EFFECT OF PRESSURE ON THE MAGNETIC SUSCEPTIBILITY OF MANGANESE AND SCANDIUM

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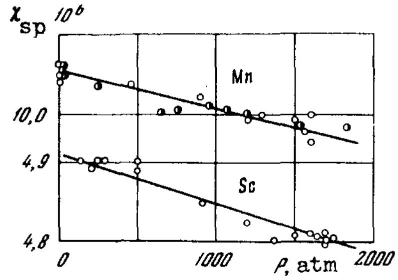
The monotonic part of the magnetic susceptibility is a valuable source of information on the structure of the energy spectrum of the electrons of weakly-magnetic metals and their alloys. It is of interest to investigate the variations of the susceptibility of these substances under pressure, for in principle this discloses effects conntected with the change of the spectrum [1] and permits an estimate of the roles of different contributions to the susceptibility. However, owing to serious technical difficulties, no such investigations were made until now. The only exception are data on $\partial\chi/\partial P$ at zero pressure, obtained by P. L. Kapitza from the magnetostriction of Bi, Sb, and graphite by an indirect method [2].

We made a direct study of the behavior of $\chi(P)$ near room temperature using a method wherein the sample was freely suspended in a magnetic field (in analogy with [3]); a hydrostatic pressure up to 2000 atm was transmitted with ethyl alcohol. The preliminary measurement results obtained during the trials of the method on manganese and scandium are shown in the figure. The accuracy with which χ_{sp} was measured at $P = 0$ was not worse than 2%. The difficulties in estimating the systematic errors, which could not be completely eliminated in the employed variant of the apparatus, and also the impossibility of comparison with similar investigations, cause us to treat the obtained value of $\kappa = (1/\chi^0_{sp})(\partial\chi_{sp}/\partial P)$ with great caution, and to propose for the results the following accuracy: $\kappa_{Mn} = -9.6 \times 10^{-6}$ atm^{-1} ± 20% and $\kappa_{Sc} = -1.3 \times 10^{-6}$ atm^{-1} ± 40%. An analysis of the sources of errors and their estimate will be presented in the near future in connection with a more detailed description of the method.



$\chi_{sp}(P)$ of electrolytic manganese (different values correspond to two samples of one material) and scandium (polycrystal with resistance ratio $R_{300°K}/R_{4.2°K} = 8$).

The state density per atom on the Fermi boundary of the investigated metals is quaite high [4] and makes it possible to attribute their paramagnetism to the Pauli contribution. For one parabolic band, κ is then expressed simply in terms of the compressibility ($\kappa = 2k/3$), amounting to -0.53×10^{-6} and -1.4×10^{-6} atm^{-1} for manganese and scandium, respectively (an estimate $k = 2.1 \times 10^{-6}$ atm^{-1} is given for Sc in [5]), or one order of magnitude lower than the measured values.

We see that some uncertainty in the obtained results does not prevent their use for more detailed analyses, which are, however, beyond the scope of this brief communications.

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POLARIZATION OF THE IONIZATION AUREOLE OF A LIGHT SPARK IN A CONSTANT ELECTRIC FIELD

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We have investigated tne polarization of the ionization aureole of a light spark which is produced rapidly by an external electric field in the focus of a laser. In the case of ordinary discharge sparks such measurements are practically impossible, in view of the presence of rapidly varying breakdown fields that produce the discharge, the closeness of the electrodes, and the weak ionizing radiation from ordinary sparks. In this respect, the light spark is an ideal object, since it combines the absence of electrodes with a rapid development time and strongly-ionizing radiation generated by high initial temperatures.

The light spark was produced in air in a laser which was Q-switched by a rotating prism. Remote plane electrodes, with holes for the passage of the laser light, produced in the focus of the lens a constant electric field of intensity E_0 = 10 V/cm - 1 kV/cm.

In the first series of experiments, the rapid alternating perturbations of this field of the ionization aureole were registered with a thin probe, on which a dielectric sleeve was placed to reduce the photoeffect from the surface. The probe was placed perpendicular to the electric field at a distance ≈1 cm above the spark. The probe signals ahead and behind the spark differed in sign, thus confirming that the registered field was due to charges produced by polarization of the ionization aureole, and not to the photoeffect from the spark, the signals from which should be of the same sign.

A typical probe signal in the presence of the field is shown in Fig. 1, obtained with a 300-nsec sweep. The pulse duration was close to the duration of the laser flash, 30 - 50 nsec. The intensity of the pulse $\mathcal{E}_m$ increased linearly with the field E_0, with $\mathcal{E}_m/E_0 \simeq 0.5 \times 10^{-3}$ cm.

Let us compare the signal with the characteristics of the ionization aureole. The perturbation of the external field is determined by the dipole moment of the aureole $\vec{P} = \alpha(t)\vec{E}_0$, where $\alpha(t)$ is the aureole polarizability coefficient. We are interested in the region of