T_c in the substance of a cold white dwarf[1]. The correct formula (7) lowers this estimate by more than one order of magnitude (at a density on the order of 10 g/cm^3). It must be borne in mind, however, that the "jelly" model is applicable to a solid, if at all, only at extremely high compressions, when the contribution of the transverse modes and of the umklapp processes is suppressed. Moreover, even under these conditions the "jelly" model is incapable of describing the interaction at large momentum transfers, which play an important role in our case. Therefore the discussed estimate of T_c can vary in either direction. At any rate, it can be firmly asserted that superconductivity of the substance in the central part of a white dwarf of the ordinary type is completely excluded, owing to the exponential smallness of T_c (see (7) and (5))[2]. As to the superconducting regions on the periphery of cold white dwarfs, referred to in [4], their existence is quite possible.

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OPTICAL FREQUENCY STANDARD WITH NONLINEARLY ABSORBING GAS CELL

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1. In [1, 2] we proposed to obtain ultrahigh frequency stability of a laser by using a narrow Lamb dip in a resonantly-absorbing cell with a molecular gas at low pressure. In this case it is possible to stabilize the frequency against the power peak[3] with the aid of external feedback [2], or else obtain self-stabilization of the frequency as a result of the nonlinear frequency pulling [1]. Stabilization against the power peak was first realized in an He-Ne laser operating at λ = 6328 Å with an Ne absorbing cell [2, 4], and recently in an He-Ne laser at 3.39 μ with a CH_4 absorbing cell [5].

The purpose of the present paper is to indicate new possibilities of obtaining ultrahigh

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1) A general analysis of superconductivity of strongly compressed matter [5] does not lead to any unambiguous results.

2) Just the opposite is concluded in a just-published paper [6], where a non-exponential formula, which we believe is wrong, was obtained for T_c. In the derivation of this formula the relative changes of the electron and ion densities are assumed equal, an assumption valid only in the case of strong coupling, $\alpha \geq 1$, if at all (in strongly compressed matter, to the contrary, $\alpha \ll 1$). As to the "jelly" model, which essentially is involved in the discussed paper, its correct application likewise leads to an exponential formula (see (7)).

3) The power peak in an He-Ne laser with an absorbing Ne cell was observed in [3].

frequency stability with the aid of nonlinear absorption in a gas. We shall show below that nonlinear frequency pulling of a laser, when the pulling region exceeds the distance between the neighboring axial modes, leads to absolute self-stabilization of the frequency without any adjustment of the resonator length. We shall show that in the case of a strong traveling wave and a weak opposing wave we can obtain a dip in the center of the absorption line even at very strong saturation, when there is practically no dip for the standing wave.

2. In the self-stabilization regime, the dependence of the generation frequency ν on the resonator frequency Ω is given by [1]:

$$\nu = \omega_b + S_1(\Omega - \omega_b) \quad \text{for } |\nu - \omega_b| \lesssim \Delta\omega_b, \tag{1}$$

where ω_b is the frequency of the center of absorption line, $\Delta\omega_b$ the width of the dip in the absorption line, $S_1 = (8/p_b)(\Delta\omega_b/\kappa_b c)$ is the factor of nonlinear pulling of the frequency towards the center of dip, $p_b = bE^2 \ll 1$ is the absorption saturation parameter, κ_b is the initial absorption per unit length, distributed over the laser length, and c is the speed of light. The condition $|\nu-\omega_b| \lesssim \Delta\omega_b$ imposes a limitation on the maximum permissible drift of the resonator frequency Ω without loss of self-stabilization:

$$|\Omega - \omega_b| < \Delta\nu_{max} \approx \Delta\omega_b/S_1 = (p_b/8)\kappa_b c. \tag{2}$$

This condition requires that the resonator length be stabilized with accuracy

However, this limitation can be eliminated by using a Fabry-Perot resonator having a sequence of natural frequencies spaced c/2L apart[1)], where L is the resonator length. In this case the maximum drift of the resonator frequency cannot exceed half the distance between modes, since frequency pulling by one resonance is replaced by pulling towards the next resonance, etc. Consequently, when $\Delta\nu_{max} > c/4L$, self-stabilization is realized regardless of the resonator length, i.e., there is no need to stabilize the resonator length. The condition for such a regime can be represented in the form

$$\mu = (p_b/2)\ln(1/\eta_0) > 1, \tag{3}$$

where $\eta_0 = \exp(-\kappa_b L)$ is the initial transmission of the absorbing cell. In such a regime, the frequency stability equals:

$$\Delta\nu/\nu = 1/\mu Q_b, \tag{4}$$

where $Q_b = \omega_b/\Delta\omega_b$ is the figure of merit of the dip.

The absolute self-stabilization condition (3) can be satisfied at a rather high Q of the dip ($Q_b \approx 10^9 - 10^{10}$), using a sufficiently long absorbing cell at low pressure, such that $\eta_0 = 10^{-1}$. This means that it is possible to produce an optical frequency standard with stability better than 10^{-9} without any tuning or stabilization elements.

3. The frequency stability is determined by the depth and width of the dip, which

[1)] We consider only axial modes, since the formation of a dip by non-axial modes has a different character [6].

depends strongly on the degree of saturation of the absorption. The width of the dip $\Delta\omega_b$ increases in the field in proportion to $(1 + bE^2)^{1/2}$ [7, 8]. The depth of the dip is determined by the difference of the coefficients of the saturated absorption at the center of the dip ($|\nu - \omega_b| << \Delta\omega_b$) and far from it ($|\nu - \omega_b| << \Delta\omega_b$). In the case of a standing wave, the difference of the absorption coefficients $\Delta\kappa_b$ is equal to

$$\Delta\kappa_b = 2\kappa_b \quad \frac{1}{\sqrt{1 + bE^2}} - \frac{1}{\sqrt{1 + 2bE^2}} \quad , \tag{5}$$

where the coefficient 2 is the result of passing in both directions. The depth of the dip $\rho = \Delta\kappa_b/\kappa_b$ is maximal ($\rho_m = 0.26$) when $bE^2 \approx 1.5$. When the saturation parameter bE^2 is increased, the depth of the dip decreases and its width increases. This excludes the possibility of obtaining high stability when the difference between the saturation parameters of the amplifying and absorbing media is large, for example in molecular lasers with a molecular absorbing cell at low pressure ($CO_2 - SF_6$, $CO_2 - BCl_3$, etc.).

However, this difficulty is eliminated when a quasi-traveling wave is used, such that the saturation of the absorption is caused only by the strong traveling wave ($bE_1^2 \gtrsim 1$), while the wave traveling in the opposite direction is weak ($bE_2^2 << 1$). The dip at the center of the absorption line arises in this case as a result of the fact that the weak traveling wave experiences a minimum of absorption when it interacts with molecules that are saturated by the opposing strong traveling wave, i.e., when $\nu = \omega_b$. The depth of the dip is determined in this case by the expression

$$\Delta\kappa_b = \kappa_b\left(1 - \frac{1}{\sqrt{1 + bE_1^2}}\right). \tag{6}$$

At small saturation, the depth of the dip in the quasi-traveling wave is half as large as in the standing wave, but when the field is increased the depth of the dip, unlike the case of the standing wave, gradually increases also in the case of strong saturation, $\rho_m = 1.0$. Thus, the use of a quasi-traveling wave line even in the case of very strong saturation. This pertains both to the case of a quasi-traveling wave and a laser with low-Q resonator, and to the case of an external non-linearly-absorbing gas cell [4].

4. The proposed schemes make it possible to obtain, by non-linear absorption methods in a gas, a frequency stability on the order of 10^{-9} - 10^{10} without any tuning elements, and 10^{-12} - 10^{-13} when the frequency is tuned to the center of the dip in a molecularly-absorbing cell with a low-pressure gas.

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