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Off-shell variation in the binding energy of triton

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Abstract. Phase-shift-equivalent potentials are used to study the sensitivity of triton binding energy (E_T) to the off-shell behaviour of two-nucleon T matrix in a translationally-invariant basis of harmonic oscillator wavefunction. For a smaller value of inverse range parameter λ (1·95 fm^{-1}), which is close to the attractive range of our model potential, a 21 % variation in the triton binding energy is obtained. For the other value of λ an off-shell variation of about 28 % in E_T is obtained.

Keywords. Off-shell effect; off-shell variation; triton binding energy.

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1. Introduction

One of the basic unresolved problems in nuclear physics is the detailed nature of the two-nucleon (N-N) interaction. The two-body nuclear interaction, which acts as the input for many-body calculations, must itself be deduced either from accepted theories of strong interactions or from two-body scattering and reaction data. However, the N-N data determine only the asymptotic form of the N-N wavefunction, or alternatively, the on-energy shell properties of the N-N transition (T) matrix. Elastic N-N scattering experiments do not say anything about the off-energy shell T matrix. To predict the properties of the few or many-nucleon system, one must have a knowledge of the off-shell T matrix (Faddeev, 1961).

In this study, we propose to investigate how changes in the off-shell T matrix influence the binding energy of a three-nucleon system. We construct phase-shift equivalent potentials by employing a unitary transformation technique suggested by Ekstein (1960). Since the uncertainty in the two-nucleon interaction is at short distances, the distorting effects on the transformations considered will be restricted to coordinate space ranges smaller than those of the long-range attractive terms of the two-nucleon interactions used in the study.

To construct potentials that lead to identical on-shell but different off-shell two-body T-matrices, we generate a set of exactly phase-shift equivalent potentials, by applying unitary transformation to our model potential. All potentials, studied are unitarily equivalent, in the two-body sense, to a two-term Yukawa potential acting in the relative S-waves. The Yukawa potential is spin-independent and corresponds very closely to the V-potential of Malflait and Tjon (1969a, b, 1971). We, thus, employ a simplified model of the N-N interaction to isolate the role of off-shell properties, without considering spin dependence, tensor forces or higher partial waves in the triton problem. Since the