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Propagation of uncertainties of nucleon-nucleon potential to three-nucleon scattering observables

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The careful analysis of modern precise data requires not only the state-of-art theoretical approaches but also estimations of uncertainties of theoretical results. Using in ab-initio calculations nuclear interactions based on different physical assumptions, the uncertainties of potential parameters and, in case of the chiral forces, the truncation errors related to neglecting the higher orders of chiral expansions, belong to the most important sources of such uncertainties in few-nucleon sector.

In recent years many efforts have been focused on clarifying this situation. The works of the Granada group focused on revising the existing data base for the nucleon-nucleon (NN) interaction and deriving, among others, the One-Pion-Exchange (OPE) Gaussian NN force [1,2]. This is a phenomenological potential which can be regarded as a remastered version of the AV18 force [3]. Since for the OPE-Gaussian force the uncertainty of its parameters together with their covariance matrix are known we use this force to estimate the corresponding uncertainty of theoretical predictions in the nucleon-deuteron (Nd) elastic scattering. Since these are the first calculations in which the OPE-Gaussian force is applied to study Nd elastic scattering I also briefly discuss description of the differential cross section and various spin observables for this process at energies up to the pion production threshold. The comparison of the obtained predictions with the ones based on the AV18 force will be shown.

As mentioned above, in case of the predictions based on the chiral interactions, the truncation errors have to be taken into account. Using the newest chiral two-body interaction with the semi-local regularization up to fifth order of chiral expansion (N4LO) [4,5] we also study few-nucleon reactions [6,7,8]. Focusing again on the Nd elastic scattering I will present various observables and show the estimations for truncation errors obtained within the prescription given in [5,6]. The dependence of results on regularization parameter as well as comparison with experimental data will be also presented.

Altogether such a study allows us to compare the magnitudes of uncertainties arising from different sources. This is important for further developing the few-body methods and NN forces. The presented results for Nd scattering will be obtained within the formalism of Faddeev equations [9].

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