Resolved Resonance Region Evaluation
Update of $^{140,142}$Ce

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Outline

• Overview

• R-matrix Analysis
  – Fitting results
  – Statistical analysis

• Validation

• Conclusions
Overview of $^{140,142}$Ce Isotopes

- New evaluations of $^{140,142}$Ce requested by Hanford Plutonium Finishing plant to the NCSP
  - 88.45% $^{140}$Ce, 11.11% $^{142}$Ce, 0.44% minor isotopes
- Used as a catalyst or additive for chemical applications
- Appears as an admixed material in process streams
- $^{140}$Ce stable secondary fission product
- $^{140}$Ce has closed neutron shell
  - Potential for direct capture contribution
Overview of $^{140,142}\text{Ce}$ Isotopes

- Current ENDF/B-VIII.0 issues:
  - Error in the 1-2 keV range of $^{142}\text{Ce}$
  - Evaluated using multi-level Breit-Wigner
  - $^{142}\text{Ce}$ has room for extending resolved resonance region current upper limit from 13 keV

- New transmission and capture measurements of $^{\text{nat}}\text{Ce} \& ^{142}\text{Ce}$ from K. Guber at GELINA

- No known integral critical experiments prominently feature Cerium
R-matrix Analysis – fitting results: $^{\text{nat}}$Ce
R-matrix Analysis – fitting results: $^{142}$Ce
R-matrix Analysis – Statistical Analysis – $^{140}$Ce

Ce-140 s-wave statistical checks

Average Level Spacing Distribution

Resonance Width Distribution

Cumulative Levels vs. Energy

Ce-140 p-wave statistical checks

Average Level Spacing Distribution

Resonance Width Distribution

Cumulative Levels vs. Energy

Resolved Resonance Region Evaluation Update of $^{140,142}$Cerium
R-matrix Analysis – Statistical Analysis – $^{142}$Ce
Validation

- No critical benchmarks containing appreciable amounts of cerium

- Previously measured $^{140,142}$Ce cross section contain troubling errors
  - Hacken: possible sample contamination
  - Ohkubo: multiple sample thicknesses not clearly reported

- Available $^{140,142}$Ce measurements:
  - Resonance integrals
  - Thermal capture cross sections
Validation – $^{140}$Ce (Panikkath (2017))

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Validation – $^{142}$Ce

Measurements of thermal capture cross section of $^{142}$Ce

Measurements of resonance integral of $^{142}$Ce

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Conclusions

• R-matrix fit for $^{140,142}$Ce nearing completion

• Thermal capture & resonance integral needs careful investigation

• Direct capture component / additional sub-threshold resonance may be necessary to get better agreement with thermal values

• Continue to search for more high quality measurements/experiments for validation
Acknowledgements

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References

  https://doi.org/10.1140/epja/i2017-12231-8
Questions?