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Title: Direct and Moment-Reconstructed Fast Neutron Multiplicity Distribution Computations

Abstract
The goal of this project was to develop and test efficient deterministic and stochastic computational methods for point kinetic neutron count multiplicity distributions. A dynamic model based on the backward Master equation was developed for the neutron count distribution in a fixed detector time gate and numerically solved to obtain the exact discrete count distribution as well as statistical moments of this distribution. An efficient algorithm was developed for handling the rapidly growing number of source terms (due to the branching process) in the sequence of count probability equations with increasing multiplicity order. Nevertheless, for scenarios when the number of counts is large, the computational cost becomes unacceptably high, although further efficiencies in the numerical implementation are currently being investigated. For such cases, multiplicity distribution reconstruction methods were developed based on a generalized Laguerre polynomial expansion and the Maximum Entropy principle, using independently obtained low-order statistical moments as constraints. Both methods show excellent agreement with kinetic or SSA Monte Carlo benchmark simulations for large time gate widths, where the zero-count probability is negligible, but are inaccurate when low count numbers dominate the multiplicity distribution. The Maximum Entropy algorithm was further enhanced for accuracy by incorporating the exact first few count probabilities, obtained from the earlier described direct solution, as additional constraints. The resulting reconstructed count distribution showed considerably higher accuracy over the entire range of counts when both discrete and moment constraints are implemented. The overall conclusion of this investigation is that for low count numbers, direct computation of the multiplicity distribution is efficient; for intermediate count numbers, a Maximum Entropy reconstruction additionally constrained by low order discrete count probabilities is highly accurate; for very large count numbers, a low order generalized Laguerre distribution provides an accurate reconstruction of the count distribution.