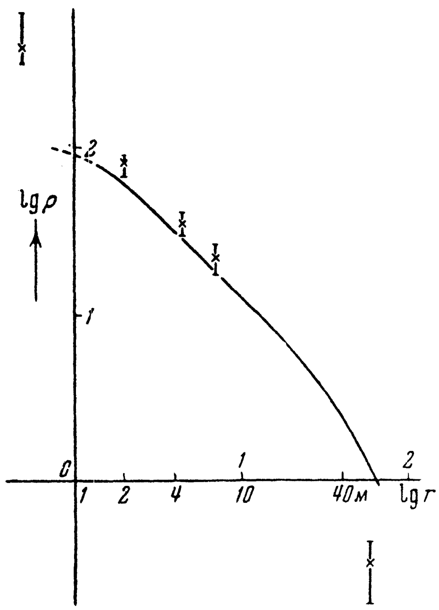

Fig. 2

are presented on Fig. 2. The log of the distance in meters is plotted on the abscissa and the log of flux densities on the ordinate (i.e., number of particles per m^2). The results are averaged around showers with 5×10^{13} to 1×10^{15} ev primary energy ($\overline{E_0} = 1.5 \times 10^{14}$ ev). For the sake of comparison, the spatial distribution of all charged particles in broad atmospheric showers of same primary energy is given in the same Figure (solid curve). The particle flux density is given by the number of particles per square decimeter.

The concentration of nuclear-active particles around the shower axis as compared to the distribution of all charged particles is in accord with the assumption of balance of photo-electron component and the nuclear-active particles in a shower. Let us remark,that as shown by analysis of nuclear-electron showers with many particles, the energy flux carried by nuclear-active particles is even more strongly concentrated around the shower axis. The results obtained for the spatial distribution of nuclear-active particles allow us to determine the portion of nuclear-active particles in the whole shower. It is about 0.3 to 0.5% of the total number of charged particles.

In conclusion the authors express their gratitude to N. A. Dobrotin and G. T. Zatsepin for valuable advice during the design of experiments and the evaluation of results.

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* The single parameter is the effective surface of the apparatus, apparently bigger than the effective surface of the counters, and of which the adopted value can increase the value of ρ.

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The Change in Dielectric Constant and Phosphors Under the Action of Infrared Light

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In this paper results are presented of the investigation of the change of the dielectric constant and losses in unexcited, infrared light sensitive phosphors, irradiated in the wavelength region of $\lambda \approx 0.8\,\mu$ and $\lambda \approx 1.3\,\mu$. Radiation of these wavelengths falls, as it is known[1], in the maximum sensitivity range of these phosphors to the infrared radiation.

Phosphors with ZnS base were investigated. The test samples were prepared in the form of thin polystyrene films in which the phosphor under investigation was introduced (in 1:1 ratio by volume). The electrodes, an aluminum disk and a thin metallic grid, coated with polystyrene lacquer to prevent a direct contact between the grains of the scintillator and the electrodes, were pressed upon the film. The change in dielectric constant and the losses were measured during illumination of such a capacitor with infrared radiation through the grid electrode. The measurements were performed with an apparatus having a circuit similar to that of a Q-meter, at frequencies of about 50 kilocycles and field potential in the dielectric of 30-50 V/cm. The necessary wavelength ranges of infrared light were obtained by use of a monochromatic illuminator with wide slits (the width of the transmission range was approximately 100 mμ).

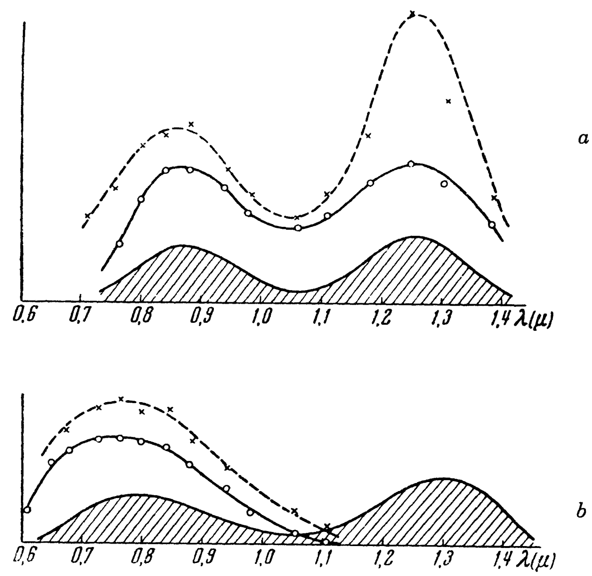
The infrared radiation acts upon the phosphors in the same way as the exciting radiation, causing an increase in dielectric constant and losses in unexcited phosphors (as it is known[2], the dielectric constant and the losses in excited phosphors decrease under influence of infrared radiation, approaching the "dark" values). The change which we observed is approximately 20-50 times weaker than that induced by the action of exciting light. The establishing of a stationary condition of dielectric constant and losses under continuous action of infrared radiation proceeds relatively slowly. Thus, for instance, for Zn-Cu, Pb phosphor, the establishing of a stationary state requires 10-12 minutes under our conditions.

In all the phosphors tested, the change in dielectric constant and losses under irradiation with infrared light takes place only when the light of a certain wavelength causes a stimulation in the excited phosphor. However, in case the infrared radiation causes a quenching, there is either no change of dielectric constant and losses or the changes are very small. The basic results of investigation are given in the table below:

Phosphor	Optical effect of infrared radiation		Change of dielectric constant and losses under the action of infrared radiation	
	0.8 μ	1.3 μ	0.8 μ	1.3 μ
ZnS-Cu, Co	Quenching	Quenching	no	no
ZnS-Cu, Sm	Stimulation	Stimulation	yes	yes
ZnS-Cu, Tu	"		"	"
ZnS-Cu, Ni	"	Quenching	"	no
ZnS·CdS-Cu, Ni	"	"	"	"
ZnS-Cu, Pb	"	Stimulation	"	yes
ZnS·CdS-Mn, Ni	"	No effect	"	no

For the phosphors, ZnS·CdS-Cu, Ni and ZnS-Cu, Tu, which show the greatest change in dielectric constant and losses, the values of the dielectric constant and losses and the values of the stimulation brightness were measured as a function of wavelengths of infrared radiation. The results of these measurements are presented in the diagram. It is seen from the diagram that there is a rather good agreement between the position of the maxima of dielectric constant and the position of maxima of stimulation brightness. The shadowed area of this figure illustrates schematically the sensitivity range of phosphors to the infrared radiation (the reduction of the amount of light is independent of the type of action of the infrared radiation, regardless of whether this action is stimulating or quenching).

The influence of infrared radiation upon the unexcited phosphor has been noted previously[3]. It has been shown that the irradiation of phosphor with infrared radiation prior to the excitation changes the course of the curve of the growth of brightness. Experiments which we performed suggest that there is a connection between the excitation ability of the phosphor and the presence in it of centers which have a strong polarizability or even an ability to be ionized by infrared radiation, since the mechanism of excitation of these phosphors is related to the separation of charges. It should be noted that the results obtained indicate the difference in stimulation and quenching kinetics in phosphors tested.



a. ZnS-Cu, Tu-phosphor, *b.* ZnS · CdS-Cu, Ni-phosphor. Continuous lines --- dielectric constant, dotted lines --- intensity of excitation.

In conclusion, I should like to take this opportunity to express my gratitude to V. V. Antonov-Romanovskii for his persistent interest in the work and his valued advice. Also, I express my gratitude to Z. A. Trapeznikova and V. V. Shchaenko for the preparation of phosphors with rare earth catalysts.

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