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Optimization of Statistical Methods for HpGe Gamma-ray Spectrometer Used in Wide Count Rate Ranges

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The need to perform gamma-ray spectroscopy measurements with HpGe detectors is a common technique in many fields as nuclear physics, radiochemistry, nuclear medicine and neutron activation analysis.
In other applications wide dynamic ranges in count rate may be encountered, for example samples taken after a nuclear accident are counted on a system normally used for environmental monitoring.
The use of HpGe detectors is chosen in situations where isotope identification is needed because of their excellent resolution.
Our challenge is to obtain the "best"spectroscopy data possible in every measurement situation. "Best"is a combination of statistical (number of counts) and spectral quality (peak, width and position) considerations over a wide range of counting rates. We present the efforts that have been done in order to optimize the statistical methods applied to HpGe detector outputs with the aim to evaluate to a better order of precision the detector efficiency, the absolute measured activity and the spectra background. Reaching a more precise knowledge of statistical and systematic uncertainties for the measured physical observables is the final goal of this research project. Use of Bayesian methods to incorporate the model uncertainty into the data analysis and the uncertainty budget could be a formidable task, which can be tackled only by exploiting appropriate numerical procedures and advances in computing technology. Moreover, when no single model stands out, the expression of the uncertainty makes necessary to report a set of models along with their probabilities, the probabilistic framework to simultaneously treat both the model and data uncertainty being given by the Bayesian model selection and model averaging. In this framework, we applied Bayesian methods and the Ellipsoidal Nested Sampling (a multidimensional integration technique) to HpGe detectors spectra. In treating these counting experiments, the prior information suggests to model the likelihood function, or probability of the data, with a product of Poisson distributions.
In this paper, we shall study two different models, i.e. "Lorentzian + offset" and "Gaussian + offset", in order two explain the experimental data and compare the evidence corresponding to each model.

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