TRITON BINDING ENERGY FOR THE REID POTENTIAL

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Preliminary results of a variational calculation of the Triton binding energy for the REID potential are presented. These results are compared with those of the Hamada—Johnston and Gammel—Bruchner potentials. Comparison is also made with the results of MALFLIET and TJON.

This paper constitutes a preliminary report on a variational calculation of the $\frac{1}{2}^+$ state of $H_3$ for the REID potential [1]. At this stage of the calculation, results are only available for the bound state, so that only results for the binding energy and percentage contribution to each state are presented.

The suite of programmes which were used in this calculation were originally written for potentials of the Hamada—Johnston type i.e. a four component (central, tensor, $L$—$S$ and $LL$) potential for each triplet/singlet — even/odd state. However, the REID potential has different potentials (with central, tensor and $L$—$S$ components) for each $L$, $S$, $I$ state (up to $L = 2$). The first step was therefore to convert the REID potential to operator form. This is easily accomplished by writing out the Schrödinger equation for each $L$, $S$, $I$ state for both potentials and then equating the results. This is a straightforward operation for the singlet — and triplet — even states, but difficulty arises in both odd states. In the singlet — odd, to completely specify the $^6U_{\ell\ell}$ and $^6U_{LL}$ potentials the potential for the $^1F_3$ state is required. In this case, $V_c (^1F_3)$ was put equal to $V_c (^1P_1)$ with the results that $^6U_{LL} = 0$. For the triplet — odd potential there are four unknowns but five equations to be satisfied (one each from $^3P_0$ and $^3P_1$, and three from $^3P_2 - ^3F_2$). This difficulty was overcome by discarding the REID potential for the $^3P_0$ state.

Neither of these modifications is likely to have an appreciable effect on the $1/2^+$ three-nucleon state. The resultant potential is given in the Appendix.

The calculation follows closely along the lines of previous variational calculations [2]. The trial function consists of core terms plus a systematic expansion. The core term $\psi_c$ is:

$$\psi_c = g(r_1)g(r_2) f(\phi_3) \psi_0(r_3),$$
\[ f(q) = \frac{2e^{-\gamma q}}{(1+e^{-2\gamma q})} \left( 1 - \frac{4}{3} e^{-\beta q} + \frac{1}{3} e^{-2\beta q} \right) q, \]

\[ g(r) = (1 - e^{-dr})^n (1 - e^{-\delta(r-r_c)}). \]

The non-linear parameters are given in Table I. The systematic expansion consists of radial functions.

![Graph](image)

**Fig. 1**

<table>
<thead>
<tr>
<th></th>
<th>H−J</th>
<th>G−B</th>
<th>Rmeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>core 1</td>
<td>−4.35</td>
<td>−5.54</td>
<td>0.206</td>
</tr>
<tr>
<td>core 2</td>
<td>−4.73</td>
<td>−5.76</td>
<td>0.121</td>
</tr>
<tr>
<td>core 3</td>
<td>−4.74</td>
<td>−5.77</td>
<td>0.112</td>
</tr>
<tr>
<td>Q = 3 core 0</td>
<td>16.82</td>
<td>12.46</td>
<td>581.7</td>
</tr>
</tbody>
</table>

\( P_{12} \) is a symmetrising operator, \( a_{1m n} \) is a linear variational parameter, and

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