(the oscillation intensity drops off at the end of the current pulse).

A detailed description of the experimental setup is contained in [3]. The high-frequency oscillations were investigated in the 100 - 7000 MHz range. The electron beam modulation and the pick-off of the high-frequency oscillation power were effected with the aid of helical junctions [3] at frequencies 291 and 880 MHz.

Thus, the experiments demonstrated the possibility of controlling two-stream instability, namely controlling the degree of regularity of the excited oscillations, the width of the spectrum, and the waveform of the excited oscillations (the degree of nonlinearity).

[1] Ya. B. Fainberg, Atomnaya energiya 11, 313 (1961).
[2] V. D. Shapiro, Dissertation, Dubna, JINR, 1963.
[3] A. K. Berezin, Ya. B. Fainberg, et al., Plasma Physics and Controlled Nuclear Fusion Research 1, 515 (1966), IAEA, Vienna.

* Special measurements similar to those described in [3] have shown that the correlation time increases with increasing modulation-power level as follows: 250 nsec at 6.5 kW and 500 nsec at 10 kW.

AMPLIFICATION OF THE ANTI-STOKES AND STOKES COMPONENTS OF STIMULATED MANDEL'SHTAM-BRILLOUIN SCATTERING AS A RESULT OF FOUR-PHOTON INTERACTION

Yu. I. Kyzylasov and V. S. Starunov
P. N. Lebedev Physics Institute, USSR Academy of Sciences

Submitted 20 December 1967
ZhETF Pis'ma 7, No. 5, 160-163 (5 March 1968)

Four-photon interaction in a nonlinear medium in stimulated scattering of light in the Rayleigh-line wing (RLW) [1,2] leads to certain new unique nonlinear optical effects, some of which were observed earlier [3-5].

In this paper we report the results of observation of the influence of four-photon interaction on the amplification of the anti-Stokes and Stokes components of stimulated Mandel'shtam-Brillouin scattering (SMBS).

One of us has already indicated [6] that four-photon interaction in stimulated scattering can be the cause of the occurrence of the anti-Stokes SMBS components.* Indeed, if the light scattered at $\theta = 180^\circ$ after successive SMBS is amplified in a laser and is again fed together with the laser radiation into a medium consisting of anisotropic molecules, then the anti-Stokes components will be amplified simultaneously with the Stokes components as a result of the four-photon interaction.

It follows from the theory of four-photon interaction in a nonlinear medium [6,7], developed for plane waves, that the maximum gain at the optimal scattering angle $\theta^2_{ph}t = A|E_0|^2$ is

$$g_2 = -2K_\omega + A|K_0||E_0|^2(1 + \Omega^2\tau^2)^{-1/2},$$

where K_ω is the amplitude coefficient of light absorption, $A \sim (\alpha_1 - \alpha_2)^2$, α_1 and $\alpha_2 = \alpha_3$ are the principal polarizabilities of the molecules of the medium, $\vec{K}_0$ and $\vec{E}_0$ are the wave vector and the field-intensity vector of the laser radiation, Ω is the frequency reckoned from the exciting line, and τ is the effective anisotropy relaxation time.

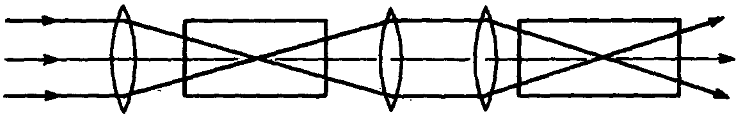

Fig. 1. Paths of rays in a system comprising quartz and a liquid in a cell.

In the described experiment, the SMBS was excited in fused quartz. This radiation, consisting of one Stokes component and the exciting line, was focused with a lens into a vessel containing carbon disulfide (Fig. 1). The spectrum of the light emerging from the liquid-containing cell contained in this case three anti-Stokes components and up to nine Stokes components corresponding to the SMBS in quartz, and not to the nonlinear medium (CS_2) in which the four-photon interaction was effected (Fig. 2a). It can be seen from the interference pattern of the same spectrum (Fig. 2b) that each SMBS component corresponding to fused quartz produces in turn a Stokes and anti-Stokes component in the carbon disulfide. For simultaneous registration of the spectrum of the scattered light we used a Fabry-Perot interferometer with 8.33 cm^{-1} dispersion, and a diffraction spectrograph with linear dispersion 1.7 Å/mm. We thus assume that in our experiments the amplification of the anti-Stokes and Stokes SMBS components is due to four-photon interaction in SRS at the optimal angle in carbon disulfide. In order to demonstrate this, we performed precisely the same experiment as described above, except that the cell was filled not with CS_2 but with acetone or water, in which no SRS could be produced. In this case the spectrum of the scattered light contained only the ruby R_1 line and one SMBS Stokes component of the fused quartz (Fig. 2c). Consequently the amplification of the Stokes and anti-Stokes SMBS components as a result of the aforementioned mechanism can be regarded as proved.

In the present study we observed only 13 components covering a frequency interval of approximately 11 cm^{-1}, although we could expect also a larger number of amplified SMBS com-

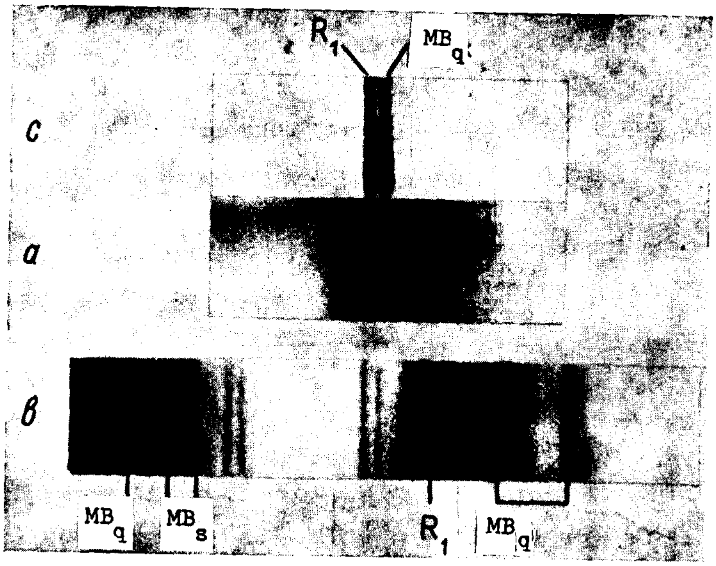

Fig. 2. a,b - spectrogram and interference pattern of SMBS of fused quartz (MB_q) with amplification in carbon disulfide. MB_s - Stokes and anti-Stokes components of SMBS in CS_2. c - spectrogram of $SMBS_q$ passing through water. There is no amplification.

ponents. It is probable that the number of registered components, at the given sensitivity of the setup, is determined also by the intensity of the exciting light and by the intensity of the SMBS of the fused quartz before entering the cell with the liquid.** Confirming the foregoing statement is an experiment in which, all other conditions being the same, the fused quartz was replaced by single-crystal quartz, the stimulated scattering of which contained only a weak Stokes MB component. In this case the spectrum of the light passing through the cell with the CS_2 revealed no additional components.

In conclusion, it must be noted that the amplification of a large number of SMBS components, occupying a region of several dozen cm^{-1}, under suitable conditions, will apparently find practical application alongside with light generators of tunable frequency.

The authors are grateful to I. L. Fabelinskii for interest and valuable discussions of the results, and to V. P. Zaitsev for help with the experiment.

[1] D. I. Mash, V. V. Morozov, V. S. Starunov, and I. L. Fabelinskii, ZhETF Pis. Red. 2, 41 (1965) [JETP Lett. 2, 25 (1965)].
[2] G. I. Zaitsev, Yu. I. Kyzylasov, V. S. Starunov, and I. L. Fabelinskii, ibid. 6, 505 (1967) [6, 35 (1967)].
[3] G. I. Zaitsev, Yu. I. Kyzylasov, V. S. Starunov, and I. L. Fabelinskii, ibid. 6, 695 (1967) [6, 180 (1967)].
[4] I. M. Arefiev, I. L. Fabelinskii, Yu. I. Kyzylasov, V. S. Starunov, and G. I. Zaitzev, Phys. Lett. 26A, 82 (1967).
[5] B. L. Carman, R. Y. Chiao, and P. L. Kelly, Phys. Rev. Lett. 17, 1281 (1966).
[6] V. S. Starunov, Dokl. Akad. Nauk SSSR 179, No. 1 (1968) [Sov. Phys.-Dokl. 12 (1968), in press].
[7] R. Y. Chiao, P. L. Kelly, and E. Garmire, Phys. Rev. Lett. 17, 1158 (1966).

* The anti-Stokes SMBS component can arise as a result of repeated scattering in the region of interaction of the laser emission with hypersound waves [3]. Then the first Stokes SMBS component scattered at $\theta = 180°$ is again scattered, but now in the direction of the laser emission, and gives rise to a hypersound wave in the opposite direction. The scattering of the laser emission by this wave leads to the appearance of the first anti-Stokes SMBS component, etc.

** We used a ruby laser of power rating ~110 MW at a pulse duration ~12 nsec.

ATTENUATION OF CURRENT IN A SUPERCONDUCTING RING UNDER THE INFLUENCE OF A LOW-FREQUENCY MAGNETIC FIELD

S. V. Odenov and V. A. Shukhman
Physics Institute, Georgian Academy of Sciences
Submitted 25 December 1967
ZhETF Pis'ma 7, No. 5, 163-165 (5 March 1968)

The problem of the dissipative mechanisms in superconductors of the first and second kind placed in an alternating magnetic field was considered in a number of papers [1-5]. The presence of dissipation was revealed in some cases by the heating of the sample [1,4], and in others by the penetration of an external field in a doubly-connected superconducting region at total fields that were known to be lower than the critical value [3,5]. These experiments, however, yielded no information to indicate whether the observed loss effects are connected with reversal of magnetization of the regions near the surface defects ("weak spots") or with resistive effects connected with the motion of n-regions.

We undertook experiments aimed at observing the attenuation of the current in a super-