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 $\pm 10\%$ 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		

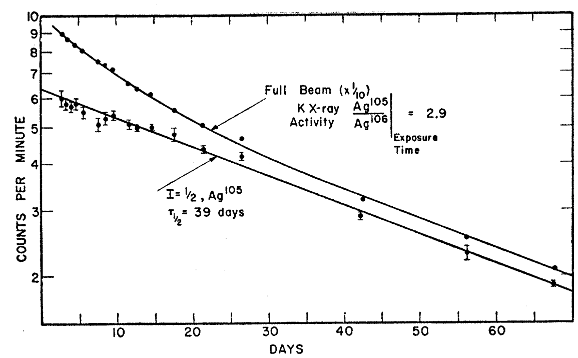

FIG. 1. The decay of spin-$\frac{1}{2}$ sample from a rhodium bombardment is compared with a full-beam sample. The essentially pure half-life of the spin-$\frac{1}{2}$ sample serves to identify Ag^{105} as responsible for the resonance signal.

Ag^{105} and Ag^{106} were produced in the Berkeley 60-inch Crocker cyclotron, both by the reaction $Rh(\alpha,kn)Ag$ 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.

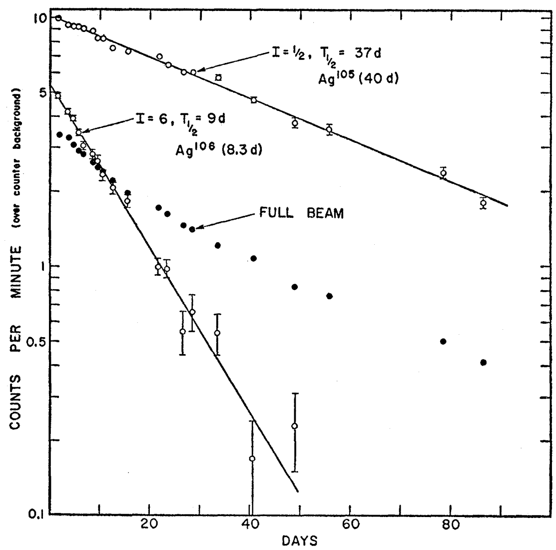

FIG. 2. The decay of an $I=6$ sample from a palladium bombardment identifies Ag^{106} as responsible for the spin-6 resonance. The Ag^{105} spin-$\frac{1}{2}$ resonance is observed by use of a different method of production from that shown in Fig. 1.

Calibration of the transition magnetic field was accomplished by observing the resonances of an atomic alkali beam from a second oven located behind the radioactive one. The latter was simply moved to one side to permit the observations.

Silver-105.—Table I indicates the results of the first spin search for Ag^{105}. There is a large signal corresponding to spin $\frac{1}{2}$. There is also an above-background rate at spin $\frac{3}{2}$, because the frequency appropriate to spin $\frac{3}{2}$ has for its second harmonic the spin-$\frac{1}{2}$ frequency. This spurious signal disappeared when proper precautions were taken.

Figure 1 compares the decay of a spin-$\frac{1}{2}$ exposure with that of a full-beam sample from the same rhodium bombardment. The latter shows a mixture of 40-day Ag^{105} activity with shorter-lived material (Ag^{106}), whereas the spin button shows a clean 40-day decay indicating a significant enrichment in Ag^{105}. The spin-$\frac{1}{2}$ signal shown in Fig. 2 is observed from activity produced by proton bombardment of palladium.

This isotope has been observed repeatedly at a variety of frequencies from 7.4 Mc/sec to 15.4 Mc/sec. No significant quadratic Zeeman shift was observable at these frequencies with the present line width.

Silver-106.—Table I (from a rhodium bombardment) gives a hint that the Ag^{106} activity has spin 6. This was confirmed by the results of a later palladium bombardment, as indicated in Table II. The decay of the spin-6 sample is compared in Fig. 2 with that of the full beam, and clearly shows enrichment of the 8.3-day activity.

TABLE II. Results of spin search for Ag^{106}.

Spin	Counting rate (counts/min)	Spin	Counting rate (counts/min)
$\frac{1}{2}$	9.94±0.22	6	4.86±0.16
5	0.33±0.09	7	0.56±0.09

No quadratic Zeeman shift was observed between 2.4 and 15.7 Mc/sec.

Silver-110m.—Results of a spin search on the Arco material are indicated in Table III. There is a clear

TABLE III. Results of spin search for Ag^{110m}.

Spin	Counting rate (counts/min)	Spin	Counting rate (counts/min)
1	2.8±0.3	5	2.6±0.3
2	1.7±0.3	6	31.1±0.5
3	2.2±0.3	7	2.0±0.3
4	1.7±0.3	8	2.7±0.2

indication of spin 6, which must be attributed to 253-day Ag^{110m}, since no other activity of comparable life can be produced in such a bombardment. The long-term stability of the counters may not be adequate for a reliable determination of the half-life; however, a check of two spin-6 buttons after 300 days showed a decrease in measured counting rates by a factor 2.1, which may be regarded as consistent with a 253-day half-life. Signals corresponding to spin 6 were observed at seven frequencies, from 2.4 Mc/sec to 15.7 Mc/sec; the quadratic Zeeman term, if any, is small.

Remarks.—The result, spin $\frac{1}{2}$ for Ag^{105}, is not surprising, since the stable isotopes Ag^{107} and Ag^{109} also have this spin; it is also consistent with the simple shell model[5] that calls for the odd proton to be in a $p_{1/2}$ level, although the $g_{9/2}$ level lies close. The odd neutron in Ag^{106} and Ag^{110m} is expected to lie in a $d_{5/2}$ state. (However, the ground state of Cd^{111}, with the same neutron number as Ag^{110m}, exhibits spin $\frac{1}{2}$; the first excited state, spin $\frac{5}{2}$.) The observed spins of 6 could thus be attributed to the coupling of a $g_{9/2}$ proton with a $d_{5/2}$ neutron to give one less than the maximum spin, in agreement with Nordheim's "weak" rule, although other possibilities exist. In any event, one would expect a large positive magnetic moment, consistent with our failure to observe appreciable quadratic Zeeman terms.

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