soft protons seems to take place at lower photon energies than the critical frequency.

The experimental results show thus that no enhancement of the transition radiation is caused by multiple scattering.

The reason for the discrepancy between our results and those of [1, 2] can be attributed to the following factors: In [1, 2], the experimental setup did not make it possible to select the electrons that did not lose most of their energy to radiative processes on passing through the radiator and passed through the entire setup without touching any metallic parts. The average energy lost to radiation in these investigations with the radiators corresponding to our results of Fig. 2 amounts to $\sim$10 MeV. Thus, both the primary electron and the secondary products formed in the radiator formed a large background radiation by touching the metallic parts of the setup located past the radiator.

In our experiment, first, the energy lost to radiation is $\sim$15 MeV; second, wince the electron was registered in a small angle interval after passing through the entire setup, we practically eliminated the background radiation due to the aforementioned causes.

Lack of control over the passage of the electron through the radiator and the entire setup obviously leads to an increase of the background, which can depend on the radiator geometry and thus imitate the effect itself.

The authors thank A. Ts. Amatuni for a discussion of the results.

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SPECTROSCOPIC INVESTIGATION OF THE INTERMEDIATE STATE IN ANTIFERROMAGNETIC MnF_2

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ZhETF Pis. Red. 18, No. 1, 39 - 42 (5 July 1973)

It is well known that an MnF_2 crystal experiences a phase transition with flipping of the sublattice magnetic moments to the basal plane in a sufficiently strong magnetic field $H_c \approx 92$ kOe [1]. Detailed magnetic measurements [2] have shown that in a narrow angle interval between the direction of the magnetic field and the easy axis of the crystal (c_e), not exceeding 0.4°, the flipping of the sublattices has the character of a first-order phase transition and is accompanied by stratification into domains with different values of the longitudinal component of the magnetization; this agrees with the results of theoretical studies [3].

Since the question of the existence of an intermediate state in antiferromagnets is of fundamental character, it is of interest to observe it by another independent method. The present paper is devoted to a spectroscopic study of this phenomenon. The idea of the method is that the flipping of the magnetic sublattices produces in the MnF_2 absorption crystal abrupt changes in the region of the $^6A_{1g}(^6S_{5/2})$ - $^4T_{2g}(^4D)$ transition, which are manifest mainly in a change in the spectral position of most D-group bands [4 - 6]. We chose for the investigation the absorption band D_1, which is the most isolated in the spectrum and whose frequency is 28024 cm^{-1} in zero field and shifts 52 cm^{-1} toward shorter wavelengths in the magnetic phase transition. Its behavior is shown schematically in the upper part of Fig. 1. The half-width of this band is equal to 10 cm^{-1}, and the absorption coefficient at the maximum is 8.2 cm^{-1}. We measured the intensity of the light passing through the sample at the wavelengths corresponding to the absorption maximum both before (λ_a) and after (λ_c) the sublattice flipping, as well as at wavelengths λ_b in the interval between λ_a and λ_b.

Light from a DKSSh-200 lamp passed through the sample along the C_4 axis and focused on the entrance slit of an STE-1 spectrograph with linear dispersion 6.5 Å in the investigated region (3600 Å). A slit that could be moved along the spectrum with high accuracy was installed at the entrance of the spectrograph. Registration was with the aid of a photomultiplier and an S1-7 high-speed two-beam oscilloscope. The change of the sample magnetic moment was registered simultaneously by an induction method [1].

The MnF_2 sample was an oriented single crystal with thickness 2.7 mm along the c_4 axis and dimensions 5 x 4 mm in the basal plane. All measurements were made at 20.4°K, which is much lower than the temperature of the antiferromagnetic ordering of the MnF_2 (T_N = 68°K). The magnetic field was produced by a pulsed solenoid through which a capacitor bank was discharge and reached an intensity higher than 100 kOe within 340 μsec. The system for adjusting the apparatus made it possible to orient the c_4 axis of the sammple relative to the magnetic field direction within 3 minutes of angle.

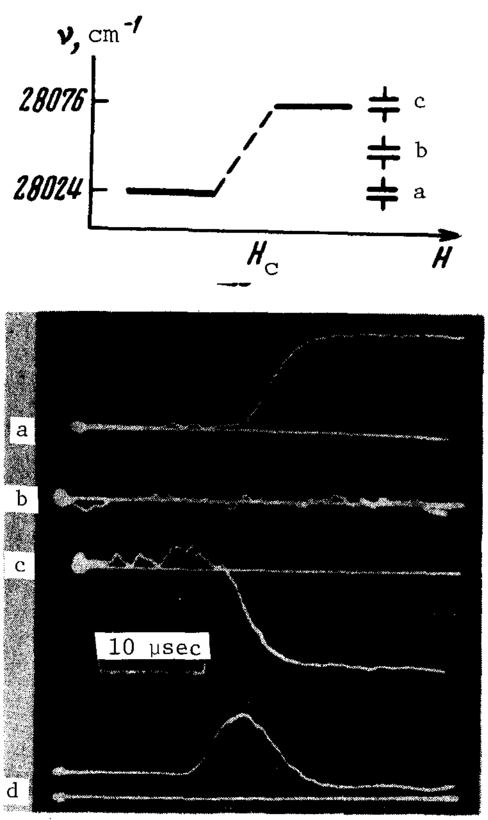

Fig. 1. Variation of intensity of light passing through sample (curves a, b, c) and of the magnetic moment of the sample dM/dt (d) at $H \parallel \bar{c}_4$ (ϕ = 0). The field growth rate in the region of H_c is 235 Oe/μsec. The upper plot shows schematically the behavior of the D_1 absorption line upon flipping of the sublattices [6] and three gap positions corresponding to oscillograms a, b, and c. Gap width 0.2 mm, T = 20.4°K.

The results of the measurements at $H \parallel c_4$ are shown in Fig. 1. We see that when the magnetic sublattices flip an abrupt change takes place in the intensity of the light passing through the sample. In the initial position of the D_1 line (H = 0) the light intensity increases (Fig. 1b) but in the final position ($H > H_c$) it decreases (Fig. 1c). It is important that during the course of the transition the absorption is observed simultaneously at both wavelengths, whereas at the intermediate wavelength curve b) the crystal remains transparent at all times. Variation of the magnetic-field growth rate in the region from H_c, from 40 to 400 Oe/μsec, changes the duration of the transition, but not the basic shape of the curves of Fig. 1.

With increasing angle ϕ between the c_4 axis of the sample and the direction of the external magnetic field, the sublattice-flipping phase transition becomes smeared out. The oscillograms showing the variation of the light intensity at wavelengths λ_a and λ_c do not change significantly. The most interesting results are connected with the behavior of light having a certain intermediate wavelength λ_b (Fig. 2) at which absorption of the light transmitted through the sample sets in already at an angle ϕ = 7'; this absorption increases with increasing angle. The absorption reaches saturation at $\phi \sim 20'$, and its lifetime corresponds to the duration of the magnetic transition.

Thus if the sample is aligned exactly along its tetragonal axis (ϕ = 0) then the restructuring of the MnF_2 sample in the region of the D-group of absorption bands, occurring when magnetic-sublattice flipping field reaches the critical value, is abrupt, but when the alignment is not exact the restructuring proceeds smooth-

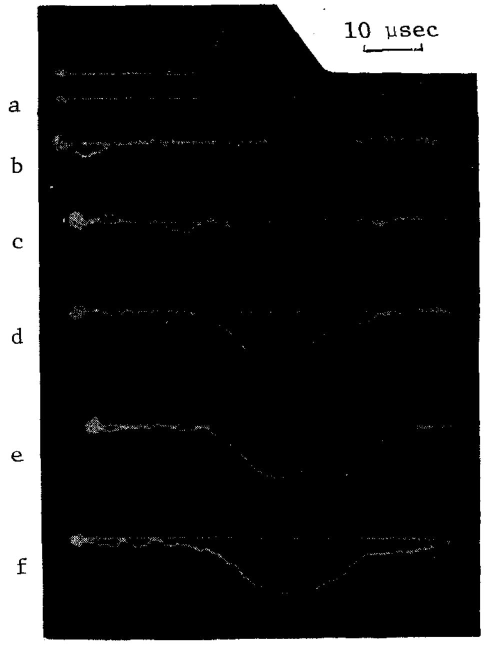

Fig. 2. Variation of magnetic moment of sample at $\phi = 0$ (a) and of the light intensity at intermediate wavelengths at angle 0 (b), 7'(c), 21'(d), 42'(e) and 56'(f) between the c_4 axis of the sample and the magnetic field direction.

ly from λ_a to λ_c. In our opinion this indicates unambiguously that in a strictly oriented sample the flipping of the MnF_2 sublattices is a first-order phase transition. In a narrow but finite interval of fields there is realized in the crystal an interemediate state, wherein there coexist two phases, antiferromagnetic ($\vec{\ell} \parallel c_4$) and with flipped sublattices ($\vec{\ell} \perp c_4$). The most clear-cut evidence of the existence of both phase is that in the vicinity of the critical field H_c light is absorbed simultaneously at two frequencies (wavelengths λ_a and λ_c), each of which is characteristic of one of the phases (Fig. 1). All these results are in good agreement with the data on the magnetic investigations of the intermediate state in the antiferromagnetic crystal MnF_2 [2]. Some discrepancies (different values of the critical angle ϕ_c, viz., $\sim$20' in our measurements and $\sim$30' according to the data of [2]; the appearance of absorption at the intermediate frequency even at ϕ = 7') are due to the fact that our sample was disk-like in shape, the temperature was higher (20.4°K), and the absorption bands had noticeable wings. These details will be discussed in a more detailed article.

In conclusion, we sincerely thank K. L. Dudko and N. F. Kharchenko for useful discussions.

Postscript. In a paper published after this article was written, A.R. King and D. Paquette (Phys. Rev. Lett. 30, 662, 1973) also demonstrate the existence of an intermediate state in MnF_2 by methods of optical absorption spectroscopy and NMR, and present photographs of the sample domain structure in the critical field.

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HIGH-EFFICIENCY VISIBLE-BAND LASER USING DYES

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ZhETF Pis. Red. 18, No. 1, 43 - 46 (5 July 1973)

The output characteristics of an organic-dye laser pumped by coaxial-lamp light were investigated. The feasibility is demonstrated of obtaining efficiencies higher than 1% at an input energy exceeding 10 J in the visible band; this is done by optimizing the lamp-supply circuit.

The efficiency of organic-dye lasers is determined by the effectiveness of the pumping system and by the spectroscopic and photochemical properties of the active molecules. Owing to T-T absorption, appreciable energies and efficiencies can be obtained for most dyes only in the case of short pump pulses. On the other hand, reducing the pulse duration lowers the pumping efficiency, owing to the deterioration of the impedance matching in the discharage circuit, due to the decreased accumulation capacity, and the shift of the lamp emission to the UV region, due to the increase in the discharge temperature.

The highest efficiency (0.75% at E_{out} = 1.5 J) [1] and the highest lasing energy (E_{out} = 110 J at $\sim$0.3% efficiency) [2] were obtained so far with solution of rhodamine-6G, which can be