3. A feature of a laser with autoresonant feedback is a hard self-excitation mode (similar to a laser with an atomic beam [5]). For self-excitation of such a laser it is necessary to excite first generation in one axial mode in a laser with an ordinary Fabry-Perot resonator, inside of which is placed an optical medium suitable for the formation of the phase lattice; after a radiation power sufficient for self-excitation by the phase lattice is attained, the reflection from one mirror is eliminated. The generation will occur first at the frequency of the resonant mode of the Fabry-Perot resonator, but gradually the generation frequency will shift toward the center of the atomic line. The process of shifting the generation frequency depends essentially on the inertia of the phase lattice. A nonlinear phase lattice has practically no inertia ($\tau < 10^{-10}$ sec). However, the inertia of a thermal phase lattice is appreciable, and this necessitates careful insulation of the laser against mechanical vibration and other factors capable of rapidly changing the distance between the mirror and the phase lattice. In the steady state the generation frequency is determined by the frequency of the maximum gain. Therefore a laser with autoresonant feedback is of interest for the development of optical lasers with stable radiation frequency.

4. Three-dimensional phase lattices produced by the laser radiation field can also be used in ordinary lasers for the selection of axial modes.

I am deeply grateful to N. G. Basov for a discussion of the problem.

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THE TRANSPARENT HEXAGONAL FERRIMAGNET $RbNiF_3$

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Submitted 25 March 1966
ZhETF Pis'ma 3, No. 10, 416-419, 15 May 1966

Substances of the type ABF_3, where A^{1+} is a diamagnetic ion and B^{2+} is an ion of a 3d-group metal, usually have a perovskite structure and are compensated antiferromagnets which sometimes have weak ferromagnetism because of the small noncollinearity of the magnetic moments.

However, $RbNiF_3$ [1,2] and $CsMnF_3$ [1,3] have a hexagonal structure, similar to the hexagonal modification of $BaTiO_3$ (space group $P6/mmc$). In this structure the B ions are in two non-equivalent positions. One-third of these ions occupies fluorine-ion octahedra connected with their vertices to other octahedra, and two-thirds are in octahedra interconnected by their faces.

$CsMnF_3$ is a compensated antiferromagnet [4]. The magnetic moments are situated in planes perpendicular to the c axis, the moments in each plane are parallel to one another, while moments in neighboring planes are antiparallel.

Investigations of the magnetic properties of $RbNiF_3$ have hitherto been confined to the paramagnetic regions and to polycrystals [2]. The investigations covered the dependence of the paramagnetic susceptibility on the temperature, and the point of magnetic ordering was approximately estimated.

We have investigated the magnetic properties of single-crystal $RbNiF_3$, using a magnetic balance and the Faraday method, in fields from 2 to 14 kOe, both above and below the magnetic-transition temperature.

The single crystals were obtained by an exchange decomposition reaction at 960°C, in accordance with the scheme

$$3RbF + NiCl_2 = RbNiF_3 + 2RbCl.$$

The $RbNiF_3$ crystals are transparent in visible light. They have the interesting feature that in the temperature interval from 77 to 900°K they change their color continuously from bright green to pink. The resistivity at room temperature exceeds 10^{11} ohm-cm, and the dielectric constant is of the order 5 - 6. Notice should be taken of the relative ease with which large and perfect crystals can be obtained (15 x 5 x 5 mm) without cleavage planes.

The dependence of the paramagnetic susceptibility on the temperature has a form characteristic of ferrimagnets. The magnetic ordering sets in at 145°K.

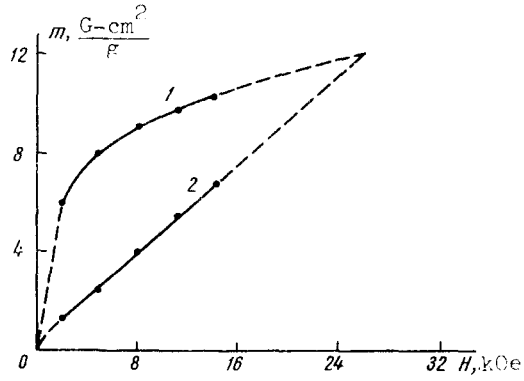

Fig. 1

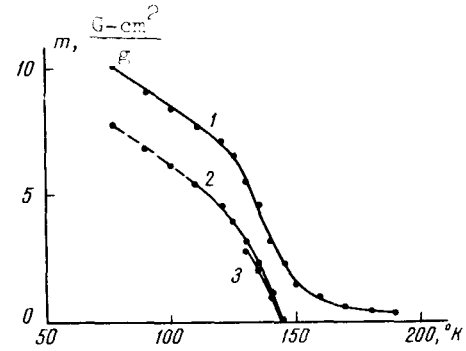

Fig. 2

Figure 1 shows the dependence of the magnetic moment at 77°K along different crystallographic axes on the field intensity. A large magnetic moment $m_{0\perp}$ is observed in the basal plane ($m_\perp$, curve 1). Along the hexagonal axis (curve 2) the dependence of the magnetic moment $m_\parallel$ on the field is of the form $m_\parallel = \chi_\parallel H$.

Extrapolating $m_\parallel(H)$ and $m_\perp(H)$ into the region of strong fields until they cross, we can approximately estimate the field of negative uniaxial anisotropy at 77°K, $H_A \simeq 25$ kOe. From the difference in the work of crystal magnetization in different directions we can determine the sum of the anisotropy constants at the same temperature $K_1 + K_2 \simeq -0.4 \times 10^6$ erg/cm³.

It seems to us that the results can be interpreted in the framework of the collinear model of ferrimagnetism, if it is assumed that the magnetic moments of the ions situated in non-equivalent positions are antiparallel. Then the saturation magnetization per formula unit at 0°K should amount to $m_{Ni}/3 = 2\mu_B/3$ (μ_B is the Bohr magneton), and the specific magnetization should be 18 G-cm^3/g. In experiment we observe at 77°K a smaller moment. This can be attributed to the fact that the temperature of the measurements was rather high (more than one-half of T_C).

Figure 2 shows the dependence of the magnetic moment on the temperature in the basal plane in a field of 14 kOe (curve 1), and also the spontaneous magnetic moment in the basal plane (curve 2) and along the c axis (curve 3), obtained by linear extrapolation to H = 0 in accordance with the law $m = m_0 + \chi H$. The dashed section of the curve corresponds to temperatures at which the linear extrapolation gives approximate results. The appearance of a spontaneous moment near T_C along the hexagonal axis is apparently connected with the sharp decrease of the anisotropy constants or the appearance of a cone of easy magnetization directions on approaching the Curie point.

Thus, $RbNiF_3$ is a transparent ferrimagnet of the ferroxplan type.

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ORIENTATION OF Cd^{111} NUCLEI BY 3261 Å RESONANT RADIATION

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Submitted 11 March 1966
ZhETF Pis'ma 3, No. 10, 419-422, 15 May 1966

We have obtained appreciable orientation of Cd^{111} nuclei in vapor at a density on the order of 10^{14} cm^{-3} with the aid of circularly-polarized 3261-Å light. The method of orientation is similar in its main outlines to that used by the Kastler-Brossel group for odd mercury isotopes [1].

Figure 1 shows the structure of the ground 5^1S_0 state and first triplet excited 5^3P_1 state of the Cd^{111} ion in a magnetic field. Excitation of the atoms along the magnetic field by circularly-polarized light produces optical transitions accompanied by a change of the angular momentum m by unit - the angular momentum of the radiation is transferred to the electron shell and then to the nucleus via the hyperfine interaction connected with the shell. The angular momentum acquired by the atom is conserved on the average during spontaneous emission, and since the shell has no angular momentum in the ground state, the nuclei of the unexcited atoms become oriented. The process leads to an appreciable orientation of the ensemble, if the intensity of the orienting light is sufficient to overcome the thermal relaxation of the nuclei. The resultant orientation can be registered, for example, by deter-