$$\beta = 8{,}8 \cdot 10^{-27} T_e^{-9/2} \ [\mathrm{cm^6 sec^{-1} eV^{9/2}}].$$

We then obtain $T_{rec} > 10^{-11}$ sec ($T_e \sim 10$ eV, $\lambda = 1.06\ \mu$). It is easy to see that the expansion of a plasma volume of 10^{-6} cm^3 and larger to a density $n_e \sim n_{e.cr}$ is even slower and can be disregarded. Finally, let us estimate the thermalization time of t_{ie} of the electrons and ions. According to [4]

$$t_{ie} \approx \frac{10^{13} A}{n_e L} T_e^{3/2},$$

where A is the atomic weight of the medium and T_e is in keV. At $T_e = 10$ eV and L = 10 this yields $T_{ie} \approx 2 \times 10^{-14}$A sec. Thus, even for heavy atoms the thermalization process is faster than the recombination process. This circumstance, however, should obviously not influence the existence of the predicted effect itself. It may become manifest only in the fact that solids become damaged at the point of focusing (reflection).

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POSSIBILITY OF GENERATING SUB-PICOSECOND PULSES IN STIMULATED RAMAN RADIATION

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We consider in this paper the features of stimulated Raman radiation (SRR) in a gas filling an optical resonator made up of slightly transparent mirrors. It is assumed here that the resonator is excited by an external longitudinal monochromatic beam of given intensity. It is also assumed that the resonator mirrors have good reflection not only at the frequency of the incident beam, but also at the first, second., etc. Stokes frequencies.

The stationary regimes of the optical oscillations in such a resonator, filled with a liquid or solid that is active in the Raman spectrum, were considered in [1, 2]. The distinguishing features of such regimes lie in the fact that the different Stokes components of the SRR interact only as a result of two-photon transitions; there is no parameteric interaction of these components, because the dispersion of the refractive index is sufficiently large in the liquid or solid. Accordingly, the oscillation phases of different Stokes components in the stationary regime are arbitrary and by the same token not connected with one another.

At the same time the dispersion of the refractive index of the gases is sufficiently small. Therefore there will be strong parametric interaction between the different Stokes components in the case of SRR in a gas under the described conditions. We shall show below that in this case the phases of the optical oscillations at different Stokes frequencies will be connected with one another in a definite manner, so that the total output radiation from the resonator constitutes a sequence of ultrashort pulses spaced by intervals $T = 2\pi/\omega_0$, where ω_0 is the frequency difference between neighboring Stokes components. The duration τ of each individual pulse will be of the order of T/N, where N is the total number of generated Stokes components. Since typical values of ω_0 are 100 - 1000 cm^{-1} it follows that, say at $N \geq 10$, pulse durations $\tau \leq 3 \times 10^{-14} - 3 \times 10^{-15}$ become attainable.

Let us consider the system of equations describing the phenomenon of stimulated Raman emission under the foregoing conditions. We assume from the outset that the frequency of the external exciting beam coincides with one of the natural axial modes of the resonator, and that the frequency ω_0 of the transition under consideration is a multiple of the interval $\Delta\omega_{ax}$ between the neighboring modes. In this case, in the absence of the refractive index of the medium has no dispersion, the complex amplitudes Y_q of the oscillations of the various field components in the resonator will satisfy in the stationary regime the following system of algebraic equations [1]:

$$(|Y_{q+1}|^2 - |Y_{q-1}|^2 - \beta_q)\, Y_q + (\sum_{\ell} Y_\ell Y^*_{\ell+1})\, Y_{q+1} - \\ - (\sum_{\ell} Y_{\ell+1} Y^*_\ell)\, Y_{q-1} + f\,\delta_{q0} = 0, \tag{1}$$

where the real positive number β_q is determined by the ratio of the linear loss in the resonator at the frequency of the q-th field component to the probability of the considered two-photon transition; the complex number $f = |f|\exp(i\psi_0)$ is proportional to the complex amplitude of the field oscillations in the external exciting beam; the value q = 0 corresponds to the component having the frequency of this beam; the values q = -1, -2, ..., correspond to the first, second, etc. Stokes components (we assume for simplicity that the mirror reflectances at the anti-Stokes frequencies are small, and therefore we must put in (1) $Y_q = 0$ if $q > 0$). The problem of the stationary resonator-field oscillations thus reduces to the solution of the system (1).

It is quite difficult to obtain a complete solution of this system in the general case. At the same time, it is possible to investigate the ratio of the phases of the quantities $Y_q = |Y_q|\exp(i\phi_q)$. To this end, we can use the following relations that follow from (1):

$$(\beta_0 + |Y_{-1}|^2)\, Y_0 + D^* Y_{-1} = f, \qquad D = \sum_{\ell} Y_\ell Y^*_{\ell+1}\,,$$

$$Y_q Y^*_{q+1} + Y^*_q Y_{q-1} + D\eta_q = 0, \qquad (q = -1, -2, \ldots), \tag{2}$$

$$(2 + \sum_{q \leq -1} \eta_q)\, D = Y_0 Y_{-1}\,, \quad \eta_q = \frac{|Y_{q+1}|^2 - |Y_{q-1}|^2}{|Y_{q+1}|^2 - |Y_{q-1}|^2 - \beta_q}.$$

In the absence of parametric interaction, the equation [2] $2(|Y_{q+1}|^2 - |Y_{q-1}|^2) - \beta_q = 0$ holds for all $q \leq -1$, from which follow in turn, the two inequalities $|Y_{q+1}|^2 - |Y_{q-1}|^2 > 0$ and $|Y_{q+1}|^2 - |Y_{q-1}|^2 - \beta_q < 0$. It is natural to assume that these inequalities remain valid (for all $q \leq -1$) also in the presence of parametric interaction. Taking this into account with the aid of (2), we can easily verify that the phases ϕ_q of the oscillations of the different field components are connected by the relation

$$\phi_q = \phi_0 + |q| (\phi_{-1} - \phi_0) \tag{3}$$

where $\phi_0 = \psi_0$ and ϕ_{-1} is arbitrary. Relation (3) denotes the synchronization of the SRR components, such that the total output radiation from the resonator constitutes a periodic sequence of ultrashort pulses; this sequence has an arbitrary initial phase given by $\phi_q = \phi_0 + |\vec{q}| (\phi_{-1} - \phi_0) + m_q\pi$ (m_q is a definite integer). It signifies that the entire sets of SRR components is broken up into two groups, in each of which a phase relation of the type (3) is satisfied.

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INTERNAL GRAVITATIONAL WAVES IN A SUPERFLUID SOLUTION

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It is known that internal gravitational waves can propagate in ordinary liquids as a result of inhomogeneity of the liquid in the gravitational field [1]. For such waves to exist it is necessary that the thermal equilibrium be established much more slowly than the mechanical equilibrium. It is clear that no such phenomenon can exist in superfluid helium, in which this requirement is not satisfied; any disturbance of the equilibrium can lead here only to waves of first or second sound.

A superfluid solution is analogous in a certain sense to an ordinary liquid, in that a temperature gradient can be produced in it under stationary conditions [2]. We shall show below that gravitational waves can also exist in such a solution.

The conditions for mechanical equilibrium of a superfluid solution in a gravitational waves are

$$\nabla p - \rho \mathbf{g} = 0; \qquad \nabla \mu_4 - \mathbf{g} = 0$$

where p is the pressure, ρ the density, g the free-fall acceleration, and μ_4 the chemical potential of He^4 in the solution.

In a gravitational wave, p and μ_4 differ little from their equilibrium values. This means that p and μ_4 should be regarded as constant when the thermodynamic quantities are differentiated. We assume the temperature gradient to be small enough, in order for the changes of the equilibrium values of the thermodynamic quantities over distances on the order of a wavelength to be small.

The hydrodynamic equations of solutions [2] linearized for the purpose of our problem can be written in the form

$$\frac{\partial \rho'}{\partial t} + \operatorname{div} \mathbf{j}' = 0, \tag{1}$$