Semester S1 – Module 3

Module Fundamentals of coherent photonics

TUTORIAL

LASERS_2

LASER CAVITY AND GAUSSIAN BEAM

Exercise 1

Let us consider a resonator with two concave spherical mirrors of radii of curvature R_1 and R_2. They are separated by the distance L (see Figure 1). It is assumed that the laser operates with the fundamental Gaussian mode.

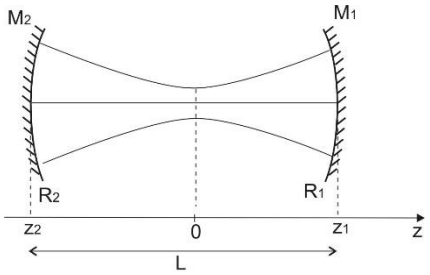


Figure 1

1. Resonator with identical mirrors : $R=R_1=R_2$
   a. From geometric considerations, show that the waist of the Gaussian beam is located in the middle of the cavity.
   b. Determine the expression of the Rayleigh length of the Gaussian beam of the cavity as a function of L and R. From this, deduce the stability condition of this type of resonator.
2. Confocal resonator: R=L

a. Determine the location and the diameter of the waist according to λ and L, as well as the diameter of the beam on the mirrors. Discuss.

b. Make the numerical applications for λ=1µm and L=1m.

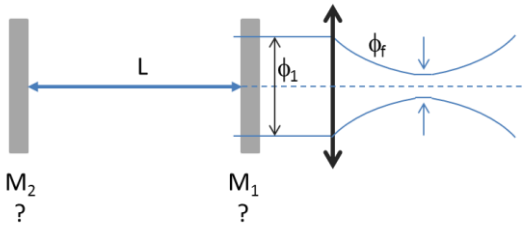
3. Resonator with a plane mirror and a concave one: $R_2=\infty$ et $R_1=R$

a. Determine le location and the diameter of the beam waist according to λ, R et L. Discuss.

b. Make the numerical application for λ=1µm, R=2m and L=1m.

Exercise 2

The Gaussian beam from a Nd:YAG laser (wavelength of 1µm) is focused using a thin lens with a focal length f = 15 mm to obtain a power density of 1.7MW/cm^2 at the focusing point using a power of 5W.



1. Compute the value of the beam diameter, ϕ_1, before the lens, onto the mirror M_1.
2. Considering that M_1 is located at 5 cm from the lens, deduce the type of the M_1 mirror (plane, convex, concave) and the one of mirror M_2.
3. Compute the mode diameter onto M_2 knowing the cavity length of 50 cm.

$$\text{Reminder: } \omega^2(z) = \omega_0^2(z)\left[1+\frac{z^2}{\alpha^2}\right], R(z) = z\left[1+\frac{\alpha^2}{z^2}\right], \alpha = \frac{\pi\omega_0^2}{\lambda}.$$
