the possibility that the pinch particles are made to drift by those layers of gas which are not set in rotation.*

The reason for the appearance of the current i_g when the tube is rotated is apparently the displacement of the pinch particles by the component of the Coriolis inertia force

$$F_x = -2m\omega_y v_z,$$

where m is the particle mass and v_z the component of its velocity along the gap. The sign of i_g corresponds to a predominant action of this force on the negative particles which move near the gap in a direction away from the droplike formation, thus causing redistribution of the currents between the anodes.

When the anode width is decreased to $d \approx 0.5$ mm, the effect first vanishes, and then a weak effect reappears but with opposite sign. This may correspond either to an intensification of the action of the Coriolis force on the positive particles or to an increase in the role of the drift.

The influence of the central force becomes pronounced if the arm R is increased at the expense of R_x. Then the symmetry of the plots in Fig. 3 first becomes distorted, and with further increase of R_x the current i_g ceases to reverse sign when the direction of rotation is reversed.

A noticeable drift effect can be attained by displacing the entire electrode block (the anodes together with the cathode) along z inside the tube away from its symmetry axis. The sign turns out to be dependent on the direction of rotation (opposite to the plot of Fig. 3), but does not depend on which end of the gap the discharge starts from.

4. The actions of the centrifugal force and of the drift become particularly noticeable when the tube is filled under the same conditions with argon, which does not produce, at a pressure $\sim 10^{-1}$ atm, as strong a contraction of the discharge as air. The droplike thickening of the positive end of the pinch is in this case practically unnoticeable and the action of the Coriolis force is insignificant.

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* At the indicated angular velocities, the gas layers in the central regions of the tube remain stationary even after very prolonged rotation.

CONNECTION BETWEEN DYNAMIC POLARIZATION OF NUCLEI AND ELECTRON SPIN-SPIN RESERVOIR TEMPERATURE

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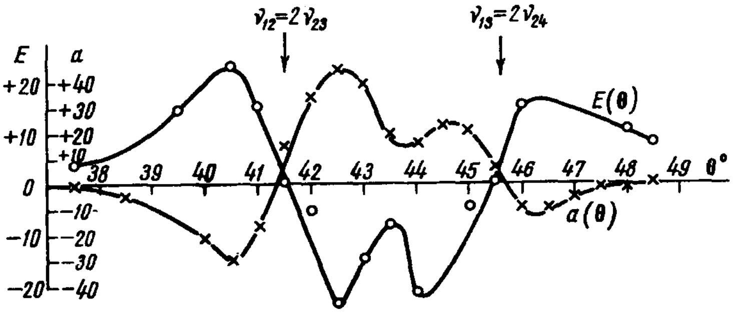
Submitted 26 September 1967
ZhETF Pis'ma 6, No. 11, 942-945 (1 December 1967)

Recent theoretical papers [1,2] mention the possibility of a new mechanism of dynamic polarization of nuclei in paramagnetic crystals, by direct transfer of temperature from the reservoir of the electron spin-spin interactions of the paramagnetic impurity (S-S system) to the Zeeman system of the lattice nuclei (Z_N system); indirect evidence of the existence of a direct contact between the S-S and Z_N systems is provided also by certain experimental data [3]. The purpose of the present paper is to obtain convincing proof of a direct coupling between the S-S and Z_N systems and show that this coupling produces dynamic polarization of the nuclei.

It follows from the theory that the temperature shift T_{SS} of the S-S system can be realized both in not-strictly-resonant saturation of the EPR line, and in line saturation under cross-relaxation conditions [4-7]. If the thermal contact between S-S and Z_N is sufficiently good (much better than the contact between these systems and the lattice), then we can expect in both cases a corresponding change in the Zeeman temperature of the nuclei (T_{Z_N}), i.e., dynamic polarization of the nuclei. In particular, a possibility appears of nuclear polarization in cross relaxation in the electronic system, even if the saturation of the EPR line is effected exactly at its peak, whereas in the classical "effect-solide" [8,9] the dynamic polarization of the nuclei is attained at the expense of saturating the forbidden electron-nuclear transitions on the wings of the EPR line.



o, E - intensification of polarization of Al^{27} nuclei in strictly resonant saturation of the EPR 2-3 line of the Cr^{3+} ion (left-hand scale); x, a - absorption (in arbitrary units) at the center of the same line after its passage from the vertex to the high-frequency wing under saturation conditions (right-hand scale). θ - angle between crystal axis and constant magnetic field. The arrows indicate the points of frequency multiplicity in harmonic cross relaxation.

We have saturated the lines of the Cr^{3+} ion in ruby (chromium concentration 0.05%) at exact resonance, i.e., at the absorption maximum, at a temperature $T_0 = 1.8°K$ and wavelength 3.2 cm, by pulses of 0.4 msec duration and at a repetition frequency 50 Hz; we observed simultaneously the NMR signal from Al^{27} nuclei. The dynamic polarization of the nuclei was indeed attained at external magnetic field orientations corresponding to the cross-relaxation regions of the Cr^{3+} ion. The figure shows the dependence of the intensification of the nuclear polarization (E) on the angle θ between the magnetic field and the crystal axis in saturation of the 2-3 transition of the chromium ion. The angles at which $E \sim 1$ correspond to exact multiplicity of the frequencies in harmonic cross relaxations: $\nu_{1-2} = 2\nu_{2-3}$ and $\nu_{1-3} = 2\nu_{3-4}$ (the levels are numbered upward). In the regions of maximum polarization, the deviation from exact multiplicity is ≈300 MHz, the sign of E corresponding throughout to the expected sign of T_{SS} in cross relaxation. Similar results were obtained also for other cross-relaxation regions with frequency ratios 1:1 and 1:2.

To monitor the value of T_{SS}, we used a special procedure consisting of rapid passage (compared with the spin-lattice relaxation of the electrons) through part of the EPR line from its vertex to the far wing, under saturation conditions, with subsequent observation of the same line by means of a weak indicating signal (the absorption at the center of the line, measured during the course of indication, will henceforth be denoted by a). The saturation procedure consists in this case in fact of two stages: 1 - saturation at exact resonance, equalizing the level populations of the electronic Zeeman system (Z_e), but not affecting the S-S system; 2 - not-strictly-resonant saturation, the result of which depends on the initial value of T_{SS}. If $T_{SS} \approx T_0$, then the absorption in the second stage will be insignificant and the Z_e system remains practically saturated ($a = 0$); on the other hand, if the S-S system had previously been, say, "supercooled" ($0 < T_{SS} \ll T_0$), then the saturation of the high-frequency wing of the line (detuning $\Delta > 0$) leads to absorption of energy by the S-S system at the frequency Δ. Simultaneously, transitions will also take place to the upper level in the Z_e system (equilibrium sets in when the sum of the Boltzmann factors of the Z_e and S-S systems vanishes [4-6]); as a result, the Z_e system is inverted, which will be noted during the course of indication ($a < 0$). If the system S-S was previously "superheated" ($T_{SS} < 0$, $|T_{SS}| \ll T_0$), saturation of the same wing of the line leads to a decrease in the saturation factor of the Z_e system, producing $a > 0$ during indication. The same effects, but with the sign reversed, occur also when the low-frequency wing the line is saturated.

Using this procedure, we observed complete correlation between the quantities E and a, and consequently between T_{Z_N} and T_{SS} (see the figure). A synchronous variation of E and a was observed also in the processes of establishment and decay of the nuclear polarization (the corresponding time constants were 25 and 35 sec; the first quantity does not take into account the off-duty factor of the pulses and corresponds to a "pure" time 0.5 sec). The indicated correlation between E and a took place both during cross relaxation and in the ordinary method of nuclear polarization by saturation of the EPR line wing. We note that in both cases an appreciable value of E was attained even when the saturation factor was equal to 1; this obviously excludes the possibility of the classical mechanism of dynamic polarization [8,9], which is connected with saturation of forbidden electron-nuclear transitions.

The obtained data are evidence of the existence of a good direct thermal contact between the S-S and Z_N systems in ruby; at any rate, the time of relaxation of the first system to the second was in our experiments apparently shorter than the time of passage through the EPR line at saturation (shorter than 1 msec). The foregoing results, which are apparently the first experimental confirmation of a new nuclear-polarization mechanism, provide a new method of polarization - by using cross relaxation in the electronic system. Furthermore, a possibility appears of investigating in detail the electronic cross relaxation by observing the NMR signal, and also directly by determining the shift of T_{SS}, measured by the here-described method of rapid passage through the EPR line in saturation.

The authors are grateful to M. E. Zhabotinskii, A. V. Frantsesson, and S. K. Morshnev for help and interest in the work, and also the authors of [3] for kindly supplying a preprint.

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GASKINETIC MAGNETIC RESONANCE

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Submitted 2 August 1967; resubmitted 29 September 1967.
ZhETF Pis'ma 6, No. 11, 945-948 (1 December 1967)

It is known that the transport coefficients of gases with nonspherical molecules are decreased in a magnetic field [1-6]. The effect is attributed to the fact that the nonsphericity of the molecules causes the precession of their magnetic moments in the magnetic field to increase their effective collision cross section. We present in this note the results of an investigation of this effect in mutually perpendicular constant and alternating magnetic fields ("crossed" fields). Since in such fields the end of the molecule angular-momentum vector describes a three-dimensional curve (and not a circle as in the case of a constant field), it can be assumed that an additional increase in the collision cross section should take place in such fields. In addition, taking into account the resonant character of the precession in these fields [7], it can be assumed that the aforementioned increase should have a maximum when the alternating-field frequency equals the precession frequency. We present below results of experiments confirming the existence of a resonance effect, using the thermal conductivity of oxygen as an example.

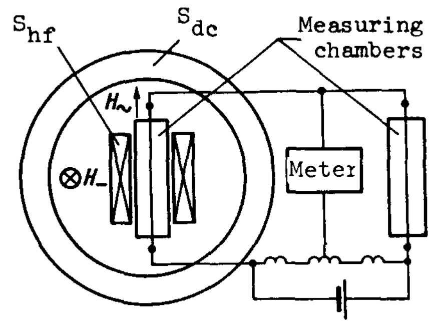

Fig. 1

Figure 1 shows the schematic diagram of the setup.* The pickup consists of two interconnected glass chambers (inside diameter 15 mm), through which are drawn electrically heated platinum filaments of 50 μ diameter. The latter serve as two arms of a Wheatstone bridge. A photooptic amplifier (F-116/1)