

Advancements in Data Analysis Tools for Gamma-Ray Spectroscopy

Gamma-ray spectroscopy is a powerful experimental tool for probing the structure of atomic nuclei. In recent decades, many incremental improvements in radiation detectors and ion accelerator technologies have dramatically increased both the quality and quantity of the nuclear data that can be collected in a single measurement. However, traditional methods of analyzing experimental gamma-ray data towards the ultimate goal of constructing accurate decay schemes have remained largely unchanged over time. Visually inspecting one- and two-dimensional histograms, time-gating on gamma-gamma coincidences, fitting spectra, and building upon previously reported level diagrams within the existing literature are time-consuming and error-prone processes, which would likely benefit from the application of modern data science techniques. Here, we discuss the development of computational tools for spectroscopic analysis.

Initially inspired by the 2009 Master's thesis of Gregory Demand [1], we have developed a new method for constructing nuclear level schemes. Instead of employing the traditional methods of spectroscopic analysis, or utilizing a genetic algorithm as proposed in Ref. [1], we have reformulated the procedure as a Bayesian inverse problem. Using modern software packages for numerical optimization, we have demonstrated that a directed level-scheme graph can be recovered from the gamma-ray singles spectrum and symmetric gamma-gamma coincidence matrix alone. The performance of this method has been benchmarked for several cases using evaluated nuclear data and appears to be robust. Additionally, software is in production for automatic peak identification and Gaussian fitting along with global background subtraction in multiple dimensions. This presentation showcases the preliminary capabilities of this suite of tools for spectroscopic analysis.

[1] G. Demand, *Development of a Novel Algorithm for Nuclear Level Scheme Determination*, Master's thesis, University of Guelph, 2009.