Calculating Double-differential and Energy-Differential Resonance Cross Sections Using the R-Matrix Limited Formalism in the AMPX Code

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Outline

- Motivation
 - Why RML?
- Computational Improvements
- Test Cases
- Future Work

Motivation

- Need ability to generate precise doubledifferential cross sections directly from resonance parameters
 - improve model fidelity for both reactor simulations and shielding problems
 - Consistency same parameters used to generate energy-differential and double-differential
- Help achieve goal of updating AMPX code package to modern language (C++)

- Why R-Matrix Limited Approximation?
 - Closest to full R-Matrix (too complex)
 - Treats capture channels in an aggregate manner, but:
 - Allows multiple inelastic channels and charged particle channels, like (n,α), (n,p), etc
 - All other reactions take into account channel-channel and level-level interference:

$$R_{cc'} = \sum_{\lambda} \frac{\gamma_{\lambda c} \gamma_{\lambda c'}}{E_{\lambda} - E} \delta_{JJ'}$$

As opposed to SLBW (all interference effects ignored), MLBW (channel-channel interference ignored), Reich-Moore (no charged particles)

Computational Improvements

- New library module is implemented in C++
 Object-oriented programming
- Maintains modularity
 - Similar structure to original SAMRML routine
- Utilizes linear algebra package LAPACK
 Takes advantage of complex data type

Test Cases

- Generated energy-differential and doubledifferential cross sections
 - Cross sections results verified by comparison with SAMMY
 - ¹⁹F
 - Two inelastic channels
 - ¹⁶O
 - (n, α), charged particle channel

Energy–Differential Results – ¹⁹F Elastic Scattering



¹⁹F Capture



¹⁹F Inelastic Scattering



¹⁶O Elastic Scattering



¹⁶O Capture



¹⁶O – (n,α)



Double Differential Results-¹⁹F Elastic Scattering



¹⁹F Inelastic Scattering



¹⁶O Elastic Scattering



¹⁶Ο (n,α)



Future Work

- Additional verification with other isotopes (have also verified ⁵⁶Fe and ³⁵Cl)
 - Need more RML formatted ENDF File 2
- Refactor code
 - Provide access to other AMPX functionality

References

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Questions?