

Are There Nuclear Structure Effects on the Isoscalar Giant Monopole Resonance Near A=90?

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Why This Question?

RAPID COMMUNICATIONS

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

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

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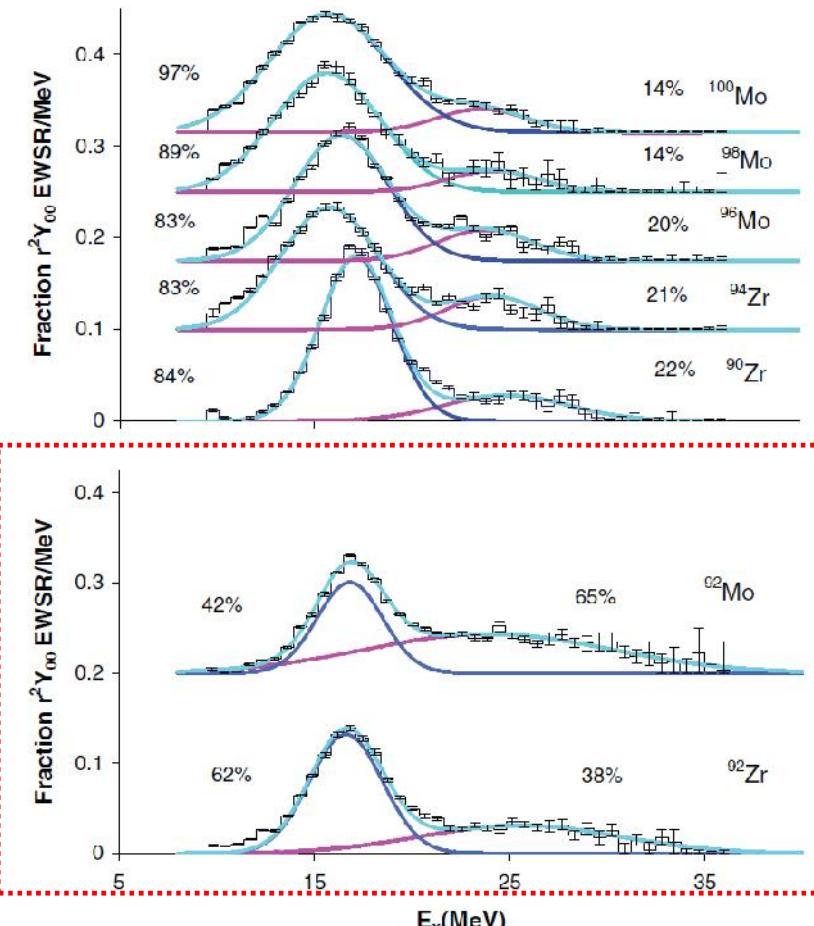
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Measurements are made for : $^{90,92,94}\text{Zr}$ and $^{92,96,98,100}\text{Mo}$

^{92}Zr and ^{92}Mo

E_{ISGMR} : 1.2 and 2.8 MeV higher than ^{90}Zr

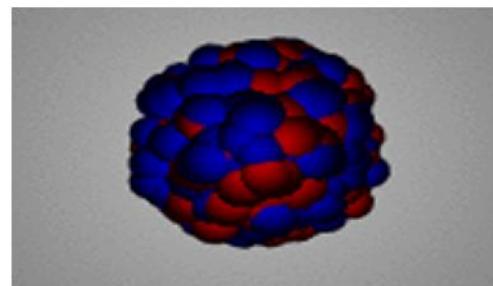
EWSR : 62% and 42%



Why This Question?

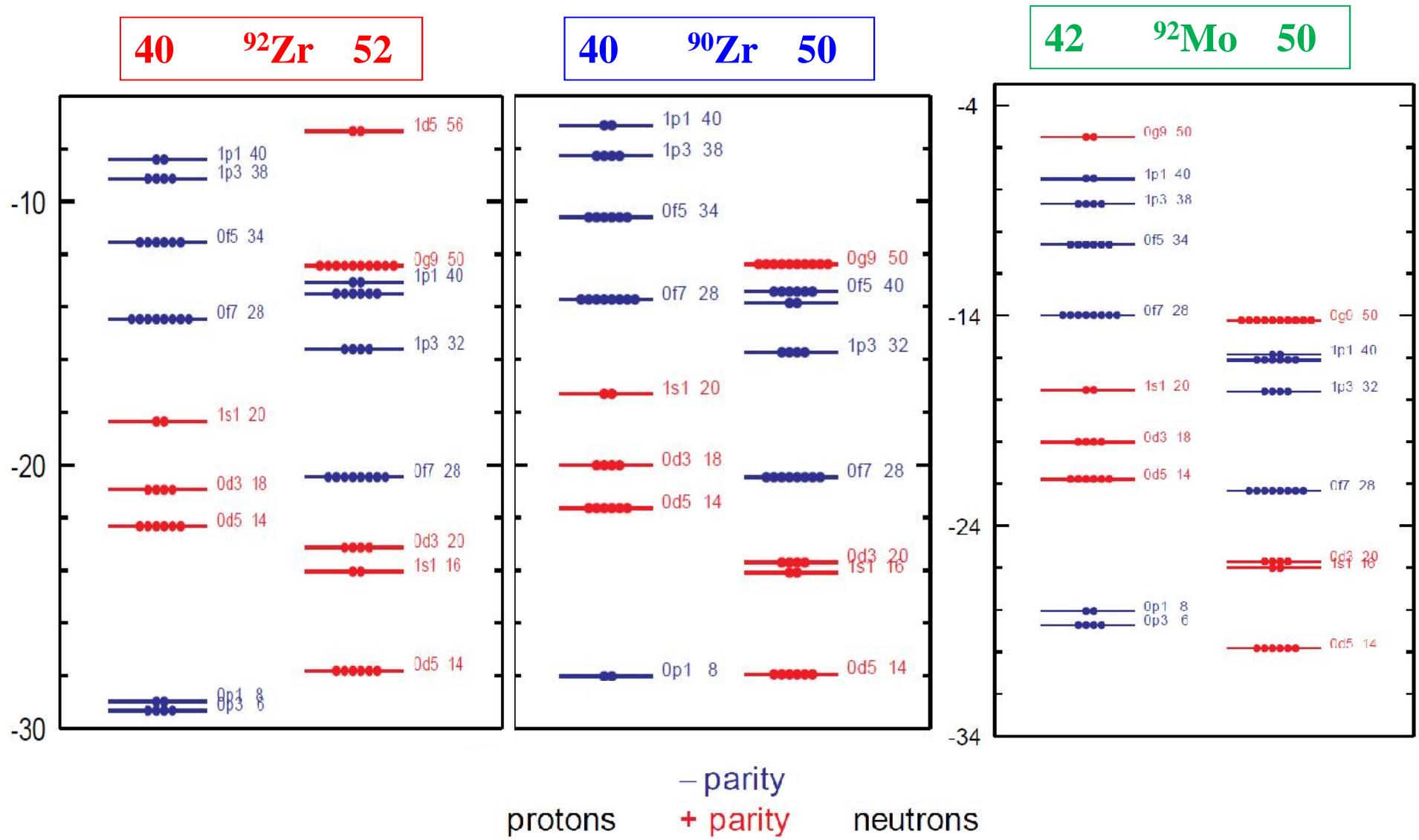
$$E_{ISGMR} = \hbar \sqrt{\frac{K_A}{m\langle r^2 \rangle}}$$

- **K_A for ⁹²Zr and ⁹²Mo being 27 and 56 MeV, respectively, higher than that for ⁹⁰Zr!!!!**
- **Significant nuclear structure contributions to the nuclear compressibility !**



ISGMR (breathing mode)

Its highly imperative to verify these very intriguing results independently.

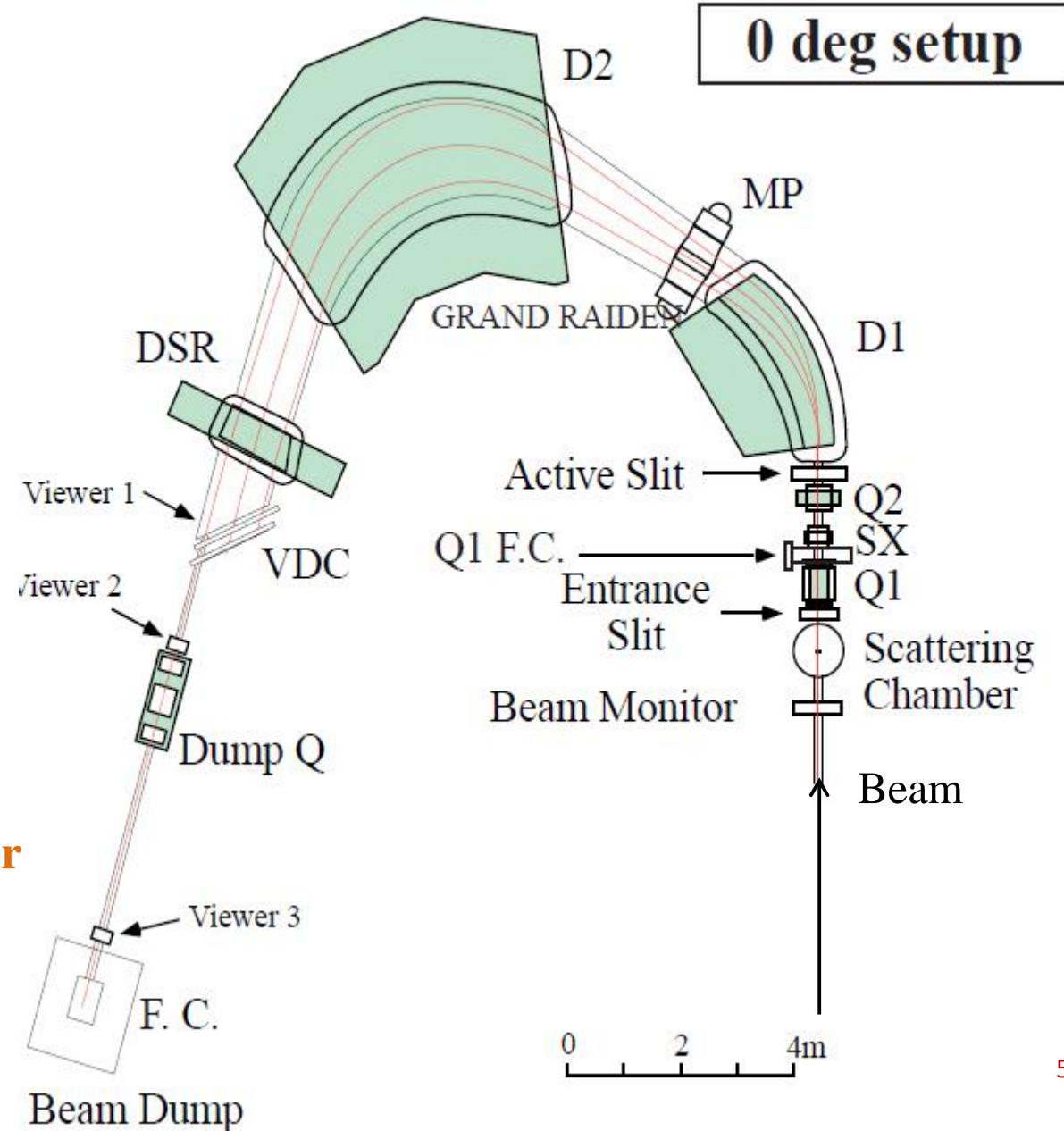


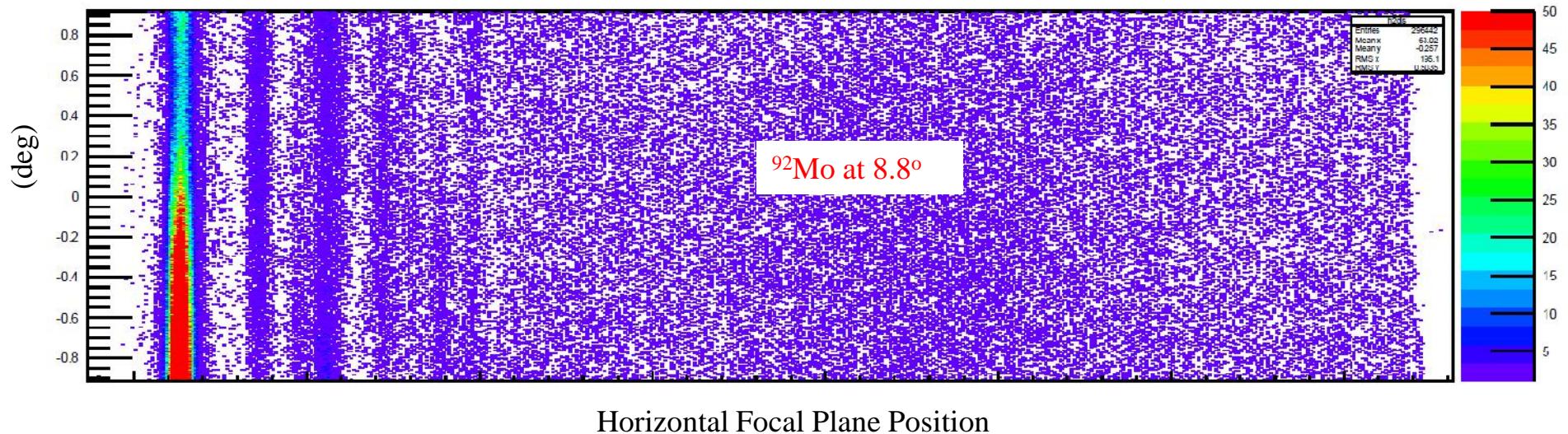
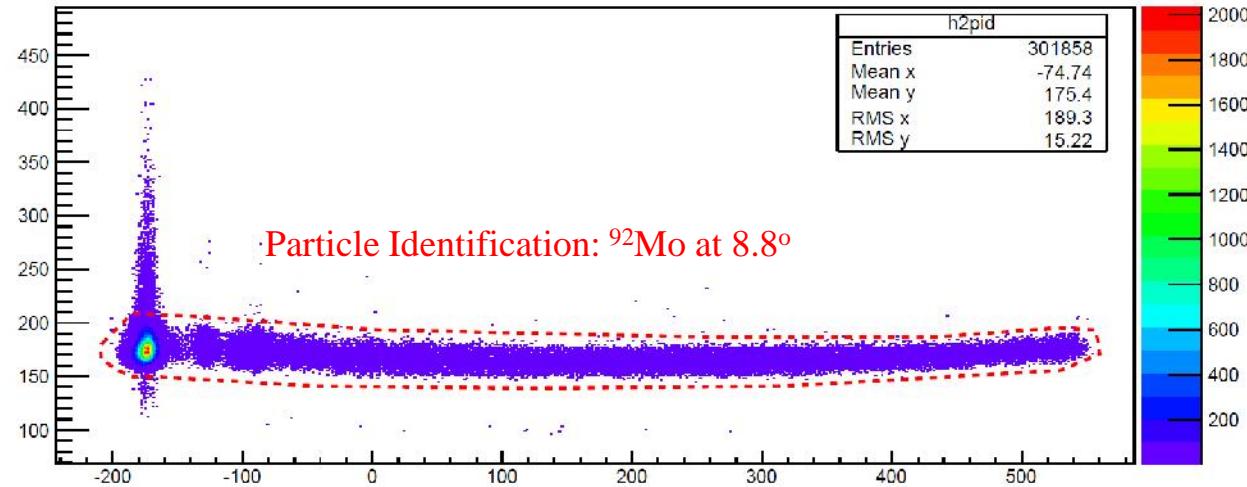
Background free measurements

A(, ')A*, 386 MeV

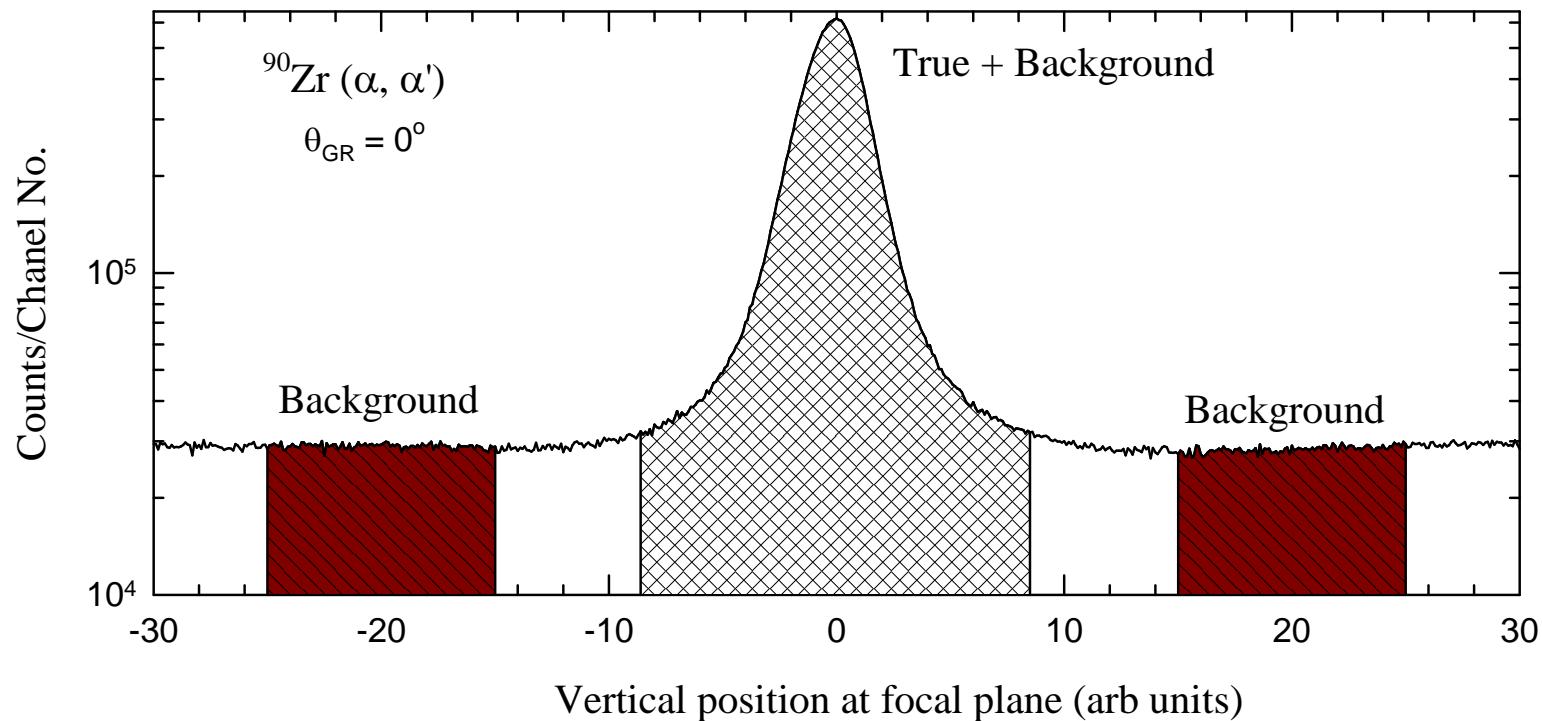
90Zr, 92Zr, 92Mo

“Grand Raiden” Spectrometer

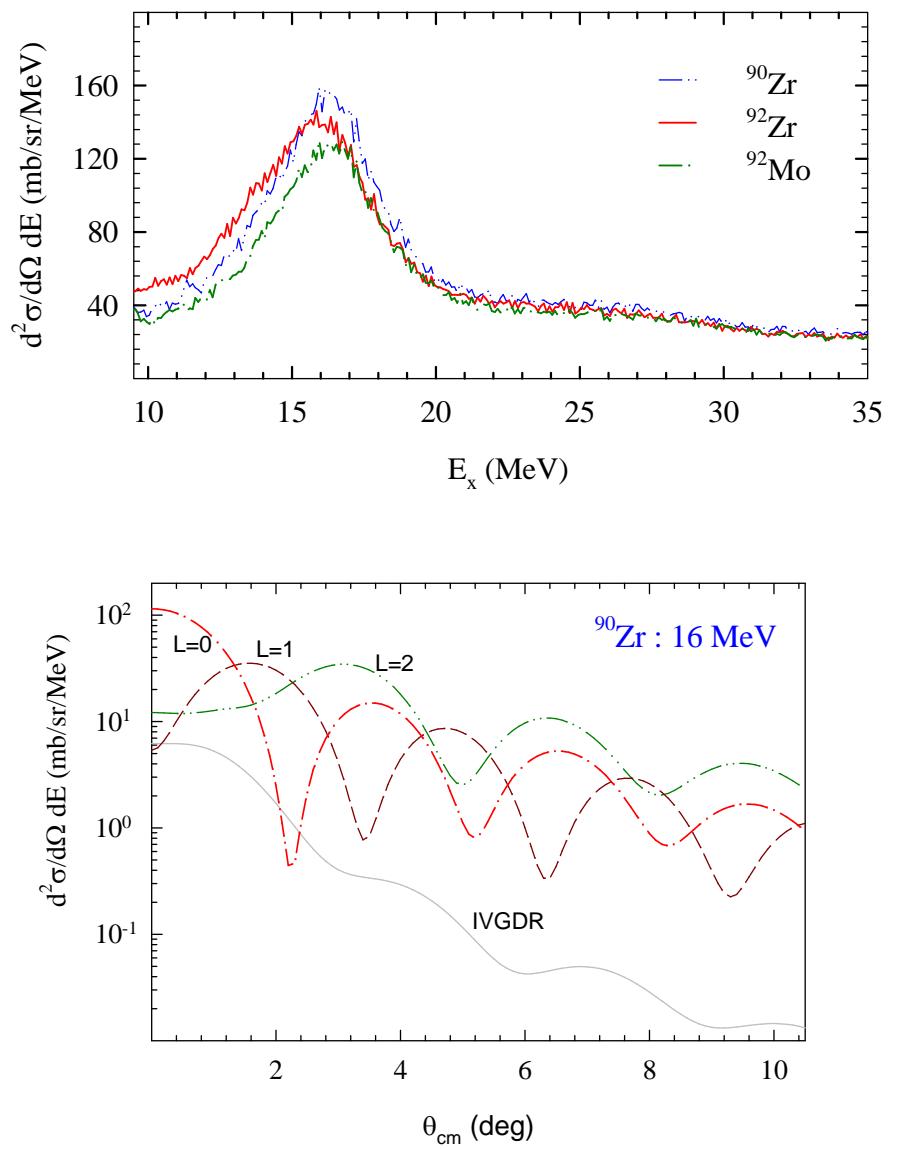
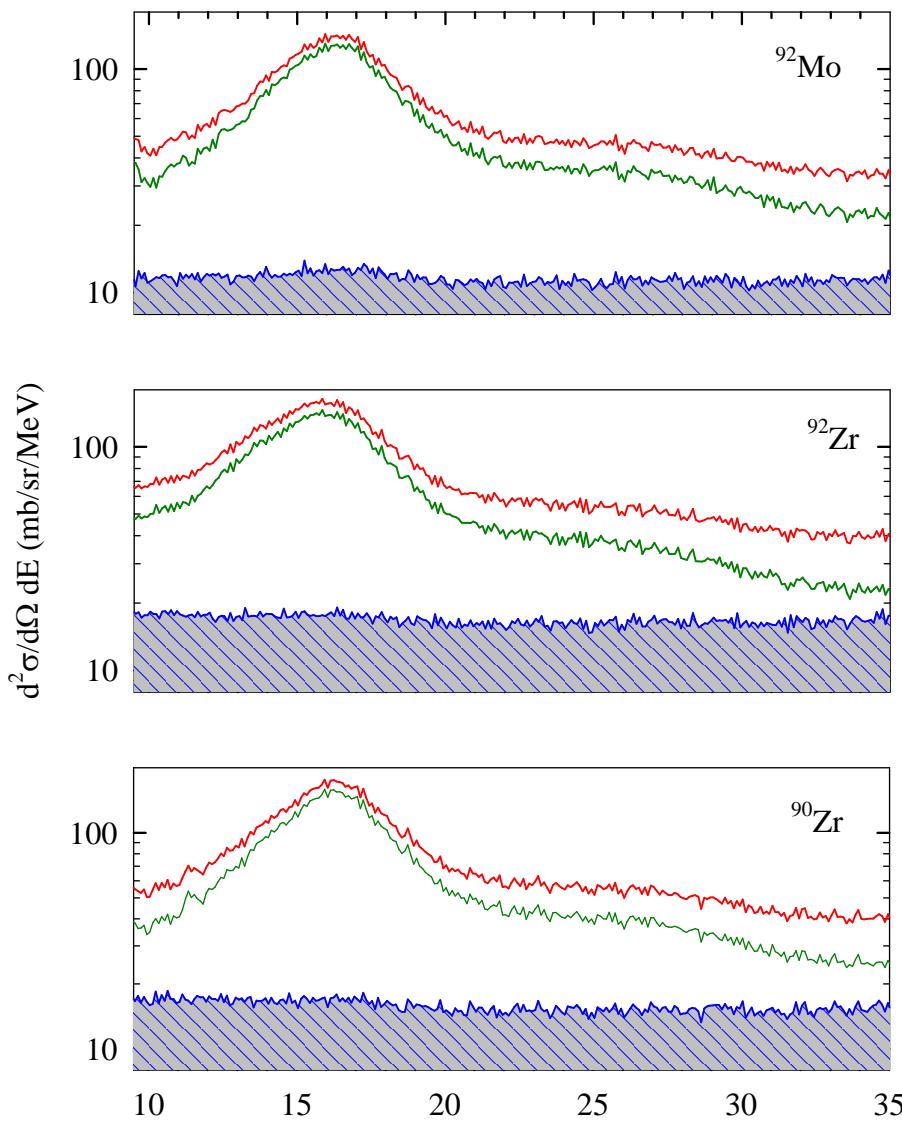




Vertical Position Spectrum:



Zero Deg Excitation Energy Spectra

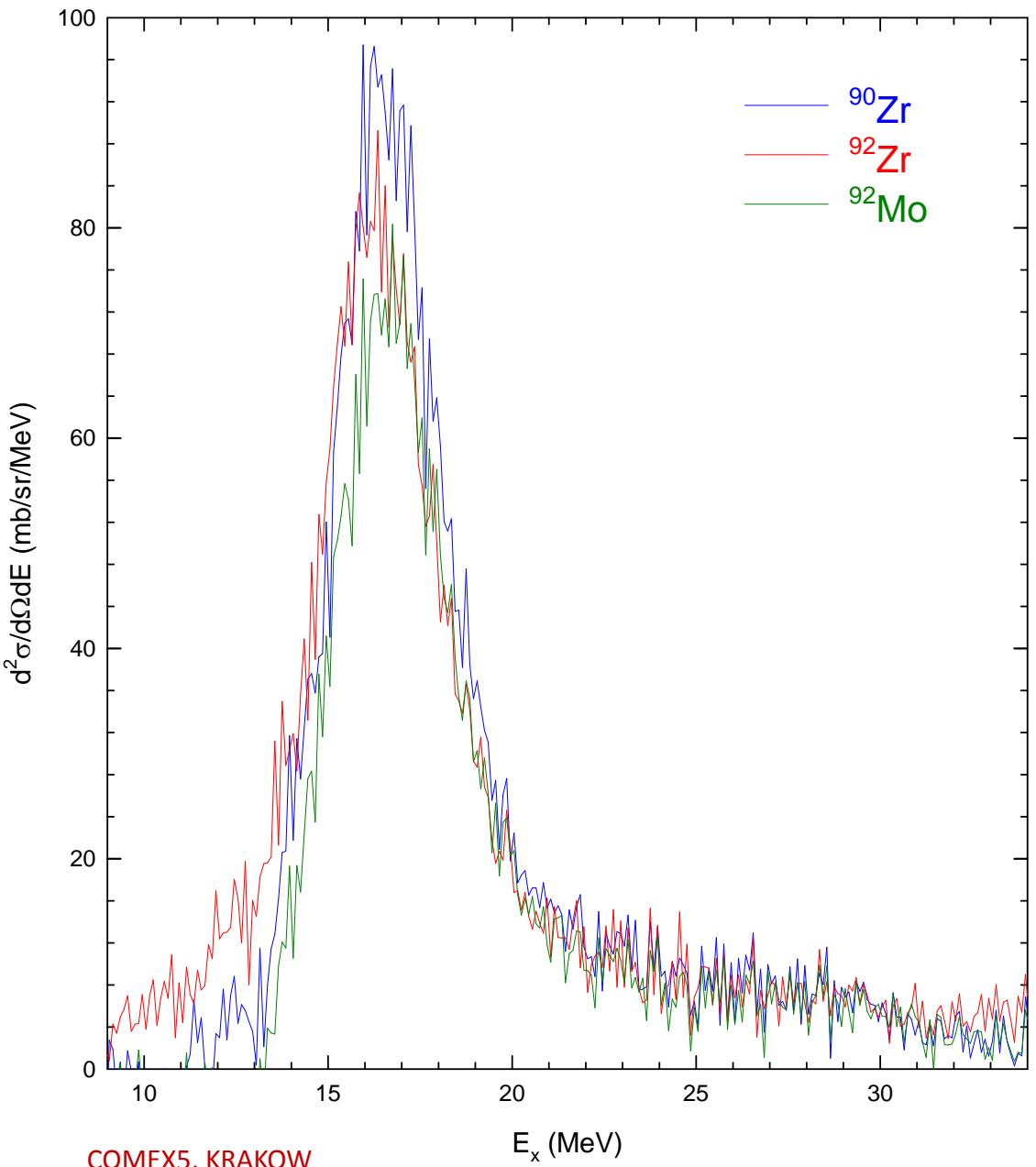


Difference Spectra

$0^\circ - 2.5^\circ$

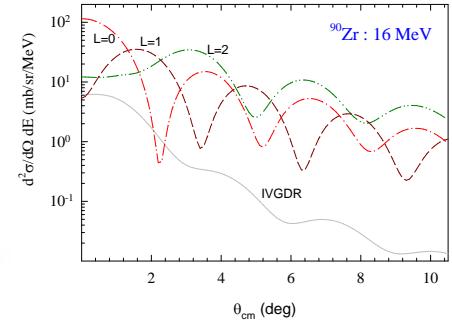
“Essentially the monopole”

Excellent agreement among all three nuclei.

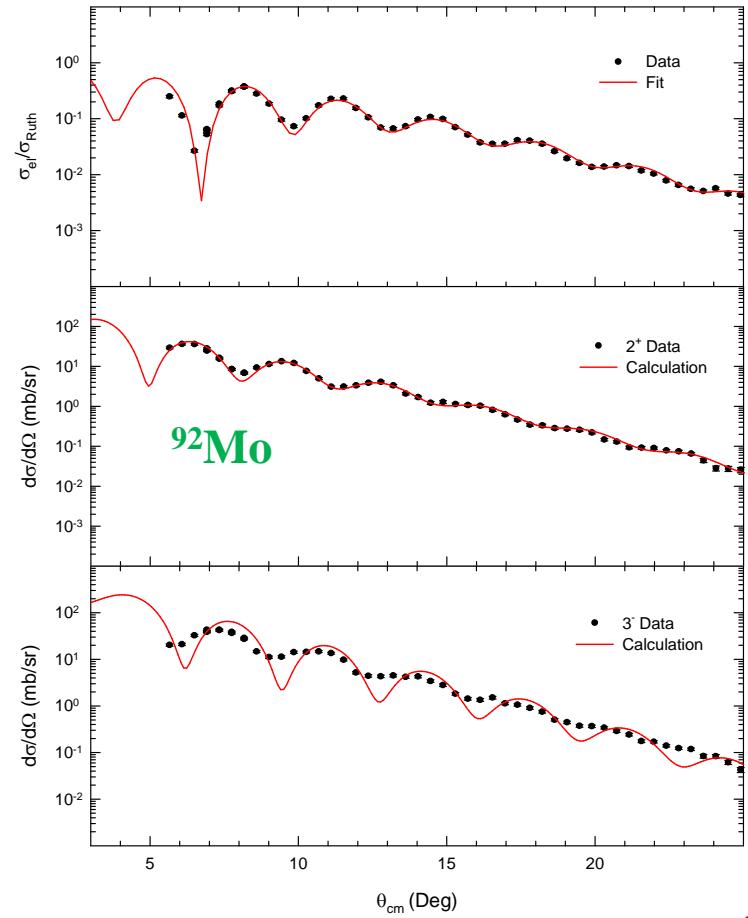


Multipole Decomposition Analysis

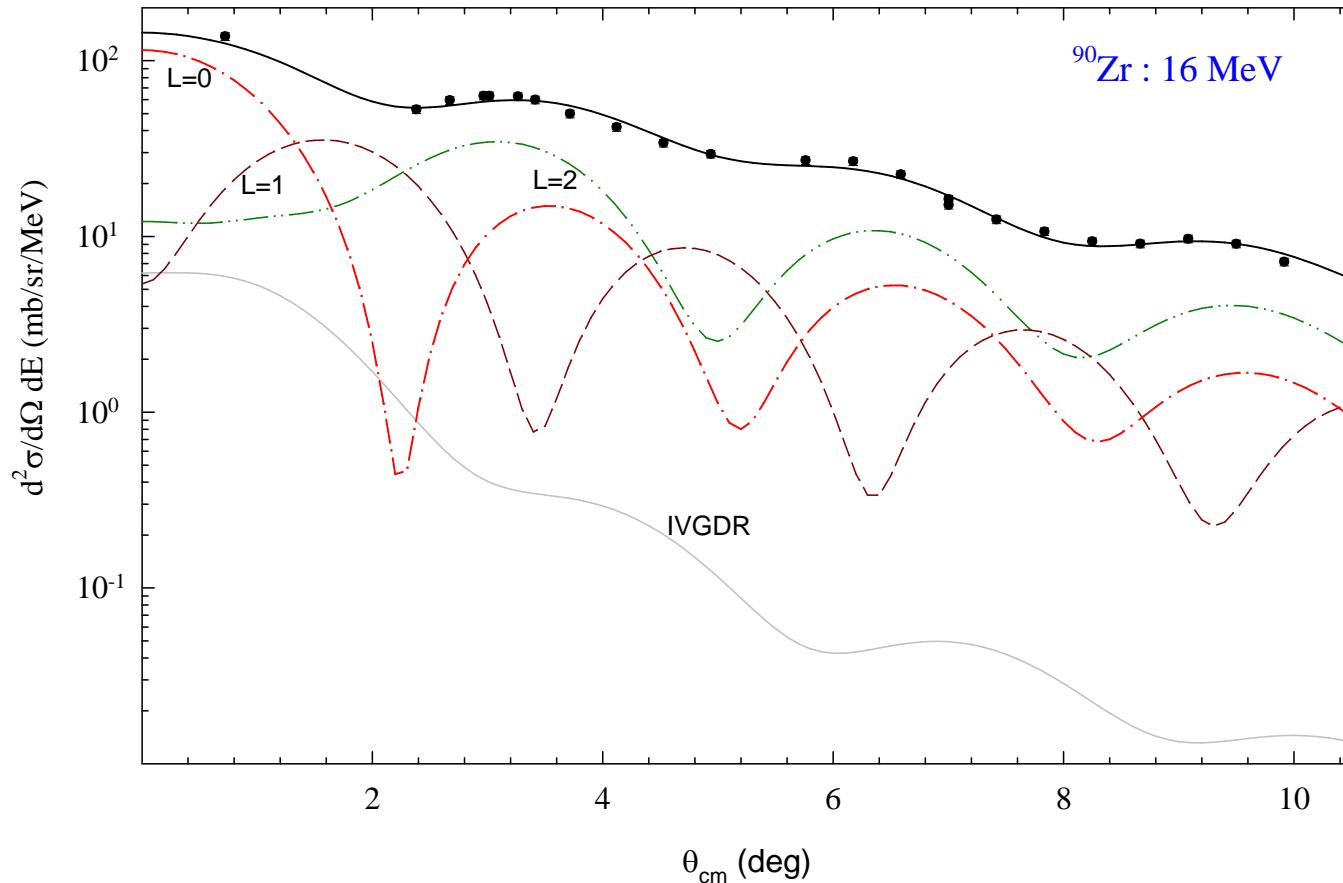
$$\frac{d\sigma^{\text{exp}}}{d\Omega}(\theta_{\text{c.m.}}, E_x) = \sum_{L=0}^7 a_L(E_x) \times \frac{d\sigma_L^{\text{cal}}}{d\Omega}(\theta_{\text{c.m.}}, E_x),$$



- DWBA calculations using Hybrid Potential Model [G. R. Satchler D. T. Khoa Phys. Rev. C 55, 285(1997)]
- Optical Models Parameters from elastic fits for each nucleus
- Determined B(E2) and B(E3) values are consistent to the EM values.

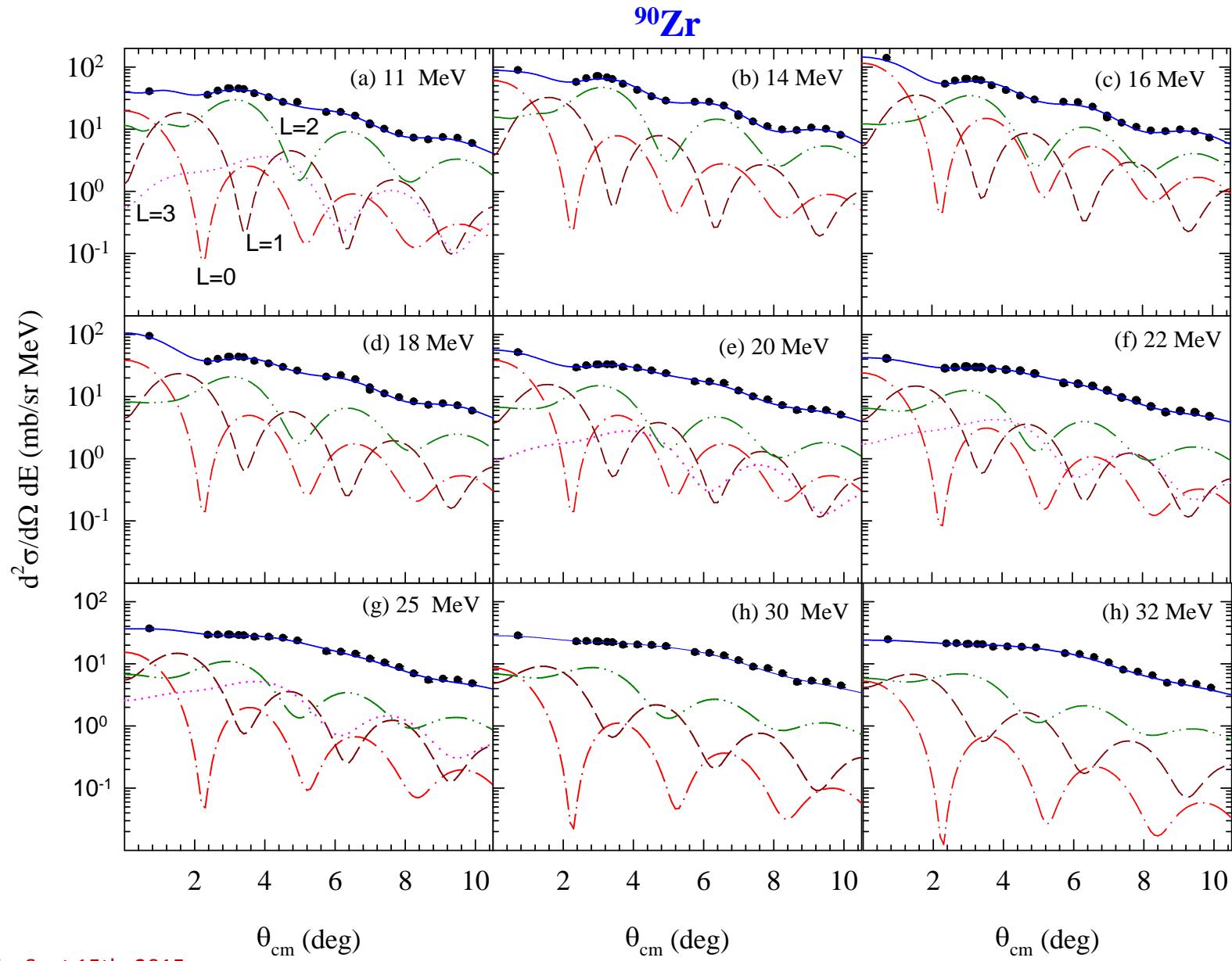


Multipole Decomposition Analysis...

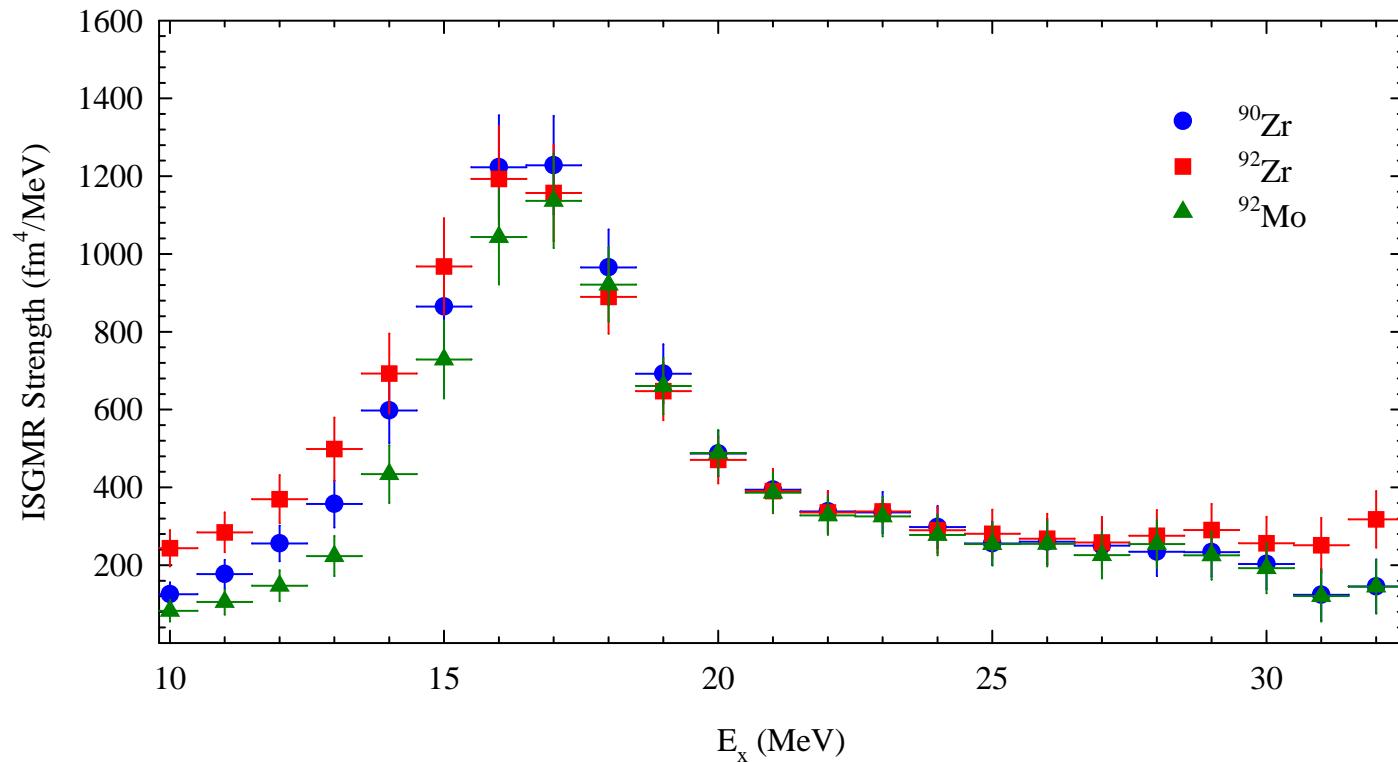


IVGDR: From measured photo neutron cross section

Multipole Decomposition Analysis...



ISGMR Strength Distribution

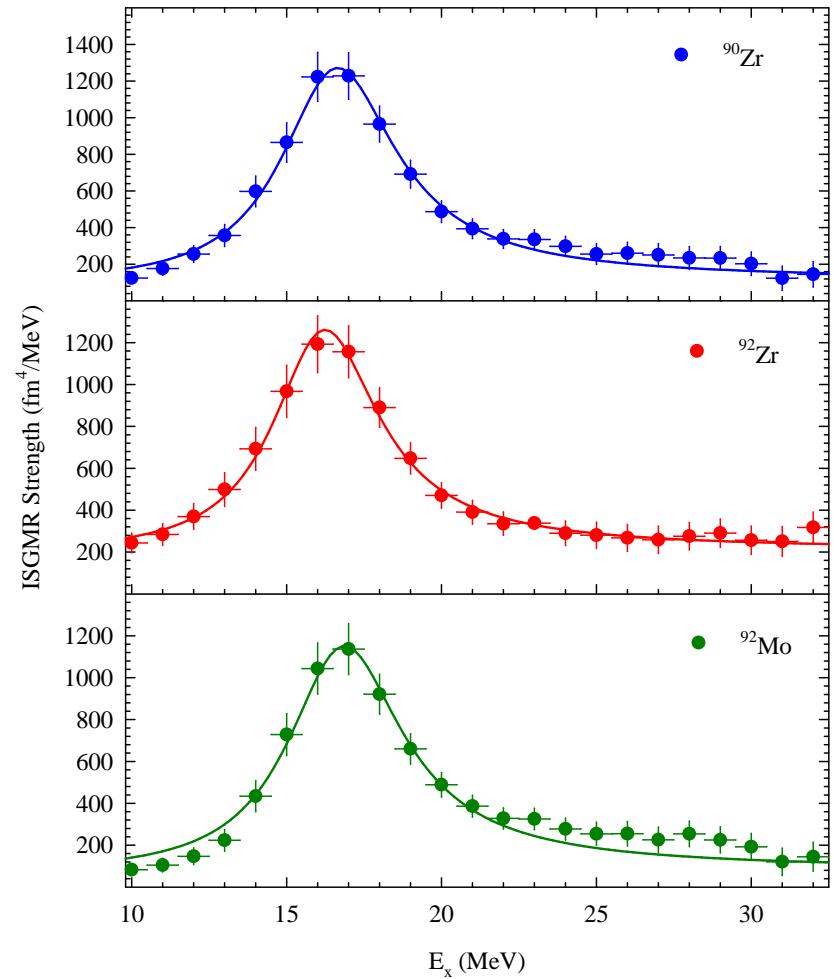


ISGMR Strength Distribution...

Lorentzian Fit

Nucleus	E_m (MeV)	Γ (MeV)
^{90}Zr	16.7 ± 0.1	4.5 ± 0.3
^{92}Zr	16.2 ± 0.1	4.2 ± 0.2
^{92}Mo	16.8 ± 0.2	4.5 ± 0.6

Similar Parameters!



ISGMR: Moment Ratios

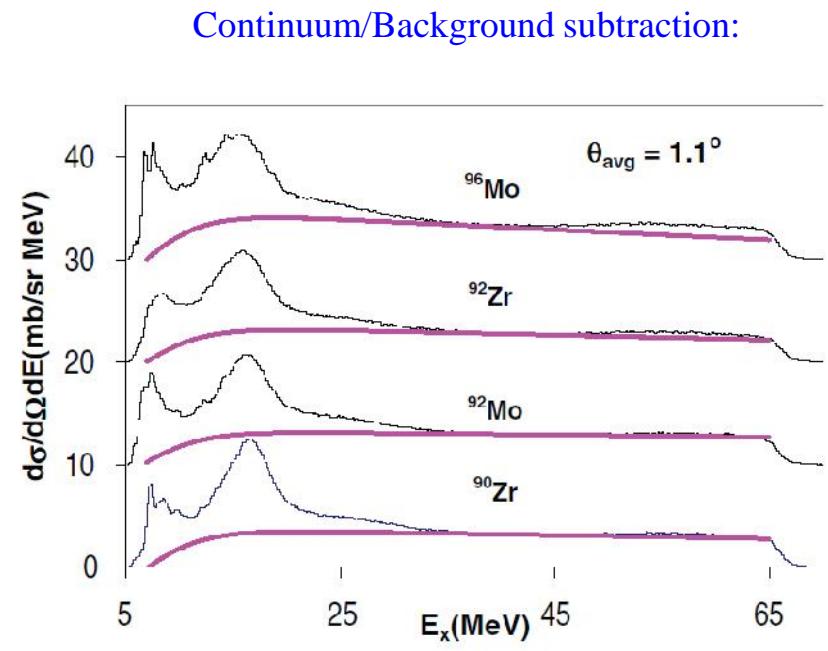
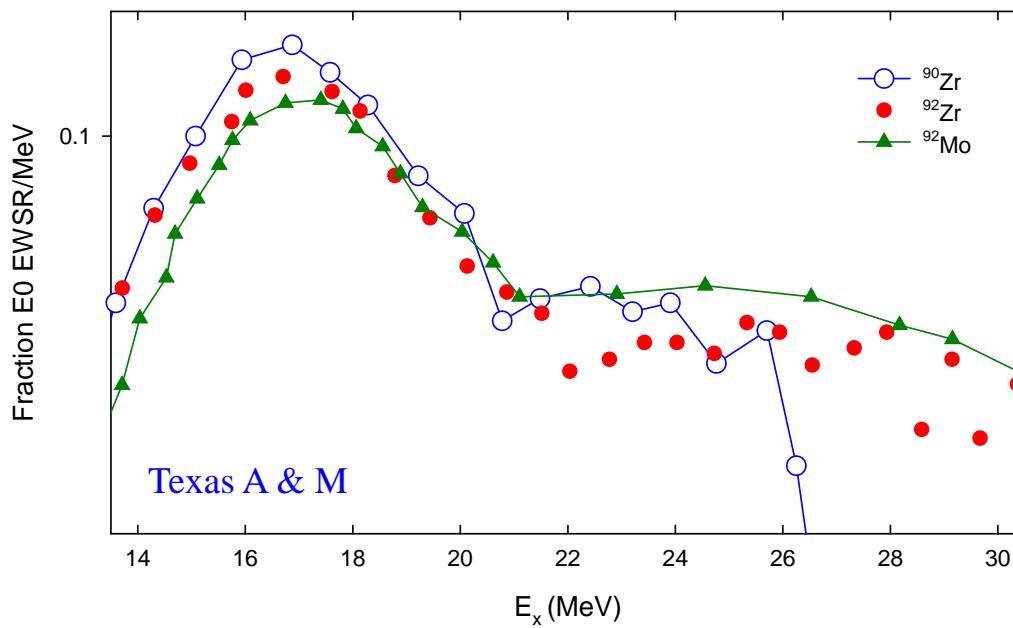
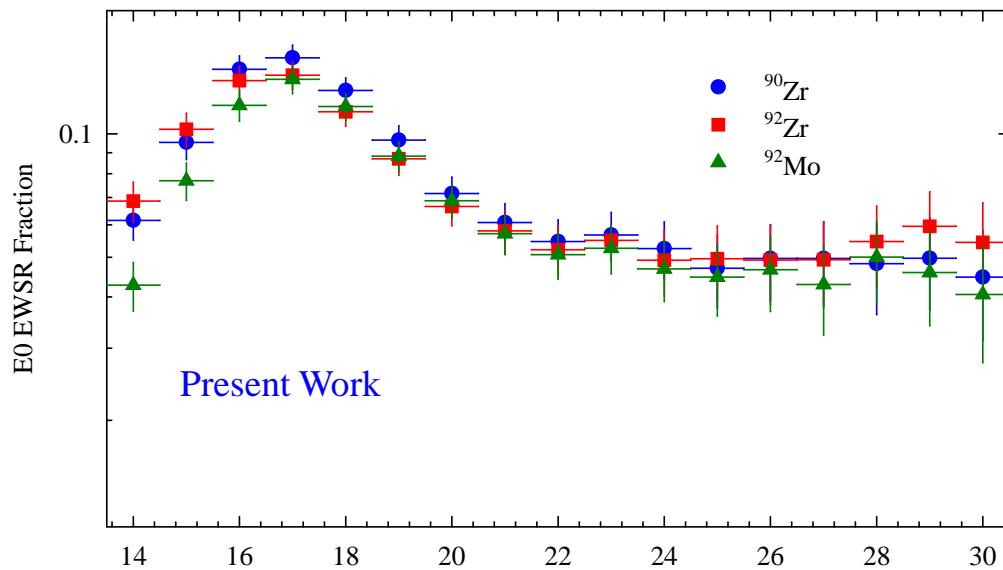
$$m_k = \int_{E_{x1}}^{E_{x2}} E_x^k S(E_x) dE_x$$

Energy range: 10-22 MeV

	$(m_3/m_1)^{1/2}$ (MeV)	$(m_1/m_{-1})^{1/2}$ (MeV)	E0 EWSR (%)
⁹⁰ Zr	17.2 ± 0.2	16.4 ± 0.4	92.1 ± 7.2
⁹² Zr	17.0 ± 0.1	16.0 ± 0.1	90.6 ± 3.9
⁹² Mo	17.3 ± 0.4	16.5 ± 0.4	78.7 ± 9.8

Within 400 keV the ISGMR energies are same for all three nuclei
 Within the experimental uncertainty the extracted strengths are similar

E0 EWSR: Present versus Texas A&M Group

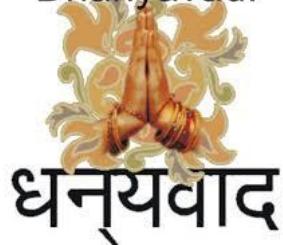


Conclusions

- ✓ In order to verify independently the highly intriguing results reported by Texas A&M group, -inelastic measurements have been carried for $^{90,92}\text{Zr}$ and ^{92}Mo nuclei at state-of-art facility; Grand Raiden Spectrometer, RCNP, Osaka University Japan.
- ✓ Multipole decomposition analysis is carried within the DWBA framework where, hybrid potential model is used.
- ✓ Close agreement between the $B(\text{EL})$ values determined in the present work and reported in literature, mostly from (e, e') scattering, for 2^+ and 3^- establishes the reliability of the OMPs and the MDA procedure.
- ✓ The ISGMR energies and strengths for all three nuclei are observed to be similar within the experimental uncertainty, ruling out any contribution from nuclear structure to the nuclear compressibility.

Thank You

Dhanyavad!



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