Direct Translation of Resonance Parameters for use in Sensitivity Analysis

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Introduction and Motivation

- High-fidelity nuclear cross section data is vital to the accuracy of modeling and simulation tools in various nonproliferation applications.
- The impact of uncertainty in evaluated resonance parameter data is not well quantified.
  - Pole representation of cross sections allows for direct calculation of this impact.

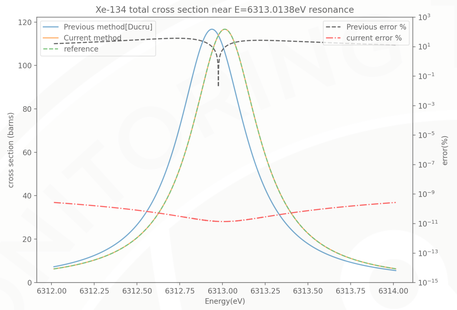
Mission Relevance

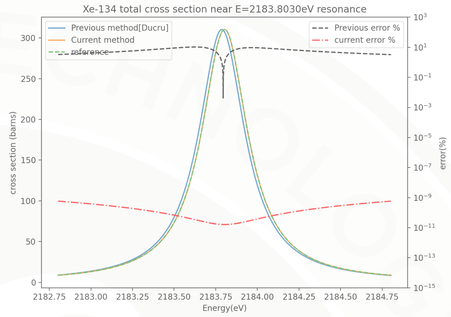
- The goal of this work is to increase the fidelity of fission cross sections to further our ability to detect and intercept fissile material
  - Cross sections are inconsistent with experimental benchmark measurements
  - This work will allow for a more quantitative approach to evaluating nuclear data

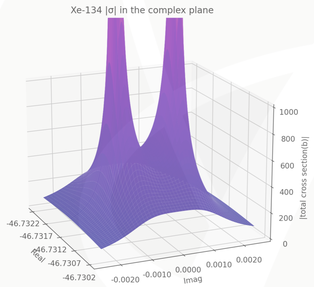
Technical Approach

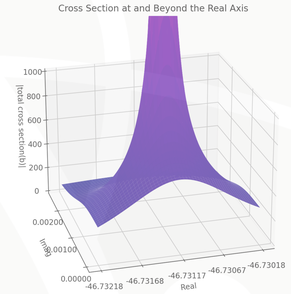
- A complex root finder technique was developed find complex poles(p_j) of nuclear cross sections
- A Cauchy's integral method was developed to find complex residues (r_j^{total}) at poles
- Build cross sections as described by:
- $\sigma_t(z) = HOL(z) + Re\left(\sum_j \frac{r_j^{total}}{z-p_j}\right)$

Results









Above: This work significantly improves the accuracy of multipole-constructed cross sections at resonance energies.

Expected Impact

- Development of this capability allows for direct calculation of $\frac{\partial \Sigma}{\partial \Gamma}$
- Combining $\frac{\partial \Sigma}{\partial \Gamma}$ with Response sensitivities gives the uncertainty in a response introduced by uncertainty in resonance parameters (Γ)

MTV Impact

- Improving nuclear data fidelity improves the accuracy of material accountability simulations for all MTV participants.
- This work has led to many fruitful collaborations between the UNM Team and National Laboratory staff, including multiple summer internships at LANL.

Conclusions

- This work demonstrates proof of principle for the direct translation of resonance parameters to the multipole formalism.
  - High degree of accuracy in cross sections when compared against reference
  - $\frac{\partial \sigma_x}{\partial r_j^{total}}$, $\frac{\partial \sigma_x}{\partial p_j}$, can be found directly
- Translation can be done using simple methods (Newton Raphson, 1st order numerical integration)

Next Steps

- Ongoing work includes Faddeeva Function developed to enable sensitivity analysis
- These methods will be implemented into a production Monte Carlo code (MCNP)

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