When the cesium source of our instrument was well conditioned and the pressure of the adsorption-active gases dropped to 10^{-11} Torr, the first ordered structure of the cesium film observed at 300°K was p(2 × 2). The maximum of the intensity of the corresponding diffraction beams correlates with the passage of the work function through a minimum. This is followed by a gradual increase in the cesium-film density, which terminates in the formation of a close-packed monolayer having a pseudo-hexagonal structure matched to the substrate at an adsorbed-atom concentration $n = 5 \times 10^{14}$ cm^{-2} (Fig. 1c).

Thus, the results obtained under clean experimental conditions do not confirm the notion advanced in [1, 2]. They lead to an optimal cesium-atom concentration 2.5×10^{14} cm^{-2} on the (100) face of tungsten, a value that agrees well with independent measurements [8]. This coating has half the cesium-atom concentration in a close-packed monolayer on the investigated surface. The changes of the work function terminate mainly with formation of the first monolayer, which is obviously connected with small field-screening length in the metal.

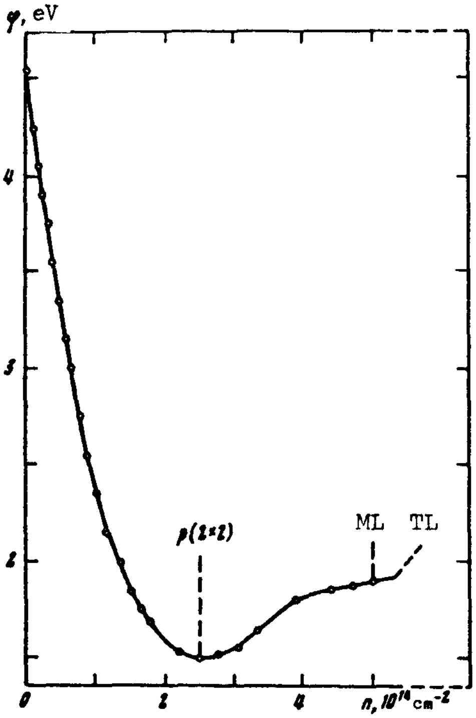

Fig. 2. Correlation between work function and surface structures for the Cs-W(100) system: n - surface concentration of cesium atoms, ML - close-packed monolayer, TL - thick layer of cesium atoms.

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FREQUENCY STABILIZATION OF A GAS LASER USING MODE-INTERACTION EFFECTS

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The method widely used presently to stabilize the frequencies of gas lasers is that of a nonlinearly-absorbing cell, which is based on the formation of narrow resonances upon saturation of the absorption of a low-pressure gas [1]. Thus, for an He-Ne laser operating at 3.39 μ and equipped with a methane absorbing cell, the long-time frequency stability obtained under laboratory conditions is $\sim 10^{-12}$ [2, 3]. In addition, a stability $\sim 10^{-13}$ at an average time of 100 sec was reported in [4].

Further progress in this stabilization method is connected with the possibilities of narrowing down the resonance and increasing its amplitude, as first realized in [5] on the basis of the competition between traveling waves of a ring laser.

We report here results obtained on the stabilization of the frequency of an He-Ne laser ($\lambda = 3.39\ \mu$) using the inverted Lamb dip in methane and the interaction of the axial modes of an anisotropic Fabry-Perot resonator. As shown in [6], a stable two-mode regime with strong coupling occurs in such a laser for two axial modes with a distance ω_{12} much smaller than the homogeneous line width in the region of symmetrical tuning. The latter, in particular, means that the presence of a slight difference in the loss (or gain) of the interacting modes leads to a sharp redistribution of their intensity. An absorbing cell can be used to vary selectively the losses for the particular mode whose frequency coincides with the center ω_- of the absorption line. A similar effect can occur when the modes are symmetrical with respect to ω_-.

Indeed, it can be shown that the intensity of one mode in a two-mode laser with an absorbing cell is determined by the expression

$$E_i^2 = \frac{(\alpha_i \beta_j - \alpha_j \theta_{ij}) - \alpha_i \beta'_j + \alpha_j \theta'_{ij}}{(\beta_i \beta_j - \theta_{ij} \theta_{ji}) - \beta_j \beta_i - \beta_i \beta'_j + \theta'_{ij} (\theta_{ij} + \theta_{ji})}; \tag{1}$$

$$(i, j = 1, 2)$$

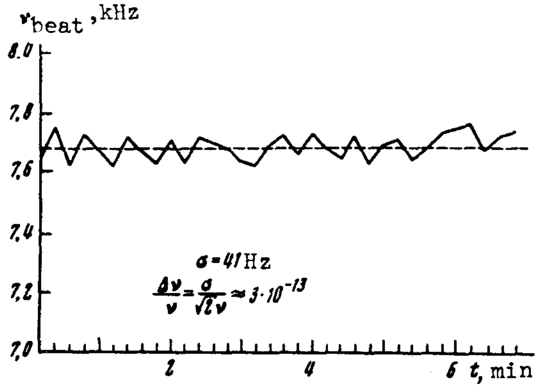
where α_i, β_i, and θ_{ij} are the polarizability coefficients of the medium [7]. The presence of a methane cell is formally taken into account by introducing the increment β'_i and θ'_{ij} to the coefficients β_i and θ_{ij} ($\beta'_i \ll \beta_i$, $\theta'_{ij} \ll \theta_{ij}$). Neglecting the non-resonant terms, these increments can be represented in the form

$$\beta'_i = B \frac{\gamma_-^2}{\gamma_-^2 + (\omega_i - \omega_-)^2}; \quad \theta'_{ij} = B \frac{\gamma_-^2}{\gamma_-^2 + \left(\omega_i - \omega_- - \frac{\omega_{12}}{2}\right)}, \tag{2}$$

where B is the constant determined by the spectroscopic characteristics of the working CH_4 transition, the level populations, etc., and γ_- is the homogeneous CH_4 line width. It is easy to see from (1) that in the field of one mode there exist three sharp structures corresponding to the resonances of the functions β'_i, θ'_{ij}, and β'_j. We confine ourselves to the resonance β'_i, and for simplicity we consider the case of a symmetrical arrangement of the modes relative to the center of the gain line. Neglecting terms with θ'_{ij} and β'_j, we obtain from (1)

$$E_i^2 = \frac{\alpha(1 - 2x/\Delta)}{2\beta\left(1 - B\frac{\gamma_-^2}{\gamma_-^2 + (\omega_i - \omega_-)^2}\right)} \tag{3}$$

where α and β are the polarizability coefficients taken in the symmetrical position, x is the deviation of the mode from this position, and Δ is the bandwidth of stable two-mode generation [6]. Assuming $\gamma_- \ll \Delta$ and a strong intermode coupling, meaning that the difference is close to zero, E_i^2 is a Lorentzian with width $\Gamma = \gamma\sqrt{\varepsilon}$, where $\varepsilon = 1 - [B/2(\beta - \theta)]$. It is realistic to expect a value of ε close to 10^{-2}, meaning a considerable narrowing of the resonance and a sharp increase of its contrast in comparison with the single-mode regime. The



possibility of experimentally realizing the described effects has been demonstrated in [8] for an He-Ne laser (λ = 3.39 μ) having an internal methane cell and operating in the regime of stable generation of two axial modes with mutually orthogonal polarizations.

In our investigation, the indicated laser was stabilized in frequency relative to the contrast peak at ω_- with the aid of an external system of automatic frequency control.

The setup for the measurement of the long-time stability was similar to that used in [9], and consisted of two indentical lasers whose emission was mixed in a photodetector. The obtained frequency-difference beat signal was measured with a frequency meter at an averaging time of 10 sec. The figure shows the best frequency drift over 7 min. The mean-squared deviation from the average value is 40 Hz, corresponding to a long-time stability of one laser $\sim 3 \times 10^{-13}$.

Besides measuring the long-time stability of the laser, we estimated experimentally the frequency reproducibility that can be expected in this method. As follows from (1), the center of resonance in the two-mode regime deviates from ω_- by an amount $\delta = \varepsilon\gamma_-^2/2\Delta$, which amounts to $\sim$100 Hz at the customarily employed laser regimes. Measurements of the dependence of δ on the working parameters of the setup (gas pressure, pump, ω_{12}) show that if these parameters are maintained accurate within 1%, then the change of δ is several Hz. The position of the center of the CH_4 line is fixed here with accuracy $\sim$10 Hz, corresponding to a laser frequency reproducibility $\sim 10^{-13}$. Further optimization of the characteristics of the resonances and increase of interference immunity of the apparatus will permit, in our opinion, an improvement of the long-time stability of the frequency to $\sim 10^{-14}$.

In conclusion we note that the highly-stabilized two-frequency generators under consideration, which operate with orthogonally polarized modes whose relative distance can be varied from several to several hundred MHz, are extremely promising for laser interferometry.

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