that the narrow lines in Shpol'skiĭ spectra have all the basic attributes of optical NPL. Investigation of the basic parameters of the NPL and PW in these spectra enables us to extract information on the phonon spectrum of the matrix crystal and the electron-phonon interaction constants in the systems concerned. However, a number of structural features of the spectra and, in particular, the problem of the origin of the "multiplets" characteristic for these spectra still await their resolution.

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E. I. Kondorskiĭ, T. I. Kostina, and L. N. Ékonomova. Investigation of the Electrical and Magnetic Properties of Chromium Single Crystals

Resistivity was investigated on 4 × 1.5 × 1 mm single-crystal samples with a ratio $R_{293°K}/R_{4.2°K} = 500$ cut from the same crystal by the electric spark method in such a way that the longitudinal axis of the sample was parallel either to the [100] or the [110] axis. The magnetic measurements were made on single-crystal samples of iodide chromium with resistivity ratios $R_{293°K}/R_{4.2°K} = 130$ and $R_{293°K}/R_{4.2°K} = 6.4$. Both of these groups of samples contained the same amount of metallic impurities (within the limits of accuracy of the spectral method), but those with $R_{293°K}/R_{4.2°K} = 6.4$ contained a larger amount of dissolved gases.

Figure 1 presents plots of the temperature $R = f(T)$ in the phase-transformation regions (the anomaly at T_{S-f} for sample Nos. 2–4 (current I ∥ [011], I ∥ [001] and I ∥ [001]); curves 1–3—before thermomagnetic treatment, 4, 5—after treatment in a field $\mathbf{H}_C$ ∥ [110], 6, 7—in a field $\mathbf{H}_C$ ∥ [100]; 1′–3′—the anomaly at the Neel point T_N before thermomagnetic treatment, 4′, 5′—after treatment in a field H_C ∥ [110]). For samples with their longitudinal axes parallel to the [110] axis and the current I ∥ [110], $T_{S-f} = 115 \pm 2°K$, while for specimens whose longitudinal axes were parallel to [100] with the current I ∥ [100], $T_{S-f} = 134 \pm 2°K$. After cooling from 360°K in a transverse magnetic field H_C = 34 kOe parallel to the [001] axis, the anomaly at T_{S-f} becomes the same for all samples, occurring at $T_{S-f} - 120 \pm 2°K$. Heating of the sample above the Neel point fully restores the original character of the $R = f(T)$ dependence and the original value

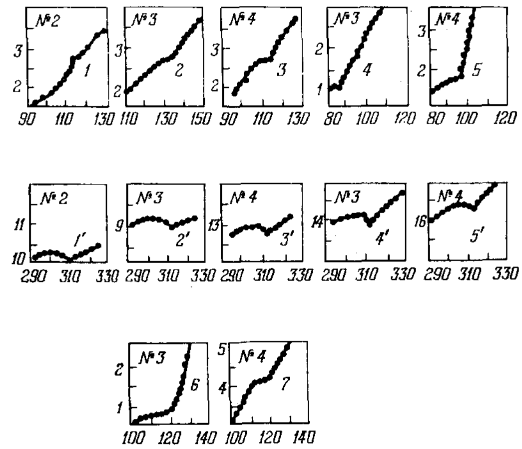

FIG. 1

of T_{S-f} (the abscissa is T in °K and the ordinate $R_T/R_{77°K}$).

Measurements of the magnetostriction λ of chromium by the wire-strain-gauge method showed that in fields of 10 kOe it approaches that of iron in order of magnitude, although the magnetization of chromium in these fields amounted to only hundredths of a gauss. The large value of λ in chromium can be explained by displacement of domain walls during magnetization. The existence of domains was recently proven by neutron-diffraction studies. It would be reasonable to assume that because of the strong magnetostriction in chromium samples with inhomogeneous internal stresses, the displacements of the domain walls will be irreversible and that magnetic hysteresis may exist in sufficiently strong fields.

Figure 2 shows the magnetization curve obtained for a sample taken from a chromium single crystal with resistivity ratio $R_{293°K}/R_{4.2°K} = 6.4$. The magnetization is found to be a nonlinear function of the field at H > 12 kOe, and a distinct magnetic hysteresis is observed, both at $T = 77°K < T_{S-f}$ (phase AF_2) and at $T = 293°K > T_{S-f}$ (phase AF_1). The residual magnetization was zero throughout the temperature range studied. Consequently, magnetic hysteresis is a property of chromium crystals and cannot be attributed to ferromagnetic impurities.

Neutron-diffraction investigations of chromium lead to the conclusion that after thermomagnetic treatment, the AF_2 phase is a single domain with a unique direction of the wave vector $\mathbf{Q}$ and the spin vector $\boldsymbol{\eta}$.

Our investigations showed that the magnetic hysteresis vanishes after thermomagnetic treatment of chromium single crystals in a field H = 19 kOe. Thus, the hysteresis exists only in specimens containing a sufficient number of domains with different directions of $\mathbf{Q}$ and $\boldsymbol{\eta}$.

R. F. Arutyunyan and M. L. Ter-Mikaelyan. The Radiation of Charged Particles in Inhomogeneous Media and its Applications

The paper summarizes data from experimental investigation of the radiation that appears when a charged particle passes through various inhomogeneous media.

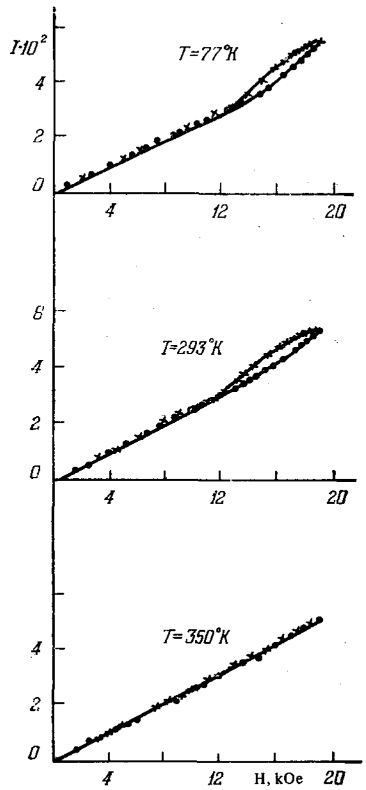

FIG. 2

The basis of these studies is the transition radiation predicted by Ginzburg and Frank in 1946[1]. The present enhanced interest in such research arises out of the possibilities for practical use of the radiation for various purposes, e.g., detection of ultrarelativistic particles, investigation of the optical properties of matter, and of metals in particular, etc.

Radiation appearing in the x-ray region of the spectrum on passage of a uniformly moving charged particle through a periodic layered medium was first observed in 1963[2]. This radiation was used to detect μ-mesons in the horizontal cosmic-radiation flux with energies $\gtrsim 7 \times 10^2$ GeV. The detection efficiency was ~9%. The experimental data were used to obtain the spectrum of μ mesons with zenith angles of 73–90° in the energy range $\sim 7 \times 10^2 - 6 \times 10^3$ GeV.

Radiation in the x-ray region ($10 \lesssim \hbar\omega \lesssim 250$ keV) was subsequently investigated for electrons with energies up to 3.7 GeV (at the Academy of Sciences Physics Institute in 1965[3,4] and at the Joint Institute of Nuclear Research in 1969–1970[5]). The spectral composition of the radiation, the dependence of its intensity on electron energy and various parameters of the layered medium, and the angular distribution of the radiation were analyzed. The experimental data were compared with the theories of resonance[6a] and transition[7] radiation. Data for periodic layered media are compared with data for media having randomly distributed inhomogeneities (foam plastic). The influence of multiple scattering on the resonance radiation is analyzed[4,6b].

Analysis of all the data and their comparison with theoretical calculations leads to the general conclusion that the resonance-radiation theory that takes account of interference in the transition radiation from the various boundaries of the layered medium provides a good description of the experimental data, while the theory that assumes independent summing of the transition quanta from the boundaries of the layered medium varies significantly from the results of measurements. It is also obvious that in those cases in which interference effects are negligible, the resonance-radiation formulas go over into the formulas for independent summing of transition quanta.

For electrons of comparatively low energy (0.25–0.6 GeV), the influence of multiple scattering, which leads to the appearance of additional "bremsstrahlung," is found to be very strong. In a given region of the spectrum of the detected quanta, the intensity of this additional radiation may be several times (depending on the parameters of the layered medium) that of the transition and ordinary (Bethe-Heitler) bremsstrahlung taken together. The contribution of the bremsstrahlung quanta to the total radiation in the spectral interval under study can be neglected in the high-energy range ($\gtrsim$1–2 GeV). At still larger energies ($\gtrsim$15 GeV), however, the influence of multiple scattering should again become substantial (in an analog of the Landau-Pomeranchuk effect).

Investigation of the radiation of relativistic electrons in isolated massive plates indicates that with increasing electron energy the ordinary Bethe-Heitler bremsstrahlung is strongly suppressed in the low-energy part of the x-ray spectrum, and that in the frequency range $\omega < \omega_{cr}$ the photon-number spectral density varies like E^{-2}, consistent with the conclusions of the theory that takes account of the polarization of the medium[6c].

The various methods of detecting single high-energy particles with the aid of resonance radiation (the energy-release method, the characteristic-radiation method, etc.) are analyzed. A resonance-radiation detector (RRD) is analogous to the Cerenkov counter as regards both determination of the direction of particle motion and the threshold properties of the instrument, but it can work in the range $v \to c$; the effect depends on E/mc^2 rather than on v/c.

The characteristics of various RRD for electrons with energies up to 3.7 GeV are presented. One 3.7-GeV electron corresponds to as many as ten resonant-radiation photons with energies above ~15 keV. This number of photons corresponds to 100% detector efficiency. The increase in the number of photons with increasing electron energy depends on the parameters of the medium and the magnitude of the energy. This dependence is weaker than linear in some cases and stronger than E^3 in others, i.e., the threshold characteristic of the detector can be regulated by varying the parameters of the layered medium (this energy dependence is predicted by resonance-radiation theory, while transition-radiation theory predicts only the linear dependence on energy).

RRD have been used successfully in a concrete experiment to separate electrons from a beam of π mesons. The efficiency of the detector reached 50%. It was shown that RRD can be used as elements in logic circuits for various physical experiments (for example, in "on line" operation). Papers by other authors on these problems have also appeared during the last two years[8].

The second part of the paper discusses the results of experiments to investigate the visible and ultraviolet radiation that appears in thin films and massive targets made from various metals (Al, Ag, Au, Cu, Ge In and Pt) under bombardment by nonrelativistic electrons[9]. The polarization, spectral composition, and angular distribution of the radiation, the dependence of its intensity on electron energy and on the impingement angle of the electron at the target, etc., are analyzed. The experimental results are compared with the theory of transition radiation[1,10], and the possible contributions of other types of radiation are analyzed.

Analysis of the data indicates that the radiation of electrons in thin films is fully described by the transition-radiation formulas. In massive samples, the electron generates, in addition to transition radiation, an additional unpolarized radiation whose intensity increases with increasing electron energy and target impingement angle. At glancing incidence angles, the intensity of the additional radiation becomes very high, and it may be several times greater than that of the transition radiation for the case of normal electron incidence onto the target. This effect is observed not only for silver, as has been reported by certain authors, e.g., in[11], but also for other metals.

The additional radiation cannot be interpreted in terms of bremsstrahlung or luminescence. It can be explained if it is assumed that it forms due to radiation at (randomly distributed) surface inhomogeneities as the electron approaches the surface (an analog of Smith-Purcell radiation for periodic inhomogeneities) or as a result of excitation of surface plasma waves, which can propagate into the vacuum owing to surface inhomogeneities.

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