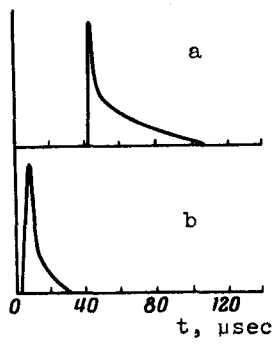

a) Generation pulse, b) pump pulse, sweep 20 μsec/div.

From the threshold condition and (8) it follows that

$$X^{-1} = 1 - e^{-\gamma_2 \tau}(1 + \gamma_2 \tau)$$

where γ_2 and τ are measurable quantities.

To perform experiments whose results could be processed by the described procedure, we chose conditions under which the chemical laser pulse occurs 20 - 30 μsec after triggering the pump lamp. This situation is observed at D_2 pressures close to 1 Torr and O_3 and CO_2 pressures near 0.1 Torr. Since there is no chain reaction, the presence of a prolonged delay suggests that the excitation of the CO_2 molecules is indeed limited under these conditions by the energy-transfer process. The validity of relations (2a - 2c) is proved a posteriori, on the basis of the measured value of K_3 and the known values $K_1 = 2 \times 10^{-10}$ cm^3/sec [2], $K_2 = 2.6 \times 10^{-11}$ cm^3/sec [2], $K_4 = 10^{-10}$ cm^3/sec [3], and $K_6 = 3 \times 10^{-12}$ cm^3/sec [2]. At a mixture pressure 10 - 20 Torr, the delay of the generation becomes much shorter and does not exceed the length of the pump pulse. Measurement of the delay in such experiments (5 and 6 in the table) was used to determine the values of X by means of formula (9). From the known two values of X corresponding to different partial compositions of the mixture, we determined the ratio $K_5/K_3 = 8$ and the value of γ_1. This has made it possible to find the values of X for experiments at low pressure, using formula (6). The experimental conditions and the measurement results are given in the table. Both procedures of determining K_3 lead to results that agree within a factor 2. The mean value of the transfer constant is $(0.5 \pm 0.25) \times 10^{-12}$ cm^3/sec. The employed procedure made it also possible to determine the constant K_5. The obtained value, $K_5 = 4 \times 10^{-12}$ cm^3/sec, is approximately equal to the rate constant of the reaction $OH^* + O_3$ [4].

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EFFECT OF RADIO-FREQUENCY FIELD ON THE DISCRETE SATURATION SPECTRUM IN EPR

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We have observed an influence of a radio-frequency (RF) field on the discrete-saturation (DS) spectrum [1, 2]. This influence is manifest in a resonant attenuation of the DS spectrum. The RF influences the DS spectrum in a frequency interval on the order of the NMR line width.

The effects of an RF field under conditions of pulsed saturation of an EPR line were discussed in [3]. In that reference, in contrast to our results, they predicted the appearance of a spectrum of induced holes and selective

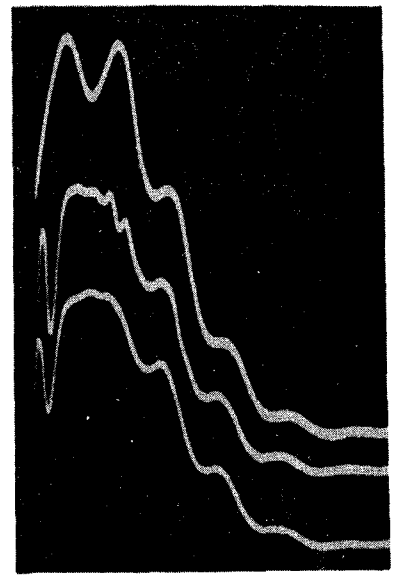
amplification of one of the subsystems of the dips in the DS spectrum[1].

We investigated CaF_2 single crystals doped with U^{3+} at concentrations 0.05 and 0.1%. We used the DS procedure described in [1], with additional application of an RF field to the sample. The sample was placed inside a cavity resonator tuned to the H_{012} mode. The RF field from a GZ-41 oscillator was applied either continuously or in pulses to a coil placed inside the cavity, in synchronism with the microwave pulse. Pulsed application of the RF pulse was necessary to prevent heating of the sample at high generation levels of the RF field.

The magnetic impurity U^{3+} is surrounded in CaF_2 single crystals by eight F^- ions in vertices of a cube, and the excess charge is compensated for by a ninth F^- ion located in the center of the neighboring cube of F^- ions along one of the [001] directions. This F^- ion lowers the symmetry of the surrounding of the paramagnetic center from cubic to tetragonal. In the principal orientations of the magnetic field $\vec{H}$ (when $\vec{H}$ is parallel or perpendicular to the tetragonal axis), the DS spectrum is due to the eight nearest-neighbor F^- nuclei and consists of two subsystems of holes, ε_- and ε_+ [1]. The electron-spin level splitting $\varepsilon^9_\pm$, due to the ninth nucleus, is given by formula (1) of [2], which in this case takes the form

$$\varepsilon^9_\pm = \left| \hbar\gamma H \mp \frac{1}{2} A^9_{\parallel} \right| ,$$

where $\hbar\gamma H$ is the Zeeman energy of the fluorine nuclei and $A^9_{\parallel}$ is the hyperfine-interaction parameter.



Oscillogram of EPR line of U^{3+} in CaF_2. Impurity concentration 0.1%. Magnetic field orientation $\vec{H} \parallel [100]$. The upper curve is the unperturbed EPR line. The middle oscillogram shows the DS spectrum (a central hole and two holes on its right at distance ε_- and ε_+ are seen), resulting from the saturation of the EPR line by the microwave pulse. No effect of the nonresonant RF field ($\sim$15 MHz) is observed in this case. The attenuating effect of the RF field (14.74 MHz) on the DS spectrum is illustrated by the lower oscillogram.

If the RF field is applied at frequencies $\nu_\pm$ corresponding to $\varepsilon^9_\pm$, then the field induces transitions with spin flip of the ninth nucleus. It is easily seen then one of the subsystem of dips in the DS spectrum will then be attenuated, depending on which of the frequencies, ν_+ or ν_-, is applied, for the population of the levels saturated by the microwave pulse is then altered. The frequencies of these transitions should have mirror symmetry relative to the frequency ν_F corresponding to the Zeeman energy of the fluorine nuclei.

Indeed, a damping of the subsystem of holes ε_- and ε_+ at the frequencies 22.54 ± 0.01 MHz and 5.73, respectively, was obtained for a magnetic field orientation $\vec{H} \parallel [100]$ (ν_F = 14.14 MHz). At the same magnetic-field orientation a damping of the hole subsystem ε_- was observed at 18.32 MHz, corresponding to the frequency of the transition between the splitting in the energy levels ε_+

[1] The appearance of additional holes in the DS spectrum under the influence of an RF field was predicted in 1970 by A.A. Manenkov, V.A. Milyaev, and independently by L.L. Buishvili.

of the eight almost equivalent nearest-neighbor nuclei U^{3+}.

A particularly strong effect occurs at frequencies in the vicinity of ν_F, namely 13.90, 14.67, and 14.74 MHz for $\vec{H} \parallel [100]$(ν_F = 14.14 MHz), and 6.65, 6.96, 8.00, and 8.10 MHz for $\vec{H} \parallel [001]$ (ν_F = 7.54 MHz), which is apparently due to the nuclei of the second coordination sphere. It is curious that in this case practically the entire DS vanishes. No satisfactory explanation of this fact has been obtained so far.

The results give grounds for hoping that the method of a radio-frequency effect on the DS spectrum (RFDS) can be successfully used to investigate the hyperfine interaction of a magnetic center with the surrounding nuclei. The RFDS possesses in this case the simplicity of the DS procedure, and the measurement accuracy is not worse than that of ENDOR.

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INHOMOGENEOUS FERRO-ANTIFERROMAGNETIC STATE OF MAGNETIC CONDUCTORS

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It will be shown in this paper that inhomogeneous states of magnetic conductors are possible when their volume breaks up into alternating ferromagnetic and antiferromagnetic domains. This, in particular, may be the ground state of a strongly doped antiferromagnetic semiconductor, which will be used as the example in this analysis.

We consider a semiconductor with impurity concentration $\sim 10^{19} - 10^{21}$ cm^{-3}, in which the electrons of the impurity atoms are collectivized, and therefore effect indirect exchange between the localized d- or f-spins. The Fermi energy μ of the carriers (s electrons in terms of the s-d model) is smaller than or comparable with AS (A is the s-d exchange integral and S is the spin of the magnetic atom). The indirect exchange can therefore not be described here with the aid of a Heisenberg Hamiltonian. The competition between the direct Heisenberg exchange and the indirect non-Heisenberg exchange between the d-spins, the former of which strives to establish an antiferromagnetic state and the latter a ferromagnetic state, results in the existence of a carrier density interval $n_L < n < n_R$, in which neither the ferromagnetic nor the antiferromagnetic order is stable [1, 2].

It was shown in [1, 2] that the energy of a noncollinear antiferromagnetic state with nonzero magnetic moment of the type proposed in [3] is lower in this interval than the energy of the collinear states. In turn, however, a homogeneous noncollinear state may turn out to be stable against breakup into domains with carrier densities $n < n_L$ and $n > n_R$, with collinear antiferromagnetic and ferromagnetic ordering established in the former and the latter respectively. The tendency to instability is obvious even from the fact that in typical cases the total energy of the d-d and s-d exchange decreases with increasing n like n^2 [2]. Therefore, if a layer with carrier density is broken up into two layers with densities $n + \Delta n$ and $n - \Delta n$, respectively, then the exchange energy is