January 27 — February 3, 1958.
[3] Pilger, Stephens, Asaro, and Perlman, Bull. Phys. Soc. **2**, 394 (1957).

Translated by J. G. Adashko
112

THE SATURATION MAGNETIZATION OF NICKEL-COPPER ALLOYS AT LOW TEMPERATURES

E. I. KONDORSKII, V. E. RODE, and U. GOFMAN

Moscow State University

Submitted to JETP editor May 28, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) **35**, 549-550 (August, 1958)

THE aim of the present investigation was to check the $\frac{3}{2}$-law, $I = I_0(1 - CT^{3/2})$, for the saturation magnetization at low temperatures, and to determine the constant C in that law for nickel-copper alloys with copper content of up to 50%.

The measurement was carried out on a setup which made it possible to follow directly the change in the saturation magnetization of the sample while its temperature was changed. The temperature of the specimen was varied by pumping out vapors of boiling liquids (oxygen, nitrogen, hydrogen, and helium) in which the specimen was placed. The temperature was determined by the vapor pressure in the cryostat. The change in the magnetization was determined by a photoelectric flux meter. The sensitivity of the flux meter was equal to 20 μ sec-v for one division of the scale, which made it possible to measure a magnetization of the order of 10^{-3} gauss.

In the table we have given the values of the magnetization I_0 of nickel and nickel-copper alloys in a field H = 3500 Oe at different temperatures, the value of

$$n = \ln(\Delta I_1/\Delta I_2)/\ln(T_1/T_2) + 1,$$

where ΔI_1 and ΔI_2 are the change in magnetization found respectively at the temperatures T_1 and T_2 for the same lowering of the temperature (for a change of the temperature by the same small amount ΔT). In the table is also given the value of C evaluated by means of the Bloch equation for

Cu content (%) in the alloys	Magnetization, gauss				n	$C\cdot 10^6$	Θ',°K	J/k	$2S^*$	J^*/k
	4.2° K	20°K	77°K	286°K						
0	512	512	510	496	1.6 ±0.2	9	2300	217	0.606	485
10	423	422	420	369	1.55±0.1	17	1500	144	0.502	475
20	348	347	342	272	1.43±0.2	32	990	94.5	0.412	440
30	255	253	246	124	1.53±0.2	67	610	58	0.302	445
44	124	121	97.5	—	1.56±0.2	320	215	20	0.147	470
50	82.5	77.5	35.5	—	1.48±0.2	780	118.5	11.5	0.098	495

an observed value of $\Delta I/\Delta T$ and the value $\Theta' = C^{-2/3}$. One sees easily that the difference $n - \frac{3}{2}$ lies within the limits of the errors, assumed in the determination of n. Hence it follows that, within the limits of the errors, the experiments observe the $\frac{3}{2}$ law for all alloys which were investigated.

From the value of C from the Bloch-Møller equation

$$C = (0.1174/2S\alpha)\left(\frac{k}{2SJ}\right)^{3/2},$$

in which S is the spin, α = 1, 2, 4 for simple, body-centered, and face-centered cubic lattices, respectively, one can evaluate the exchange integral J for pure metals. To evaluate the exchange integral of iron we take[1-3] 2S = 2; for nickel we take 2S = 1. However, for nickel and its alloys the average magnetic moment for one atom is not equal to an integral number of Bohr magnetons, and the above expression for C loses its meaning. We can, however, by considering J as a parameter characterizing the alloy, attempt to determine its value substituting for 2S the number 2S* of Bohr magnetons per atom of the alloy obtained from the experimental values for the magnetic saturation.

The results of these calculations are given in the table.

The exchange parameter J* evaluated in this way stays constant for all the copper-nickel alloys investigated within an accuracy of 10 to 15%.

[1] E. M. Lifshitz, J. Exptl. Theoret. Phys. (U.S.S.R.) **15**, 97 (1945), J. Phys. (U.S.S.R.) **8**, 337 (1944).

[2] E. I. Kondorskii and L. N. Fedotov, Izv. Akad. Nauk SSSR, Ser. Fiz. **16**, 432 (1952).
[3] C. Kittel, Revs. Modern Phys. **21**, 541 (1949).

Translated by D. ter Haar
113

PARAMAGNETIC RESONANCE OF THE FREE RADICALS OBTAINED BY FREEZING A PLASMA OF H_2S

S. D. KAITMAZOV and A. M. PROKHOROV

P. N. Lebedev Physical Institute, Academy of Science, U.S.S.R.

Submitted to JETP editor May 31, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) **35**, 551 (August, 1958)

HYDROGEN sulfide, generated by the usual method and dried over calcium chloride under a pressure of 0.3 mm Hg, was passed into a quartz tube in which a high frequency electrodeless discharge was excited. The power in the discharge was 120 w and the frequency was 40 Mcs. The discharge tube was joined to a quartz trap cooled by liquid nitrogen. The dissociation products of the H_2S were frozen out on the inner surface of the trap. The electron paramagnetic resonance spectrum was observed for the material condensed below the nitrogen level. The substance had a dark green color and a snow-like structure.

Observations were carried out at 1300 and 9400 Mcs. For observation at 1300 Mcs, the frozen material was placed in a previously cooled through-type quarter-wave coaxial resonator connected to a vacuum pump. The absorption spectrum was observed on the screen of an oscillograph. Observations were made at 77°K. The line observed was 16 ± 1 gauss wide at half intensity and had a nearly Gaussian shape.

The dependence of the absorption line on preliminary warming of the specimen was qualitatively investigated. It was found that keeping the specimen for an hour at 120 to 130°K is not accompanied by an essential change in the intensity and shape of the line. Keeping the specimen at 170°K for an hour causes a several-fold drop in intensity and a narrowing of the line to 12 gauss. A very weak line continued to be observed after 30 min at dry-ice temperature. Let us note that storing the specimen at 77°K for two months did not give rise to a noticeable change of intensity of the line.

Observations at 9400 Mcs were carried out on a superheterodyne spectroscope[1] in a cylindrical resonator in an H_{011} mode. The shape of the line differed radically from Gaussian. The line breadth was 85 ± 5 gauss, and the spectroscopic splitting factor $g \approx 2.03$. On warming the specimen, the peak of the line deformed asymmetrically. The change of shape of the line on warming indicates that the condensed material contains two radicals with different stability to warming.

A comparison of the line breadths at 1300 and 9400 Mcs, as well as the asymmetry of the line at 9400 Mcs, are evidence of a strong anisotropy of broadening ($g_{\parallel} > g_{\perp}$).

The authors express their thanks to G. Ia. Vzenkova for her part in the work.

[1] A. A. Manenkov and A. M. Prokhorov, Радиотехника и электроника (Radio Engg. and Electronics) **1**, 469 (1956).

Translated by R. Eisner
114

ON THE PROBLEM OF ANGULAR CORRELATION OF SECONDARY PARTICLES PRODUCED IN HIGH-ENERGY NUCLEAR COLLISIONS

I. M. GRAMENITSKII, M. Ia. DANYSH, V. B. LIUBIMOV, M. I. PODGORETSKII, and D. TUVDENDORZH

Joint Institute for Nuclear Research

Submitted to JETP editor May 31, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) **35**, 552-553 (August, 1958)

WE report here the results of a study of the correlation between the emission angles of secondary relativistic particles produced in interactions between ~ 9-Bev protons and emulsion nuclei. The coefficient of correlation between the number of particles emitted within various solid angles was measured for that purpose.

Consider two non-overlapping solid angles Ω_1 and Ω_2, and two random variables n_1 and n_2, equal to the number of secondary relativistic particles in a given star emitted within Ω_1 and Ω_2 respectively. We denote by p_1 and p_2 the emis-