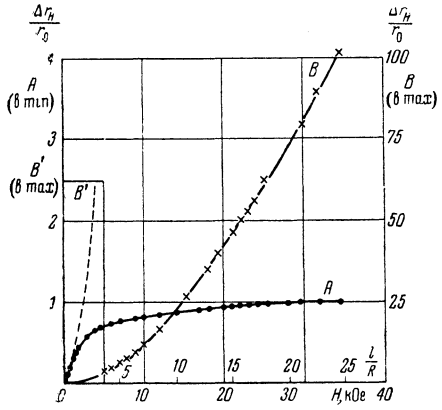

FIG. 1

nitude of the ratio of the mean free path l to the radius of curvature R of the trajectory of the conduction electrons in the magnetic field ($l/R = H/\rho nec$, where e and n are the charge and density of the conduction electrons, ρ is the resistivity, and c is the velocity of light) is given along the x axis in addition to the magnetic field intensity.

From the dependences shown in the figures it is evident that while in the direction of the maximum the resistance increases indefinitely ($\Delta r_H/r_0 \sim H^{1.8}$), the resistance in the direction of the minimum becomes completely saturated,* with $\Delta r_H/r_0 \approx 1$ for fields $H \gg H_0$ (H_0 is determined from the equality $l/R = 1$, and is in the present case equal to 1.4 koe). Analogous behavior is observed for all of the maxima and minima of the polar diagram.

It should be noted that for monocrystals of Pb[4] and Cu[5] a weak tendency towards saturation has been observed in the direction of the minimum.

On the basis of the results obtained it may be suggested that the linear increase in resistance in a magnetic field found by Kapitza,[6] observable in polycrystalline samples,[1,2] is the result of an averaging over angle of the various dependences† for $\Delta r_H/r_0$.

We assume that the considerable anisotropy of the resistance in a magnetic field is associated with the existence of an open Fermi energy surface for gold.[7]

We regard it as a pleasant duty to express our gratitude to Academician P. L. Kapitza for his consideration of the results obtained.

*The copper monocrystal with which preliminary measurements were carried out behaves in a similar fashion.

†We have averaged the experimental curves of $\Delta r_H/r_0$ obtained for various angles with the gold monocrystal. The averaged dependence of $\Delta r_H/r_0$ upon H thus obtained has indeed a linear character.

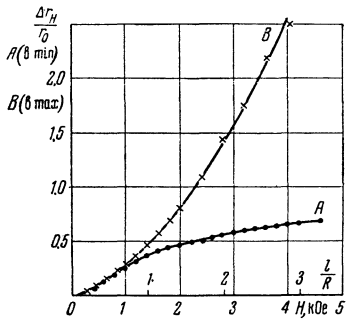

FIG. 2

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OPTICAL METHODS OF OBSERVING THE IONIZATION ALONG FAST PARTICLE TRACKS

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THE following processes accompany the passage of ionizing particles through a gas: ionization, excitation of atoms and molecules, and dissociation of molecules. Two of the processes are used for particle detection: ionization (ionization chambers, gas counters) and excitation (scintillation detectors). For observation of the tracks, the method of vapor condensation on ions is used in cloud and diffusion chambers. The amount of light from excited atoms in the gas is too small for a direct ob-

servation of particle tracks. So far, a similar method has been successful only in solid luminescence chambers.

It can be shown that when atoms and ions produced along the tracks are illuminated by resonance light, the number of scattered photons is much larger than the number of photons that can be recorded in a direct observation of scintillations in the gas. This opens a possibility of direct observation of tracts without vapor condensation on ions. In principle, it is possible to record optically both the ions and the neutral atoms originating in the dissociation of molecules along the particle tracks. In observation of neutral atoms it is easier to obtain a suitable intensive light source, but difficulties arise due to quenching of the resonance fluorescence by the gas molecules. Besides, for neutral atoms it is difficult to devise a method of cleaning the chamber of old tracks and the background due to thermal and photodissociation of molecules. Unnecessary ions can be removed from the working volume by means of an electric field. In connection with this, a method utilizing ions is preferable.

We shall estimate the intensity of light scattered by an ion. The scattering cross-section[2,5] at resonance line maximum for a dipole transition is

$$\sigma_0 = 2\pi\lambda\!\!\!^{-2}(2J_r + 1)/(2J_0 + 1),$$

where J_0 and J_r are the moments of the initial and resonance states respectively. The integral cross section is given by the expression

$$\int \sigma d\omega = (\pi^2\lambda\!\!\!^{-2}/\tau)(2J_r + 1)/(2J_0 + 1),$$

where τ is half-life of the excited state which is connected with the oscillator force f by the relation

$$(2J_r + 1)/\tau(2J_0 + 1) = 2r_0 cf/\lambda\!\!\!^{-2}.$$

Most of the suitable transition are formed by dublets $^2S_{1/2} \rightarrow {}^2P_{3/2}$, for which the sum of statistical factors is 3, and τ is in the range 10^{-8} to 10^{-9} [5] The maximum flux of light quanta of both polarization senses from a light source per unit solid angle is

$$\frac{2\omega^2 d\omega}{(2\pi)^3 c^2}(e^{\hbar\omega/kT} - 1)^{-1},$$

where kT can attain the value of 1 ev in intensive discharges. Assuming for simplicity that the scattering is isotropic, and that the line width of the source is greater than that of the scattering medium, and taking the statistical factor equal to 3, we obtain the total number of scattered photons

$$3\frac{\Omega_1\Omega_2}{16\pi^2}\frac{t}{\tau}(e^{\hbar\omega/kT} - 1)^{-1}, \quad (1)$$

where t is the time of observation and Ω_1 and Ω_2 are the solid angle of illumination and observation respectively.

The time of observation is limited by the diffusion of ions and can be chosen from 0.01 to 0.1 sec. For t = 0.03 sec, $\Omega_1 = 2$, $\Omega_2 = 0.1$, $\exp(-\hbar\omega/kT) = 0.05$, and $\tau = 3 \times 10^{-9}$, Eq. (1) yields the number of photons from a single scattering ion, $\sim 2 \times 10^3$. Such an amount of light can be detected by means of a photoelectric device. Direct photographic recording is, probably, possible for thick tracks of heavily-ionizing particles.

Singly-charged ions of Mg, Ca, Sr. Ba, Cd, Zn, and Pb have suitable lines in the visible part of the spectrum and in the near ultraviolet.[3] Mercury would be advantageous in view of its high vapor tension, but the resonance lines Hg II lie in far ultraviolet. It is probable that a combination of one of the above mentioned metals with a noble gas, say A + Cd, would be more suitable. Since the ionization potential of argon is greater than the sum of the energies of ionization and excitation of the resonance level of Cd, one would expect that argon ions will be neutralized irreversibly in collisions $A^+ + Cd \rightarrow A + Cd^+$, and that a number of Cd ions sufficient for recording will be obtained at a relatively low pressure of cadmium vapor. Noble gases practically do not quench resonance fluorescence and the pressure can be therefore sufficiently high.

Ions of Ca, Sr, and Ba have metastable[4] states and can be used for observing the Raman scattering if the difficulties due to the general background of scattered light in observation of unshifted lines turn out to be too great.

It is difficult to say at present if the proposed method would be advantageous compared with conventional methods, but the possibility of its realization is beyond any serious doubt.

The author takes the advantage to express his thanks to I. S. Abramson for valuable advice.

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A METHOD FOR THE OBSERVATION OF HELIUM II FILMS

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FOR the observation of helium II films and the investigation of their behavior, a simple method has been employed which makes use of the absorption within the film of photoelectrons ejected from the surface upon which the film is formed. With the aid of this method it is readily possible to follow the formation of the film in various regions of temperature and pressure. The magnitude of the photoelectric current, characterizing the state of the film, was measured with the aid of an inverse-feedback electrometer amplifier connected to the output of the apparatus described, making it possible in some cases to follow as well the kinetics of the processes involved.

I am deeply grateful to D. I. Vasil'ev for aid in the performance of these experiments.

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