

state energies of -0.1859 eV for neutral S and -0.3655 eV for S^+ . These agree quite well with binding energies obtained from photoconductivity and Hall data.

The transitions listed in the table for $(1)(1) \rightarrow (1)(3)$ in S and $(1) \rightarrow (3)$ in S^+ are the mean values for the lines observed in these regions, and their identification is not completely certain. From the energy differences shown, these groups of lines do seem to fall close to the effective mass ground state relative to the $2p_0$ levels. If they are $(1) \rightarrow (3)$ transitions, it is not, as yet, clear what has caused the splitting into two or possibly three lines for S^+ and three lines for neutral S. Spin-orbit interaction could cause a splitting of the lines, but the free S-atom spin-orbit splitting is so small that it does not seem likely that residual spin-orbit effect in the solid could be this large. It is also possible that there are a number of different inequivalent sites for sulfur impurities in the Si samples which produce a number of $(1) \rightarrow (3)$ lines. A similar pair of lines, split by ~ 0.001 eV, has been seen in the spectrum of Bi in Si. Bi has a large atomic spin-orbit inter-

action, and the observed splitting in Si is consistent with a rough estimate of residual spin-orbit effect.²

We have observed a preliminary effect of pressure on the $(1) \rightarrow (3)$ absorption lines, and hope that further experiments will clarify the nature of these transitions. Experiments are also under way on the absorption spectra of other group VI elements in Si.

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DEPENDENCE OF THE ATOMIC MAGNETIC MOMENT IN α IRON ON LATTICE SPACING

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It has been suggested by Galperin¹ that an increase in the lattice parameter of iron would cause an increase in the atomic magnetic moment. On the other hand, in the application of the Weiss theory of intrinsic magnetization, it is generally assumed that the atomic magnetic moment remains constant over the entire ferromagnetic range of temperature with a sudden (apparent) increase occurring upon passing into the paramagnetic region. It will be shown that by regarding the electronic configuration of the iron atom at the Curie temperature as being equivalent to that of the isolated iron atom ($3d^64s^2$ with 4 net spins per atom), various discrepancies in the Weiss theory can be resolved. In particular, by regarding the atomic magnetic moment as increasing with lattice expansion (and therefore with the temperature), it is possible to compute from the Weiss theory, using intrinsic magnetization data, the variation of atomic magnetic moment with

temperature.

The internal field hypothesis of Weiss leads to a theoretical expression for the intrinsic magnetization curve of ferromagnetic materials which Wannier² presents in the following way:

$$M/N = \tanh \frac{M/N\mu}{(kT/\alpha)N\mu^2}. \quad (1)$$

Here M is the intrinsic magnetization at temperature T , N is the number of spins per unit volume, μ is the Bohr magneton, α is the Weiss constant, and k is Boltzmann's constant. If the viewpoint is adopted that N is a function of T , then (1) may be rearranged to solve for N (or n , the number of spins per atom) in terms of $M/N(0)\mu$ (to be called x) and T/T_c (to be called y) where T_c is the observed Curie temperature. If this is done, it is found that

$$n(T) = \frac{n(0)x}{\tanh[x/(yn(T_c)/n(0))]} \quad (2)$$

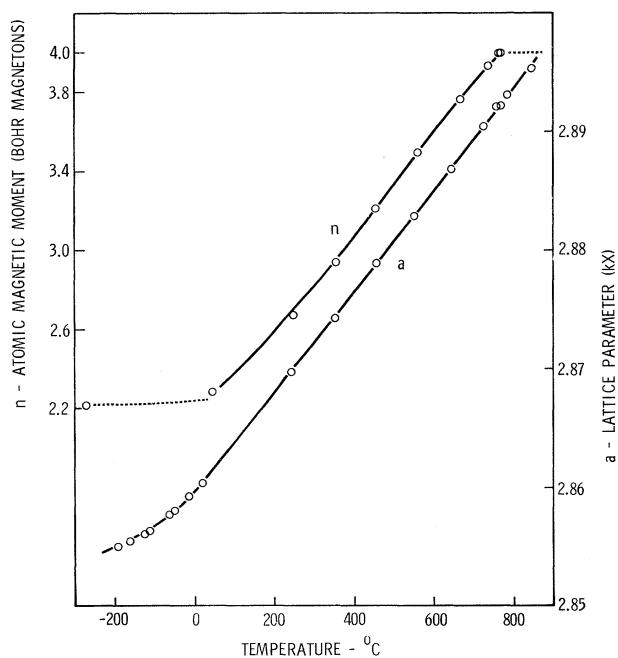


FIG. 1. Temperature dependence of computed atomic magnetic moment and observed lattice parameter of iron.

If the accepted value³ of 2.22 is taken for $n(0)$ and $n(T_C)$ is taken as 4, as suggested above, then

$$n(T) = \frac{2.22x}{\tanh(x/1.8y)} \quad (3)$$

Experimental data for x and y may be found in the work of Tyler⁴ and Potter.⁵ The curve obtained for $n(T)$ is presented in Fig. 1. It may be seen that n increases linearly with the temperature above room temperature attaining a value of 4 before the Curie temperature is reached and leveling off at that value. This zero slope on approaching the Curie temperature is consistent with a determination of n from the Curie-Weiss law and the paramagnetic susceptibility data of Sucksmith and Pearce.⁶ Their data

indicate that $n=4$ from just above the Curie temperature to the α - γ transition at 910°C. The n vs T curve of Fig. 1 can be used to resolve various discrepancies usually associated with the Weiss theory. First, the value of n in the ferromagnetic region joins smoothly with the value of n in the paramagnetic region. Second, the value of the specific heat discontinuity at the Curie temperature (computed from $\Delta C = \frac{3}{2}nR$) turns out to be 12 cal/mole-deg, compared to 12.3 cal/mole-deg estimated from the specific heat data of Wallace *et al.*⁷ Third, the value of the Weiss coefficient α , as computed from the Curie temperature, is brought into agreement with the value of α , as computed from the magnetocaloric effect.

Also shown in Fig. 1 is the lattice parameter (plotted as a function of the temperature) of iron as taken from the data of Basinski *et al.*⁸ and Owen and Williams.⁹ It is apparent from the parallelism of these two curves that the information presented in Fig. 1 permits the dependence of the atomic magnetic moment upon lattice spacing to be established.

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