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A Novel Approach for the Calculation of Few-body Response Functions

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There are two common approaches for calculating cross-sections for weak probes: one involves using square-integrable basis functions [1-5], while the other relies on response functions (dynamical polarizabilities) [6]. For multi-open-channel problems, all methods struggle to some extent. Considering these issues, we develop a powerful novel alternative which takes advantage of the randomness of the Stochastic Variational Method (SVM) [7].

Our method extracts response functions (dynamical polarisabilities) directly from a bound-state approach for perturbation-induced reactions [7]. Explicitly, we express the response as a sum of ⊠ functions (inspired by the Lorentz integral transform (LIT) method [2, 8, 9]). In the LIT formalism, an analogous sum is convoluted with a Lorentzian, yielding a smooth function, which then gives the response function after a numerical inversion. We determine this latter function directly by solving an inhomogeneous bound-state problem while avoiding the problems that the inversion can ill-pose.

Instead of folding the response with a smearing function as in the LIT, we use the integrated response, that is, the integral up to some energy of a response function. Hence, the sum of ⊠ distributions becomes a stepwise continuous function of energy, which we fit with a differentiable function. This facilitates a robust derivation of the smooth physical response function. Ostensibly, we have replaced one hard problem (robust inversion of the LIT) with another (fitting of a function). However, the fitting procedure seems to be very robust. We will demonstrate this advantage by using a stochastic basis choice that covers the dominant important areas of the spectrum. We benchmark our method with both an analytically solvable model and results from the LIT for photo-dissociation of the deuteron. We also intend to discuss our preliminary results for the photo-dissociation of 3He.

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