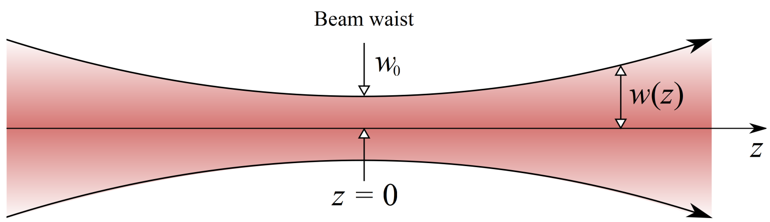
Fall 2011

WPE Problem 7: Optics

November 5, 2011

Consider a Gaussian beam whose width (beam radius) $W(z)$ and wavefront radius of curvature $R(z)$ are given by

$$W(z) = \sqrt{W_0^2 + \frac{\lambda^2 z^2}{\pi^2 W_0^2}} \qquad R(z) = z\left[1 + \left(\frac{\pi W_0^2}{\lambda z}\right)^2\right]$$



Here λ is the wavelength and W_0 is the beam radius at the center.

(a) (1 points) The axial distance within which the beam width is no greater than $\sqrt{2}$ times its minimum value is known as the depth of focus. For a HeNe wavelength, $\lambda = 633$ nm, calculate a depth of focus for a Gaussian beam with a spot diameter $2 \times W_0 = 2$ cm.

<u>For (b), (c) and (d)</u>: A symmetrical cavity is formed by two concave spherical mirrors, each of radius of curvature R and separated by a distance d.

(b) (1.5 points) Calculate the spot size, $2W_0$, at the center of the cavity, as a function of R, d, and λ.

One of the most commonly used cavity configuration is known as the confocal resonator, which consists of two identical concave spherical mirrors with R = d.

(c) (0.25 points) What is the advantage of using the confocal cavity compared with a cavity consisting of flat parallel mirrors?

(d) (1.25 points) In the case of a confocal resonator with R = d, calculate the spot size at the center and the spot size at either mirror (i.e. z = ± d/2).