SLAC-PUB-702

Binding Energy of the Symmetric S State of the Triton for Various Local Potentials

H. Pierre Noyes and T. Osborn
Stanford Linear Accelerator Center, Stanford University,
Stanford, California

Since variational and form-factor studies indicate that at least 90% of the time the triton is in the symmetric S-state, and since, neglecting coupling to other states, the Schroedinger equation for that state corresponds to three spinless particles interacting via the potential $\frac{1}{2}(V_s+V_t)$, this model gives a realistic first approximation for computing the binding energy. Further, Wong has shown that in the appropriate range of interaction strengths, the D-wave interactions between the particle pairs contribute less than 1/2% to the binding energy of Yukawa interactions. Hence, including only S-wave interactions between the particle pairs is an excellent approximation for this particular problem.

We adopt $a_s = -23.688$ F, $r_s = 2.7251$ F, $a_t = 5.4039$ F, and $\gamma = 0.231608\ F^{-1}$, and solve the two-variable Faddeev equation for the binding energy to a numerical accuracy of better than 1%. For the sum of two separable Yamaguchi potentials fitted to these parameters, the binding energy of the three-particle state is 11.24 MeV, while for the sum of two Yukawa potentials fitted to the same parameters, the binding energy is 12.76 MeV, while two exponential potentials give 10.50 MeV. It is necessary to us sophisticated quadrature rules to give the necessary numerical accuracy for the double integrals, but if this is done with care, a modest number of mesh points suffice to give 1/2% accuracy in the binding energy.

Since comparable results for this simple case can be obtained by variational calculations, this result is confirmatory rather than new. It remains to demonstrate that the method can give accurate results when short-range repulsion, tensor and L·S forces are included.