Bayesian Monte Carlo Evaluation Framework for Imperfect Data and Models

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Nuclear data evaluation methods conventionally make the following assumptions: prior and posterior probability distribution functions (PDFs) of all model parameters and data are normal (Gaussian); the linear approximation is sufficiently accurate for minimization of a cost function (even for non-linear models); and that both the model (of, *e.g.*, neutron cross section) and experimental data (including their covariance data) are perfect[1]. These assumptions are inherent to the well-known generalized linear least squares (GLLS) minimization method commonly used for evaluations of resolved resonance region (RRR) neutron cross sections. However, these assumptions are often not justified due to the presence of non-normal PDFs, non-linear models (e.g. *R*-matrix formalism), and inherent imperfections in data and models (e.g. discrepant data sets, discrepancies between the previous evaluation and newly measured data, or imperfect covariance data). We remove the said assumptions in a mathematical framework of Bayes' theorem, and implement it using the Metropolis-Hastings Monte Carlo method. Parameters of a new kind are introduced to parameterize inherent imperfections, *e.g.*, any discrepancies between the theoretical model and measured data. These new parameters enable evaluators to quantify their expert judgement about any discrepancies or imperfections in a reproducible manner. We demonstrate the framework with an ongoing evaluation of ^{233}U in the eV region using the ENDF-B/VIII library and transmission data measured by Guber, *et al.*, and compare the posterior parameters to those obtained by conventional evaluation methods.

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[1]This encompasses the assumption that the model is perfect, *i.e.*, without defect, and also another, lesser known, assumption that the prior PDF of both model parameters and measured data is also known *perfectly*. For example, the neglect of covariance between model parameters and measured data in conventional evaluations contributes to such data imperfections.