by L-capture; that the ratio of β^+/K in Pr^{140} is $\sim 1.6/1$, and that the decay energy of Nd^{140} is 105 ± 40 kev.

The ground state of Ce^{140} is very probably S_0, so that the state of Pr^{140}, by Nordheim's[5] rule that $\Delta L=0$ for an allowed transition, must be S_1. Both the odd nucleons in Pr^{140} fall into the shell $50<N\leqq 82$, with possible states, by the Mayer model, of $g_{7/2}$, $d_{5/2}$, $d_{3/2}$, $s_{1/2}$, and $h_{11/2}$. Since the total angular momentum is low, Nordheim's[5] rule 9 should apply to Pr^{140}, leading to six possible combinations of these states as describing the odd neutron and the odd proton. However, the total angular momentum of Pr^{141} is known to be 5/2, and that of $_{56}Ba^{137}$ as 3/2, suggesting the probable choice of $d_{5/2}$ as the state of the proton, and $d_{3/2}$ as that of the neutron, which is one of the combinations admitted by Nordheim's rule. If, then, the angular momenta couple antiparallel, as Nordheim implies, the resulting over-all state of Pr^{140} would be S_1, in agreement with the conclusion reached earlier.

We have also integrated the β^+ and e^- spectra, and find a ratio of β^+/e^- of approximately 50, leading to a K/e^- ratio of 100. Such a value leads to a very high figure (0.99) for the mean K fluorescent yield at $Z=58$ and 59. Considering that an error of a factor of 10 (a very high estimate indeed) because of self-absorption, backscattering, etc., in the e^- spectrum would reduce the value of W_K to 0.90, it seems likely that W_K in this region is at least 0.90.

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Quadrupole Radiation in nD Capture

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THAT thermal neutrons are captured by deuterons, appears to be largely a consequence of the existence of nuclear interaction currents ("exchange" currents), and may provide a measure of those currents.[1,2] The very small size of the capture cross section makes it essential to investigate the competing electric quadrupole process. Although an earlier estimate[1] showed this process to be of approximately equal importance with the magnetic one, it is the purpose of the present note to report that the quadrupole contribution is actually completely negligible. The capture must therefore proceed entirely by the emission of magnetic dipole radiation, and may be exclusively a result of the presence of interaction currents.

The earlier crude estimate of the importance of the quadrupole process was obtained in the usual manner, by computing the square of the ratio of the interaction operators. In the electric operator e^2/mc^2 was used for the displacement of the proton charge. After correction for the 4 percent probability of triton ^4D state, the ratio came out to be unity. A more elaborate calculation seemed to be improper, the three-body wave functions being so nearly unknown that any numerical result would be of slight significance. It has since been found that the numerical value of the quadrupole contribution is actually so very small that even an unreliable calculation shows it to be negligible.

The calculation is based upon the evaluation of the dimensionless ratio,

$$|R|^2=\frac{\langle|(^4S,\ (\mathbf{u}\cdot\boldsymbol{\varrho}_3)(\boldsymbol{\kappa}\cdot\boldsymbol{\varrho}_3)^4D)|^2\rangle_{\mathrm{Av}}}{(e^2/mc^2)^4\langle(^4S,\ ^4S)\rangle_{\mathrm{Av}}(^4D,\ ^4D)}. \quad (1)$$

Here ^4S is the continuum wave function and ^4D the ground-state wave function, while $\boldsymbol{\varrho}_3$ is the separation of the proton from the center of mass of the nucleus, and $\mathbf{u}$ and $\boldsymbol{\kappa}$ are the unit polarization and propagation vectors of the light wave. The angular brackets enclosing the matrix elements indicate averaging over continuum spin states. The earlier estimate is obtained if $|R|$ is replaced by unity. Actually, $|R|^2$ is of the order of 10^{-5}. Most of the discrepancy comes in the angular integration in the numerator of $|R|^2$, part from the spin sum, and part because the root mean square proton coordinate is only about half e^2/mc^2.

The ^4D functions of Pease and Feshbach[3] were employed for this calculation. For ^4S the following form was chosen (unnormalized)

$$\psi_{4S}=(r_{13}-r_{23})\exp[-\tfrac{1}{2}a(r_{12}+r_{23}+r_{31})]\times\{\chi_1{}^m(23)\chi^\mu(1)+\chi_1{}^m(13)\chi^\mu(2)\}. \quad (2)$$

Particles 1, 2, and 3 are the two neutrons and the proton, respectively. The function $\chi_1{}^m$ is the triplet spin function of its arguments, while χ^μ is the single particle spin function of its argument. The ground state damping parameter of Avery and Adams[4] was arbitrarily chosen for the parameter a. This ψ_{4S} exhibits the major properties of the state it is intended to describe, but is certainly wrong in its details. That the function is written as if the state were bound is, however, satisfactory for the present application. It is also exactly correct to use product spin functions in the present application, as this device incorporates the correct relative amplitudes of the quartet continuum states.

There is yet another quadrupole nD capture transition. The deuteron ^3D wave gives the continuum nD system some ^2D part, even at zero energy. From this the system can then make an electric quadrupole transition to the triton ^2S ground state. The resulting capture cross section is again negligibly small.

With the elimination of electric quadrupole transitions as important contributors to nD capture, it becomes more likely that the entire capture cross section must be attributed to interaction currents. Capture into an antisymmetric ^2S wave part of the triton ground state now provides the only competing process. (It is interesting that if nuclear forces are invariant against rotations in isotopic spin space, then there can be no such antisymmetric admixture.) Although the earlier interaction moment estimate only led to about half the observed cross section, a revised estimate is in good agreement with the corresponding portion of the similar calculation by Roth, and is in as good agreement with the measured value as can be expected.

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Absence of Spontaneous Emission of Neutrons from Samarium

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YAGODA and Kaplan[1] claim to have detected spontaneous emission of neutrons from samarium, corresponding to a half-life of $\sim 10^{16}$ years. Their experiments were carried out with 200-micron Ilford C2 plates, loaded with B^{10} and Li^6 nuclei, the source of neutrons being 18.6 g of Sm_2O_3, which could be used either in the form of powder or a pellet.

In view of the far-reaching consequences of such a process, it was considered worthwhile to repeat their experiment with a much larger quantity of samarium, using a different method for the detection of neutrons.

The source consisted of samarium oxalate in the form of powder, with a samarium-content of 782 g. Spectrochemical analysis re-