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A scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the USSR Academy of Sciences was held on December 22 and 23, 1971 at the conference hall of the P. N. Lebedev Physics Institute. The following papers were delivered at the session:

1. R. I. Personov, Shpol'skiĭ Spectra and the Optical Analog of the Mossbauer Effect.
2. E. I. Kondorskiĭ, T. I. Kostina, and L. N. Ekonomova, Investigation of the Electrical and Magnetic Properties of Chromium Single Crystals.
3. M. N. Yakimenko, High-powered Ultraviolet and X-ray Sources.
4. F. R. Arutyunyan and M. L. Ter-Mikaelyan, The Radiation of Charged Particles in Inhomogeneous Media and its Applications.
5. G. M. Garibyan, Transition Radiation.

We publish below brief contents of some of the papers.

R. I. Personov. Shpol'skiĭ Spectra and the Optical Analog of the Mossbauer Effect.

In 1952, É. V. Shpol'skiĭ, A. A. Il'ina, and L. A. Klimova observed that the electronic vibrational spectra of certain complex organic molecules in crystalline n-paraffin solutions consist of tens and hundreds of narrow lines instead of the usual blurred bands[1]. Spectra with fine structure have now been obtained for several hundred complex organic compounds of various classes, such as aromatic hydrocarbons, heterocyclic compounds, porphyrins, etc. For example, a compound as important and complex as chlorophyll was recently added to the list[2]. The Shpol'skiĭ spectra have opened new opportunities for various scientific and practical applications, some of which are considered in the present paper. However, the paper is basically concerned with questions as to the origin of the narrow lines in Shpol'skiĭ spectra and the structural features of these spectra.

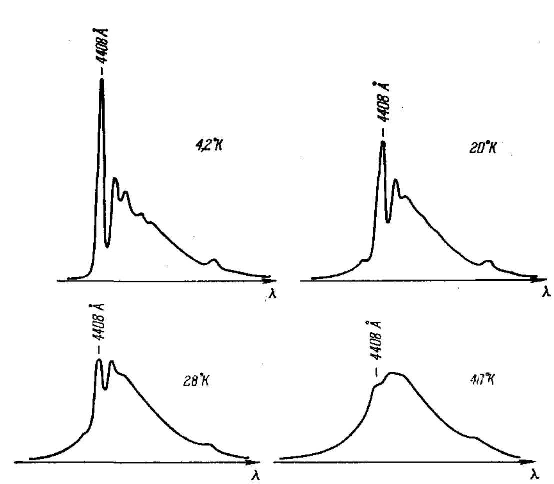
According to the theory of crystal impurity-center spectra[3], the narrow resonance lines in these spectra correspond to non-phonon transitions in the impurity and are optical analogs of the resonance γ lines in the Mossbauer effect. This question has also been discussed in[4] as applied to Shpol'skiĭ spectra. The conclusions that a characteristic band consisting of a non-phonon line (NPL) and a phonon wing (PW exist in the spectrum and that the intensity of the NPL drops off sharply with rising temperature offer the simplest way to verify the theory experimentally.

It has recently been possible to detect spectral bands consisting of narrow NPL and attendant bright PW in a number of substances that have Shpol'skiĭ spectra and to investigate the structure of the PW and the temperature dependence of the optical bands[5]. The theoretically predicted decrease in the intensity of the NPL with rising temperature was clearly observed (see the figure, which shows the temperature decrease in the intensity of the 4408 Å NPL in the fluorescence spectra of perylene in n-heptane). Detailed analysis of the PW structure made it possible to extract information on such characteristics of the impurity crystal as the density of states in the phonon band and the nature of the relation between intramolecular and crystalline motions. The weighted phonon state density function of n-paraffin impurity crystals was reconstructed from the spectral curves for the PW on the basis of the corresponding analysis, and the corresponding Debye temperature was determined ($\theta_D \sim 40–50°K$)[5].

Detailed investigations have been made of the shape, broadening, and shifts of the narrow (width $\sim 1\ cm^{-1}$) NPL in Shpol'skiĭ spectra in the range of low temperatures (4.2–100°K)[6]. The contours of the lines investigated were approximated by Voigt curves, and the Lorentzian and Gaussian width components were isolated at various temperatures. It was established that the Gausian component depends weakly on temperature and is due to inhomogeneous broadening. The temperature broadening of the NPL results from an increase in the Lorentz component. The experimental relations for the broadening and shift of the Lorentz NPL component were compared with those predicted theoretically for the case of weak electron-phonon coupling[6b]. Quite good agreement between theory and experiment was found for lines with comparatively small temperature broadenings and shifts. However, the above theory is totally inapplicable for lines that are more strongly broadened and shifted.

Very recently, Osad'ko[7] examined the problem of optical NPL broadening in the more general case, i.e., for arbitrary electron-phonon coupling. The comparison made between the experimental data and the results of this theory indicated qualitative agreement between theory and experiment for all of the lines investigated.

The experimental data that were analyzed confirm



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.

[1] E. V. Shpol'skiĭ, Usp. Fiz. Nauk 77, 321 (1962); 80, 255 (1963) [Sov. Phys.-Usp. 5, 522 (1962); 6, 411 (1963)].
[2] F. F. Litvin, R. I. Personov, and O. N. Korotaev, Dokl. Akad. Nauk SSSR 188, 211 (1969).
[3] A. Maradudin, (Defects and the Vibrational Spectra of Crystals (Russ. transl.), Mir, 1968, Chap. VIII.
[4] K. K. Rebane and V. V. Khizhnyakov, Opt. Spektr. 14, 362, 491 (1963).
[5] R. I. Personov et al., Fiz. Tverd. Tela 13, 2653 (1971) [Sov. Phys.-Solid State 13, 2224 (1972)].
[6] a) R. I. Personov et al., ibid. 13, 111 (1971) [13, 81 (1971)]; b) E. I. Al'shitz, É. D. Godyaev, and R. I. Personov, Izv. Akad. Nauk SSSR, Ser. Fiz. 36, 1117 (1972); Fiz. Tverd. Tela 14, 1605 (1972) [Sov. Phys.-Solid State 14, 1385 (1972)].
[7] I. S. Osad'ko, ibid. 13, 1178 (1971) [13, 974 (1971)].

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 $T_{S\text{-}f}$ 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 $\mathbf{H}_c$ ∥ [110]). For samples with their longitudinal axes parallel to the [110] axis and the current I ∥ [110], $T_{S\text{-}f} = 115 \pm 2°K$, while for specimens whose longitudinal axes were parallel to [100] with the current I ∥ [100], $T_{S\text{-}f} = 134 \pm 2°K$. After cooling from 360°K in a transverse magnetic field $H_c = 34$ kOe parallel to the [001] axis, the anomaly at $T_{S\text{-}f}$ becomes the same for all samples, occurring at $T_{S\text{-}f} - 120 \pm 2°K$. Heating of the sample above the Neel point fully restores the original character of the $R = f(T)$ dependence and the original value

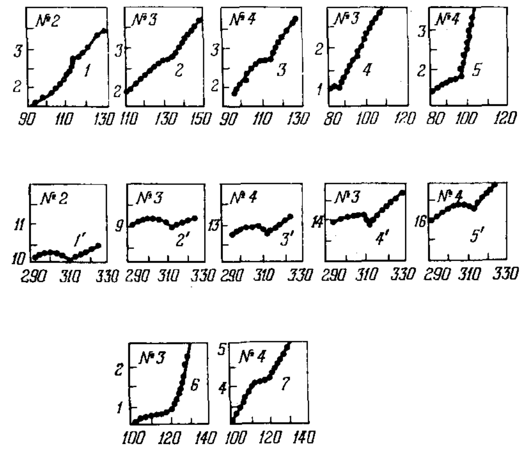


FIG. 1

of $T_{S\text{-}f}$ (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 $T = 77°K < T_{S\text{-}f}$ (phase AF_2) and at $T = 293°K > T_{S\text{-}f}$ (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 η.

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.