Reactor Neutrino Spectrum Prediction: Nuclear Data Impacts and Interplays

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Motivations

• **Scientific and Application needs:**
  • Reactor antineutrino anomaly.
  • Reactor CEvNS flux prediction.
  • Predictions for reactor monitoring, e.g. advanced reactors.

• **Structural motivations:**
  • Modern neutrino flux prediction (vs 10-40 yr-old works).
  • Build and maintain publicly available tool – with modularity and completeness.
  • Provide standard and accessible structures for full documentation of prediction inputs, facilitating comparisons and reproduction.
  • Provide standard inputs, e.g. reactor evolution & nuclear data, to lower ‘barrier to entry’ for neutrino community.
CONFLUX - Calculation Of Neutrino FLUX

- Prediction with three different modes.
- Allows analyzers to input time dependent reactor models/compositions, including fission isotopes and non-fission contributions.
- DBs are saved in xml formats for accessibility.
- Summation is commonly used to account unmeasured isotopic contributions.
Current Focus

• Summation code under development, for it is common components for three modes
  • Inputs: time dependent reactor compositions (measurement or simulation), fission yield and beta-decay databases
  • Process: fission yields fractions, beta spectra calculations
  • Output: spectrum, flux

• Built a series readable databases from latest ENDF and ENDSF.
• Study the fidelity of reactor simulation needed for reactor neutrino calculation.

Based on nuclear DBs
Difference with Past Works

- Flexible and time dependent reactor model.
- Full energy range (< 1.8 MeV included for CEvNS and BSM measurements).
- Use of modern databases.
- Cross-mode comparison in single package.
Needs from Nuclear Data

• Decay information of missing branches:
  • Roughly 6% of beta decay branches missing.
  • Unknown impact in the below IBD range.

• Result of pandemonium effect:
  • Biased branching fractions.

• Correlated uncertainty:
  • Correlation among fission yields needs to be accounted.
  • Program needs to calculate correlated uncertainty
Contribute to the Nuclear Data Community

• Cross-database comparisons can:
  • Investigate the difference between ENDF and JEFF.

• Cross-mode comparison in CONFLUX, or compare summation to experiments:
  • Search for deviations to prioritize beta decay measurements to be revisited.

• Support and combine the analysis among neutrino measurement
Summary

• Reactor neutrino prediction is essential to particle physics research, and application of neutrino for nuclear engineering.

• A new framework of reactor neutrino flux prediction - CONFLUX.

• All neutrino flux calculation modes relies on some degrees of summations based on nuclear DBs.

• Resolving missing branches, biases, and correlations of branch fractions are important to improve the reactor neutrino prediction.

• Precise data to calculation comparisons and cross-database comparisons of neutrino flux are important to pinpoint deviations that need more investigations.
Team

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