ANTIFERROMAGNETIC RESONANCE IN $CuCl_2.2H_2O$ AT LOW TEMPERATURES

A. A. Galkin and S. N. Kovner
Donets Physico-technical Institute, Ukrainian Academy of Sciences
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The study of antiferromagnetic resonance (AFMR) in $CuCl_2.2H_2O$ has been the subject of a number of papers [1 - 4]. One of the difficulties in the explanation of the AFMR resonance in this crystal is the behavior of the resonance fields at small inclinations of the constant magnetic field from the easy-magnetization axis (a axis) in the ab plane. At present there is no explanation of the increase of the resonance fields in the case of small inclination of the field H from the a axis, corresponding to the low-frequency branch of the spin waves in phase with the turned magnetic sublattices. An attempt is made in [4] to attribute this phenomeon to the presence of a new resonance line, the nature of which, however, remains unclear.

In the present paper we present results of a detailed investigation of AFMR in single crystal $CuCl_2.2H_2O$ at the low frequency branch of the spin wave at small deviations of the external magnetic field from the easy-axis direction.

We investigated single crystals of $CuCl_2 2H_2O$ grown from the saturated aqueous solution of cupric chloride at room temperature for 20 days. The experiment was performed at a frequency of 3 GHz and temperature 1.57° K. The orientation of the crystal was monitored additionally by measurements of the resonance fields upon rotation in the ab plane. Starting with angles 0.03°, we observed three absorption lines, rather than the two observed at 9 GHz in [4]. The behavior of the resonance field corresponding to these three absorption lines is shown in Fig. 1. It is clearly seen that the two spin-wave frequencies and the corresponding resonance fields H_1 and H_2 are practically independent of the inclination of the external magnetic field in the small-angle region $(\partial H_{res}/\partial\phi)_{\psi=0} = 0$. The resonance field H_3 increases noticeably at small changes of the angle $\phi \sim 0° - 0.2°$. It can be assumed that the resonance field H_3 corresponds to an additional resonant line observed in [4] at 9 and 4.2 GHz.

As seen from Fig. 1, the additional line arises at the very base of the dip on the $H_{res} = H(\phi)$ curve (see Fig. 1b). Curve A of Fig. 1a is in qualitative agreement with the theory of Ubbink, Nagamiya, and Yoshida [5].

At the present time there is neither a theory nor a clearly formulated mechanism capable of explaining the existence of the third resonance line and the angular dependence of the resonance field H_3.

An investigation was made of the relative intensity of these lines (Fig. 2). The figure shows that the intensity of line I is actually independent of the existence of line III, whereas the intensity of line II changes

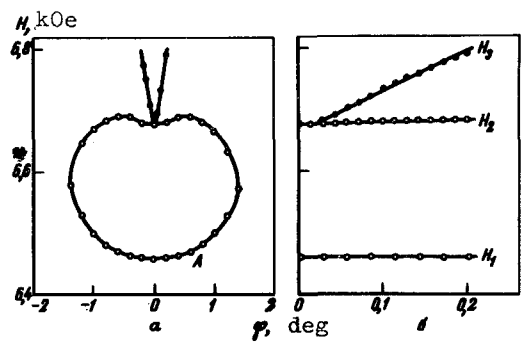

Fig. 1 Angular dependence of resonance fields.

greatly when line III appears (compares curves b, c, and d of Fig. 2).

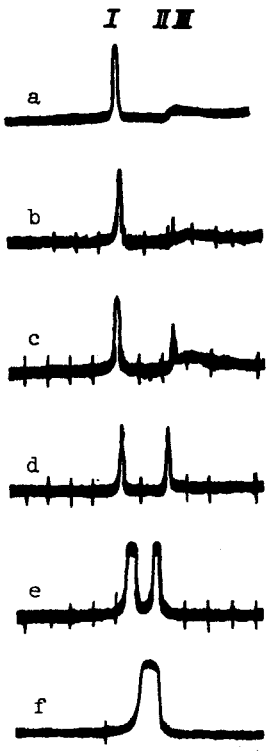

Fig. 2. Intensity of resonance lines.

The intensity data suggest that the occurrence of the new line is connected with a certain absorption mechanism in phase with the turning of the magnetic moments.

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PHOTOSENSITIVE DAMPING OF ULTRASONIC WAVES NEAR THE PHASE TRANSITION IN THE FERROELECTRIC SEMICONDUCTOR SbSI

V. I. Samulionis, V. F. Kunigelis, and V. P. Gashka
Vilnius State University
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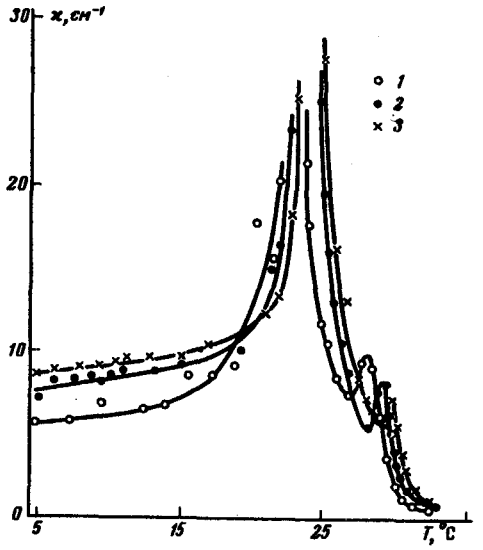
SbSI crystals have been attracting attention because they combine ferroelectric and superconducting properties [1]. The combination of these properties makes it possible to use SbSI under definite conditions, i.e., at a large concentration of the nonequilibrium carriers and in an external electrical field, both for amplification of ultrasonic waves [2] and for the amplification of transverse optical phonons.[3]. An investigation of the damping of ultrasound in an illuminated SbSI crystal is therefore of great interest.



Temperature dependence of the ultrasound damping coefficient at 10^7 GHz and at different sample resistnaces: o - 1 GΩ, o - 2 GΩ, × - 3 GΩ.

We have previously reported the anomalous absorption of ultrasound in an SbSI sample stored in darkness for a long time [4]. We have investigated this phenomenon in an illuminated sample, i.e., following the appearance of different concentrations of nonequilibrium carriers, and observed that the damping of the ultrasound near the first-order phase transition at a temperature 24.5° C is strongly influenced by illumination, especially in the ferroelectric phase.

We used single crystals grown from the gas phase. The cross section of the sample was approximately 0.02 cm^2. The samples were cut with a corundum disc strictly perpendicularly to the ferroelectric axis, and were 9.3 cm long. The end surfaces were ground, and the sample was then inserted in a mechanical system whose temperature was thermostatically controlled. The measurements were made by a pulsed method using a procedure described elsewhere [5]. The longitudinal ultrasonic wave propagated in the sample along the C axis. We measured the change of the transmission level under the condition that the damping far from the phase transition in the para-phase was equal to zero. The sample was illuminated with an incandescent lamp. The crystal resistance was varied by means of neutral optical filters which attenuated the illumination intensity.

The figure shows three temperature dependence curves of the absorption at different sample resistances at 10^7 Hz. In the direct vicinity of the phase transition it is impossible to measure the damping, owing to the oscillations of the absorption [4]. In the ferroelectric phase, far from the temperature of the phase transition, the illumination decreases the absorption strongly, and this may be due to the decrease of the interaction of the ultrasonic waves with the ferroelectric domains with increasing concentration of the nonequilibrium carriers. In the paraelectric phase, the damping decreases upon illumination, this being connected with the shift of the phase transition towards lower temperatures [6]. We see that when the resistance of the sample is decreased by approximately two orders of magnitude, the phase-transition point shifts by approximately 1.8° C towards the lower temperatures, in good agreement with data obtained by other methods [7, 8].

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TOTAL CROSS SECTION OF THE REACTION He^4 (γ, pn)H^2

Yu. M. Arkatov, A. V. Bazaeva, P. I. Vatset, V. I. Voloshchuk, A. P. Klyucharev, and A. F. Khodyachikh
Physicotechnical Institute, Ukrainian Academy of Sciences
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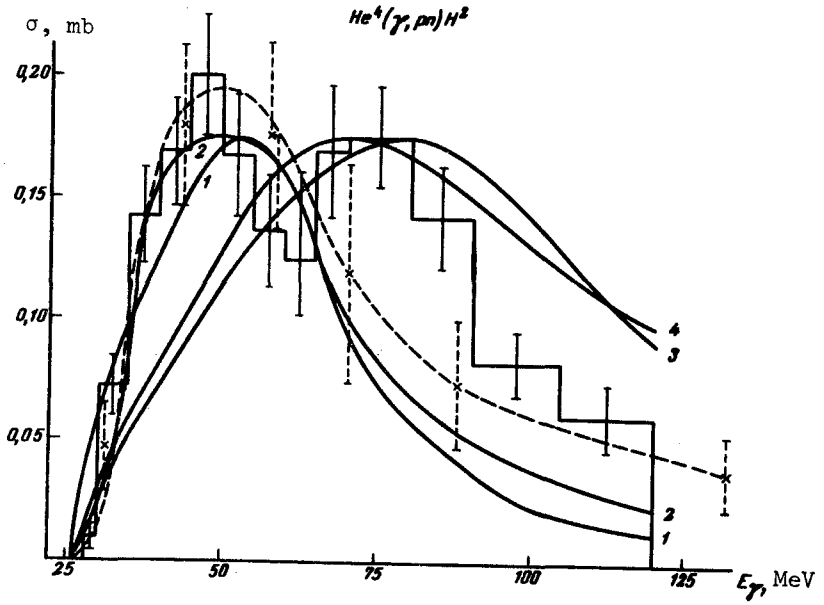
Investigation of the reaction $He^4(\gamma, pn)H^2$ yields information on the structure of the ground state of the He^4 nucleus, on the quantum absorption mechanism, and on the correlation of the nucleons in the nucleus.

However, there are few experimental investigations of this reaction [1 - 3]. It was investigated in greatest detail by Gorbunov et al. [3] but at relatively low statistics. We started a study of the reaction with the aid of a diffusion chamber operating in a magnetic field of approximate intensity 15 kOe, using a linear electron accelerator with maximum γ-quantum energy 120 MeV. In the present paper we discuss only the total cross section of the reaction, obtained on the basis of much larger statistics than in [3].

The figure shows the dependence of the total cross section on the γ-quantum energy. Our results are represented by the histogram, and Gorbunov's data by the dashed curve. The figure shows also a comparison with the theory (solid curves). Curve 1 was calculated by Dzhibuti et al. [4], who considered the reaction $He^4(\gamma, pn)H^2$ on the basis of the mechanisms of pair absorption of the γ quanta, and took explicit account of the Majorana exchange



Total cross section of the reaction $He^4(\gamma, pn)H^2$ vs. gamma-quantum energy. Histogram - our results; dahsed curve - data of Gorbunov et al. [3]; solid curves - results of theoretical calculations [4, 5].