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* All the potentials given above are relative to the z.c.p.

INFLUENCE OF INDIRECT SPIN-SPIN INTERACTIONS ON QUADRUPOLE SPIN ECHO

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The multipolarity of nuclear quadrupole resonance (NQR) lines, which results from indirect spin-spin interaction of nuclei via the electron shells, was first observed by Kojima et al. [1], who observed by means of the standard procedure the splitting of the I^{127} line for the $1/2 \rightarrow 3/2$ transition in crystalline I_2.

The complicated line structure cannot be related to non-equivalent positions of the I_2 molecules in the lattice, since the positions of all the molecules in the unit cell cannot be obtained by symmetry transformations [2,3].

The Hamiltonian of the indirect spin-spin interaction between the I^{127} nuclei was chosen in the form [4]

$$H_{AB} = J\hat{I}_{Az}\hat{I}_{Bz} + K(\hat{I}_{Ax}\hat{I}_{Bx} + \hat{I}_{Ay}\hat{I}_{By}), \tag{1}$$

where $\hat{I}_{Az}$, $\hat{I}_{Bz}$, $\hat{I}_{Ax}$, $\hat{I}_{Bx}$, $\hat{I}_{Ay}$, and $\hat{I}_{By}$ are the spin operators of nuclei A and B, and J and K are the spin-spin interaction constants. For the $1/2 \rightarrow 3/2$ transition, agreement between theory and experiment was obtained under the assumption that J = K = 3 kHz.

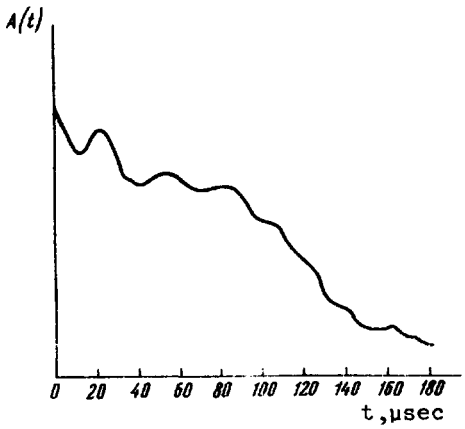
The use of a stationary procedure for the investigation of indirect spin-spin interactions between nuclei in NQR always leaves doubts whether the fine structure is connected with the non-equivalent positions of the molecules in the lattice. For an unequivocal answer to this question it is necessary to know the structure of the crystal, and also to investigate the Zeeman effect in single crystals [5].

It is known from nuclear magnetic resonance experiments [6] that indirect spin-spin interactions give rise to "slow beats" in the envelope of the echo signal when the time interval τ between pulses is varied. If there are several NQR lines due to non-equivalent positions in the lattice, then no beats are observed in the echo envelope in the case of a zero magnetic field [7].

We attempted to observe the "slow beats" in semiconducting I_2 at 77°K. A quadrupole spin echo setup was constructed for the frequency range 130 - 600 MHz. The pulsed generator was constructed of long Lecher lines, and had a tuned anode, a tuned cathode, and a grid modulator. The receiver was a commercial superheterodyne with modified input preamplifier. A grounded-grid preamplifier with a "butterfly" tank circuit was used. The pulse duration was chosen such that their spectrum subtended the entire range of the fine structure (80 kHz).

At 77°K and 333.94 MHz we observed in I_2 (I^{127}) an intense spin-echo signal ($t = 2\tau$) for the $\pm 1/2 \rightarrow \pm 3/2$ transition. A false low-intensity echo signal at $t = 3\tau$ is sometimes observed in semiconductors.

From the drop of the amplitude of the stimulated echo after the third 90° pulse at 77°K, the spin-lattice relaxation time for the $\pm 1/2 \rightarrow \pm 3/2$ transition was found to be $T_1 = 450$ μsec. When the time interval τ between pulses was varied, the envelope of the echo signals exhibited "slow beats" (see the figure). The frequencies of the "slow beats" were 7 and 25 kHz. In other substances, such as SnI_4, no "slow beats" were observed in a zero external magnetic field. Nor were "slow beats" observed in the echo envelope of Br^{79} nuclei in $SbBr_3$, etc., i.e., where there is no spin-spin line splitting. On the other hand, the frequency of the "slow beats" in Br_2 turned out to be of the order of 10 kHz; this does not contradict the stationary measurement procedure.



Envelope of spin-echo signals at $t = 2\tau$, where τ is the time interval between the 90 and 180° pulses.

It remains to propose that we succeeded, for the first time, to observe in NQR "slow beats" in the echo-signal envelope; these beats are to to indirect spin-spin interactions between iodine nuclei. This uncovers a way of investigating indirect spin-spin interactions between nuclei in crystals in NQR with the aid of pulsed methods.

Our research touches upon recently initiated experiments on hyperfine splitting in EPR by the spin-echo method [8], which also led to the appearance of "slow beats" in the envelope.

Observation of this new phenomenon in nuclear quadrupole resonance calls for the development of a theory for different interacting spins as applied to pulsed methods.

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CORRELATION PROPERTIES OF GAMMA BEAMS IN THE X-RAY BAND

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The purpose of the present research was to study the correlation properties of gamma beams in the x-ray band. The monochromatic source of the Mossbauer gamma quanta of energy 23.8 keV was the radioactive isotope Sn^{119m}. The characteristic K-series radiation of the tin was filtered out with palladium 20 μ thick. The radiation from source 1 passes through