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Assessing Theory Errors from Residual Cutoff Dependence[1]

HARALD W. GRIESSHAMMER, Institute for Nuclear Studies, Department of Physics, George Washington University, Washington DC, USA — A recent editorial [Phys. Rev. A 83, 040001] emphasised the need to quantify theoretical uncertainties. Ideally, "double-blind" calculations would assess theory-errors based on input and method, and not by comparison to data. This is particularly important if data is absent or its consistency is checked. Effective Field Theories (EFTs) promise a well-defined scheme to provide such reproducible, objective, quantitative error estimates. But how can one validate the expansion? This is a particularly nagging question in Nuclear Physics, where a fully consistent chiral EFT is still under development since the NN interaction is non-perturbative. One can indeed quantify the consistency of an EFT from the dependence of observables $\mathcal{O}(k;\lambda)$ at low momentum k on the cutoff λ employed in numerical calculations. The power-counting in the small, dimensionless quantity $Q \propto k$ of an EFT quanitiatively predicts $1-\mathcal{O}(k;\lambda_1)/\mathcal{O}(k;\lambda_2) \propto k^{n+1}$ for a calculation at order Q^n. The slope of a double-logarithmic plot of this quantity against k reveals thus the order of accuracy n. In contradistinction to a method proposed by Lepage, this approach does not compare to data to assess uncertainties. Examples are given.

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