the validity of the omission of lambda spin dependence in this potential, as further variational calculations with Slater determinants of plane waves as trial functions indicate that without such dependence the binding energy should be extremely large, 30 Mev or more, while with it the energy could be much lower.

To estimate $g_{\Sigma\Lambda\pi}^2/g_{N\pi}^2$, the property of the potential that the hyperdeuteron has zero energy was used. By use of baryon equivalence[1] and the resulting interpretation of the operators $\boldsymbol{\tau}_\Lambda$, the static nucleon-nucleon potential may be interpreted as a nucleon-lambda-sigma potential. In the singlet state, it is readily shown that with the chosen ratio the hyperdeuteron is just unbound. The extension to other hyperfragments of this procedure at present seems unfeasible. Relations between V, V^1 and the masses and coupling constants are of questionable accuracy considering the changes the explicit form of the potential has undergone. These relations give roughly the same ratio.

Hyperfragments also give information on the scalar meson introduced by Schwinger[1] to produce further symmetries among the elementary particles. This meson also has a universal baryon interaction. Provided all other interactions between a nucleon and a lambda are attractive, the nonexistence of ${}_\Lambda H^2$ restricts the mass and coupling constant of the meson so that $m/m_N > 0.65(g^2/4\pi)$. If the contribution of this meson to the limiting value of the lambda heavy-nucleus binding energy is denoted by B, then further $B \cong 6.5 \times (g^2/4\pi)(m_N/m)^2$.

These restrictions are valid only as long as the meson mass is not so large that the nonrelativistic static limit ceases to apply. Since the masses and coupling constants are renormalized, initially equal constants may now differ as a result of the breaking of symmetries by the interactions.

* National Science Foundation Predoctoral Fellow.
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Neutron Spectrum from $p+d$ Reaction*

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OBSERVATION of the neutron spectrum when deuterons are disintegrated through proton bombardment might give information on nucleon interactions.[1,2]

Neutrons produced when 8.9-Mev protons bombard deuterium in a gas cell were observed by time-of-flight techniques[3] on the Livermore variable-energy cyclotron. Figure 1 shows a time spectrum that was obtained.

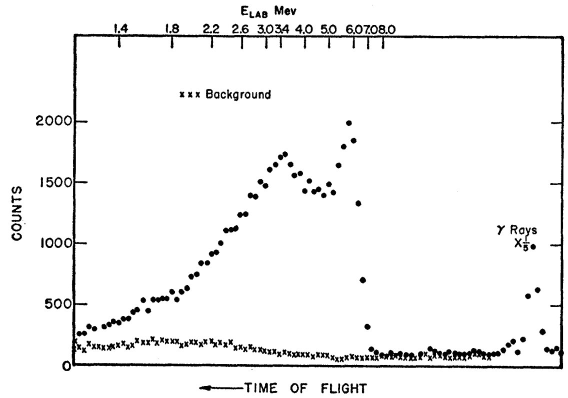

FIG. 1. Typical time-of-flight neutron spectrum for $p+d\rightarrow p+p+n$ reaction at 0°. The time scale is 1.012 mμsec per channel. The gamma rays are produced by protons striking the beam stopper in the gas target. The background run is taken on an evacuated target and also shows a gamma peak. The neutron energy scale is indicated above.

The peak near 6-Mev neutron energy is surprising when compared to the unstructured time spectrum that is obtained in d-d breakup; a previous observation[4] of d-d breakup at 6.3 Mev and our observations at 11.75 Mev show unstructured time distributions. To check the reality of the peak, the possibility of contaminants in the beam and gas cell was examined by checking on purity and by making observations on possible contaminants. Although such parameters as

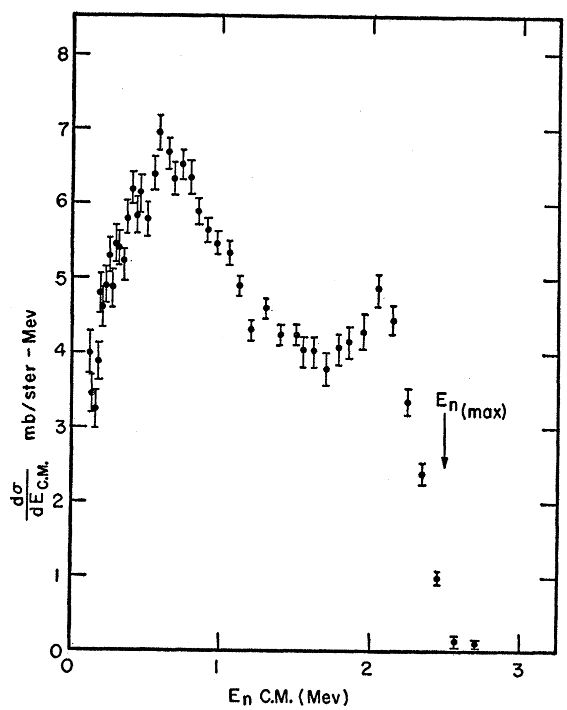

FIG. 2. Differential cross sections in the center-of-mass coordinate system for neutrons from the $p+d\rightarrow p+p+n$ reaction at 0°. E_n(max) is the calculated, maximum possible neutron energy from the breakup reaction.

target thickness, target to detector distance, angle of observation, detector efficiency, and incident proton energy were varied, the distribution continued to show the peaking for angles less than 10°.

After subtraction of background, the time distribution was converted to an energy distribution in the center-of-mass coordinate system. The time spectrum has not been unfolded by the time resolution function; the effect of the time unfolding would be to make the peak more pronounced. Figure 2 shows center-of-mass results for 0°. The errors shown are statistical; the cross-section scale has an uncertainty of ±10% and is due primarily to monitoring. The peak near the high-energy end of the neutron spectrum persists and is most probably due to an interaction between the two protons in the reaction.

Heckrotte and MacGregor[5] have assumed that the peak is primarily due to a collision between the incoming proton and the neutron of the deuteron and that the recoiling proton interacts with the other proton. They derive the p-p interaction from scattering data. Both the position and shape of their calculated results are in qualitative agreement with experimental results.

Further data on the angular and energy dependence of the reaction will be published.

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Spins of Silver-105, Silver-106, and Silver-110*m**

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The spins of three radioactive silver isotopes, Ag^{105} ($T_{\frac{1}{2}}=40$ days,[1] $I=\frac{1}{2}$), Ag^{106} ($T_{\frac{1}{2}}=8.3$ days,[2] $I=6$), and Ag^{110m} ($T_{\frac{1}{2}}=253$ days,[3] $I=6$), have been measured by atomic-beam techniques similar to those previously described.[4]

Table I. Results of spin search for Ag^{105}.

Spin	Counting rate (counts/min)	Spin	Counting rate (counts/min)
0	0.15±0.05	3	0.07±0.07
$\frac{1}{2}$	4.8 ±0.2	4	0.5 ±0.1
1	0.15±0.05	5	0.4 ±0.1
$\frac{3}{2}$	1.4 ±0.1	6	2.0 ±0.2
2	0.10±0.07	7	0.5 ±0.1
$\frac{5}{2}$	0.10±0.05		

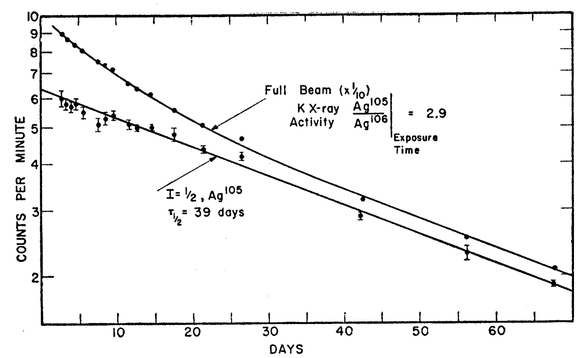

Fig. 1. The decay of spin-$\frac{1}{2}$ sample from a rhodium bombardment is compared with a full-beam sample. The essentially pure half-life of the spin-$\frac{1}{2}$ sample serves to identify Ag^{105} as responsible for the resonance signal.

Ag^{105} and Ag^{106} were produced in the Berkeley 60-inch Crocker cyclotron, both by the reaction Rh(α,kn)Ag and by Pd(p,n)Ag. After rhodium bombardments, the target material was simply transferred to the atomic-beam oven and heated until atomic silver diffused out at a satisfactory rate. Difficulty was sometimes encountered in getting a sufficiently intense beam without melting the rhodium. If the rhodium melts, the silver comes out too rapidly for use, and the rhodium flows into the oven slits and plugs them. The same technique was used for some palladium targets, but chemical separation of the silver proved more satisfactory. The target was dissolved and the active silver (plus stable carrier) was precipitated as AgCl. This was washed and dissolved in ammonium hydroxide. Then metallic silver was recovered by electroplating and transferred to the atomic-beam apparatus.

Ag^{110m} was produced in a 4-week neutron bombardment of natural silver in the Arco reactor. The silver target evidently contained appreciable mercury, since simple qualitative analysis using radioactive detection showed the presence of 46-day Hg^{203}. The mercury tended to come from the atomic-beam oven in bursts and thus to give occasional spurious signals—which could be identified, however, by a crude analysis of their γ-ray spectrum.

Since the stable silver carrier is not readily detectable, it could not be used to monitor the intensity of the atomic beam. Instead, the radioactive beam was collected for short periods when the stops in the apparatus were removed. Under such conditions, the fast tail of the Maxwell distribution reaches the collector position in spite of the deflecting magnets, and the counting rates from such "half-beam" exposures were used to normalize spin counting rates.

A small amount of an appropriate alkali compound, e.g., CsCl, was included with the radioactive material in the oven. Surface-ionization detection of this material facilitated lining up of the beam apparatus at the beginning of the run.