Approximate R-Matrix Resonance Parameter Sensitivity Using Pole Representation of Cross Sections

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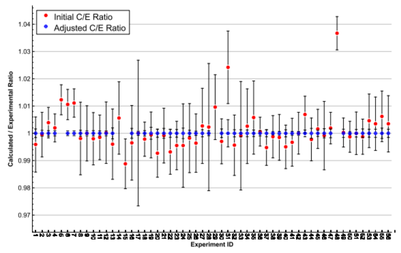
Introduction and Motivation

- R-Matrix, the framework for evaluated nuclear data has existed in its current form for decades with some evaluations in the most recent ENDF6 libraries dating back decades.
- Nuclear data evaluations are based on a combination of experimental data and the expert judgment of the evaluators. Because of this, it is difficult to determine what level of uncertainty is placed on the different parameters of the evaluation.
- A common method of improving existing nuclear data evaluations uses sensitivity coefficients to adjust cross sections.



Mission Relevance

- Accurate and precise nuclear data is a cornerstone of modern nonproliferation efforts.
- This work aims to increase the fidelity of nuclear data evaluation by creating a tool to more precisely adjust cross sections to better match reality,
- *NNSA Mission* https://www.energy.gov/nnsa/missions/nonproliferation

Technical Approach

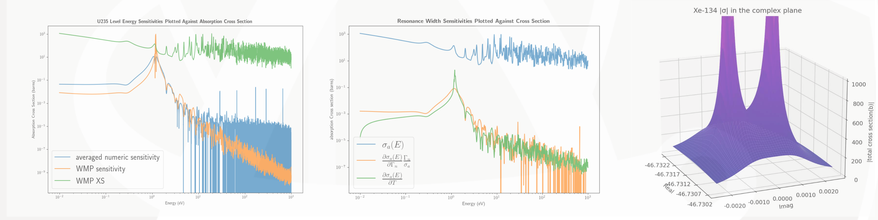
- The Pole Representation builds cross sections as a sum of simple poles (p_j) and residues (r_j).

$$\sigma(E) \propto Re\left(\sum_j \frac{r_j}{\sqrt{E} - p_j}\right); \quad p_j, r_j \in \mathbb{C}$$

This allows for direct calculation of the sensitivity coefficients S_{σ,p_j}.

- These poles and residues are related to the resonance parameters used in R-matrix. This approach attempts to approximate R-matrix resonance parameter sensitivities with multipole parameter sensitivities.

Results



- Preliminary results show that there is a relationship between resonance parameter sensitivities and the analytic derivatives of the Multipole cross sections.
- Left: Comparison of R-matrix level energy sensitivities and pole sensitivities
- Right: Comparison of R-matrix resonance width sensitivities against pole temperatures sensitivities

Expected Impact

- The capability to generate resonance parameters sensitivities allows for adjustment of evaluations in way that is consistent with the way that they are constructed (i.e. Adjustments will not create non-physical phenomena)
- This work provides an alternate method of improving evaluated nuclear data using only simulation results

MTV Impact

- MTV has provided outstanding opportunities to further my professional development
  - Provided funding to send me to international conferences (IAEA,CSEWG)
  - Provided funding for internships an Los Alamos National Laboratory
  - Introduced me to other professionals through MTV itself or UPR
- Collaboration with national lab:
  - Mark Paris, Mike Rising, Wim Haeck, Colin Josey
- Technology Transitions
  - Nuclear data evaluators will be able to use this method to adjust individual aspects of an evaluation
  - The On-The-Fly doppler broadening capability of the WMP in MCNP would have wide reaching effects in the modeling and simulation community

Conclusion

- Thus far we have seen a distinct relationship between analytic WMP sensitivities and numeric R-matrix parameter sensitivities. Local sensitivities (i.e. near the perturbed component) Match the closest.
- Improvements to evaluated nuclear data impacts countless aspects of the nonproliferation goal. This work will improve the characterization of SNM reducing uncertainty in identification, Measurement and monitoring.

Next Steps

- Plans for ongoing work include:
  - Implement a version of WMP into MCNP6 to generate sensitivities
  - Investigating the cause of the differences between WMP sensitivities and numeric

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