Because of the large quadrupole coupling found for this molecule, $eQ\partial^2V/\partial z^2=-1422$ mc, second order effects[1] cause slight deviations of the observed from the calculated spectrum for 7/2 spin. For example, these effects make one of the lines appear as a doublet, which according to first order theory would be a single line, composed of three components.

The quadrupole moment of I^{129} is negative—that is, the nucleus is oblate, or flattened along the spin axis. The ratio of $Q(I^{129})$ to $Q(I^{127})$ is 0.7353. If the quadrupole moment of I^{127} from atomic spectra,[2] -0.46×10^{-24} cm^2, is used, the value for the quadrupole moment of I^{129} is determined as -0.34×10^{-24} cm^2. With the value of -0.59×10^{-24} cm^2 for the quadrupole moment[3] of I^{127}, obtained from microwave measurements[4] for CH_3I^{127}, the quadrupole moment of I^{129} is found to be -0.43×10^{-24} cm^2. We are inclined to favor the latter value, which depends on the calculation of $\partial^2V/\partial z^2$ from the doublet separation of iodine, according to the formula[5]

$$\partial^2V/\partial z^2=8e\Delta\nu/15Z_iR\alpha^2a_0^3.$$

The C—I bond in methyl iodide is close to a pure single bond formed by a p-orbital of the iodine. The bond should have very little ionic character since the electro-negativities of iodine and carbon are approximately equal. Hence, the application of this formula to methyl iodide should give a more accurate value of the $\partial^2V/\partial z^2$ than it would when applied to ICN, where the C—I bond is complicated by appreciable resonance with double bond structures, or to ICl, where there is a fairly large electro-negativity difference of the bonded atoms.

I^{129} is known to emit beta-rays and to decay to Xe^{129}, with a long half-life.[6] Since the spin of Xe^{129} is $\frac{1}{2}$, the spin change in this reaction is therefore 3. The long half-life of I^{129} is consistent with this spin change, and its spectrum should be of the second forbidden type or higher.

We are now attempting to determine the nuclear magnetic moment of I^{129} from the Zeeman effect on the hyperfine structure and are using the present data to obtain a more accurate determination of the structure of the methyl iodide molecule. This information, with details on experimental procedure, will be given in a later publication.

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[1] Gilliam, Edwards, and Gordy, Phys. Rev. **73**, 635 (1948); J. Bardeen and C. H. Townes, Phys. Rev. **73**, 627, 1204 (1948).
[2] K. Murakawa, Zeits. f. Physik **114**, 651 (1939); T. Schmidt, Zeits. f. Physik **113**, 140 (1939).
[3] W. Gordy, Rev. Mod. Phys. **20**, 714 (1948).
[4] Gordy, Simmons, and Smith, Phys. Rev. **74**, 243 (1948).
[5] H. A. Bethe and R. F. Bacher, Rev. Mod. Phys. **8**, 226 (1936); C. H. Townes, Phys. Rev. **71**, 909 (1947).
[6] G. T. Seaborg and I. Perlman, Rev. Mod. Phys. **20**, 585 (1948); personal communication with Mr. George Parker; details to be published at a later date.

Nuclear Magnetic Moments and Hyperfine Structure of the Rubidium Isotopes*

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A RECENT determination[1] of the nuclear moments of the rubidium isotopes indicates that, as was first suspected by Millman and Kusch,[2] the observed ratio of the magnetic moments does not agree with the ratio calculated from hyperfine structure,

$$\mu\,Rb^{87}/\mu\,R^{85},$$

Observed	(1)	2.0327±0.001
Observed	(3)	2.038 ±0.01
Calculated	(2)	2.0261±0.0003.

The interaction between the optical electron and the nucleus is of two kinds—electrostatic and magnetic—and it is of interest to determine whether the observed effect can be accounted for on the basis of either of these two forces. The effect of spreading the nuclear charge, usually considered concentrated at a point at the origin, over a finite sphere of radius R_0, is to reduce the electronic density $\psi^2(0)$ at the nucleus. This effect was shown by Rosenthal and Breit[4] to lead to a correction in calculating hyperfine structure of the order of zR_0/a_0 for atoms having a nuclear charge in the range of rubidium. The a_0 is the radius of the first Bohr hydrogen orbit. While this ratio is 0.5 percent for rubidium, and can account for discrepancies in the hyperfine structure of the order of the observed discrepancy (0.3 percent), it is very unlikely that this is the explanation, as it would require an enormous difference in size of Rb^{85} and Rb^{87}. Besides the fact that all available evidence supports a slowly varying nuclear radius proportional to the cube root of the mass number, we have specific evidence[5] that there is no observable isotope shift in the spectrum of rubidium, and therefore no such very large difference in nuclear size. Effects due to a magnetic structure inside the nucleus, first proposed by Kopfermann[6] in the days when such effects could well be dismissed as negligible, and recently applied by Bohr[7] to the proton-deuteron problem, also lead to a correction of the order of zR_0/a_0. This is a much more reasonable explanation, since there is no objection to assuming the wave function for the odd proton in rubidium to be quite different for the two isotopes. In fact, this might be expected on the basis of a vector model[8] of the nucleus, which would assign to Rb^{87} with $I=3/2$, $l+s=1+1/2$, and to Rb^{85} with $I=5/2$, $l-s=3-1/2$.

The fact that effects of this order of magnitude have not been observed for the gallium isotopes[9] or for the thallium isotopes[10] is not unreasonable since, in both cases, the two isotopes have the same nuclear spin and comparable nuclear moments, and it is therefore not unreasonable to assume that they also have comparable wave functions for the odd proton.

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[1] F. Bitter, Phys. Rev. **75**, 1326 (1949).
[2] Millman and Kusch, Phys. Rev. **58**, 438 (1940).
[3] Kusch and Millman, Phys. Rev. **56**, 527 (1939).
[4] Rosenthal and Breit, Phys. Rev. **41**, 459 (1932).
[5] Kopfermann and Kruger, Zeits. f. Physik. **103**, 48J (1936).
[6] H. Kopfermann, *Kernmomente* (Akademische Verlagsgesellschaft, M.B.H., Leipzig, 1940), p. 17.
[7] A. Bohr, Phys. Rev. **73**, 1109 (1948).
[8] See, for example, Brookhaven National Laboratory publication 1-5, by Goldsmith and Inglis, on "Spins, Magnetic Moments, and Electric Quadrupole Moments," dated October 1, 1948.
[9] R. B. Pound, Phys. Rev. **73**, 1112 (1948).
[10] H. Poss, Phys. Rev. **75**, 600 (1949).

Hall Effect in Metal-Semiconductor Point Contacts

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TRANSVERSE Hall effect determinations have been a very useful tool in the study of conductivity in bulk semiconductors. According to the elementary theory of the Hall effect, if a current I passes through a parallelepiped (Fig. 1(a)) and a perpendicular magnetic field H is applied, a transverse e.m.f. is observed given by the formula $E=RHI(1/t)$, where t is the thickness of the specimen (in the H direction) and R is a constant characteristic of the material. The magnitude and sign of R yield information regarding the density of current carriers and whether they are predominantly electrons or holes; studies of Hall effect

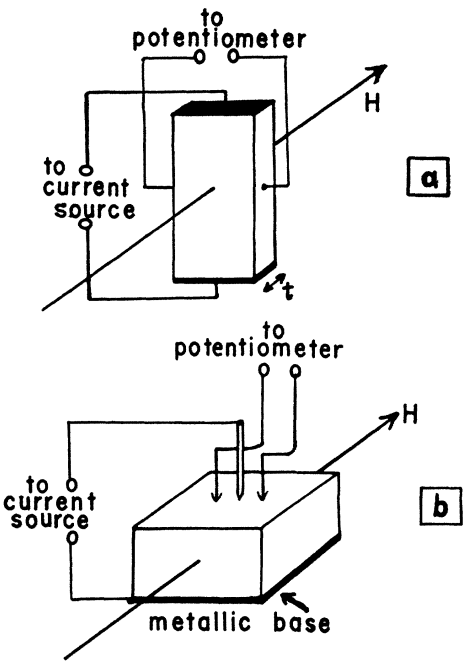

FIG. 1. (a) Conventional arrangement for measuring transverse Hall effect in a bulk semiconductor. (b) Method for determining Hall effect in the neighborhood of a metal-semiconductor point contact.

vs. temperature enable one to separate the electron and hole components.[1]

Information of this type is much needed for an understanding of conduction mechanisms in point contact rectifiers and transistors. It would seem possible, using the configuration illustrated in Fig. 1(b), to perform a Hall effect measurement in a point contact. Two metal probes are placed diametrically opposite from the current-carrying central contact and a magnetic field is applied in a direction perpendicular to the plane made by them. Assuming (1) the semiconductor resistivity is homogeneous, isotropic, and independent of current density and magnetic field, (2) the distance of the probes from the center contact is large compared with the radius of the contact, one can show that an e.m.f. is induced between the probes given by $E=RHI(1/d)$, where d is the distance between the probes. Thus, one may expect to observe a Hall e.m.f. comparable in magnitude to that observed in a plate as in Fig. 1(a). In germanium crystals, most of the assumptions above are generally not correct, especially if one is dealing with contacts showing rectification, photoelectric effects or surface conduction, and a really quantitative study of such Hall effects would be difficult. However, the sign and approximate magnitude of the e.m.f.'s would be of considerable value.

Note that the induced e.m.f. increases as the probes are placed close to the contact. In an arrangement of contacts such as one finds in the transistor, sizable effects may be expected if one measures the e.m.f. induced between the emitter and the collector while current is passed from one of them to the base. In this case, however, there will be a large unbalance voltage before application of the magnetic field which is canceled for the most part when two pick-up probes are used.

Preliminary trials have shown that a Hall e.m.f. is easily observable in germanium and that reversals in sign may occur as the current through the contact is increased.

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[1] For example, detailed analyses for bulk germanium semiconductors have been made by K. Lark-Horovitz *et al.*—N.D.R.C. Report No. 14-585 (1945); Phys. Rev. **69**, 258 (1946).

Nuclear Spin of Fe^{57}

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THE spectrogram of a 29 milligram sample of iron enriched in the isotope Fe^{57} was inspected for hyperfine structure. The spectrographic apparatus consisted of a one-meter, flint glass, three prism spectrograph[1] crossed with a Fabry-Perot interferometer. The light source was a liquid-air cooled Schuler tube.[1]

Many of the iron lines observed in the region λ4000A to λ6800A involved states having J values greater than one-half and involving penetrating s electrons.[2] No structure was observable in any of these lines.

The wave number difference which could be resolved in the region of the line $\lambda 4071.748(3d^74s\cdot F_2-3d^74p\cdot F_2^0)$ was estimated to be 0.029 cm^{-1}. To avoid overestimating the resolution, the total apparent width on the plate of the line λ4071.748 was assumed to be the actual half-width. Since the lines were intense the apparent full width was probably greater than the actual half-width.

That Fe^{57} has no measureable magnetic moment is not surprising, when one considers that many of the elements whose atomic mass is odd, but whose nuclear charge is even, give the same result.

The Fe^{57} was obtained from the Manhattan District.

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[1] M. Gurevitch, Phys. Rev. **75**, 767 (1949).
[2] H. N. Russell and C. E. Moore, Trans. Am. Phil. Soc. **34**, 113 (1944).

Infra-Red Absorption by Homonuclear Diatomic Molecules

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WE have recently investigated the absorption spectrum of liquid air in the near infra-red region between 1μ and 12μ. Several absorption bands were observed, the most intense bands being near 4.3μ and 6.4μ. The band near 4.3μ overlaps the atmospheric CO_2 band in this region but is somewhat broader than the CO_2 band. The band near 6.4μ overlaps the atmospheric water-vapor band with center at 6.26μ but is quite different in shape from the water-vapor band and from the bands in the spectrum of liquid water and ice.

It is rather difficult to account for the intense bands in the liquid air spectrum in terms of CO_2 or H_2O dissolved in the liquid air or condensed in the liquid air from atmospheric CO_2 and H_2O, since the observed absorption is more intense than would be expected from CO_2 and H_2O as impurities. However, the observed bands appear at positions where one would expect absorption *if the fundamental vibrations of N_2 and O_2 were infra-red active.* The vibrations of N_2 and O_2 have not been regarded as infra-red-active since these molecules are non-polar and hence transitions between vibrational levels cannot be produced by processes involving ordinary dipole radiation; infra-red absorption has not been reported for gaseous nitrogen or oxygen. However, Raman lines have been observed for N_2 and O_2; the frequencies of the Raman lines and the corresponding infra-red wave-lengths are as follows:

Molecule	Observed Raman frequency	Corresponding wave-length* in the infra-red
N_2	2330.7 cm^{-1}	4.2905μ
O_2	1554.7	6.4321μ