The excitation function for this activity proved to be the same as that for the 3.08-MeV alpha activity reported in an earlier Letter.[7] Also, the half-life is the same as that of the alpha group, 5.3 ± 0.4 sec. This means that the proton activity has to be due to the same isotope, Te^{108}, which partly decays through the emission of 3.08-MeV alpha particles, and whose main decay is positron emission and electron capture to Sb^{108}.

No proton groups that could be assigned to isotopes lighter than Te^{108} were present. In the earlier work, Te^{107} was found by measuring its alpha decay,[7] but it apparently beta decays mainly to the ground state or to low-lying excited states of Sb^{107}. The proton-decay energy of these states has to be less than 2.5 MeV, otherwise they would have been seen. This indicates that the observed protons really originate from excited states of Sb^{108}, because its ground-state proton-decay energy has to be less than that of Sb^{107}. The proton binding energies of Te and Sb nuclei are not known for mass numbers less than 110, so that it is not possible to find out how highly excited the proton-emitting states are. As for the absence of isotopes lighter than Te^{107}, according to mass tables,[9] it is possible that their ground states are unstable against proton (or two-proton) emission and have half-lives considerably shorter than 0.1 sec, in which case they cannot be detected by using the present method. For Te^{108}, the mass tables predict a beta-decay energy of 7 to 8 MeV, and for Sb^{108}, a proton binding energy of ~1 MeV,[9] so that the situation is favorable for delayed proton emission.

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EXACT CALCULATION OF TRITON PARAMETERS WITH REALISTIC POTENTIALS

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We present here the results of exact calculation of the binding energy, the magnetic moment, as well as the percentage mixtures of *S*, *P*, and *D* states, for the triton looked upon as a three-body problem. This is in pursuance of the general objective set out in an earlier paper,[1] which envisaged the exact solution of a three-body problem with the help of the so-called separable potentials. The physics behind such an approach was discussed in A in the context of a bound-state problem and in a second paper[2] for the corresponding scattering problem. The physical question is, of course, whether the two-body force can be parametrized in a fairly realistic manner by a sum of several separable potentials so as to provide a detailed fit to the two-body data (for both bound and scattering states), so that a calculation of various three-body parameters with such a force may, in principle at least, offer some sort of test of its off-diagonal elements. The work of Yamaguchi[3,4] and, subsequently, by members of this group,[5-8] suggested that such a parametrization is indeed possible up to a few hundred MeV, the price being the inclusion of tensor and spin-orbit terms. Fortunately, hard cores are much less important with separable potentials than with local potentials, since at least the saturation property is already incorporated in the former.[3,9]

The formulation of the triton problem using full antisymmetrization for the three-body wave function was given in a recent paper[10] for the cases of (1) central forces (s wave) in both singlet and triplet N-N states, and (2) mixture of central and tensor forces (s and d waves) of the Yamaguchi type[4] in the triplet state. While the calculation is almost trivial for pure s-wave forces (some results for which were reported in B), the problem already acquires nontrivial proportions when the more realistic Yamaguchi form[4] is included in the three-body formalism. To take in more separable terms (for a better representation of the two-body force) into the exact three-body Schrödinger equation seems to us at the moment rather unfeasible, and perhaps unnecessary, since physically the extra terms (like L-S, ${}^1D_2$, etc.) represent much smaller effects at the low energies relevant to the triton, and can therefore be included in a perturbative manner at most.

The results of calculations which have been made with the potentials of Yamaguchi[3,4] and Naqvi[6,7] are summarized in Table I. The s-wave forces considered in these papers are all of the form

$$M\langle\vec{p}\,|\,V\,|\,\vec{p}'\rangle = -\lambda(\beta^2+p^2)^{-1}(\beta^2+p'^2)^{-1}, \qquad (1)$$

with the "strength" parameter λ and "inverse-range" parameter β chosen differently for the various cases. This would also give some idea of the variation of the binding energy with β when λ is correspondingly adjusted to fit the

Table I. Binding energy and percentage probabilities P_L of states.

Potential[a]	Binding energy (MeV)	$[3]P_0$	$[2,1]P_0$	P_1	P_2
$C_Y^{\mathrm{eff}}+S_Y$	12.189	99.19	0.81	0	0
$C_Y^{\mathrm{eff}}+S_N$	11.819	99.038	0.962	0	0
C_N+S_N	7.036				
$(C+T)_Y+S_Y$	10.40	93.412	1.285	0.023	5.280
$(C+T)_Y+S_N$	9.951	94.055	0.850	0.021	5.073
$(C+T)_N+S_N$	8.850				

[a]The potential terms have the following parameter values: C_Y^{eff}, $\beta=6.255\alpha$ and $\lambda=33.29\alpha^3$; S_Y, $\beta=6.255\alpha$ and $\lambda=23.43\alpha^3$; S_N, $\beta=5.8\alpha$ and $\lambda=18.9\alpha^3$; C_N, $\beta=5.8\alpha$ and $\lambda=22.9\alpha^3$.

two-body data. The Yamaguchi and Naqvi cases are distinguished by the suffixes Y and N, respectively. The singlet potentials are denoted by S and the triplet ones (central and tensor) by C and T. For the triplet potential, we have considered separately the "effective" central force, denoted by C^{eff}, e.g., one given in reference 3, and the actual central part C present in the total $(C+T)$ potential. We note that the potential $(C+T)_Y$ of reference 4 is complete in the sense that any attempt to improve it, say by introducing L-S forces, would necessitate a corresponding adjustment in the parameters of C_Y and T_Y. On the other hand, $(C+T)_N$ is "incomplete" in as much as the full potential of reference 7 is $(C+T)_N$ plus an L-S term.

The following conclusions can be drawn from the figures in Table I: While an "effective" central force leads to overbinding, the mere central part of the triplet potential gives insufficient binding, for the triton. Also, the binding energy shows a tendency to decrease somewhat with the range of the interaction. These results, of course, are in accord with expectations. Inclusion of tensor forces in the formalism brings about a substantial improvement over the pure s-wave results. The somewhat higher binding (10.4 MeV) predicted by the Yamaguchi potential $(C+T+S)_Y$ is due to the rather short range of S_Y ($\beta=6.255\alpha$). Actually, the replacement of S_Y by S_N ($\beta=5.8\alpha$), which definitely gives a better fit to p-p scattering,[6] is seen also to give a slight improvement in the H^3 binding energy. The value 8.85 MeV predicted by $(C+T+S)_N$, though embarrassingly close to the experimental value of 8.482 MeV, is perhaps misleading, because this is not the complete triplet potential. So far the best case seems to be represented by $(C+T)_Y+S_N$, a potential which we believe to be the best available among those which have been "exactly diagonalized" within our three-body formalism. This still leaves open the question whether the full Naqvi potential,[7] viz. $(C+T+S)_N+V(L\text{-}S)$, which fits two-body data better than $(C+T)_Y+S_N$, gives a better fit to the triton parameters.

As for the possible effects of hard cores in this formalism, we have some idea of their magnitudes from the work of Tabakin,[11] in which a decrease of 0.5-0.9 MeV in the binding energy is predicted when a "core" term is introduced along with the attractive interaction.

Actually, for the "hard-shell" case of Tabakin, the correction seems to be nearer the lower figure; namely, about 0.5 MeV. These magnitudes, being of the order of relativistic corrections, should thus be important only in the context of such finer effects also being taken into account. In any case, core effects in this model seem to be small, as are the hitherto neglected parts of a realistic potential, e.g., the L-S and ${}^1D_2$ terms of references 6-8. We hope to take these into account in a perturbative fashion in the near future.[12] It is at least encouraging to note that both the Yamaguchi and Naqvi potentials considered in this paper leave enough margin (in terms of Tabakin's estimates) for reduction by hard-core effects.

The percentage probabilities P_L for the states $L = 0, 1, 2$, using the three-body wave functions of B, are also listed in Table I. It is seen that while the inclusion of tensor forces brings about a small increase in the $[2, 1]$ or S' part of P_0, over a calculation with a pure s-wave interaction, this still falls far short of Schiff's[13] requirement of 4% to account for the observed difference in the H^3 and He^3 magnetic form factors. On the other hand, this value is in qualitative agreement with the variational results of Blatt and Delves,[14] using the (more classical) Gammel-Thaler, Hamada-Johnson, and Yale potentials. The small P-state probability is again reasonable, but the D-state probability exceeds the value needed to account for $\mu_{H^3} + \mu_{He^3}$ via the mirror theorem.[15] This also seems to agree with the results of Blatt and Delves[14] for most of the cases considered by them. The magnetic moment of the triton comes out as $\mu_{H^3} = 2.6945\mu_N$ with $(C^{\text{eff}} + S)_Y$ and $\mu_{H^3} = +2.4593\mu_N$ with $(C + T + S)_Y$, as against its experimental value of $2.9786\mu_N$. While we have no comments to make on the well-known "adverse effects" of the D state[15] on μ_{H^3}, and the likely solution of the discrepancy through exchange-moment contributions,[16] we would like to add that a potential with an L-S term could alter this value, as is also the case for the deuteron magnetic moment.[5,7] Calculation of the L-S effects on the binding energy and magnetic moment of the triton is in progress.

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