smallness of the deviation from the standard TF function for a free atom, are not strictly valid.

Equation (2) yields further an analytic expression for the dependence of the boundary value of the TF function on the radius of the atom,

$$\phi(x_0)=2.060\frac{z_0}{z_0-0.2651}\frac{1}{(1+z_0)^{3.886}},\tag{3}$$

in place of the tabular form given by Feynman *et al.*[3] Putting Eq. (3) into the equation of state of a solid in the simple TF approximation given by Slater and Krutter,[4] we can transform it into an explicit function of the atomic number Z and the volume v associated with the atom alone,

$$pv=\frac{0.437Z^{7/3}(Zv/a_0^3)^{0.810}}{[0.212(Zv/a_0^3)^{0.257}+1]^{9.72}[0.798(Zv/a_0^3)^{0.257}-1]^{5/2}}\left(\frac{e^2}{a_0}\right),\tag{4}$$

where a_0 denotes the Bohr radius.

Details of this investigation, including the full comparison of Eq. (2) with the Slater-Krutter values, will be published shortly in the *Journal of the Faculty of Science*, Hokkaido University, Japan.

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4 Reference 2, p. 564; reference 3, Eq. (6).

π^--Meson Reactions in Tritium

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It has been shown that the relative yields of the various possible reactions of slow negative π-mesons with hydrogen[1] and deuterium[2] are very sensitive to the spin and parity of the meson. In fact, the order of magnitude of the branching ratios can be predicted on the basis of angular momentum and parity selection rules. As a consequence, many of the conclusions concerning the spin and parity of the charged and neutral π-mesons which can be drawn on the basis of weak coupling calculations, still hold independently of this assumption. In particular, the results of the absorption experiments in deuterium appear to rule out the scalar and vector fields for the π^--meson.

We report here on a study of the selection rules in the reactions of slow π^--mesons with tritium, namely:

$$\pi^-+H^3\rightarrow 3n,\tag{1}$$
$$\pi^-+H^3\rightarrow 3n+\gamma.\tag{2}$$

Let I (symmetric), A (antisymmetric), U (2-dimensional) be the 3 irreducible representations of the group[3] of permutations of order 3. From the laws of reduction of the direct products of two such representations, one obtains the following symmetry-character for the wave function of a 3-neutron system:

$$\begin{array}{lll} \text{For total spin } S=\frac{3}{2}, & \text{spin part } I & \text{space part } A \\ S=\frac{1}{2}, & \text{spin part } U & \text{space part } U. \end{array}\tag{3}$$

About H^3, we know that it possesses spin $\frac{1}{2}$ and even parity. If one assumes charge-independence of nuclear forces, the experimental values of its magnetic moment leads[4] to the following additional information, in agreement with Wigner's theory of supermultiplets:

(a) Its isotopic spin $T=\frac{1}{2}$; i.e., its spin-space wave function is of type U.
(b) It is mainly ^2S space-symmetrical (type I in space).

A wave function, fitting very well the binding energy of H^3, has recently been obtained by Pease and Feshbach;[5] it is a ^2S space-symmetric with a very small ^4D admixture (about 2 percent). Although the importance of terms of other type (in particular ^2S with space part of type U) is still an open question, it is reasonable to assume the admixture of terms nonsymmetric in space to be, at least, of the same order of magnitude as the ^4D admixture obtained by Pease and Feshbach.

The selection rules for reaction (1) were investigated first. We searched for selection rules in the usual sense, i.e., based on conservation of angular momentum and parity; we found that, contrary to the deuterium case, such rules do not exist. If, however, we take into account the additional information quoted above concerning the ground state of H^3, reaction (1) is seen to be very sensitive to the spin and the parity of π^-. Assuming the π^- to be absorbed from the K-shell, one gets the following nonrelativistic approximations to the interaction in the various meson theories (constants have been omitted):

$$\begin{array}{ccccc} & S & PS & V & PV \\ \phi_k\times & 1 & \boldsymbol{\sigma}\cdot\mathbf{P} & \mathbf{e}\cdot\mathbf{P} & \mathbf{e}\cdot\boldsymbol{\sigma} \end{array}\tag{4}$$

(ϕ_k is the wave function of the π^- meson in the K-shell taken at the position of the proton; $\boldsymbol{\sigma}$, $\mathbf{P}$, are the spin and momentum operators acting on the proton; $\mathbf{e}$ is the polarization of the spin 1 meson). ϕ_k varies very slowly inside the H^3 nucleus and may be replaced by its value at the origin and considered as a constant. Then, if the meson is scalar, the interaction is a pure constant and cannot give a transition to final wave functions having another type of symmetry than the initial one, i.e., other than U; thus the reaction is forbidden. If the meson is PV, the interaction does not involve operators acting on the space dynamical variables; one sees from (3) that the final 3-neutron wave function cannot be space symmetric. On the other hand, most of the H^3 wave function is space symmetric; thus, the reaction is practically forbidden. Following the same line of argument, one can even derive selection rules regarding the contribution of the nonsymmetric part, namely:

(1) The ^4D contribution vanishes if the initial system (π^-, H^3) has total angular momentum $\frac{1}{2}$.

(2) The contribution of the ^2S of the type U vanishes if the initial system (π^-, H^3) has total angular momentum $\frac{3}{2}$. However, in view of the smallness of the nonsymmetric admixture, the contribution of such terms is very small anyway, and the relativistic corrections, which have been neglected in our study, may be more important. For a PS or V meson, no such selection rules appear.

We have also investigated reaction (2). There appears no evidence for any selection rules, whatever be the spin and the parity of the meson. This can be verified by taking the nonrelativistic approximation of the interaction, as it is given in reference 2, and looking at the formulas given by the weak coupling calculation.

In conclusion, since reaction (1) is forbidden in the case of scalar and pseudovector mesons, whereas reaction (2) is allowed for all types of meson fields, it follows that the ratio of the yields of the nonradiative to that of the radiative absorption reaction, (n/γ), is greater in the case of an odd meson than in the case of an even meson, and in particular: $(n/\gamma)_{PS}\gg(n/\gamma)_{PV}$. A calculation of those ratios by one of us (S.B.) is in progress.

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