TABLE I. Calculated values of $\log_{10}(P_{mm}/T^{5/2})$.[a]

Temperature (°K)	0.3	0.6	1.0	1.2	1.5	2.0	2.5
New equation	$\bar{2}.4553$	+0.2367	0.9272	1.0971	1.2620	1.4280	1.5176
Abraham *et al.*	$\bar{2}.6494$	0.2828	0.9363	1.0999	1.2636	1.4284	1.5280
Chen and London	$\bar{2}.3849$	0.2317	0.9379				

[a] The two empirical equations are already known (see reference 2) to agree between 1° and 2.5°. Above 2.5° higher virial coefficients of the vapor become important.

In the foregoing equations, B is the second virial coefficient of the vapor, L_0 the "latent heat at absolute zero," P_{mm} the vapor pressure in millimeters of mercury. the other symbols having their usual meanings.

Some calculated vapor pressures are given in Table I. Between 1° and 2.5° the comparison is with the equation of Abraham *et al.*[4] which represents a satisfactory smoothing of their data. Below 1°, comparison is also made with the equation of Chen and London.[2] In the latter range preliminary measurements by Sydoriak and Roberts[5] agree with the latter equation to within 2 percent. These workers give a value of 5.30 calories/mole for L_0.

In Fig. 2 the calculated specific heat is compared with measurements by Abraham *et al.*,[6] Sydoriak and Roberts[7] and de Vries and Daunt.[8] (Only a few representative values have been taken from the rather large number of points reported by the last workers.) In Table II, calculated susceptibilities are compared with the data of Fairbank *et al.*[9]

A Gibbs' function like (1) can be plausibly derived from the cell model of a liquid developed on lines

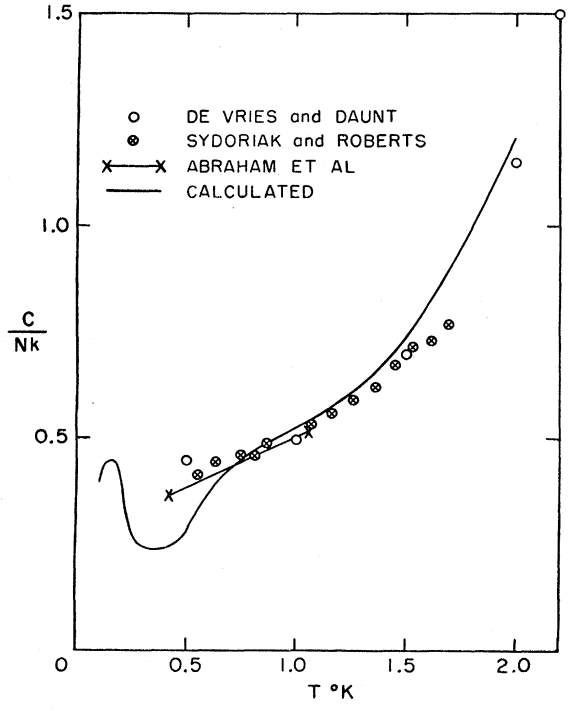

FIG. 2. Calculated and observed specific heats.

TABLE II. Calculated and observed values of $kT\chi/N\mu^2$.

Temperature (°K)	0.2	0.3	0.5	0.6	0.8	1.0	1.2	1.5
Calculated	0.385	0.661	0.776	0.808	0.861	0.891	0.910	0.929
Observed	0.50	0.63	0.82	0.85	0.90	0.93	0.94	0.95

suggested by the "pairwise" approximation of Heitler-London type. A detailed derivation will be published shortly, together with a critical comparison with the Fermi gas model. It turns out that an acceptable level scheme cannot depart greatly from that shown in Fig. 1.

The present equations predict a transition at about 0.1–0.2°K to an antiferromagnetic state, via a Schottky type anomaly (Fig. 2). A Curie type anomaly is predicted if the theory is developed on lines suggested by the theory of ferromagnetism, but it may be difficult to establish its existence experimentally. Either way, it is very likely that the specific heat will start to rise again at about 0.2°K–0.3°K.

[1] H. N. V. Temperley, Proc. Phys. Soc. (London) **A67**, 495 (1954).
[2] T. C. Chen and F. London, Phys. Rev. **89**, 1038 (1953).
[3] P. J. Price (unpublished).
[4] Abraham, Weinstock, and Osborne, Phys. Rev. **80**, 366 (1950).
[5] S. G. Sydoriak and T. R. Roberts in Proceedings of the Low Temperature Conference at Rice Institute, *Abstracts of Papers* (Rice Institute, Houston, 1953).
[6] Abraham, Weinstock, and Osborne, Phys. Rev. **94**, 202 (1954).
[7] S. G. Sydoriak and T. R. Roberts, Phys. Rev. **93**, 1418 (1954).
[8] G. de Vries and J. G. Daunt, Phys. Rev. **93**, 631 (1954).
[9] Fairbank, Ard, and Walters, Phys. Rev. **95**, 567 (1954).

Mechanism of Intermetallic Diffusion*

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THREE mechanisms for intermetallic diffusion have been extensively discussed: (1) interchange, (2) vacancy, and (3) interstitial. The interchange mechanism cannot result in a net atomic flow and hence is presumably not of major importance in those cases in which a Kirkendall effect is exhibited. It is proposed that a distinction may be made between the other two possibilities by studying self-diffusion in ordered crystals.

Consider a binary alloy which is ordered such that each atom is surrounded only by unlike atoms. If vacancies move by jumping to nearest-neighbor sites then the motion of a vacancy through the lattice would produce equal amounts of diffusion of both constituents. The interstitial mechanism, on the other hand, would allow the two types of atoms to move independently and, if they are quite dissimilar, would be expected to lead to different diffusion coefficients. The existence of an appreciable difference in diffusion coefficients alone, however, does not necessarily imply the interstitial

mechanism, since it is still conceivably possible for two independent processes of vacancy diffusion to take place within the sublattices which are each made up solely of one of the constituents of the alloy. Thus, a comparison of the diffusion of tracers of both components should allow, to a limited extent, a choice to be made between the two mechanisms.

Tracer experiments on β brass which should give such information are now being performed by Kuper and Tomizuka[1] of this laboratory.

Measurements of the diffusion of In and Sb in InSb are underway by Millea and Tomizuka. Preliminary data on this experiment by Slifkin and Tomizuka indicate an appreciably faster diffusion rate of In than of Sb.

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[1] A. B. Kuper and C. T. Tomizuka, Bull. Am. Phys. Soc. **29**, No. 7, 29 (1954).

Decay of Co^{57}†

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LIVINGOOD and Seaborg[1] attributed a 270-day positron activity to Co^{57} and deduced a maximum positron energy of 0.26 Mev from absorption measurements. Plesset[2] assigned to the same isotope gamma rays of 117 and 130 kev determined by a magnetic analysis of the conversion spectrum. Deutsch and Wright[3] reported a 14-kev transition with a mean life of 0.1 microsecond. Cheng, Dick, and Kurbatov[4] analyzed the positron spectrum of a mixed source of Co^{57} and Co^{58}, attributing to Co^{57} a component with 0.32-Mev maximum energy. They also observed conversion electrons from gamma-ray lines at 119 and 133 kev. Alburger and Grace[5] studied the gamma-ray spectrum using proportional counters and reported gamma-ray energies of 123 and 137 kev with relative intensities in emission about 20:1. In the conversion spectrum, however, the lines appeared with equal intensities. Crasemann and Manley[6] reported energies of 119 and 133 kev, an intensity ratio of 30:1, and a K/positron ratio of the order of 10^3.

A source of Co^{57}, prepared by proton bombardment of nickel, was supplied by the Oak Ridge National Laboratory. Examination of the radiation with a scintillation spectrometer showed almost total absence of annihilation radiation, indicating that the main decay process could not be positron emission. The radiations of this source were studied by means of scintillation spectrometers with various crystal thicknesses (sometimes used in coincidence with resolving time of 1.5 microseconds) and Geiger counters. Chemical separation from added Fe and Ni showed that the activity was due to cobalt.

Gamma-ray lines of approximately 14 and 120 kev were observed, in addition to strong x-rays at 6.4 kev (K radiation of Fe). The reported line (crossover transision) at 134 kev was not found; however, in view of its low reported intensity it is doubtful whether it could be resolved from the wing of the 120-kev line. Cohen, Charpie, Handley, and Olson[7] state that in the spectrum of Mn^{57} the 117- and 134-kev lines have approximately equal intensities; this is certainly not true in our case. Extremely weak annihilation radiation (about 8×10^{-3} quanta for each quantum of 120 kev) was detected by means of thick NaI crystals. However, the annihilation photons did not appear to coincide with the 120-kev line, indicating either that they belong to an impurity, or that positron decay, if any, leads mainly to the ground state of Fe^{57}.

Within the accuracy of the measurements, every gamma ray of 14 kev and every x-ray coincide with the 120-kev gamma ray. The 14-kev gamma ray, however, does not coincide with the x-ray. A low coincidence rate observed with one spectrometer covering the x-ray region and the other scanning the 14-kev region appeared to be due to Compton scattering of the 120-kev line in one of the crystals and other spurious effects. This conclusion was also confirmed by preparing a NaI(Tl) crystal containing the activity. Pulses of 14 kev were observed in this crystal, instead of pulses of 21 kev as expected in the case of prompt coincidence of the gamma transition with K excitation.

Intensity measurements showed that the numbers of x-rays and 120-kev gamma rays are about equal, indicating one 120-kev transition per disintegration. The intensity of the 14-kev gamma ray is about 0.1 quantum per decay. Within the accuracy of the measurements its intensity did not appear higher when the source was embedded in the crystal, showing that the conversion coefficient is low. We also measured the number of high-energy conversion electrons in a Geiger counter with a 2-mg/cm^2 mica window. An absorption curve taken with additional mica foils was used to correct for absorption in the window. The ratio of conversion electrons to 120-kev photons was found to be 0.10.

These observations show that: (1) Co^{57} decays mainly if not exclusively, by orbital electron capture. (2) The 14-kev and 120-kev transitions are in cascade. (3) The 14-kev transition precedes the other, has a lifetime at least an order of magnitude longer than a microsecond, and is not highly converted. (4) The 120-kev transition has a short lifetime and a conversion coefficient lower than 0.1. (5) The crossover transition is weak. (6) Most of the disintegrations lead to the 120-kev excited state, about 10 percent to the 134-kev state, and none or few to the ground state. The decay scheme is repre-