$$\eta(\xi) = \begin{cases} 0, & \xi < a \\ 1, & a < \xi < b \\ 0, & \xi > b; \end{cases}$$

U_0 is the depth of potential well, and $b - a = d$ is the width of potential well. Knowing the binding energy E_0 per atom of He^4 at a temperature close to the absolute zero (the experiment gives for this energy the value $\sim \kappa 7°K$, where κ is the Boltzmann's constant), and using the known results of quantum mechanics, a relationship can be established between the binding energy and the width and depth of the potential well. Then only one parameter (with the exception of ρ and a) will appear in the energy spectrum of the system. This relation is expressed by the equation

$$d = d_0 \left(\frac{U_0}{2E_0} - 1\right)^{-1/2} \tan^{-1}\left(-\sqrt{\frac{U_0}{2E_0} - 1}\right),$$

$$d_0 = \left(\frac{mE_0}{\hbar^2}\right)^{-1/2}.$$

Use of the potential (7) instead of (6) leads to the following energy spectrum:

$$E(x) = \left(\frac{\hbar^2}{2ma^2}\right) x \left[x^2 + 2\lambda^2 \frac{\sin x}{x} - \gamma^2 x^{-3}\left(\sin\left(1 + \frac{d}{a}\right)x - \sin x\right) + \gamma^2\left(1 + \frac{d}{a}\right)x^{-2}\cos\left(1 + \frac{d}{a}\right)x - \gamma^2 x^{-2}\cos x\right]^{1/2}, \quad (8)$$

$$\gamma^2 = 4\pi U_0 \rho a^5 m/\hbar^2.$$

This form of the spectrum yields a better approximation to the experimental curve $E(x)$ for He^4 than equation (6), as is shown by an analysis of the relationship (8).

Note added in proof (February 21, 1957). Taking exchange forces into account leads to a change of parameter $\lambda^2 = 16\pi\rho a^3$. In the limit of $k \to 0$ this change is equivalent to the introduction of an effective mass $m^* = m/2$.

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THE ANTIFERROMAGNETIC ORIENTATION OF MAGNETIC MOMENTS IN THE ALLOY* Ni_3Fe

M. V. DEKHTIAR

Moscow State University

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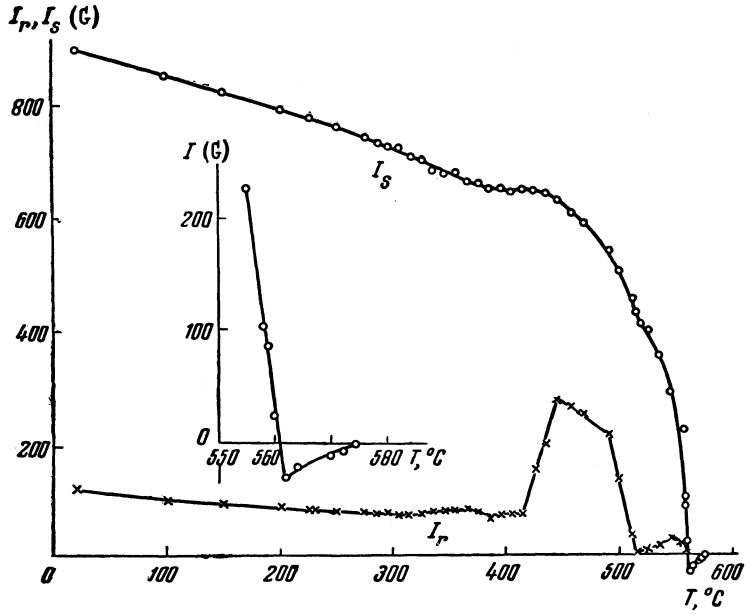
THE influence of ordering the atoms on the magnetic structure of the alloy Ni_3Fe has been studied by Shull and Wilkinson[1] by means of neutron diffraction. These authors discovered the effect of the magnetic state of the alloy on the intensity of the superlattice lines which are observed as a result of the atomic ordering. The intensity of these lines is weakened when the neutron diffraction is observed on a magnetized sample. On this basis, the authors have concluded that the rearrangement of the atoms is accompanied by the appearance of a magnetic superlattice. The nature of the latter, however, remained unclear.

We have shown earlier[2] that the observed anomalies accompanying the variation of the magnetic properties with temperature permit the detection of structural changes in single phase alloys caused by ordering processes. In the present paper the temperature dependence of the saturation magnetization I_S, the remanent magnetization I_r and of the coercive force H_C of the alloy Ni_3Fe is investigated over a wide temperature range.

The investigated sample, with a diameter of 4.5 mm, was enclosed in a thin quartz tube, evacuated to 10^{-4} mm Hg, and quenched together with it in water after two hours of annealing at 1200°C. The experimental points in the region from 300 to 600°C were obtained for closely spaced values of the temperature (at intervals of 10 to 15°C) in order to determine more accurately the shape of the temperature dependence of I_S, I_r and H_C. The sample was kept one hour at each temperature before taking a reading.



The figure shows the temperature dependence of I_S and I_r. A plateau appears on the I_S curve in the region from 385 to 435°C. Over a temperature range of about 50°C, the decrease in I_S with rising temperature is compensated by an increase in I_S caused by the establishment of an order at close range in the distribution of the atoms in the crystal lattice of the quenched disordered alloy.

Another indication of the establishment of order at close range is given by the threefold increase in I_r over the range 415 — 434°C, whereas I_r stays practically constant over the temperature range from room temperature to 415°C. H_c varies approximately in the same manner. These results are in agreement with the anomalous dependence of the thermal capacity over the same temperature range.[3]

In the narrow region from 490 to 510°C the residual magnetic moment per unit volume measured at field H = 0 decreases sharply from 240 gausses to almost zero (see drawing). The saturation magnetization at this temperature still remains at about 50% of the value of I_S at room temperature. At higher temperatures, saturation is not reached in the fields investigated by us; a compensation point is found on the I(T) curve (according to Néel,[4] see drawing). If in a field H = 135 oersted the magnetic moment per unit volume at 555°C is 0.25 I_S at room temperature, then on raising the temperature by another 5°C it suddenly drops to zero. On increasing the temperature further, the magnetic moment in a field of the indicated intensity has a negative value.

The presence of a compensation temperature in the I(T) curve and the appearance of negative magnetic moments above this temperature show the existence of an uncompensated antiferromagnetic orientation of the spin moments. One may assume that the latter appears close to 510°C, where a sharp drop of I_r to zero is observed.

The transition of the alloy from the ferromagnetic to the paramagnetic state occurs in the neighborhood of 574°C.

The observed changes in the magnetic structure of the alloy Ni_3Fe near 510°C and 574°C appear to correspond to the two maxima in the curve of thermal capacity vs. temperature shown in the paper by Leech and Sykes.[3]

The anomalous temperature variation of the magnetic properties of the alloy Ni_3Fe exemplifies the process of atomic ordering and the change in magnetic structure, which is connected, as we have shown, with the transition of the alloy Ni_3Fe from the ferromagnetic to the ferrimagnetic state.

The results of our investigation are in agreement with the papers by Smart[5] and Pratt,[6] who discuss the possibility of rearrangements which are caused not by the disappearance of the magnetic structure, but by changes in it.

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NUCLEAR MAGNETIC MOMENTS OF Sr^{87} *AND* Mg^{25}

A. G. KUCHERIAEV, Iu. K. SZHENOV, Sh. M. GOGICHAISHVILI, I. N. LEONT' EVA, and L. V. VASIL' EV

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THE gyromagnetic ratio of the Sr^{87} nucleus was measured by us by the atomic-beam magnetic-resonance method.[1] Since the beam consisted of strontium atoms, intramolecular interactions could be disregarded and the diamagnetic correction[2] could be evaluated accurately. The beam was 378 cm long and was detected by surface ionization on an incandescent tungsten wire, upon which an oxygen jet was blowing. Under optimum conditions the coefficient of surface ionization was about 20 percent. The Sr^{87} ions were separated out by a magnetic analyzer and recorded with an electron multiplier and a galvanometer with a sensitivity of 4×10^{-10}amp/mm. The galvanometer deflection due to the narrow strontium beam at mass 87 was 250 mm. The strontium beam was produced by heating metallic strontium to 740°C in an oven made of Armco iron.

The nuclear gyromagnetic ratio g was determined from the equation[1] $g = 1.3122 \times 10^{-3} f_r/H_r$, where f_r is the resonance frequency of the oscillating field that induces the transitions, and H_r is the corresponding resonance value of the strength of the static magnetic field in which the transitions occur. The resonance values f_r and H_r are those which correspond to the minimum intensity of the refocused beam. Measurements were made both at constant field and at constant frequency. The fluctuations in beam intensity were compensated by two methods: (a) alternate measurements of beam intensity with the oscillating field on and off, and (b) continuous recording of the beam intensity by an instrument with a fast response. The frequency f was measured with a type 528 heterodyne wavemeter by observing zero beats on an oscilloscope. The magnetic field strength H was measured by proton resonance in water; the resonance frequency ν_H of the protons was measured by the method indicated above. Since the position of the field-measuring probe did not coincide with the place in the field H where the atomic beam was exposed to the oscillating field, the measured value ν_H was corrected by adding to it the difference between the proton resonance frequencies of the field-measuring probe and of another probe located in the place of beam passage; this difference had been measured before installing the electromagnet in the apparatus. A sharp and deep resonance dip of the intensity of the refocused beam, amounting to 60 percent, was observed at frequencies around 1.07 Mcs and fields around 5800 oersted. To cancel out end effects of the oscillating field[3] the measurements were carried out at opposite directions of the field H.

The maximum error of measurement — determined by nonuniqueness under reversals of magnetism, by the inhomogeneity of the field, and also by the sharpness of the resonance curves — is estimated to be 0.12 percent. The average value of 26 measurements of the gyromagnetic ratio is

$$g(Sr^{87}) = 0.2423 \pm 0.0003,$$

which within the limits of the errors of the measurements agrees with the value obtained by Jeffries and Sogo by the method of nuclear induction. Because of the diamagnetism of the atom the true value H_{true} of the magnetic field strength at the nucleus is less than the measured H_r, so that $H_{true} = (1-\sigma)H_{meas}$, where σ is the magnetic shielding constant. According to Dickinson[5] $\sigma = 0.00345$ for strontium. With this correction and the known[6] value of the spin of the Sr^{87} nucleus, $I = 9/2$, we obtain for the magnetic moment of the Sr^{87} nucleus

$$\mu(Sr^{87}) = 1.0939 \pm 0.0014 \text{ nuclear magnetons.}$$

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