

Application of the Extracted Reactor Antineutrino Spectrum

Daya Bay Reactor Antineutrino Experiment

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The extracted reactor antineutrino spectrum of IBD reactions together with the average fission fractions from the Daya Bay experiment provide a new option for predicting reactor antineutrino spectra.

Suppose there is a reactor antineutrino experiment noted as experiment A , which also utilizes the inverse beta decay reaction to detect antineutrinos. Suppose the thermal power of experiment A is W_A , the fission fraction of fissile isotope i is f_A^i , the number of target protons is $N_{p,A}$, and the baseline from reactor to detector is L_A . The predicted antineutrino spectrum for experiment A (S_A) can be calculated using the extracted spectrum from the Daya Bay experiment ($S_{reactor}$):

$$S_A(E_\nu) = \frac{N_{p,A}}{4\pi L_A^2} \sum_i \frac{W_A}{\sum_j f_A^j e_j} \cdot [S_{reactor}(E_\nu) + (f_A^i - f_{DYB}^i) S_x^i(E_\nu) \sigma_{IBD}], \quad (1)$$

where $S_{reactor}$ is in units of $\text{cm}^2/\text{fission}/\text{MeV}$, f_{DYB}^i is the associated average fission fraction for isotope i at Daya Bay, e_j is the energy released per fission for isotope j , and S_x are fissile isotope antineutrino spectra from, for example, the ILL+Vogel model or Huber+Mueller model, σ_{IBD} is the cross-section of the IBD reaction.

The spectrum S_A is primarily determined by $S_{reactor}$, and residually influenced by the S_x . The dependence on the S_x is weaker when the fission fractions of experiment A are closer to those of the average fission fractions of the Daya Bay experiment. For PWR-type reactors, the fission fractions are similar because the fuel rods have a similar enrichment of uranium.

The uncertainties of the prediction are comprised of the uncertainties of experiment A (thermal power, baseline, and fission fractions), the uncertainty of fission energies, and the uncertainties of the extracted reactor antineutrino spectrum $S_{reactor}$ and average fission fractions f_A^i from the Daya Bay experiment, which are included in the supplemental materials.