bends are kept at different temperatures designated by *H*, hot, and *C*, cold, Fig. 1. (b) A single wire is placed between the poles of a magnet and at right angles to the field, so that the part of the wire lying in the field is magnetized while the ends extending away from the magnet are practically unmagnetized. A temperature difference was maintained at the junctions between the magnetized and unmagnetized parts of the wire. (c) This is similar to (b) except that the wire is longitudinally magnetized. For this set-up pole pieces with holes bored through them were used.

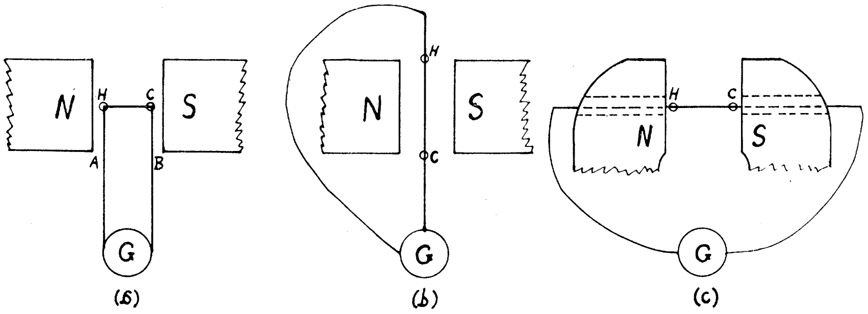

Fig. 1.

Data were taken for nickel, iron and permalloy for all three set-ups, and the curves obtained by plotting e.m.f. with field strength for each specimen were different for each arrangement.

In (b) and (c) Fig. 1 it was found that when the points which were maintained at the temperatures *H* and *C*, were moved away from the magnet the e.m.f. was decreased. This, of course, was to be expected since the temperature difference at the magnetized and unmagnetized junctions is then less. However, a considerable amount of e.m.f. is still present even when these points are moved some distance away from the magnet. For example, when the points *H* and *C* were each 20 cm away from the edges of the magnet, the e.m.f. was found to be about one-eighth as great as that produced when *H* and *C* are as shown in (b) and (c), i.e., close to the magnet.

Referring now to (a), we can readily see that in addition to the e.m.f. due to the longitudinally and transversely magnetized junctions, there will be an e.m.f. due to the magnetized-unmagnetized junctions at *A* and *B* Fig. 1, which may be comparatively large since the length of wire from *H* to *A* and *C* to *B* is small.

In taking the data in the above experiments two readings were observed for each tabulated e.m.f. The first was taken without a magnetic field; the second with a field present. When no magnetic field is present the e.m.f. observed is that due to the Thomson effect in the wire. The e.m.f. tabulated was taken as the difference between the first and second readings. It is to be noticed that Ross' curve for iron shows an e.m.f. of 100×10^{-7}, volts at zero field. This leads us to believe that he did not subtract the initial Thomson e.m.f. in his readings, and that his curve does not represent a purely thermomagnetic e.m.f. On the other hand his curve for nickel begins at zero e.m.f. for zero field. This leaves us at a loss as to the interpretation of his results.

Quantitative results for the above experiments will be published later.

Roland Schaffert

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February 26, 1932.

Solid Solutions of Lead and Tin in Bismuth

In two recent notes[1] Goetz and Fock have given some of the results and conclusions from their investigations on the magnetic properties of single crystals of bismuth and its alloys with lead and tin. In the latter communication it is stated concerning an alloy containing 3 percent tin that ". . . the x-ray

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[1] Goetz and Fock, Phys. Rev. **38**, 1569, (1931); Science. **74**, 603, (1932).

analysis of such crystals does not show any difference from the normal Bi-crystal", and another statement of similar character also appears later on. The difference in the atomic radii of these metal atoms caused us to suspect that these statements were but approximations and the following measurements were made to discover if there were any discernable changes in the lattice parameters.

Materials

Bi from Merck with maximum impurities totalling 0.046 including 0.01 percent each of Pb, Ag and S; Pb from Merck, maximum impurities of heavy metals 0.10 percent; Sn from J. T. Baker containing 0.01 percent Pb. Alloys of bismuth containing 1 percent and 10 percent Pb and 1 percent and 10 percent Sn respectively, were made by melting weighed quantities of the metals in sealed, evacuated glass tubes. The ingots were annealed for seven days at 116°C and filings from each annealed for the same period and temperature also in evacuated tubes. The filings were quenched from this temperature.

TABLE I.

		Bi	10% Pb	10% Sn
Hexagonal axes	*a*	4.5353 = 0.0005	4.5331 = 0.0003	4.5300 = 0.0006
Hexagonal axes	*c*	11.836 = 0.001	11.848 = 0.006	11.850 = 0.004
Hexagonal axes	*a*/*c*	2.610	2.614	2.616
Rhombohedral axes	*a*	4.735 = 0.001	4.738 = 0.002	4.737 = 0.002
Rhombohedral axes	α	57°13.7′ = 0.5′	57°9.6′ = 1.6′	57°7.4′ = 1.3′

X-ray Apparatus

Seeman-Bohlin cameras of the construction devised by Phragmen.[2] These cameras are calibrated empirically against NaCl taking the lattice constant for this substance 5.628A. The measurements resulting in the values reported below were all taken in the cameras recording the most deviated reflections which in these cases give a separation of the $K\alpha$ doublet (Fe radiation) of about 1.8 mm for the outermost reflections used.

TABLE II.

Pure	Bi	(119)	α_1	35.1 mm	α_2	35.6	(220)	α_1	35.9	α_2	36.5
10%	Sn	(119)	α_1	35.1 mm		35.7	(220)		36.4		37.0

The values in Table I were obtained from measurements of the last seven $K\alpha$ doublets. The deviations are the most probable errors of our measurements and not absolute errors. They are therefore not necessarily valid criteria for comparison with the measurements of other workers. However, the agreement between the lattice dimensions of bismuth summarized by Ewald and Hermann[3] and those reported above is entirely satisfactory.

The differences observed in the dimensions of the hexagonal unit are, in our opinion, significant. The nature of the transformation to rhombohedral axes is such as to minimize these difference and hence the discussion following will refer only to the larger unit. It seems safe to say there is a slight but measurable change in the bismuth lattice when the saturated solutions of Pb or Sn in this metal are formed. The most striking fact in the above table is that the *a* axis decreases and the *c* axis increases which would therefore increase the anisotropy of the metal. This fact is possibly of importance in connection with the magnetic anisotropy discussed by Goetz and Fock. In complex structures of this sort the spacing of some planes is influenced much more than others. The effect of solid solution on the bismuth lattice could be seen very strikingly in the reflections from the 119 and 220 planes. Direct film measurements for the α-doublets for these planes are as shown in Table II. It will be seen that the two lines closest together α_2 (119) and α_1 (220) are separated by only 0.3 mm in pure Bi but by 0.7 mm in the alloy. The line width over this portion of the film is about 0.2 mm for intense lines and each of the four lines was clearly separated from its nearest neighbor. A similar behavior was noted with 10 percent Pb. On the films of

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[2] Phragmen, a description of these cameras is given by Westgren. Trans. American Inst. of Min. and Met. Eng'rs., Inst. Metals Div. 1931, p. 13.

[3] Ewald and Hermann, "Structurbericht 1913–1928," Acak, Verlagsges, Leipzig 1931, p. 58.

alloys containing 1 percent of the solute element apparently most or all of this shift had taken place so that the solid solution range cannot be very extensive in either case. On the other hand, these lines showed no measureable change in their relative positions compared with pure Bi on films obtained from alloys of Bi with Mg and Bi with Si.

It was somewhat surprising that both Sn and Pb which have respectively smaller and larger atomic radii than Bi should both affect the Bi lattice in the same way. The volumes of the unit hexagonal prisms are Bi 210.83 $\doteq$0.07A,[3] Bi-Pb 210.85$\doteq$0.11 and Bi-Sn 210.58$\doteq$0.07. The decrease in the volume in the Bi-Sn case seems significant and in the right direction. The Bi-Pb results are inconclusive.

These results are presented for their interest in connection with the problem of the magnetic properties of these substances but it is by no means even suggested that the slight variations observed in the lattice constants can account for the whole of the variations in the magnetic properties. The results given above have been obtained on alloys sufficiently high in solute concentration to insure having the solid solution phase saturated. Variations within the solid solution range cannot be measured with the means at present avilable. A new camera of considerably greater resolution and, it is hoped, greater accuracy, is in construction and it is planned to investigate this part of the problem at a later date.

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March 2, 1932.

The Infrared and Raman Spectra of CS_2

In a recent note entitled "A new long wavelength absorption band of CS_2" Dennison and Wright[1] have arrived at the conclusion that the fundamental frequencies ν_1, ν_2 and ν_3 of the CS_2 molecule are respectively given as 655.5, 396.8 and 1523. Of these three, ν_1 represents a symmetric mode of oscillation and is observed only in the Raman effect while ν_2 and ν_3 respectively arise from a transverse and a longitudinal motion of the central carbon atom and give rise to intense infrared absorption. These authors interpret the Raman line 795.0 as a harmonic of ν_2. In this connection I should like to draw attention to two earlier communications[2] by me regarding the subject. Two very faint bands were recorded in the Raman spectrum of this substance having approximate frequency shifts 412 and 1577. More reliable measurements on better photographs recently obtained show these frequencies to be 400 ± 5 and 1500 ± 20, and enable them to be identified as ν_2 and ν_3 respectively. It was also pointed out that the Raman lines 655.5 and 795.0 are both strongly polarized and to about the same extent (80 percent). More recent observations on the other hand indicate the Raman line at 400 to be practically unpolarized while the one at 1500 is partially polarized. The observed facts that 795 is inactive in infrared absorption, and strongly polarized in scattering, while ν_2 is intensely active in absorption and unpolarized in scattering do not appear easy to reconcile with the view that one is a harmonic of the other. It is evident from the facts that the two modes of oscillations of the molecule represented by the Raman lines 655.5 and 795.0 are very similar to each other. Designating the latter by the symbol ν_1', we may offer the following scheme for identifying the observed infrared absorptions.

Identification	Frequency (observed)	Frequency (calculated)
ν_2	396.8	—
ν_1	655.5	—
ν_1'	795.0	—
ν_3	1523	—
$\nu_3-\nu_1$	878	867.5
$\nu_3-\nu_1'$	746*	728
$\nu_3+\nu_1$	2179	2178.5
$\nu_3+\nu_1'$	2330	2318

* Observed only by Coblentz in the liquid state.

According to the theory recently developed by Manneback[3] ν_2 and ν_3 should not appear in the Raman effect as the corresponding oscillations would not involve any *first order* variation in either the optical polarizability or the anisotropy of the molecule. That they do appear, though with extreme feebleness, is therefore a fact of great interest.

S. Bhagavantam

Calcutta, (India),
March 4, 1932.

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[1] Dennison and Wright, Phys. Rev. **38**, 2077 (1931).

[2] Nature **126**, 995 (1930); Ind. Jour. Phys., **5**, 59 (1930).

[3] Manneback, Zeits. f. Physik. **62**, 224 (1930).