The Atlas of Gamma-ray Spectra from the Inelastic Scattering of Reactor Fast Neutrons

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The “Baghdad Atlas” [1] is a large compilation of identified gamma-ray intensities from a fast reactor spectrum

- The neutron source was the Al-Tuwaitha research facility outside of Baghdad in the 1970s
  - A low-energy filter was used to simulate a fast reactor spectrum

- All intensities were measured in reference to the 847 keV gamma ray in $^{56}\text{Fe}$

- A single Ge(Li) detector at 90° measured the gamma rays from 105 targets

- Uncertainties
  - Flux
  - Statistics
  - Detector efficiency
  - Non-linearity in energy
  - Gamma-ray self-absorption
  - Sample

  No model of the reactor, so this is determined by fitting

  Provided by the experimentalists (at 2-sigma)

  Given with the normalization to $^{56}\text{Fe}$

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The Baghdad Atlas provides a broad ability to uncover problems in evaluated inelastic cross sections

- The Atlas tests elastic and inelastic scattering and discrete and statistical structure

- $^{19}$F inelastic scattering was shown to be problematic using machine learning on $k_{\text{eff}}$ benchmarks [2]

- The Atlas can also find the problem, based on the 197.1 keV gamma:
  - With a preliminary flux shape, the ENDF/B-VIII.0 value is around 50% lower than the Atlas value.

[3] EXFOR entry 41186
The Atlas data tables are already available and the flux will be published soon

- A digitized version of the database is available at [nucleardata.berkeley.edu/atlas](nucleardata.berkeley.edu/atlas)

- A future publication will detail the flux shape that should be used
  - We don’t have an MCNP input – the setup is not well characterized
  - Instead, the flux shape is fit based on the $^{56}$Fe values

- A new database should be developed for “quasi-differential” benchmarks
  - Differential in reaction, but integral in energy
  - More benchmarks like the Baghdad Atlas need to be created, with:
    - More modern technology
    - Well-characterized neutron sources and experimental setups
    - Neutron spectra that are directly relevant to applications
      - The ENDF format does not allow for direct calculation of gamma-ray cross sections to compare to the Atlas values for many isotopes