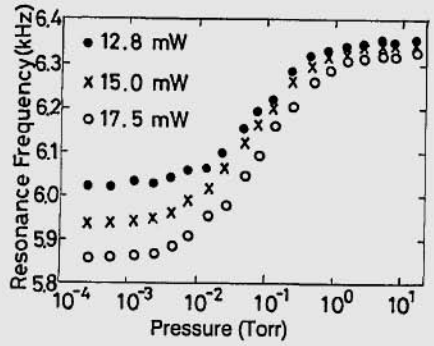

Fig. 2. Resonance frequency as a function of the pressure.

from 10^{-4} to 1 Torr. This shows the possibility for optical pressure sensing in the medium vacuum region by frequency measurements. The resonance frequency for a vibrating object, such as the quartz oscillator, was constant, generally in the medium vacuum region.[4] This shift is a particular characteristic of the vibration by the drum effect and is explained by the rising temperature at the vibrating plate. The heat given by the laser diode is released through the base thick plate and through the gas around the PET plate. The thermal conduction through the gas is independent of the pressure in the viscosity flow region but is

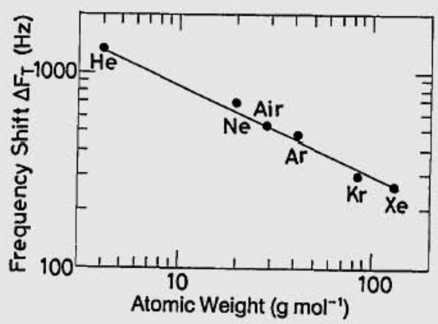

Fig. 3. Total resonance frequency shift ΔF_T in the medium vacuum region as a function of the atomic weight.

dependent on that in the molecular flow region theoretically. From this it is believed that the temperature of the plate rises with decreasing pressure in the medium vacuum region. The resonance frequency was reduced by the looseness of the tension caused by the rising temperature at the vibrating plate, as was already investigated by Thornton *et al.*[5] The higher power of the laser diode caused a larger resonance frequency shift because of a higher rising temperature. If this shift is due to the thermal conduction of gas it has the different value for the different gas. Figure 3 shows the total frequency shift ΔF_T in the medium vacuum region as a function of the atomic weight. The thermal conduction is inversely proportional to the root of the atomic weight generally. Since the slope of the line in Fig. 3 is approximately equal to $-1/2$ it is believed that this frequency shift is caused by the thermal conduction of the ambient gas. For the other gases the frequency shift can be estimated from this figure. However, for a gas of unknown composition it is impossible to determine the pressure exactly by using this method. This is a common disadvantage for a thermal conduction-type vacuum gauge, such as the Pirani gauge.

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Linear Gaussian intensity distributions synthesized by reflection on elliptic cylinders: a proposal

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A procedure for obtaining linear (one-dimensional) Gaussian intensity distributions over certain plane regions is proposed. The method is based on the reflection of plane beams on elliptic cylinders.

As is well known, the TEM_{00} Hermite (or Laguerre) modes produced in common laser cavities provide circular Gaussian intensity distributions at any plane that is normal to the propagation direction of the beam (the resonator axis). However, linear Gaussian distributions (of use, for example, for generating linear Gaussian apertures[1] that could be employed for improving the beam quality[2] of astigmatic fields emerging from diode lasers[3]) cannot be obtained as the output of a laser resonator. In this Note we propose a simple method by means of which such intensity distributions can be synthesized with accuracy over certain plane regions. Nonmonochromatic sources could be used, with the subsequent advantage of removing certain typical harmful laser effects, such as speckle or ringing.

The procedure we propose is sketched in Fig. 1. A plane polychromatic (wide spectrum) light beam propagating along the z direction impinges on a reflecting surface (elliptic cylinder) whose cross section at any plane normal to the y axis is an ellipse E. The reflected beam is finally collected over the receiver plane $x = x_0$ (which contains the z axis in Fig. 1). From the geometry of the system, since all

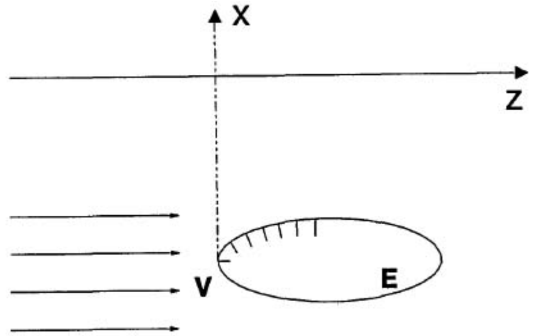

Fig. 1. Schematic diagram of the system: the major and minor axes of the ellipse E are parallel to the z axis and the x axis, respectively. Plane $z = 0$ is tangent to the ellipse at its vertex V.

the incident rays are parallel to the z axis all the reflected rays are contained in planes perpendicular to the y axis. In other words only meridional rays should be considered and the reflected light distribution will be independent of the y coordinate. Note that, from a practical point of view, it is not difficult to achieve an incident well-collimated light beam, at least over the regions we consider here. On the other hand, since grazing incidence is explicitly excluded, no appreciable edge diffraction would appear. Also, for the sake of simplicity, we assume that reflectivity remains essentially constant for the incidence angles and wavelength intervals we consider here (in fact, reflectivity changes do not exceed 2%, which can be reduced further by appropriately selecting coating materials and beam polarization).

From the above, to calculate the reflected intensity at an arbitrary plane $x = x_0$ a geometric optics (nonparaxial) analysis could be applied.[4–6] In this way, after we perform the numerical computations (taking into account the ratio of the intensities at any two points of a ray[7]) the reflected intensity distribution at the receiver area normal to the x-axis is plotted as in Fig. 2 for an arbitrary y (recall that the intensity remains constant along the y direction). The value of the eccentricity that defines the optimized shape of the ellipse is found to be 0.84. Comparison of the calculated intensity with a Gaussian intensity profile shows good agreement over a broad region (20-cm length for $x_0 = 6$ cm). Note, however, that in order to attain the best fit we have introduced, in ordinates, a bias term that has been added to the Gaussian profile. In other words, the continuous curve is the sum of a Gaussian function plus a constant. This bias can, however, be removed, for example, in the photographic procedure that is required for producing a prescribed linear Gaussian aperture (the plate should be developed in the linear region of the transmittance versus exposition curve).

We finally remark that the width of our Gaussian intensity distribution can be easily controlled at will; it suffices to modify the relative position of the receiver surface with respect to the elliptic cylinder in order to change the width of the simulated linear Gaussian distribution. The peak reflected intensity is selected by suitably choosing the intensity of the input beam.

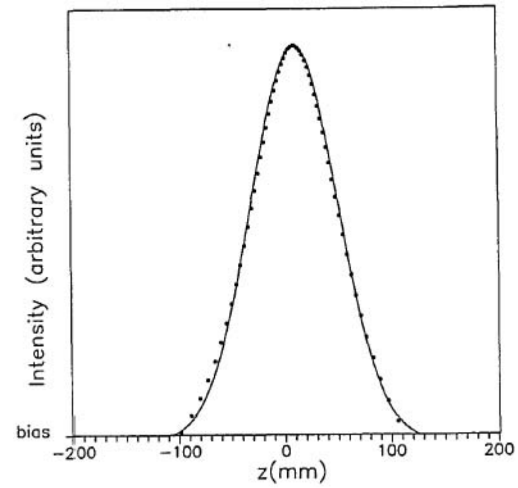

Fig. 2. Comparison between a Gaussian function (plus a constant) and the reflected intensity at the plane $x = 6$ cm (this is the distance between V and the z axis). The eccentricity of the optimized ellipse is 0.84. The major axis has been chosen to be 1.33 cm in length.

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