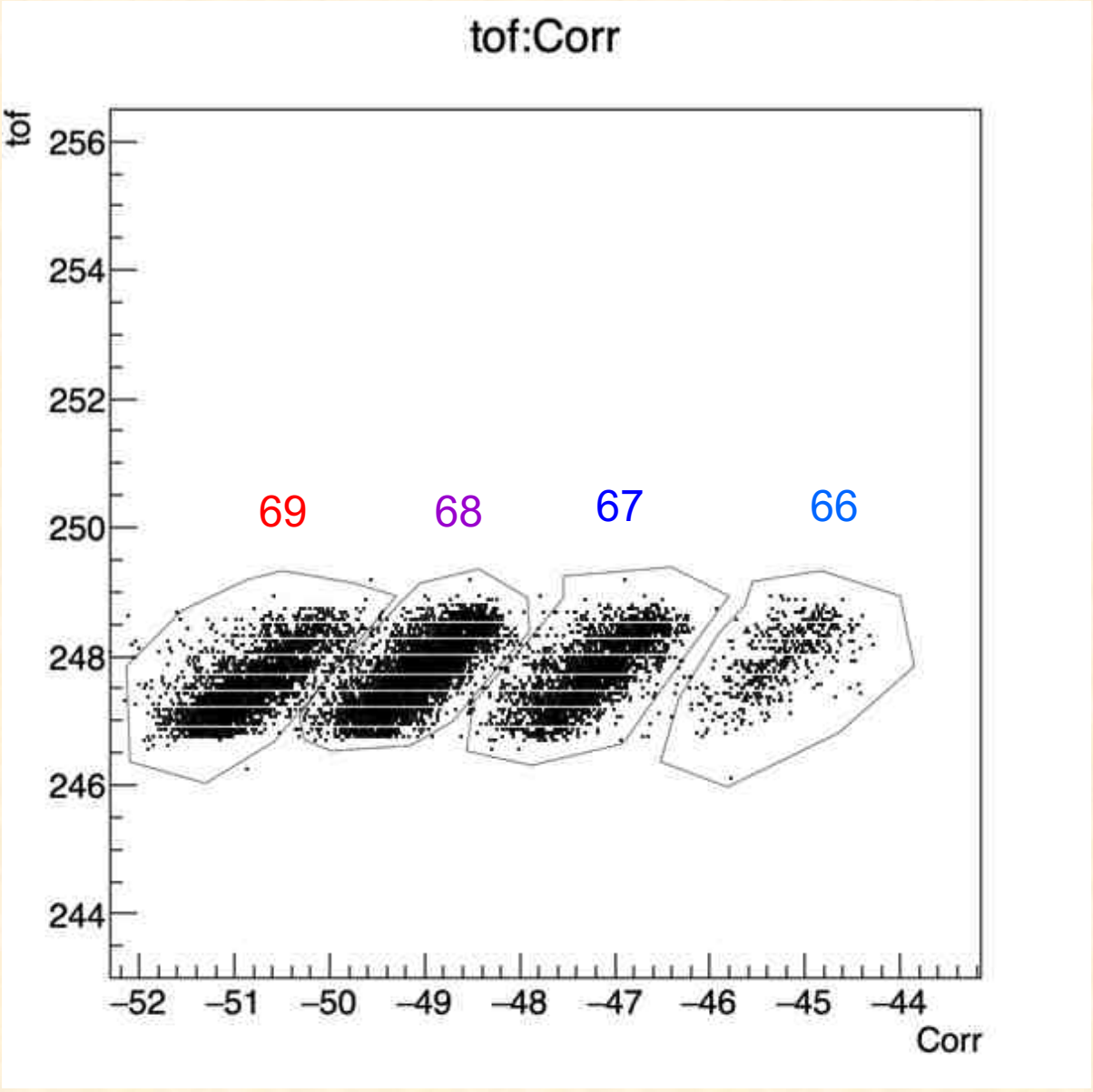
e18207



150 torr of
pure ^{4}He gas



J. Bradt et al., Nucl. Inst. Meth. Phys. Res. A **875**, 65 (2017)


tof:Corr
tof
256
254
252
250
248
246
244
69
68
67
66
−52
−51
−50
−49
−48
−47
−46
−45
−44
Corr

- We have investigated the ISGMR in the Mo isotopes, via inelastic scattering of 386-MeV α particles at extremely forward angles (including 0^{o}).

- In the Cd and Sn isotopes, the ISGMR energy was significantly lower than that expected from the accepted value of K_{∞}. There has been no satisfactory theoretical explanation of this "fluffiiness" of open-shell nuclei.

- The "fluffiness" appears in the Mo isotopes, beginning with ^{92}Mo, just two nucleons out of the "doubly-closed" nucleus ^{90}Zr.

- I hope one of the theorists among you will pick up the the gauntlet of trying to find a satisfactory explanation of this phenomenon.

- We have just completed measurements at NSCL on ^{70}Ni using pure 4He gas and trigger with S800. Very clean spectra have been observed with a "peak" at ~17 MeV consistent with GMR.

Need much better statistics, however!

U. Garg, G.P.A. Berg, J. Hoffman, M. Koss, T. Li, Y. Liu, R. Marks, E. Martis, B.K. Nayak, D. Patel, P.V. Madhusudhana Rao, K. Sault, K. Schlax, R. Talwar, M. White

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[illegible]

Y. [illegible] Murakami, H. Sakaguchi, S. [illegible] Uchida, Y. Yasuda, J. Zenihiro

Kyoto University

H. Akimune, C. Iwamoto, A. Okamoto

Konan University

T. Adachi, M.N. Harakeh

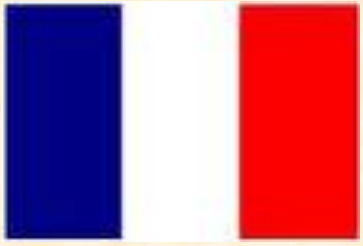
KVI, Groningen

CAT and AT-TPC collaborations

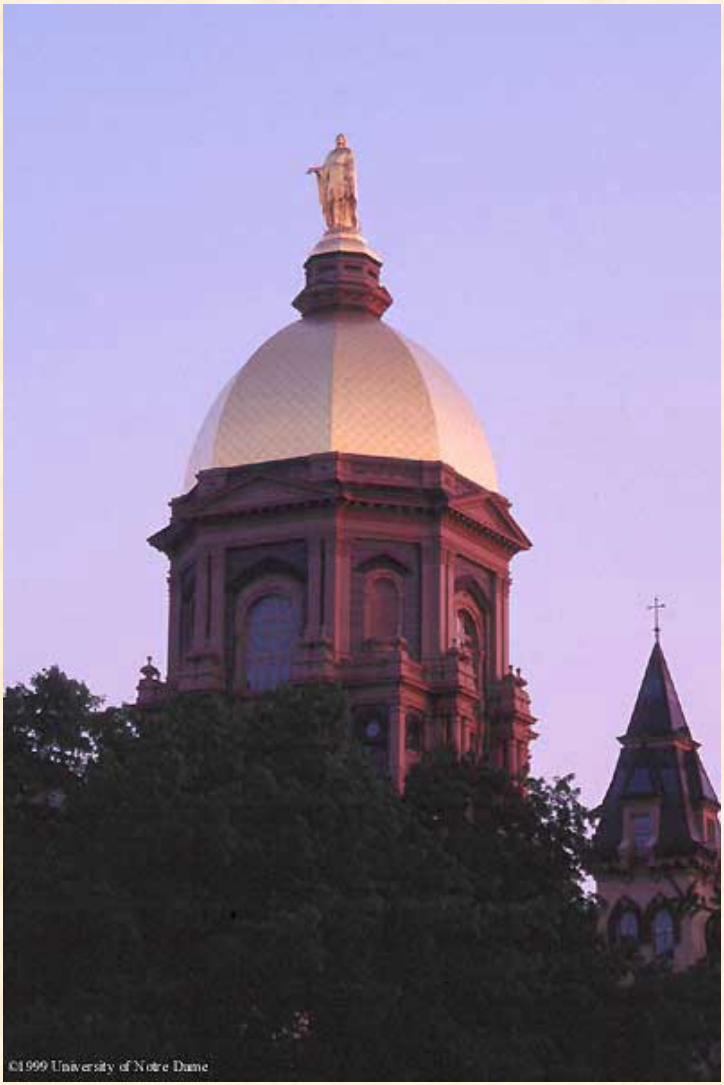
Merci beaucoup

धन्यवाद

Thanks!


The Question Kitten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