direction opposite that of the 3d electrons.

In conclusion we thank Prof. E. I. Kondorskiĭ for help during the performance of this work.

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THE THRESHOLD AND INTENSITY OF STIMULATED RAMAN RADIATION LINES IN LIQUIDS

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THE phenomenon of stimulated Raman radiation (SRR) in which coherent oscillations of molecules of the scattering medium are excited has, as is well known, a sharp threshold (cf., for example,[1]). An exponential growth of the amplitude of the field of the first Stokes component E_{S1} which plays a dominant role in the development of SRR occurs if the following condition is fulfilled (cf.[2])

$$\beta_{s1}E_0^2 \geqslant \delta_{s1}. \quad (1)$$

Here E_0 is the intensity of the field of the incident wave (of frequency ω_0), β_{S1} is a quantity determined by the polarization of the molecule of the scattering medium at a frequency $\omega_0 - \Omega = \omega_{S1}$ (Ω is the characteristic frequency of the molecular oscillations) and δ_{S1} is the absorption coefficient of the medium at a frequency ω_{S1}. When (1) is satisfied the expression for the variation of the amplitude of the component E_{S1} in the medium is

$$E_{s1}(l) = E_{s1}(0)\exp\left\{\int_0^l [\beta_{s1}E_0^2(z) - \delta_{s1}(z)]\,dz\right\}. \quad (2)$$

In the general case the amplitude of the pumping field depends on the coordinate; the dependence $\delta_{S1} = \delta_{S1}(z)$ can be related to the multiphoton absorption in the scattering medium [3]. It is important to emphasize that the intensity and the number of SRR lines depends not only on the "excess" over the threshold [cf., condition (1)], but also on the geometry of the experimental system.

In experiments described in [1,4], SRR was excited in a resonator tuned to the frequency ω_{S1}; on the other hand, as has been shown in [5,6], considerably broader possibilities of the study of SRR occur when the beam of the original radiation is focused into a volume of the substance under investigation. It is interesting that in the latter case not only does the number of SRR lines increase, but, as measurements show, their intensity increases also.

At the same time it should be noted that the factors which determine the value of the threshold and the intensity of the SRR lines cannot be considered as being fully understood at present. The restricted nature of the information obtained from the experimental papers quoted above is related largely to the circumstance that for the excitation of SRR the authors of these papers used only a ruby oscillator with $\lambda_0 \approx 0.69\mu$. In connection with these statements it appeared to us to be useful to carry out experiments on the excitation of SRR in other ranges, and in particular in those of shorter wavelength. Below we present some results of such experiments carried out with organic liquids. For the excitation of SRR we used the second harmonic of an oscillator utilizing glass activated by neodymium ($\lambda_0 = 0.53\mu$). The Q of the neodymium glass oscillator was modulated by means of a rotating prism; the frequency was doubled by a KDP crystal. The second harmonic radiation was focused on a cell with the liquid under investigation; in our experiments we utilized cells of length $l = 10$ cm, the cell windows were made of quartz. We observed the stimulated Raman scattering in benzene and in cyclohexane. The data of the experiments carried out under conditions optimal for our experimental arrangement are summarized in table I (the frequency ω_0 corresponds to the second harmonic of the oscillator utilizing glass activated by neodymium).

In liquids investigated by us we observed considerable lowering of the threshold of SRR compared to the corresponding value for $\lambda_0 \approx 0.7\mu$.

Table I

Substance	Observed lines	Relative intensity of lines (%)
Benzene $\Omega_1 = 992\ cm^{-1}$ $\Omega_2 = 3064\ cm^{-1}$	ω_0	$I_0 = 100$
	$\omega_0 + \Omega_1$	$I_{+1} = 0.4$
	$\omega_0 - \Omega_1$	$I_{-1} = 5$
	$\omega_0 - 2\Omega_1$	$I_{-2} = 0.5$
	$\omega_0 - \Omega_2$	$I_{-1} = 0.8$
Cyclohexane $\Omega_1 = 2852\ cm^{-1}$	ω_0	$I_0 = 100$
	$\Omega_0 - \Omega_1$	$I_{-1} = 10$

In particular, in benzene the SRR threshold was lower by approximately a factor of two than the value obtained under the same conditions (focusing, geometrical arrangement) at $\lambda_0 \approx 0.7\mu$[1]. In our opinion the latter fact can be related to two circumstances. First, as the working frequency ω_0 increases the value of β_{S1} also increases. This is associated with an approach to an electron absorption line[8]; one must also have in mind the fact that the dependence of the SRR threshold on the working frequency is considerably less pronounced than the corresponding dependence of the scattering cross section in the case of ordinary spontaneous Raman scattering (which varies like ω_0^4). Second, the diameter of the focused spot from an oscillator emitting optical harmonics can be considerably smaller than a similar spot in the case of a ruby oscillator; the latter is explained by a smaller divergence of the beam of a harmonic (cf., for example, [9]).

We should make a few remarks with respect to the intensity of the SRR lines observed in our experiments. As follows from the table, the coefficient of transformation of the energy of the initial radiation into the energy of the first Stokes component has turned out to be sufficiently high. If only the direct waves are propagated in the medium, then the intensity of the SRR lines can be calculated utilizing (2). For a focused beam expression (2) should be written only for that part of the beam for which the threshold (1) is exceeded; the length of this region L (of the focused spot) for the intensities and the relatively short focal length lenses (f = 4-6 cm) utilized in our experiments was considerably smaller than the length of the cell l.

Then for the intensity of the first Stokes component one can write the approximate formula:

$$I_{s1} \approx \bar{I}_{s1}(z) \exp\{2[\beta_{s1}\bar{E}_0^2 - \delta_{s1}]L\}.$$

Here $\bar{E}_0^2$ is the value of the field E_0 averaged over L, $\bar{I}_{S1}(z)$ is the average intensity of spontaneous scattering in the region of the focal spot (z is the distance of the focal spot from the edge of the cell). Evidently, $\bar{I}_{S1}(z) \sim z$ and, consequently, the intensity of SRR increases as the focus is moved further away from the forward end of the cell. Specially designed experiments confirmed this assumption. At the same time it should be noted, that even for $z \approx 5$-6 cm the ratio $I_{S1}/\bar{I}_{S1}(z) \approx 10^7$ and, consequently, amplification in the focal spot must be exceedingly large. With such large values of amplification we cannot exclude the possibility of the occurrence of oscillations in the volume associated with the undisplaced component of Rayleigh scattering.

In conclusion we note that in addition to the very interesting possibilities of observing SRR near electron absorption bands the use of harmonic generators also opens up interesting prospects of the investigation of SRR and of the effects of nonlinear absorption in intense biharmonic fields (both of original and harmonic frequencies).

Among a number of new effects possible here one should include the Raman scattering of the harmonic field by coherent molecular oscillations excited by waves of the fundamental frequency, and the nondegenerate multiphoton absorption (degenerate two-photon absorption has already been observed, cf., for example, [3]). In particular in our experiments we have observed the strong influence of the original radiation ($\lambda = 1.06\mu$) on the SRR process utilizing the second harmonic in benzene. As the intensity of the original radiation entering the cell was increased we recorded a rapid decrease in intensity and a decrease in the number of SRR components, and also a decrease in the intensity of the radiation of the second harmonic. In cyclohexane these effects were much less pronounced.

Table II summarizes the results of the corresponding experiments; T denotes the transparency of the front window of the cell containing the sample at $\lambda = 1.06\mu$; the intensities of the components of SRR (I_{-1}) and of the harmonic (I_0) at the exit from the cell for T = 0 have been taken equal to unity.

The experimental data in the case of benzene can be interpreted as a consequence of nondegenerate two- or three-photon absorption. Cascade

Table II

		T=30 %	T=60 %
Benzene	I_0	24%	6.8%
	I_{-1}	19%	3.2%
Cyclohexane	I_0	40%	40%
	I_{-1}	23%	22%

absorption of photons of $\lambda = 1.06\ \mu$ and $\lambda = 0.53\ \mu$ by CH bonds in a strong field is also possible.

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S AMPLITUDES OF HADRONIC DECAYS OF BARYONS AND SU (6) SYMMETRY

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IN the present letter we examine the S-wave amplitudes of hadronic decays of baryons in the scheme of SU(6) symmetry, which was successfully introduced not long ago for the description of the static characteristics of strong and electromagnetic interactions of baryons and mesons [1-6].

The octuplet (b) and decuplet (d) baryons are incorporated in the representation $\underline{56}$ (B) of SU(6) and the octet of pseudoscalar mesons (P) and the nonet of vector mesons in the representation $\underline{35}$ (M) of the same group.

The transformation properties of the Lagrangian of weak interactions of hadrons (or the associated spurion) in SU(6) require that it transform according to the representation $\underline{35}$ and at the same time belong to the representation ($\underline{1}$, $\underline{8}$) of the group SU(2) $\otimes$ SU(3). It must furthermore be the sixth component of the octuplet of SU(3) [7,8]. Thus the unitary properties of the spurion are characterized by the tensor

$$H_\beta{}^\alpha = \delta_j{}^i h_B{}^A = \delta_j{}^i (\delta_2{}^A \delta_B{}^3 + \delta_B{}^2 \delta_3{}^A). \qquad (1)$$

Here and below Greek indices of a tensor of SU(6) ($\alpha, \beta = 1, \ldots, 6$) correspond to the following pair of indices: lower case Latin letters denote tensor indices of SU(2) and capital Latin letters denote tensor indices of SU(3). For example $\alpha = (i, A)$, $\beta = (j, B)$, $\gamma = (k, C)$ etc.

Recognizing that

$$\underline{35} \otimes \underline{35} = \underline{1} + \underline{35a} + \underline{35s} + \underline{189} + \underline{280} + \underline{\overline{280}} + \underline{405}, \qquad (2)$$

$$\underline{56} \otimes \underline{56} = \underline{1} + \underline{35} + \underline{405} + \underline{2695}, \qquad (3)$$

and also the fact that on the right-hand side of Eq. (2) one of the representations $\underline{35}$ is antisymmetric with respect to a permutation of tensors and the other is symmetric, we obtain for the matrix element of the decay B $\rightarrow$ B + M.

$$M = B^{\alpha\beta\gamma} B^{+}_{\delta\beta\gamma} [f_1 (M_\alpha{}^\varepsilon H_\varepsilon{}^\delta - M_\varepsilon{}^\delta H_\alpha{}^\varepsilon) + f_2 (M_\alpha{}^\varepsilon H_\varepsilon{}^\delta + M_\varepsilon{}^\delta H_\alpha{}^\varepsilon)] + f_3 B^{\alpha\beta\gamma} B^{+}_{\delta\varepsilon\gamma} M_\alpha{}^\delta H_\beta{}^\varepsilon, \qquad (4)$$

where

$$B^{\alpha\beta\gamma} = \chi^{ijk} d^{ABC} + \frac{1}{3\sqrt{2}} [(2\varepsilon^{ij}\chi^k + \varepsilon^{jk}\chi^i)\varepsilon^{ABN} b_N{}^C + (\varepsilon^{ij}\chi^k + 2\varepsilon^{jk}\chi^i)\varepsilon^{BCN} b_N{}^A],$$

$$M_\beta{}^\alpha = i(q_\mu \sigma_\mu)_j{}^i P_B{}^A(q) / |q|.$$

Here χ^i and χ^{ijk} are a first-rank spinors and a symmetrical third rank spinor, respectively. ϵ^{ij} and ϵ^{ABC} are completely antisymmetric tensors of SU(2) and SU(3). σ_μ is a Pauli matrix ($\mu = 1, 2, 3$) and unit matrix, ($\mu = 4$); q_μ is the 4-momentum of the meson ($|q|^2 = q_0^2 - q^2$). We do not include the vector mesons in M_β^α as we will not be concerned with them. SU(6) symmetry has meaning strictly speaking only in the static limit [6], and therefore we examine only the S-wave amplitudes.

The requirement of CP invariance [7,8] of expression (4) gives

$$(f_2)_S = (f_3)_S = 0.$$

From this it follows that the S-wave amplitude $\Sigma^+ \rightarrow n\pi^+$ decay is zero [1)] since this decay, as is easily seen, is due only to the term with f_3 ($\underline{405}$). In this manner we find for the first time a theoretical explanation of the well-known experimental