Reconciling Giant Resonance Data

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Motivation

- Giant Resonances are important because they tell us about bulk properties of the nucleus, such as its compression modulus.
- While Gaussian fits are most common in the study of Giant Resonances, the group from Osaka University in Japan use either Lorentzian or Breit-Wigner fits. This presents a challenge when it comes to comparing results.
- The Osaka group primarily publishes radiative strength distributions rather than energy-weighted-sum-rule (EWSR) strength distributions, which also creates complications for comparing data.
- The aim of this project was to gather data from Osaka publications, convert to EWSR distributions and carry out Gaussian fits.

Background

- Giant Resonances are the collective motion of the nucleons within the nucleus.
- Resonance typically occurs at excitation energies between 10-30 MeV.
- Resonances can be isoscalar (i.e. the nucleons move in phase) or isovector (i.e. the nucleons move out of phase).
- The nucleus can take on monopole (L=0), dipole (L=1), quadrupole (L=2), etc., structures.
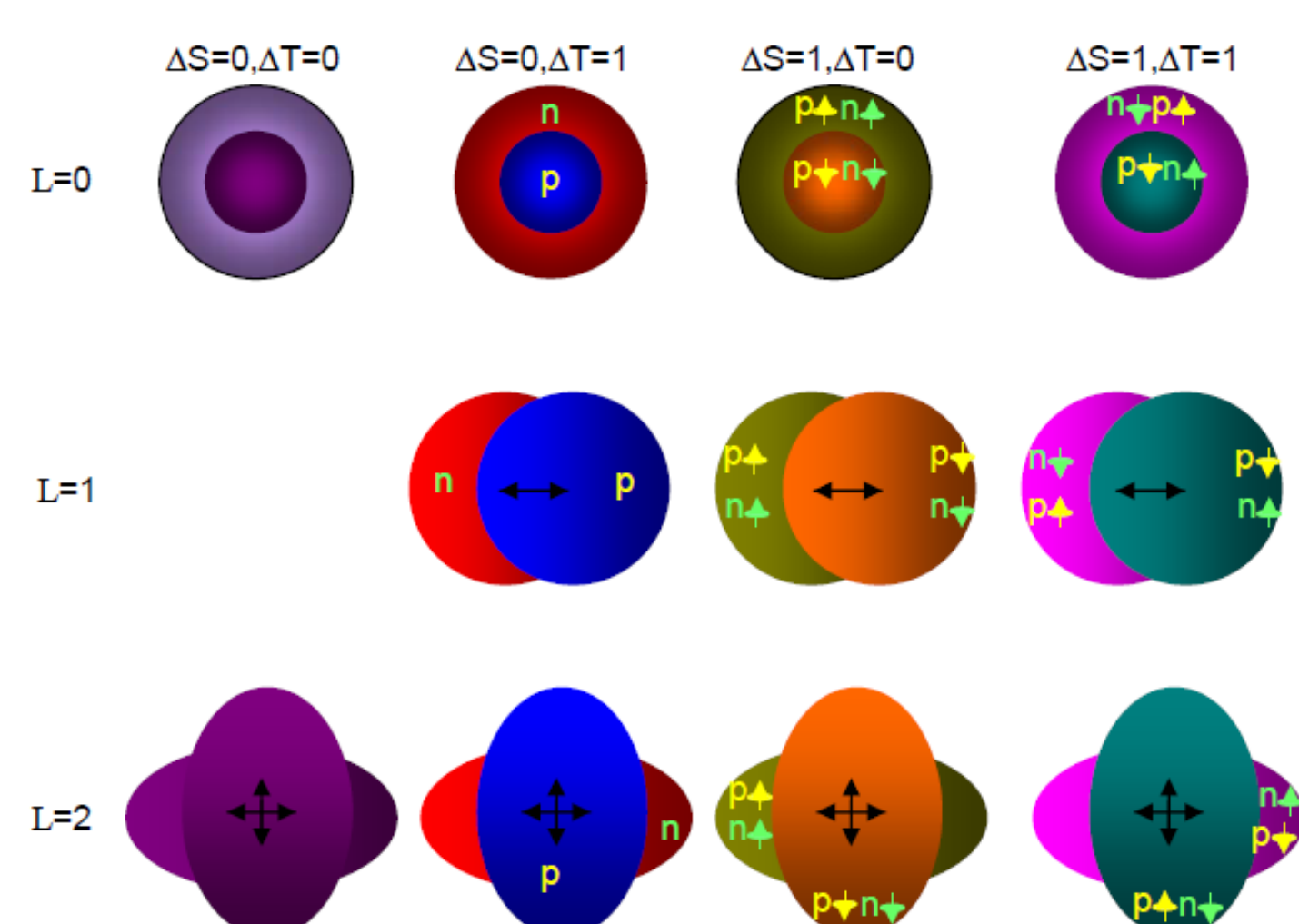
Figure 1: Visual representation of giant resonances. Originally from [1].
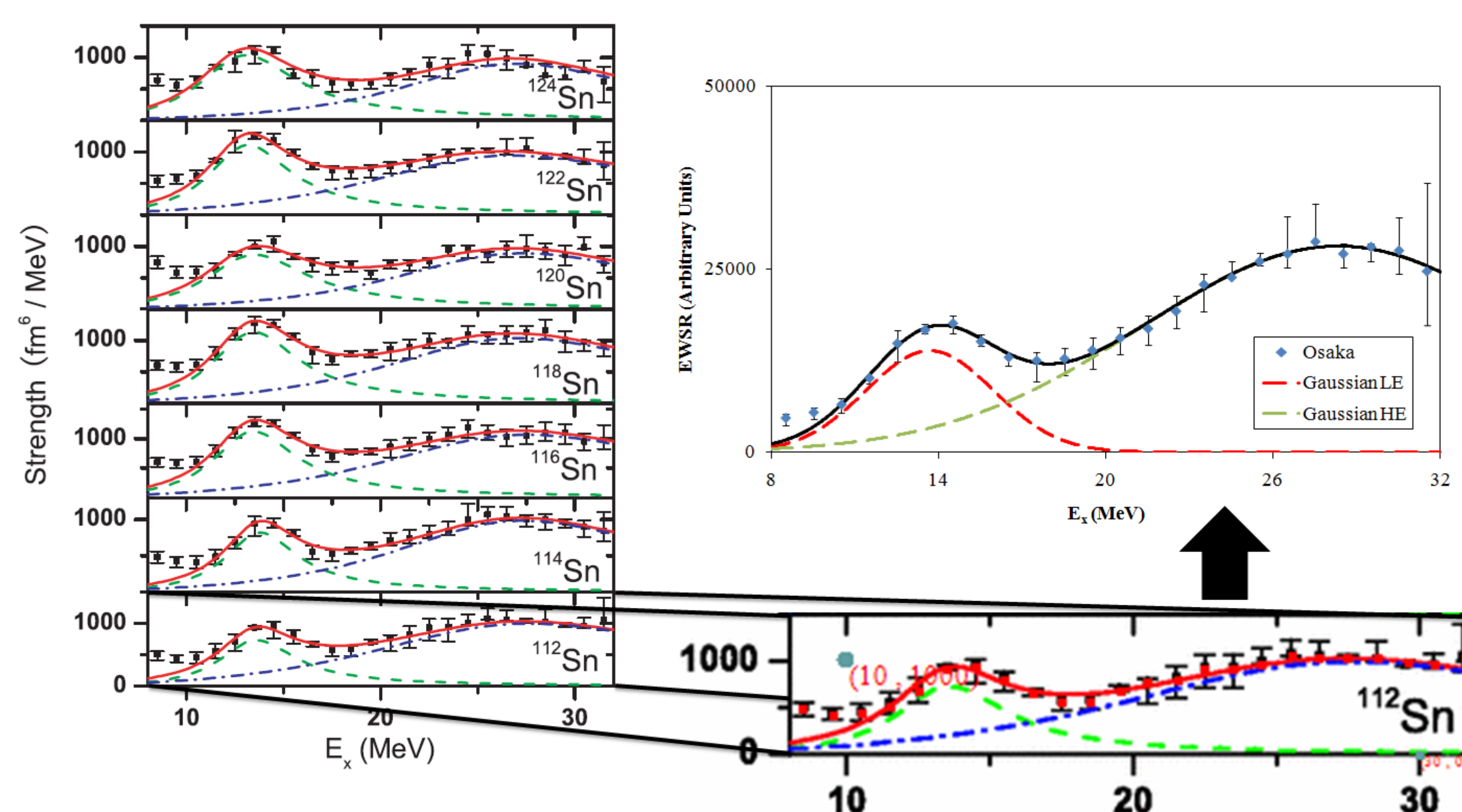
Data Extraction Process

Figure 2: Data extraction process for the ISGDR in ^{112}Sn.

- All plots taken from publications by the Osaka group.
- Data from each plot were extracted using digitization software.
- After adjusting the data to an EWSR strength distribution, the resulting data were fit with a Gaussian distribution.
- This was done for 49 different giant resonances.
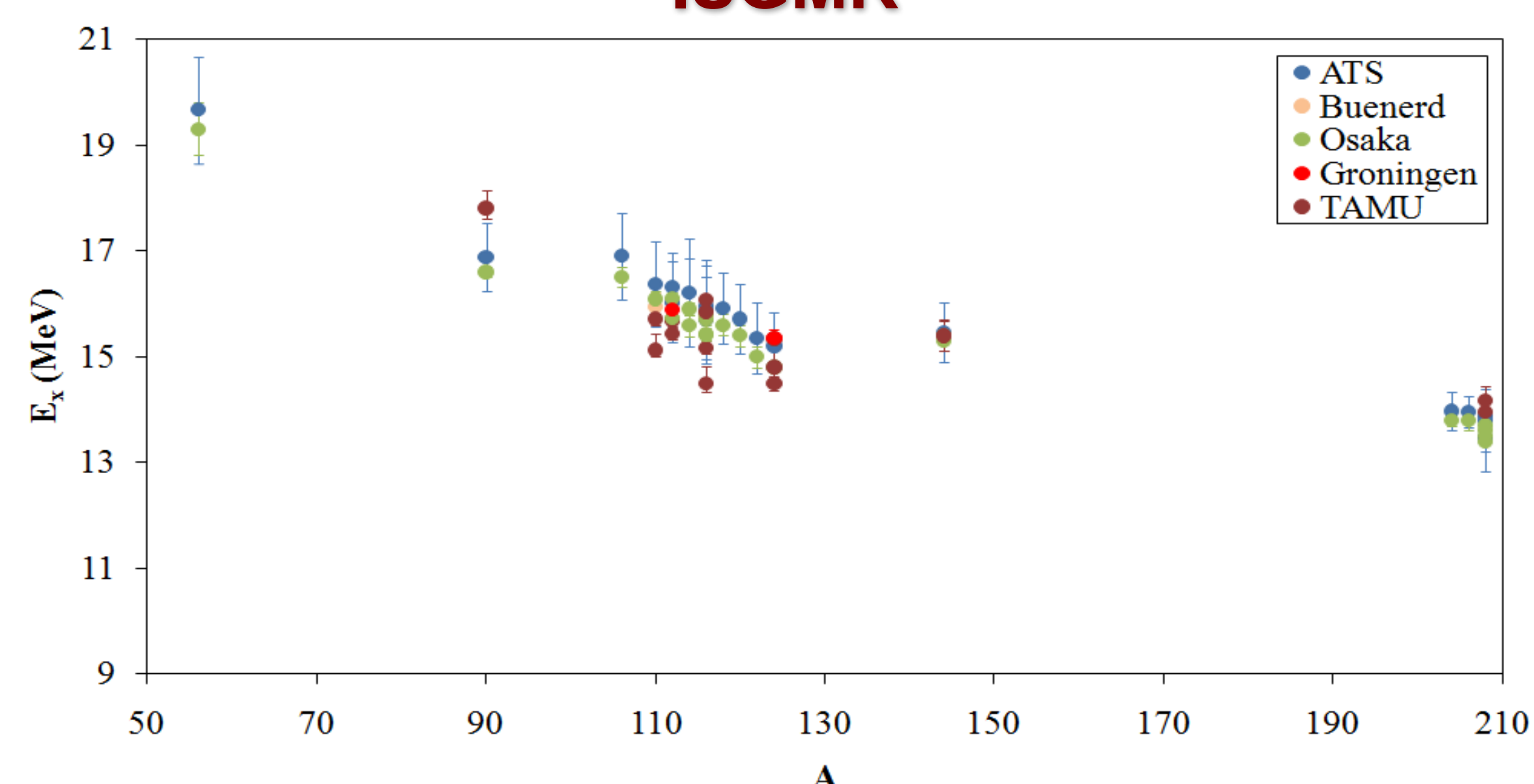
ISGMR

Figure 3: Comparison of excitation energies vs. atomic mass number for various nuclei for the Isoscalar Giant Monopole Resonance (ISGMR).
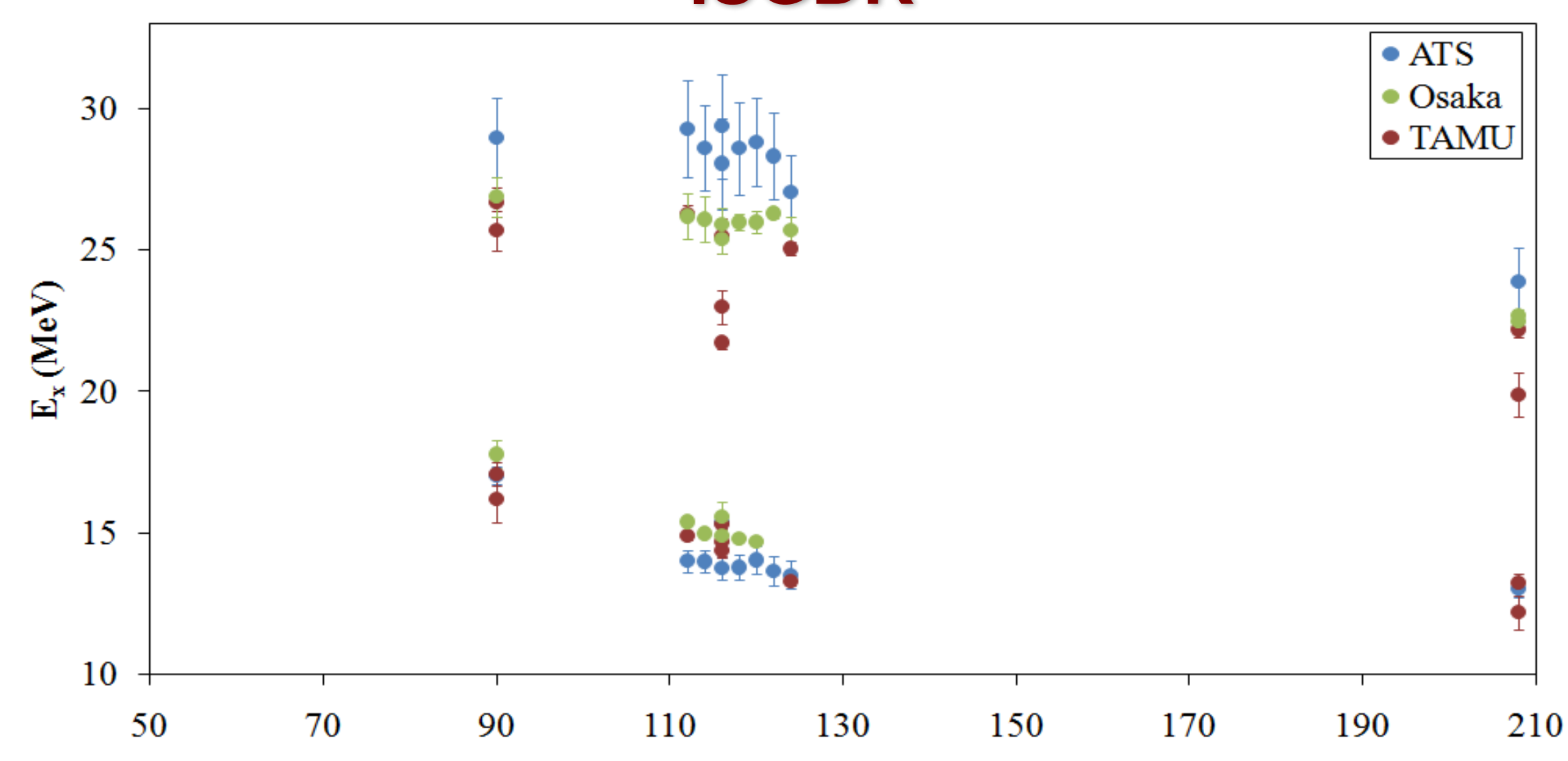
ISGDR

Figure 4: Comparison of excitation energies vs. atomic mass number for various nuclei for both Low Energy (LE) and High Energy (HE) components of the Isoscalar Giant Dipole Resonance (ISGDR).
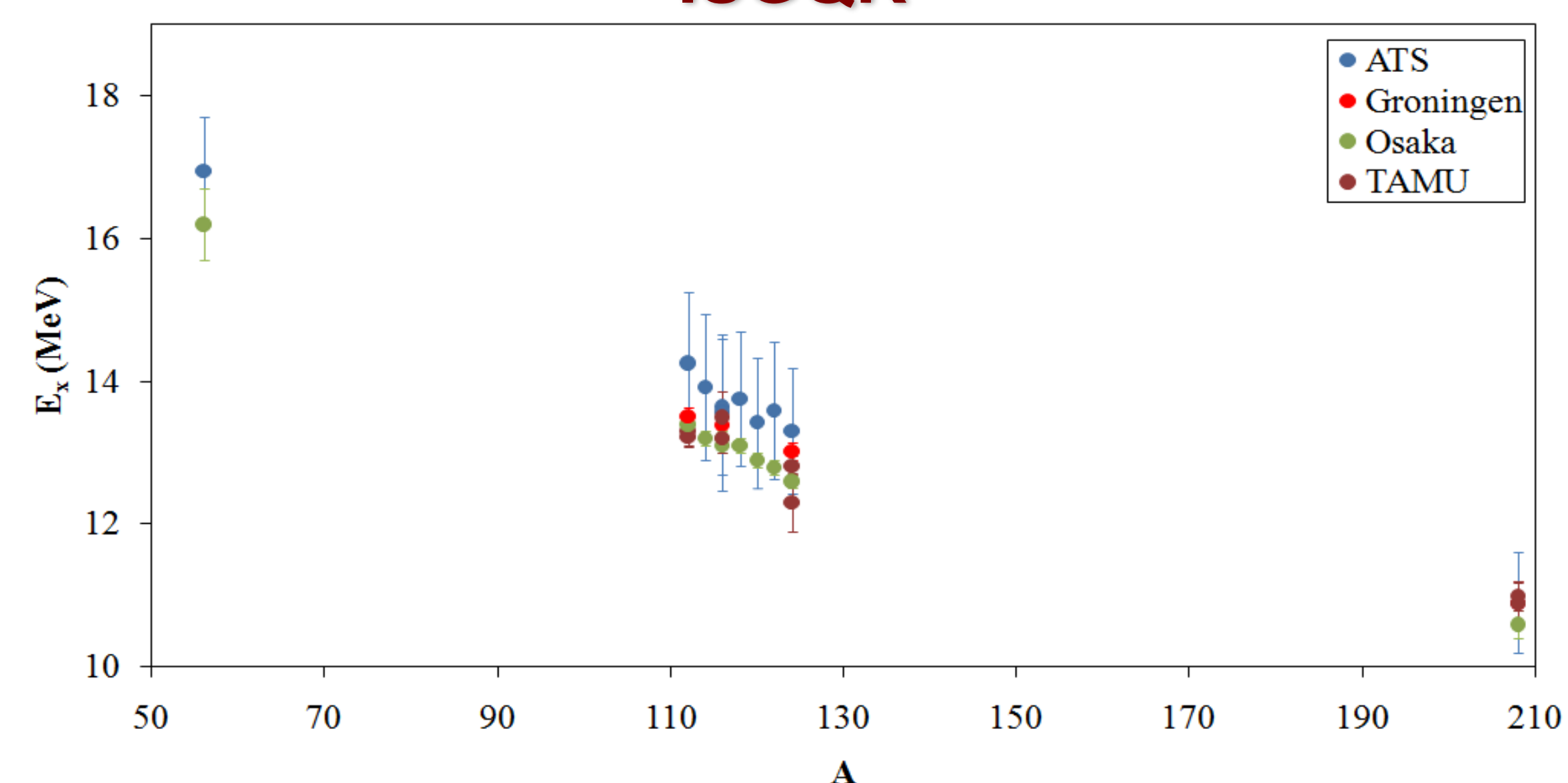
ISGQR

Figure 5: Comparison of excitation energies vs. atomic mass number for various nuclei for the Isoscalar Giant Quadrupole Resonance (ISGQR).
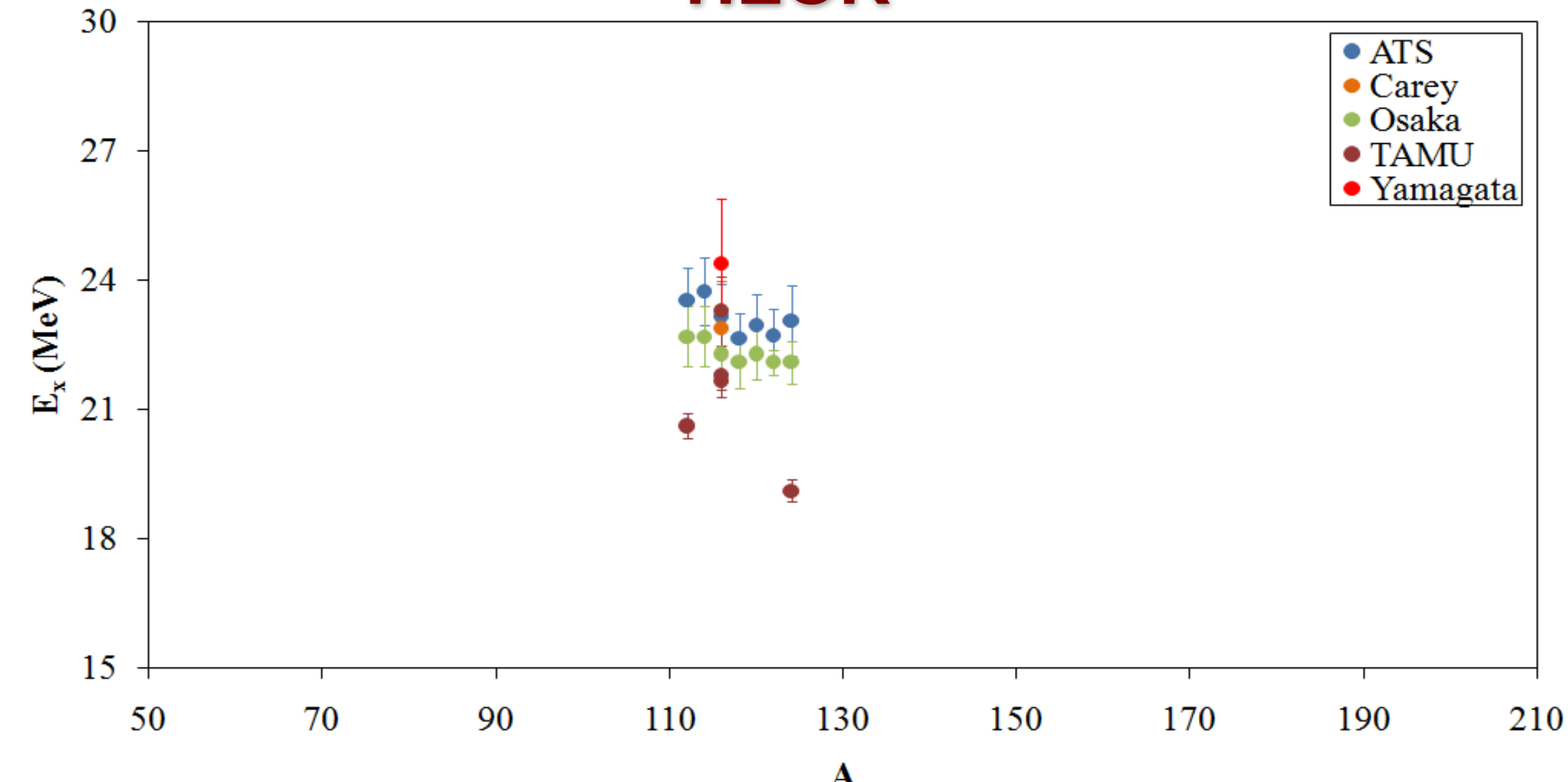
HEOR

Figure 6: Comparison of excitation energies vs. atomic mass number for various nuclei for the High Energy Octupole Resonance (HEOR).

Results

- In Figures 3-6, excitation energies published by Osaka and the values found from Gaussian fits, labeled ATS, are plotted along with work done by other authors, including the TAMU group.
- In Figure 4 the higher excitation energies correspond to the HE component of the ISGDR, while the lower excitation energies correspond to the LE component of the ISGDR.

Conclusion

- The centroids obtained from the Gaussian fits to the EWSR strength distributions are generally higher than the energies reported by the Osaka group, however in most cases are well within the uncertainties.
- The Gaussian fit to the EWSR distributions for the high energy ISGDR data results in substantially higher energies than the fits to the radiative strengths, primarily due to the large widths of these resonances.

References

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On Graphs
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