wave is not plane but has an angular spread $2\theta \approx \lambda/D$, where D is the linear dimension of the mirror. Because of this effect, the energy P_n after n reflections will be

$$P_n = P_0 / (1 + nl\lambda / D^2)^2. \tag{3}$$

The quantity nl is the path traversed by the wave during the n reflections. This time is equal to $\tau = nl/c$.

If we know the Q -factor of the system, the time in which the power decreases by a factor e is equal to $\tau = Q/2\pi\nu$. During this time the wave traverses a path $nl = c\tau$; if $Q = 2400$, and $\nu = 6 \times 10^{11}$ cps, $nl = 21$ cm.

If $D = 3$ cm, we get from (3) $P_n = 0.8P_0$, i.e., in our case the losses during reflection play the dominant part.

The condition for self-excitation can be written in the form

$$ke^{\alpha l} > 1. \tag{4}$$

If $\alpha = 1$ cm^{-1}, $l = 1$ cm, $k = 0.95$, condition (4) is satisfied by a wide margin. If $e^{\alpha l} \gg 1$, self-excitation occurs for small k.

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A CHROMIUM CORUNDUM PARAMAGNETIC AMPLIFIER AND GENERATOR

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IN reference 1 it was proposed to use a molecular system possessing three energy levels for the construction of molecular amplifiers and generators. Later this problem was considered in more detail as applied to paramagnetic crystals.[2] There are reports about the construction of three-level paramagnetic amplifiers using a single crystal of gadolinium ethylsulphate[3] and a single crystal of chromium cyanide.[4,5] We have investigated the possibility of constructing a paramagnetic amplifier and generator using a single crystal of chromium corundum ($Al_2O_3 \cdot Cr_2O_3$). The spectrum of Cr^{3+} in
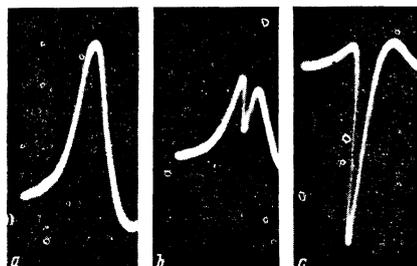
Photograph of the $M = 3/2 \to 1/2$ absorption line at 3000 Mcs for different power levels of the auxiliary radiation P_{aux}. Fig. 1a corresponds to $P_{aux} = 0$. Fig. 1c corresponds to a value of P_{aux} for which saturation is reached. Fig. 1b corresponds to an intermediate case.

corundum was investigated in a number of papers.[6-9] The Cr^{3+} ion in corundum is in an axial electrical field which splits the spin quadruplet of the lower orbital singlet level into two doublets, the distance between which is equal to $2D = -0.3824$ cm^{-1}. The spin-lattice relaxation time of Cr^{3+}, even at liquid nitrogen temperatures, is sufficiently long,[10] $\sim 10^{-4}$ sec.

For a paramagnetic amplifier, we have used the levels that are characterized by the quantum numbers $M = 3/2$, $\pm 1/2$ when the crystalline axis is oriented parallel to the constant external magnetic field. If the axis of the crystal is turned, the states mix and transitions between all three levels become allowed. The levels $M = -1/2$, $1/2$ were used for amplification, and the auxiliary radiation excited transitions between the levels $M = 1/2$, $-3/2$. The frequency at which emission (or generation) occurred was ~ 3000 Mcs and the frequency of the auxiliary radiation ~ 15000 Mcs.

In the figure we show photographs of the line corresponding to the $-1/2 \longleftrightarrow +1/2$ transition at a frequency of 3000 Mcs, as a function of the power level of the auxiliary radiation. It is clear from the photographs how the absorption line (1a) goes over into an emission line (1c) when the power of the auxiliary radiation is increased. At $T \sim 2°K$, the system became self-excited and acted as a generator.

Detailed data on the operation of the constructed amplifier will be published later.

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ON THE ELECTROSTATIC THEORY OF IONIC CRYSTALS

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IT is impossible to define a sharp boundary between typical ionic crystals and typical molecular crystals.

1. It is well known, that ionic compounds evaporate in the form of molecules, which are quite stable. Their energy of dissociation (into ions) is in the range of 160 to 40 kcal/mole and exceeds the sublimation heat of the same crystals. Considering the formation of liquid and solid state as the result of condensation of molecular vapor, it is possible to expect the molecules to be conserved, to some degree, also in the crystalline state.

2. A considerable part of the molecules of ionic compounds have large dipole moments, and the interaction between them can supply binding energies on the order of the sublimation heat of these substances. For example, for the molecules of CsI, $\mu = 10 \times 10^{-18}$ CGS electrostatic units. Supposing that the intermolecular distances are equal to 5×10^{-8} cm, we find the work of the attraction forces between two molecules to be 11 kcal/mole. Hence the contribution of the dipole interaction to the energy in the molecular lattice of CsI is approximately equal to $11(l/2) = 66$ kcal/mole (assuming that the coordination number is $l = 12$ for a hypothetical lattice comprising two atomic molecules). In those cases, when the molecules of the ionic compounds have no dipole moments, as for example $HgCl_2$, the Van-der-Waals interaction between them can provide a binding energy on the order of their sublimation heat. Example:

The energy of the dispersion interaction between two $HgCl_2$ molecules is 3 kcal/mole (taking the ionization potential as 12 ev, the coefficient of polarization as 9×10^{-24} cm^{-3}, and the distances between molecules as 4.3×10^{-8} cm) and the lattice energy is approximately equal to $3(l/2) = 18$ kcal/mole (if $l = 12$). In practice the sublimation heat of $HgCl_2$ is 20 kcal/mole.

3. The principal feature of the molecular structure of crystals is the existence of differences in the interatomic distances between a given atom (ion) and its nearest neighbor. In these cases it is possible to distinguish the "molecules" in the structure. At the same time, the structure is characterized by the distances (radii) between the molecules and inside the molecules. The majority of studied heteropolar compounds exhibit this feature, although, with some exceptions, no attempt has yet been made to describe the structures of the ionic compounds as molecular ones. Things are different for a comparatively small number of heteropolar compounds with structures of the NaCl, CsCl, ZnS type. It is therefore possible to consider these structures not as the rule, but as an exception in the group of heteropolar substances.

4. In many compounds such as NaCl, $HgCl_2$ or HCl properties such as the temperature and the heat of melting and evaporation, as well as compressibility, change gradually from typical ionic to typical molecular structures, which indicates a gradual change in the degree of molecularity of the crystals, and the presence, to a certain degree, of bonds of molecular character in typical ion substances.

5. Based on the above, one might think that many properties of ionic crystals are determined by the energy U^S of "small" intermolecular interaction, which is less than the Born lattice energy E^B. In particular cases, $U^e = S$, the sublimation heat. The question of the dimensions and forms of the molecules in crystals of different substances should be resolved separately. In some cases one must consider the "molecules" that make