| Working molecule | Submillim. radiation λ, microns | Submillimeter power, P mW | $CO_2$ laser λ, microns | Relat. polariz. | Vapor press. mm Hg |
|---|---|---|---|---|---|
| $C_2H_2F_2$ | 288.5 | 0.30 | 10.513 | ∥ | $3 \cdot 10^{-1}$ |
| | 375.0 | 1.60 | 10.513 | ∥ | $3 \cdot 10^{-1}$ |
| | 458.0 | 0.20 | 10.695 | ∥ | $1.5 \cdot 10^{-1}$ |
| | 464.3 | 0.30 | 10.245 | ∥ | $2.5 \cdot 10^{-1}$ |
| | 554.4 | 3.00 | 10.532 | ⊥ | $8 \cdot 10^{-2}$ |
| | 663.3 | 0.20 | 10.632 | ∥ | $1.5 \cdot 10^{-1}$ |
| | 890.0 | 0.30 | 10.611 | ∥ | $1 \cdot 10^{-1}$ |
| | 890.1 | 0.20 | 10.611 | ∥ | $1 \cdot 10^{-1}$ |
| | 990.0 | 0.20 | 10.611 | ∥ | $1 \cdot 10^{-1}$ |
| $CH_2CHCN$ | 586.6 | 0.32 | 10.591 | ∥ | $1.5 \cdot 10^{-1}$ |
| | 584.0 | 0.06 | 10.513 | ⊥ | $1 \cdot 10^{-1}$ |
| | 574.4 | 0.30 | 10.274 | ⊥ | $2.5 \cdot 10^{-1}$ |
| | 550.0 | 0.06 | 10.532 | ∥ | $1.5 \cdot 10^{-1}$ |
| | 270.6 | 0.06 | 10.653 | ⊥ | $1 \cdot 10^{-1}$ |
| $CH_3NH_2$ | 251.3 | 0.30 | 9.585 | ∥ | $4 \cdot 10^{-1}$ |
| | 218.0 | 1.00 | 9.585 | ∥ | $4 \cdot 10^{-1}$ |
| | 198.0 | 1.00 | 9.585 | ∥ | $4 \cdot 10^{-1}$ |
| | 148.5 | 10.00 | 9.585 | ⊥ | $4 \cdot 10^{-1}$ |

much superior in efficiency, dimensions, number of generation lines, and frequency of the spectrum.

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## ULTRASHORT SRS PULSES AND MULTIFOCUS STRUCTURE OF LIGHT BEAMS

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In 1966, Maier et al. [1, 2] observed ultrashort pulses of the first Stokes component of stimulated Raman scattering (SRS). These pulses were produced at the end of a cell with the investigated liquid and propagated in a direction opposite to that of the laser beam. They also noted a correlation between the occurrence of these pulses and the appearance of the so-called "filaments" when sufficiently strong radiation propagates in a nonlinear medium. Loy and Shen

[3] subsequently observed that the pulses in question are produced also at the center of the cell. The explanation proposed in [3] is that these pulses are due to moving foci and arise at the instant when the velocity of the focus moving against the incident beam is equal to the velocity of light in the medium.

We call attention in the present paper to the possibility of another mechanism capable of producing ultrashort pulses of the first SRS Stokes component. This mechanism is connected with the fact that the SRS is, generally speaking, nonstationary in the fast-moving focal region of the multifocus structure of the light beam. This stationary behavior is deduced from the following estimates.

Indeed, measurements of the absolute values of the cross section and width of the Raman scattering line [4, 5] show that for typical liquids (carbon disulfide, toluene, etc.), the gain of the first Stokes component in the steady state, over the length of the focal region (0.1 - 0.5 cm), can exceed $e^{100}$. The characteristic time $\tau_{SRS}$ in which the steady SRS state sets in can be estimated, as is well known [6, 7], from the condition $\tau_{SRS} \sim K\tau_{RS}$, where $K \sim 100$ is the gain, and $\tau_{RS}$ is the reciprocal of the half-width of the spontaneous Raman scattering line, $\sim 10^{-11}$ for the media in question. Thus, $\tau_{SRS} \sim 10^{-9}$ sec. At the same time, the characteristic time $\tau$ that the focal region stays at a given point in the medium is shorter than $10^{-10}$ [8]. Since $\tau < \tau_{SRS}$ under the conditions in question, it is clear that the SRS process is nonstationary. Its effectiveness depends therefore on the velocity of the foci. This velocity can vary during the laser pulse in a wide range, from a value on the order of the velocity of the light in the medium to zero (at the turning points) [8, 9].

With decreasing velocity of the focus, the SRS process can become sufficiently effective at some instant of time to convert the energy of the focal region into the energy of the first SRS Stokes component. Thus, an ultrashort pulse of this component can be excited on the path of the focal region from the output plane of the medium to the turning point.

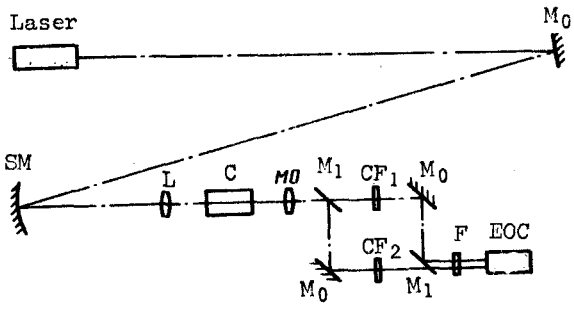


Fig. 1a

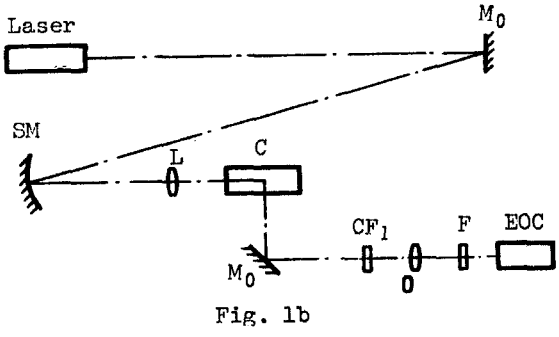


Fig. 1b

Fig. 1a. Setup for the investigation of self-focusing and SRS from the output end face of the cell: $M_0$ - totally reflecting mirrors, $M_1$ - semitransparent mirrors, SM (spherical mirror) and L (lens) make up a telescope, C - cell 10 cm long filled with the investigated liquid, MO - micro-objective, F - neutral filters, $CF_1$ - filter passing only the SRS radiation, $CF_2$ - filter passing only the laser radiation.

Fig. 1b. Setup for the investigation of the onset and propagation of SRS pulses: O - objective projecting the plane of the cell in which the light beam propagates onto the cathode of an electron-optical converter (EOC). The remaining symbols are the same as in Fig. 1a.

If this excitation occurs in the immediate vicinity of the turning point, then pulses of the first SRS component can occur in both the forward and the backward direction. The duration of these pulses can equal $\ell_f/v$, where $\ell_f$ is the length of the focal region and v is the velocity of light in the medium. If, however, the time of vanishing of the focal region is shorter than $\ell_f/v$, then the pulse duration will be determined precisely by the time of vanishing of the focal region.

The experimental setup is shown in Fig. 1. We used a ruby laser operating in one angle mode and one $TEM_{00}$ axial mode. The pulse duration at half-width was ∿12 nsec at a maximum power ∿3 MW. The cell length was 10 cm and the half-width of the input distribution ∿300 μ. The investigation was made with an electron-optical camera operating in the linear sweep mode. In the first series of the experiments (Fig. 1a) we investigated the correlation between the multifocus structure and the ultrashort pulses of the first SRS Stokes component in the forward direction from the output face of the cell. A typical photograph, obtained for nitrobenzene, is shown in Fig. 2a. The lower half of the photograph shows the successive passage of the foci of the multifocus structure through the output face of the cell, and the upper half shows the ultrashort SRS pulses. These pulses were observed only after the passage of the first focus. The SRS points and the points corresponding to the laser radiation coincide on the output face of the cell within 20 μ. In the second series of experiments (Fig. 1b) we investigated the onset of the SRS as observed from the side of the cell in scattered light at the SRS wavelength. A typical photograph is shown in Fig. 2b. We see that the SRS pulses propagate in the medium at the speed of light, and predominantly in the backward direction, but in approximately 25% of

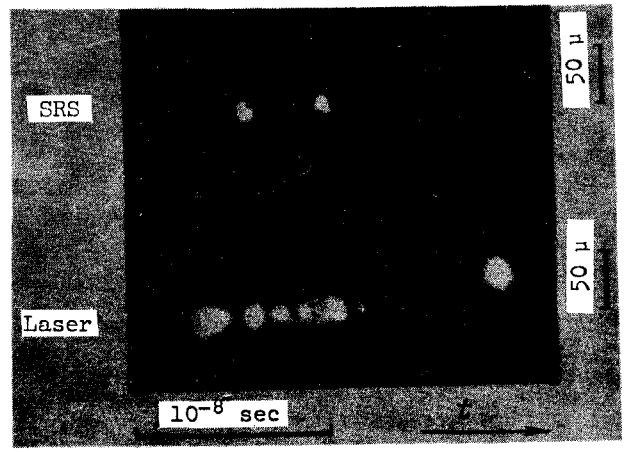


Fig. 2a. Time sweep of the foci of the multifocus structure and of the ultrashort SRS pulses (viewed from the end of the cell).

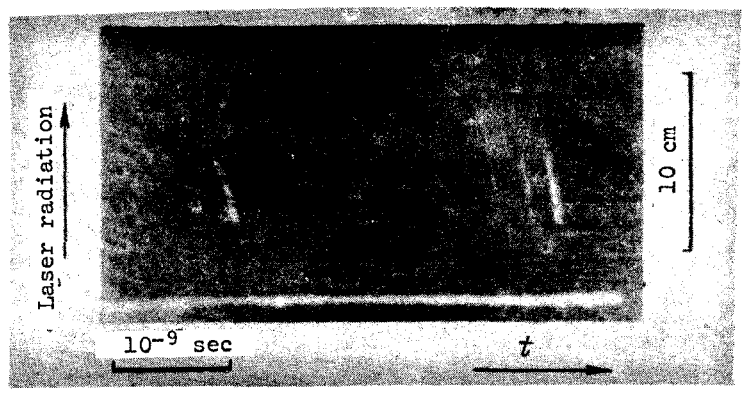


Fig. 2b. Time sweep of the onset and development of SRS pulses (viewed from the side). The slope of the line corresponds to the velocity of the light in the medium.

the cases of SRS is observed in both directions. The points at which SRS pulses that travel only backwards are produced lie closer to the end of the cell, where the foci of the multifocus structure move with appreciable velocity, whereas the points where SRS propagating in both directions occur correspond to the points where the foci are stopped. These results are in good agreement with the concepts developed above.

We note also that although the SRS pulses are produced at a distance on the order of several centimeters from the ends of the cell, in regions having a transverse dimension on the order of several microns their transverse dimension on emerging from the cell is $\sim$10 $\mu$ at a duration $<10^{-10}$ sec (Fig. 2a). This shows that the power of the SRS pulses is more critical and they undergo critical refraction. Consequently, the propagation of the SRS pulses in the medium should be accompanied by formation of a (secondary) multifocus structure inside these pulses [10]. Indeed, the side-view photographs show on the paths of the SRS pulses themselves bright points that correspond apparently to the stopping points of the foci of this secondary multifocus structure [11 - 12].

Thus, the results presented here offer evidence in favor of the nonstationary mechanism of the ultrashort SRS pulses.


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## INFLUENCE OF MAGNETIC FIELD ON RADICAL REACTIONS


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The purpose of the present paper is to show that an external magnetic field can exert a noticeable influence on the rates of chemical reactions in which free radicals take part. Such an influence may be due to the fact that the radical-recombination products are usually formed from a radical pair (RP) in the singlet rather than the triplet state. The hyperfine interactions inside the RP cause transitions between the singlet and triplet states, and the probability of such a conversion depends on the magnetic field intensity.

A well-known manifestation of these effects is the influence of the magnetic field on the chemical polarization of nuclei in radical reactions [1].

An influence of the magnetic field on the rates of certain photochemical processes in which triplet states participate was observed earlier by Merrifield