ID de Contribution: **113** Type: **Non spécifié**

Gamma-ray spectrometry of fission fragments : ML analysis of multi-dimensional spectra

jeudi 21 novembre 2024 10:45 (25 minutes)

The analysis of gamma radiation emitted by fission fragments has become an essential tool for studying the nuclear fission process. It allows probing the intrinsic properties of the fragments or exploring effects that are little studied experimentally, such as the sharing of excitation energy between fragments during nuclear fission.

However, the analysis of experimental fission gamma-ray data using traditional techniques is time-consuming and complex. The main task is to find and extract peak intensities on 2D or 3D distributions (gamma-ray energies measured in coincidence), which are filled with thousands of peaks of variable amplitude, often overlapping with significant background noise. Classical methods rely on large models that can be difficult to fit. To overcome this, we implemented a Convolutional Neural Network (UNET-like architecture) and trained it using synthetic data that closely imitate experimental data. To account for uncertainties in the input histograms and provide uncertainty estimates for the predicted intensities, we use an approach based on resampling and ensemble methods.

Preliminary results of applying the neural network to synthetic data indicate promising accuracy in identifying peak intensities, but further investigation is required to determine if this approach outperforms classical fit methods. The final goal is to apply the trained model to real data obtained with the FIPPS instrument (a high-resolution HPGe spectrometer) at the nuclear facility of the Laue-Langevin Institute (ILL) to provide experimental verification of fission-delayed gamma-ray modelling.

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Classification de Session: Thursday morning

Classification de thématique: Analysis : event classification, statistical analysis and inference, anomaly detection