coronal rays and helmets on the Sun, the structure of the field during solar flares, and a two-dimensional model of the Earth's magnetosphere.

The main results of the work will be published in JETP.

G. S. Krinchik. The Optics of Ferromagnets.

Three concrete examples are used in the report to demonstrate the effectiveness of the application of optical methods in the investigation of ferromagnets.

1. The electron-structure model of ferromagnetic with a reverse level order. The foremost problem in the physics of ferromagnetism today is the problem of the quantitative determination of the band structure of ferromagnetic metals, of which ferromagnetic nickel is the most widely studied both experimentally and theoretically. The initial attempts were directed at the construction of an electron-structure model for nickel by analogy with copper. However, on the basis of a magneto-optical investigation of nickel[1], a model with a reverse order (with respect to copper) of the d- and p-bands at the L point in the Brillouin zone was proposed. The results of this model are: the characteristic frequencies of interband transitions, the disappearance of hole pockets at the L point, the appearance of a region of strong hybridization of the d- and p-bands in the vicinity of the Fermi level, a distinctive behavior of the hole pockets at the X point, etc. At the present time, the model with a reverse level order has been confirmed by direct theoretical calculations[2] and independent experiments[3] and is a generally accepted model.

2. Orientational magneto-optical effect. Since the orbital angular momenta in ferromagnetic d-metals are "quenched," while the orientation of the spin angular momentum—the saturation magnetization I—can be changed by an external magnetic field, the rotation of I leads to considerable (of the order of 0.1 eV) changes in the band structure of a ferromagnetic metal on account of the spin-orbit coupling. There arises, in principle, a possibility for observing this change through the interband transition frequencies by means of optical methods. The indicated magneto-optical effect, whereby the electronic structure of a ferromagnetic metal changes with rotation of I, was experimentally discovered in[4] and was called orientational magneto-optical effect (OME) in[5]. OME is the change in the intensity of reflected light which is quadratic in the component of the magnetization perpendicular to the incidence plane of the light[5]. Let us compare the OME, in order of magnitude, to the ordinary odd equitorial magneto-optical Kerr effect (EKE). It is shown in[6] that the OME is strongly anisotropic when the EKE is totally isotropic. The OME is characterized by a distinctive frequency dependence with multiple changes in sign, by a characteristic spin-orbital fine structure of the maxima, etc.[6]

Three types of changes in the band structure which can lead to orientational effects are considered in[7]. These are: 1) spin-orbital splitting of the degenerate d-bands in the vicinity of definite symmetry lines; 2) spin-orbital removal of the incidental degeneracy of intersecting bands; 3) the formation or disappearance of hole pockets under the action of the spin-orbit interaction. The third mechanism, although very strong, is exotic. A specific analysis shows that for a fixed frequency the interband transitions for changes of the type (2) occur in a considerably larger—with respect to volume—region of the Brillouin zone than for changes of the type 1). In the case of 1) this is approximately a sphere of volume $4\pi\delta^3/3$, while in the case 2), it is a toroid of volume $2\pi r\delta^2$, i.e., a ratio of volumes of the order of r/δ, where $r \gg \delta$. Therefore, the second mechanism is apparently the principal mechanism in the OME. The prospect of the OME for the study of the ferromagnetism of metals can also be characterized by the following example. In[7] a concrete interband transition of the type 2) is indicated, which is identified with an OME peak at $\hbar\omega \approx 0.4$ eV and for which the quantity $\hbar\omega$ is numerically equal to the exchange splitting of the 3d-band, independently of the details of the band structure. Thus, we obtain a direct method for a spectroscopic determination of the magnitude of the exchange splitting, as well as the possibility of studying the variation of this most important—for ferromagnets—quantity under the influence of diverse factors in metals and alloys.

3. The magnetic susceptibility of ferromagnets at optical frequencies. Magneto-optical methods were used in[8] to observe and measure for the first time the effect of magnetization by light of ferromagnetic dielectrics—from garnets—and of the ferromagnetic metal—iron. The magnetic susceptibility of these ferromagnets for circularly polarized light $\kappa_\pm^{\rm opt}$ turned out to be equal to 10^{-4}–10^{-5}. For transparent ferromagnets this result did not give rise to doubts and was subsequently repeatedly confirmed, but for ferromagnetic metals one more measurement of $\kappa_\pm^{\rm opt}$ [9] was made which resulted in overestimated values of $\kappa_\pm^{\rm opt}$ (roughly by two orders of magnitude. The inaccuracy of[9] was recently demonstrated and the result obtained in[8b] confirmed in[10]. The question arises in connection with the possibility of the correct determination of $\kappa_\pm^{\rm opt}$ as to what use this effect may be put. In transparent ferromagnets, we can, by measuring $\kappa_\pm^{\rm opt}$, determine the g-factor of magneto-active ions[8a]. In ferromagnetic metals by measuring the function $\kappa_\pm^{\rm opt}(\omega)$, we may hope to detect an exchange resonance—the optical mode of spin oscillations.[1a] It is proposed in[11] that the measurement of $\kappa_\pm^{\rm opt}$ should be used to detect the exchange resonance in ferrites and the magnetic modes localized on impurities. In[12] the intensity of infrared-light scattering by spin waves, the concentration of which can be increased by several orders of magnitude by pumping, is calculated.

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Translated by A. K. Agyei