The electric field acting on the iron ion is taken to be due to the octahedron of water molecules surrounding the ion and is, therefore, of predominantly cubic symmetry. The single energy level of the ^6S state of the normal ion splits,[3] under the influence of the crystalline field, into two levels, one doubly degenerate, the other quadruply degenerate. The expected relative intensities and positions in oersteds of the absorption lines are shown in Table I for the three orientations used in these measurements. δ is the level separation, or zero-field splitting in cm^{-1}, and g is the effective g value of the paramagnetic ion.

The patterns for the three orientations differ only in the separation of the side peaks from the central maximum. The side peaks are resolved from the central peak only in the (100) orientation of the diluted salts, although here, too, the overlapping of lines is appreciable. The theoretical spectra shown in the figure are those obtained with $\delta = 0.032$ cm^{-1}; this value of δ was chosen to give the best fit between the weighted mean of the side peaks in the theoretical spectrum and the observed side peaks of the (100) orientation. Because of the overlapping of the lines and their unknown shapes this value is approximate.

The curves for the (111) and (110) orientations are not inconsistent with this choice of δ. Although it is impossible to assign a value to the splitting for the undiluted salt, it appears that there is very little change in the splitting with changes in dilution.

The position of the central peak is the same for all curves and corresponds to $g = 1.99 \pm 0.01$.

A rough graphical analysis of the observed pattern made on the assumption of a Gaussian line shape and a constant line width for all resonances in a given orientation does not yield agreement with the theoretical intensities, the intensity of the observed central peak being relatively too strong.

* This work was supported by the Joint Program of the ONR and the AEC, by the RCA Research Laboratories, and by the Rutgers University Research Council.
** Deceased October 8, 1949.
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Energy for Diffusion by Direct Interchange

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WE are much indebted to Professor Zener for calling our attention to an error in the value given in our paper[1] for the electrostatic energy associated with the saddle-point configuration (Fig. 2A in reference 1) for direct-interchange diffusion in copper. The original value was 11 ev. On recalculation the energy for the same configuration turns out to be 4.8 ev.

Besides the electrostatic term there is an increase in the energy of this configuration associated with the closed shell repulsion of the ion cores. This has been estimated to be 6.2 ev on the basis of a repulsive potential of exponential form with parameters chosen to fit with the known elastic constants of copper. It is admittedly a severe extrapolation to use the elastic data to calculate the interaction energy of copper ions at distances of approach as close as those occurring in this configuration. We decided to re-examine also this part of the direct interchange calculation to find out to what extent the result had been prejudiced by the choice of an exponential repulsion. Recent measurements on the compressibility of copper have been reported by Bridgman[2] for pressures up to 30,000 kg/cm^2. They can be interpreted to give a variation of bulk modulus of 7.8×10^{10} dy/cm^2 for one percent change in

volume. This turns out to be only about 20 percent more than the value obtained from the fourth term in the expansion of the exponential potential. While the closeness of this agreement may be some extent fortuitous, the general validity of the original approach appears to be substantiated. If one constructs a cubic expression for the potential, using the same constant term as in the expansion of the exponential and evaluating the other coefficients from the elastic constants and the high pressure data, one obtains for the energy of repulsion for the saddle-point about 5.5 ev against 6.2 as previously quoted.

Within the limits of this calculation, the results indicate that direct interchange is ruled out for the self-diffusion of copper by energetic considerations.

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[2] P. W. Bridgman, Proc. Am. Acad. Arts Sci. 77, 198 (1949).

Erratum: The Equation of State of Gaseous He³

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IN consequence of an unfortunate misunderstanding this letter has been printed with the following errors:

The formula (1) for B should read:

$$B = -\frac{N}{2\pi^2}\left(\frac{h^2}{\pi m\kappa T}\right)^{5/2} \int_0^\infty \sum_l (2l+1)\delta_l \eta_l(k) \exp\left(-\frac{h^2 k^2}{m\kappa T}\right)kdk$$
$$+ N\left(\frac{h^2}{\pi m\kappa T}\right)^{3/2} \sum_n \sum_l (2l+1)\delta_l(e^{-E_{nl}/\kappa T}-1) + \frac{N}{32}\left(\frac{h^2}{\pi m\kappa T}\right)^{3/2},$$

where $\delta_l = \frac{1}{2} - (-1)^l \frac{1}{4}$."

The last sentence in the lines following the equation should read: "*The influence of the statistics*, i.e., of the symmetry character of the wave functions is reflected, firstly in the last term which is positive for F.D. statistics and negative for B.E. statistics, and secondly in the value of δ_l which transforms into $\frac{1}{2} + (-1)^l \frac{1}{4}$ in the case of B.E. statistics."

The table should be corrected as follows:

T	He³ B.T³/²	He⁴ B.T³/²
0.51	-107	-388
1.02	-205	-401
2.04	-331	-477
3.07	-412	-543
4.09	-469	-592
5.11	-511	-625
6.13	-541	-644
7.15	-561	-654

"The contribution of the last term of (1) to $BT^{3/2}$ is constant and equal to 45.5 cm^3 degree $^{3/2}$/mole. A detailed account of these calculations will appear shortly in *Physica*."

On the Magnetic Moments of Sn¹¹⁵, Cd¹¹¹, Cd¹¹³, Pt¹⁹⁵, and Hg¹⁹⁹ *

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October 13, 1949

USING the nuclear induction spectrometer described in an earlier letter,[1] the magnetic moments of Sn^{115}, Cd^{111}, Cd^{113}, Pt^{195}, and Hg^{199} have been measured, in good agreement with these results from hyperfine structure measurements: $\mu(Sn^{115}) = -0.89\mu_N$;[2] $\mu(Cd^{111}) = -0.65\mu_N$;[3] $\mu(Cd^{113}) = -0.65\mu_N$;[3] $\mu(Pt^{195}) = 0.6\mu_N$;[4] $\mu(Hg^{199}) = 0.547\mu_N$.[5] Resonance amplitudes were consistent with a spin of $\frac{1}{2}$, as obtained by hyperfine structure ob-

TABLE I. Magnetic moments and diamagnetic corrections.

Nucleus	Magnetic moment in nuclear magnetons	Diamagnetic correction in percent
Sn^{115}	-0.9132 ± 0.0003	0.50
Cd^{111}	-0.5922 ± 0.0002	0.47
Cd^{113}	-0.6194 ± 0.0002	0.47
Pt^{195}	$+0.6004 \pm 0.0002$	0.93
Hg^{199}	$+0.4993 \pm 0.0002$	0.96

servations. The signs of the magnetic moments agreed in each case with those above.

The abundance of the isotope Sn^{115} being 0.4 percent,[6] its resonance was not observed with the sample which revealed the resonances of Sn^{117} and Sn^{119} reported earlier,[7] the latter nuclei having abundances near 9 percent. However, by dissolving $SnCl_2$ $2H_2O$ in an aqueous solution of 2.0-molar $MnSO_4$ at 100°C it was possible to have a liquid sample in the form of a supersaturated solution that would not crystallize for many hours at room temperature. The sample finally contained tin to about a 12-molar concentration and $MnSO_4$ to about an 0.7-molar concentration. The resonance was found in the neighborhood of 6200 kc, or about 700 kc below the Sn^{117} resonance frequency for a magnetic field of 4500 gauss. The frequency of the Sn^{115} resonance was compared to that of Na^{23} from an aqueous solution of 0.2-molar $NaCl$ with 0.2-molar $MnSO_4$. Each resonance was recorded five times with the result that

$$\nu(Sn^{115})/\nu(Na^{23}) = 1.2362 \pm 0.0001.$$

The cadmium resonances were found at a field of 6600 gauss with radiofrequencies near 6000 kc, using a saturated solution of $CdCl_2$ in 0.3-molar $MnSO_4$ as a sample. Recording each resonance four times, the frequency ratios were found to be

$$\nu(Cd^{111})/\nu(Na^{23}) = 0.8016 \pm 0.0001,$$
$$\nu(Cd^{113})/\nu(Na^{23}) = 0.8386 \pm 0.0001,$$
$$\nu(Cd^{113})/\nu(Cd^{111}) = 1.0461 \pm 0.0001.$$

The last ratio, of course, gives the ratio of the magnetic moments of Cd^{113} to Cd^{111}. The resonances were identified by using samples of cadmium enriched to about 80 percent in Cd^{111} and in Cd^{113}.[8]

The resonance of Pt^{195} was observed near 5900 kc, using a magnetic field of 6600 gauss. The sample was a 1.0-molar solution of H_2PtCl_6 with a 0.5-molar concentration of $MnCl_2$. By comparing the resonance frequency of Pt^{195} with that of Na^{23} five times, we found

$$\nu(Pt^{195})/\nu(Na^{23}) = 0.8127 \pm 0.0001.$$

The resonance of Hg^{199} was observed near 6800 kc with a magnetic field of 8900 gauss. The sample contained $HgNO_3$ in dilute nitric acid to a 7.0-molar concentration with a 0.2-molar concentration with a 0.2-molar concentration of $Mn(NO_3)_2$. By comparing the resonance frequency of Hg^{199} four times with that from D^2 from a 1.8-molar aqueous solution of $MnSO_4$ containing 25 percent D_2O, we found

$$\nu(Hg^{199})/\nu(D^2) = 1.1647 \pm 0.0001.$$

The magnetic moments resulting from the above frequency ratios are given in the second column of Table I. A correction due to the diamagnetic field of the atomic electrons has not been included in the computation for the magnetic moments but its magnitude is given in the third column. These values have been determined by linear interpolation from the values for specific atoms given by Lamb using Hartree fields,[9] and they are to be applied so as to increase the magnitudes of the magnetic moments. The magnetic moment of Na^{23} has been computed by taking

$$\mu(H^1) = (2.7928 \pm 0.0008)\mu_N \text{ [10]}$$

and

$$\nu(Na^{23})/\nu(H^1) = 0.26450 \pm 0.00003. \text{ [11]}$$

The magnetic moment of D^2 was similarly computed using

$$\mu(D_2)/\mu(H^1) = 0.307013. \text{ [12]}$$

We should like to express here our gratitude to Professor Felix Bloch for many helpful consultations during the course of this work.

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[8] We are grateful to Dr. B. J. Moyer of the Radiation Laboratory at the University of California for lending us the enriched cadmium samples.
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[11] F. Bitter, Phys. Rev. 75, 1326 (1949).
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Stopping Power of Nuclear Emulsions for Ionizing Particles

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October 17, 1949

RANGE measurements in nuclear emulsions for particles of known energy are comparatively few in number. The more abundant experimental and theoretical data on range-energy relations for ionizing particles in air can be utilized in evaluating the energy of particles from track length measurements in the emulsion provided the stopping power "s" of the recording medium relative to air is known as a function of the velocity "v". We want to indicate that an empirical relation of the type:

$$S = R_0/R = A\beta^k \tag{1}$$

holds in a wide range of velocities; R is the length of the track in the medium under consideration, R_0, in dry air at 15°C and 760 mm of pressure, A and k being constants which depend only on the nature of the medium, and $\beta = v/c$. That this is satisfactory in the range of β from 0.035 to 0.28 is exhibited in the lower part of Fig. 1 where we have plotted log "s" against β (in logarithmic
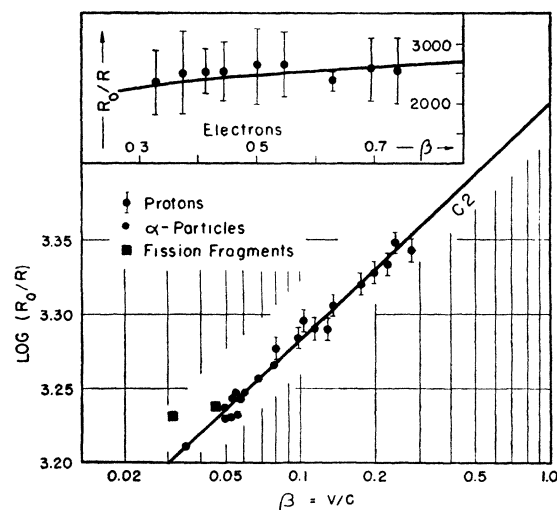

FIG. 1. Variation of R_0/R as a function of β.