$$\nabla T = \frac{\alpha \vec{W}}{ns} T[1 + (\kappa_L/\kappa_e)]^{-1} \frac{\langle\langle \epsilon\tau \rangle\rangle \langle \tau \rangle - \langle\langle \tau \rangle\rangle \langle \epsilon\tau \rangle}{\langle \epsilon^2 \tau \rangle \langle \tau \rangle - \langle \epsilon\tau \rangle^2}, \quad (2)$$

where α is the electronic coefficient of sound absorption, and κ_e the electronic thermal conductivity,

$$\langle \ldots \rangle = -\frac{(2m)^{3/2}}{3\pi^2\hbar^3 n}\int_0^\infty (\ldots)\frac{\partial f_0}{\partial \epsilon}\epsilon^{3/2}\, d\epsilon, \quad \langle\langle \ldots \rangle\rangle = -\frac{1}{f_0\epsilon_0}\int_{\epsilon_0}^\infty \frac{\partial f_0}{\partial \epsilon}\, d\epsilon,$$

and n is the electron density.

Putting $\tau(\epsilon) \sim \epsilon^\nu$ and considering a nondegenerate electron gas, we obtain for $\epsilon_0 \ll kT$

$$\nabla T = -\frac{\alpha \vec{W}}{kns}[1 + (\kappa_L/\kappa_e)]^{-1} \frac{9\sqrt{\pi}}{8} \frac{\Gamma(1+\nu)}{\Gamma[(7/2)+\nu]}. \quad (3)$$

We see that in this case the heat rise is produced in that end of the sample in which the sound "enters" (since $\nu > -1$). In the other limiting case ($\epsilon_0 \gg kT$) we have

$$\nabla T = \frac{\alpha \vec{W}}{kns}[+ (\kappa_L/\kappa_e)]^{-1}(\epsilon_0/kT)^{1+\nu} \frac{\Gamma(s/2)}{\Gamma[(7/2)+\nu]}. \quad (4)$$

Thus, the effect reverses sign when the frequency of the hypersound is raised.

Let us estimate the magnitude of the effect. Putting $\kappa_e \gtrsim \kappa_L$ we get for $\epsilon_0 \lesssim kT$, $m \sim 0.1m_e$, $q \sim 10^6\ cm^{-1}$, $\Xi \sim 10$ eV, and $T \sim 10°K$

$$\left|\frac{\nabla T}{W}\right| \sim 10^4 \left(\frac{deg}{cm}\right)/\left(\frac{W}{cm^2}\right).$$

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AUTORESONANT FEEDBACK IN LASERS

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1. At present there are two types of lasers: with resonant feedback [1] (the feedback is produced by reflection from the mirror system), and with nonresonant feedback [2] (feedback due to back-scattering). In this note we consider the possibility of producing optical lasers in which autoresonant feedback is realized by reflecting the light from a three-dimensional phase lattice produced in the medium by the laser's own light wave.

In a laser with resonant feedback the resonance frequency is determined by the geometry of the mirrors and is dictated by external factors. In a laser with autoresonant feedback the position of the resonance in the established mode is determined by the frequency of the maximum gain of the active medium. This is of interest for the development of optical lasers with stable emission frequency.

2. The three-dimensional periodic variation of the refractive index of the medium in a standing light wave can be the result of diverse mechanisms. For example, in a strong light field the refractive index depends on the intensity I (Kerr effect, electrostriction): $n = n_0 + I(\partial n/\partial I)$. Another possibility is that the medium becomes heated by absorption of the radiation of the standing light waves, with the source of heat having a spatial distribution with period $\lambda/2$. This leads to a periodic change of the temperature and consequently to a change in the refractive index $n = n_0 + \delta T(\partial n/\partial t)$.

The coefficient of reflection of light of wavelength λ from a three-dimensional phase lattice of length ℓ and period $\pi/2$ with change δn in the refractive index amounts to $r \simeq (2\ell/\lambda)\delta n$. Consequently the coefficient of reflection from a phase lattice, resulting from the nonlinearity, is

$$r \simeq \frac{2\ell}{\lambda} I \frac{\partial n}{\partial I} . \tag{1}$$

By way of an example let us consider a lattice in liquid CS_2, for which $\partial n/\partial I = 10^{-7}$ $(MW/cm^2)^{-1}$ [3], and a ruby active medium ($\lambda = 7 \times 10^{-5}$ cm). At a radiation intensity $I = 1$ MW/cm^2 and at a lattice length $\ell = 35$ cm the reflection coefficient is $r \simeq 10\%$. If we use as the second reflector a dense mirror (see the figure), then the threshold gain per passage is $k = r^{-1/2} \simeq 3$. Such values of the intensity and of the gain are perfectly feasible in lasers using luminescent crystals and glasses.

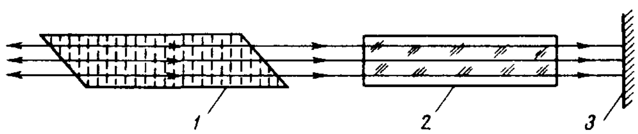

Diagram of laser with autoresonant feedback: 1 -- three-dimensional phase lattice, 2 -- active medium, 3 -- mirror.

The coefficient of reflection of light from a thermal phase lattice in a medium is $r \simeq (2\ell/\lambda)\delta T(\partial n/\partial T)$, where ∂T is the amplitude of the temperature change. If the lattice length ℓ is much larger than the radius a, then

$$\delta T \simeq \frac{P}{\kappa \ell} \left(\frac{\lambda}{a} \right)^2 \qquad (a > \lambda),$$

where P is the radiation power absorbed in the medium and κ is the thermal condictivity of the medium. Consequently the coefficient of reflection from a thermal lattice is

$$r \simeq \frac{2P}{\lambda\kappa} \left(\frac{\lambda}{a} \right)^2 \frac{\partial n}{\partial T} . \tag{2}$$

Let us consider, for example, a thermal lattice in a liquid with $\partial n/\partial T \simeq 10^{-4}$ deg^{-1} and $\kappa \simeq 10^{-3}$ J/sec-cm-deg, of dimensions $2a = 1$ cm and $\ell = 10$ cm, produced by absorption of a radiation power $P = 10^{-2}$ W at a wavelength $\lambda = 3.5$ μ. In this case $\delta T \simeq 10^{-7}$ deg and $r \simeq 10^{-6}$, and the threshold gain per passage is $k \simeq 10^{-3}$. This gain is perfectly attainable with several transitions in gaseous active media, for example in Xe at $\lambda = 3.5$ μ, where the gain is 50 dB/m [4].

3. A feature of a laser with autoresonant feedback is a hard self-excitation mode (similar to a laser with an atomic beam [5]). For self-excitation of such a laser it is necessary to excite first generation in one axial mode in a laser with an ordinary Fabry-Perot resonator, inside of which is placed an optical medium suitable for the formation of the phase lattice; after a radiation power sufficient for self-excitation by the phase lattice is attained, the reflection from one mirror is eliminated. The generation will occur first at the frequency of the resonant mode of the Fabry-Perot resonator, but gradually the generation frequency will shift toward the center of the atomic line. The process of shifting the generation frequency depends essentially on the inertia of the phase lattice. A nonlinear phase lattice has practically no inertia ($\tau < 10^{-10}$ sec). However, the inertia of a thermal phase lattice is appreciable, and this necessitates careful insulation of the laser against mechanical vibration and other factors capable of rapidly changing the distance between the mirror and the phase lattice. In the steady state the generation frequency is determined by the frequency of the maximum gain. Therefore a laser with autoresonant feedback is of interest for the development of optical lasers with stable radiation frequency.

4. Three-dimensional phase lattices produced by the laser radiation field can also be used in ordinary lasers for the selection of axial modes.

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THE TRANSPARENT HEXAGONAL FERRIMAGNET $RbNiF_3$

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Substances of the type ABF_3, where A^{1+} is a diamagnetic ion and B^{2+} is an ion of a 3d-group metal, usually have a perovskite structure and are compensated antiferromagnets which sometimes have weak ferromagnetism because of the small noncollinearity of the magnetic moments.

However, $RbNiF_3$ [1,2] and $CsMnF_3$ [1,3] have a hexagonal structure, similar to the hexagonal modification of $BaTiO_3$ (space group P6/mmc). In this structure the B ions are in two non-equivalent positions. One-third of these ions occupies fluorine-ion octahedra connected with their vertices to other octahedra, and two-thirds are in octahedra interconnected by their faces.