(Fig. 2*a*). At forward bias of less than 0.18V and for bias in the back direction the resistance is determined primarily by the barrier resistance of the rectifier and since this barrier in an N-type rectifier is transparent for holes a decrease of resistance is expected and is actually observed (Fig. 2*b*).

The rectifier shows after prolonged irradiation ohmic behavior, but when reassembled with an aluminum point shows the behavior of a P-type rectifier.

When exposed in cadmium shields, the samples reach the point of minimum conductance at larger nvt values than in a graphite torpedo. Heat treatment reproduces the original behavior observed before neutron irradiation as in the case of deuteron and alpha-bombardment.

Silicon samples both N- and P-type show an increase in resistivity in a similar way, as has been observed with deuteron bombarded silicon samples. Heat treatment restores the original resistivity values; it also shows that deep lying traps of about 0.5 ev above the full band are produced, removing electrons and holes, thus producing poorly conducting material.

Preliminary experiments on Si-rectifiers (IN 21) Cu_2O semiconductors in bulk and rectifiers, Se bulk material and rectifiers, all show a behavior similar to the one observed for silicon samples discussed above.

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[2] We are indebted to members of the Purdue Semiconductor Laboratory: V. Bottom, J. W. Cleland, R. E. Davis, and J. C. Thornhill, for the preparation of the samples and the Hall effect measurements before and after irradiation.

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Nuclear Magnetic Moments from Microwave Spectra: I^{127} and I^{129}

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June 14, 1949

THE effects of a magnetic field on the hyperfine structure of the $J=2\rightarrow3$ transition of CH_3I^{127} and CH_3I^{129} have been studied. The Zeeman components of several F transitions of these molecules were completely or partially resolved. Observations were made with a coiled wave guide cell in such a way that the magnetic field was parallel to the E vector of the radiation. This allowed detection of the p components, $\Delta M_F=0$ transitions, without complications from the s components, $\Delta M_F=\pm1$ transitions. The field strengths used in the study ranged from 1160 gauss to 3700 gauss.

The nuclear magnetic moment of I^{127} has already been determined by Pound,[1] using the nuclear resonance method, to a greater accuracy than can be reached by the present method. The remeasurement of this moment, however, helps to evaluate the accuracy obtainable with the microwave method. In Table I are listed the results obtained on different CH_3I^{127} transitions. The average value for $\mu(I^{127})$ from these data is 2.792, which, when corrected for diamagnetic effects[2] of the extranuclear electrons of the iodine, is 2.810. The mean deviation from this value is 0.062, or 2.2 percent. The value obtained by Pound is 2.8122±0.003.

In Table I are also given results on two transitions of CH_3I^{129}, one of which is shown in Fig. 1. When diamagnetic corrections are made, our preliminary values*** for the I^{129} nuclear g-factor and magnetic moment are 0.783 and 2.74, respectively. We believe these to be accurate to about five percent. The major factor limiting the accuracy is the incomplete resolution of the transitions used. Small errors may also arise from the measurement of the strength of the magnetic field. The 3/2→1/2 transition, since it splits into a wide doublet, should be more favorable for these determinations. Unfortunately, this line, though detectable, was too weak to be measured when split by the magnetic field. We hope, with later improvements of the spectrometer, to measure the magnetic moment of I^{129} to an accuracy of one percent.

TABLE I. Nuclear magnetic moments as calculated from several observed Zeeman effects in the CH_3I spectrum, $J=2\rightarrow3$.

Isotope	K	F transition	H gauss	Separation Mc	μ[a] nuclear magnetons
I^{127}	0	$1/2\rightarrow1/2$	1160	4.07	2.878
	0	$1/2\rightarrow1/2$	2320	7.70	2.723
	0	$1/2\rightarrow1/2$	3010	10.17	2.773
	1	$1/2\rightarrow1/2$	3010	10.47	2.853
	1	$1/2\rightarrow1/2$	3180	10.64	2.745
	0	$3/2\rightarrow3/2$	2600	5.22[b]	2.743
	1	$3/2\rightarrow3/2$	2600	5.19[b]	2.728
	0	$5/2\rightarrow5/2$	3000	4.28[c]	2.89
				Average	2.792
I^{129}	1	$9/2\rightarrow9/2$	3700	2.25[c]	2.78
	1	$7/2\rightarrow7/2$	3700	2.64[c]	2.66
				Average	2.72

[a] These values are not corrected for diamagnetic effects.

[b] These separations represent the total spacing of the multiplet.

[c] These separations are for peaks containing unresolved components (see Fig. 1).

So far as we know, this is the first determination of an unknown nuclear magnetic moment with the microwave method.**** This method, though not so precise as the molecular beam method or the nuclear resonance method, is particularly well suited to the study of rare or radioactive nuclei. Less than 10^{-5} g of I^{129} was needed for each series of measurements. Previously, the Zeeman effect on the microwave spectrum of ammonia has been observed by Coles and Good[3] and by Jen.[4] The latter observer also studied the Zeeman effect in methyl chloride.[4]

The theory used for the Zeeman effect of the hyperfine structure is that developed for atomic spectra by Back and Goudsmit[5] and previously applied to molecular spectra by Jen.[4] In the present work, the effects caused by the molecular magnetic moment were considered to be negligible. The theory fits all observations satisfactorily except those for the $F=5/2\rightarrow7/2$ transitions of CH_3I^{127}. Here, an anomaly was detected which appears to result from a breaking down of the nuclear quadrupole coupling by the applied magnetic field.† This is being studied further.

The magnetic moment of I^{129} with the previously measured spin[6] of 7/2 allows an assignment of the state of the last proton in the I^{129} nucleus as $5g^-$, according to the Nordheim[7] scheme. The mag-

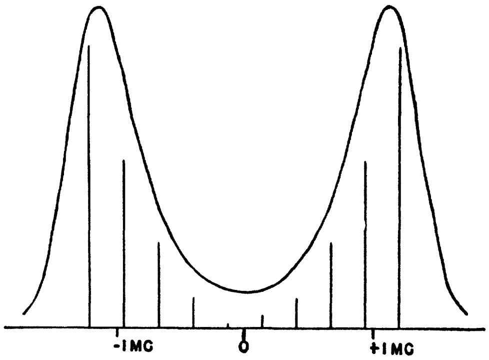

FIG. 1. Zeeman splitting of the hyperfine structure of the $J=2\rightarrow3$ transition of CH_3I^{129}. $F=9/2\rightarrow9/2$. $\Delta M_F=0$. Separation of the observed peaks is 2.25 mc/sec. $H=3700$ gauss. Bars represent calculated lines; curve represents the observed spectrum.

netic moment of 2.74 and the spin of 7/2, with the theory of Inglis,[8] indicate that the orbital and spin vectors of the odd proton in the nucleus are opposed, $I=l-\frac{1}{2}$. Thus, the nuclear orbital momentum, l, equals four.

We wish to acknowledge the help of Mr. George Parker and Mr. Gordon Hebert, of the Chemistry Division, Oak Ridge National Laboratory, who isolated the I^{129} from fission material.

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* The work at this institution was supported by Contract No. W-19-122-ac-35 with the U. S. Air Forces, Cambridge Field Station.

** The work at Oak Ridge National Laboratory was performed under Contract No. W-7405, eng 26 for the Atomic Energy Project.

*** The sign of the magnetic moment is not obtained directly from the experiment because the Zeeman patterns are symmetrical. However, since the I^{129} nucleus has an odd number of protons and an even number of neutrons, a positive sign for μ is reasonable in view of the large spin value and the large magnitude of μ.

**** After this note was written, Dr. C. K. Jen informed us by private communication that he has measured the nuclear magnetic moment of S^{33} with the microwave method.

† This effect is analogous to the Paschen-Back effect in atomic fine structure and to the Back-Goudsmit effect in atomic hyperfine structure.

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Latitude Dependence at 30,000 Feet of Penetrating Particles Slowed Down After Traversing 15 cm of Lead*

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June 20, 1949

IN two recent B-29 expeditions from China Lake (California) to Lima, Peru, and to Fairbanks, Alaska, experiments have been carried out to investigate the composition of ionizing cosmic rays slowed down after traversing a certain thickness of lead. Mesons were separated from other ionizing particles with the counter arrangement sketched in the left side of Fig. 1. Counters A_1, A_2 (A_2 being two counters in parallel), and A_3 were in coincidence with counters B_1 plus B_2 (two in parallel), B_2 and B_2 plus B_3, respectively. All these double coincidences, added by means of a mixer, will be indicated as (AB). A 10-cm thick block of graphite surrounded by a group of counters, C, was placed below counters B and used as an absorber for the particles coming within the solid angle corresponding to the coincidences (AB). Counters C covered this solid angle. They were at the same time in "delayed coincidence" and in "anticoincidence" with respect to the coincidences (AB), while counters D were only used as additional anticoincidence counters. The delayed coincidences were registered by four "channels" of the same "time width" $\Delta\theta$ (2.8 μsec.), so that four points of the decay curve of mesons slowed down in the absorber were obtained simultaneously. The minimum delay for which a delayed coincidence was registered in the first channel was 1.14 μsec. The time distance between each channel and the next one was 0.98 μsec. For the apparatus employed, spurious delayed coincidences could practically occur only for random events in which an anticoincidence $(AB-C)$ was followed after a short time by a single discharge (C) of counters C.*** Examples of decay curves obtained at altitude have been shown in a previous paper.[1]

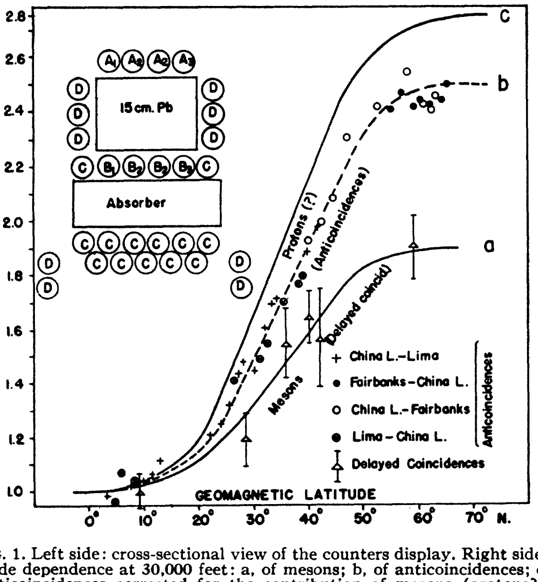

FIG. 1. Left side: cross-sectional view of the counters display. Right side: latitude dependence at 30,000 feet: a, of mesons; b, of anticoincidences; c, of anticoincidences corrected for the contribution of mesons (protons?). A discussion of the errors of the points representing the latitude ratio I/I_0 of the anticoincidences will be given elsewhere.

TABLE I. Results of measurements of delayed coincidences with graphite absorber at 30,000 feet at several latitudes. Mesons observed belong to the momentum range 315 to 348 Mev/C.

Average geomagnetic latitude (North)		9.0°N	28.5°	35.5°	40.0°	42.0°	59.0°
Duration of observation (minutes)	(Δt)	350	298	220	290	142	220
Delayed coincidences per hour due to mesons disintegrating in the time interval	1.14 to 3.94 μsec.	27.5 ±2.4	32.0 ±3.2	38.5 ±3.5	42.8 ±4.5	*	50.7 ±5.0
	2.12 to 4.92 μsec.	17.4 ±1.7	17.6 ±1.9	26.6 ±2.7	28.1 ±2.4	24.2 ±3.2	33.3 ±3.0
	3.10 to 5.90 μsec.	10.4 ±1.3	11.6 ±1.5	*	17.2 ±1.9	16.1 ±2.5	18.3 ±2.2
	4.08 to 6.88 μsec.	6.5 ±1.05	6.45 ±1.25	*	11.6 ±1.55	10.5 ±2.1	13.4 ±1.9
Extrapolated delayed coincid. per hour	(N)	46.5 ±2.7	53.5 ±4.4	72.0 ±6.0	76.9 ±4.5	73.2 ±8.6	89.1 ±5.2
Latitude ratio	(I/I_0)	1.00 ±0.06	1.14 ±0.095	1.55 ±0.13	1.65 ±0.095	1.57 ±0.185	1.91 ±0.11

* Not recorded.

By extrapolation of the decay curve to the zero time, one obtains the number, N, of mesons stopped per unit time in the absorber and which disintegrate between 0 and $\Delta\theta$ into electrons striking counters C. If p is the average value of the probability for the decay electrons of mesons, stopped in the absorber, to strike counters C, the number, M, of mesons stopped in the absorber after traversing the counter telescope is

$$M=N/p(1-\exp(-\Delta\theta/\tau)). \tag{1}$$

Events were registered as anticoincidences when no anticoincidence counter fired within 1.1 μsec. before or 7.8 μsec. after the arrival of a particle producing a coincidence (AB). Since the probability for an ordinary meson to disintegrate more than 7.8 μsec. after it has been stopped is less than 3 percent, the intensity, I_a, of the "true anticoincidences" (difference between the anticoincidences registered with and without absorber) is

$$I_a=(1-p)M+X, \tag{2}$$

where X represents the contribution due to particles which did not give rise, within 7.8 μsec. after they had been stopped in the absorber, to emission of secondary ionizing particles striking counters C.

In order to obtain the value of p, measurements with and without graphite absorber have been performed in Chicago, before and after the flights, with supplementary 5 cm and 20 cm of lead above counters A. From the results of these measurements the same value, 0.29±0.015, is obtained in both cases for p, through Eqs. (1) and (2), if X is assumed to be negligible in these conditions.