Assignment #4

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1 Problem 1

Draw the curves similar to Fig. 2.4 for the range of $0 < d < 2R$ with the parameters that you are interested in e.g. $R = 15cm$, $\lambda = 0.37\mu m$ or $R = 20cm$, $\lambda = 0.78\mu$m or $R = 10cm$, $\lambda = 0.532\mu m$.

Solution

According to eqaution 2.21 and 2.22 in textbook we know that,

$$\begin{aligned} \omega^2 &= \left(\frac{\lambda R}{n\pi}\right)\sqrt{\frac{d}{2R-d}} \\ \omega_0^2 &= \left(\frac{\lambda}{n\pi}\right)\sqrt{\frac{dR}{2} - \frac{d^2}{4}} \end{aligned} \tag{1}$$

Choose the parameters as $R = 20cm$, $\lambda = 0.78\mu$,we can get the following figure.

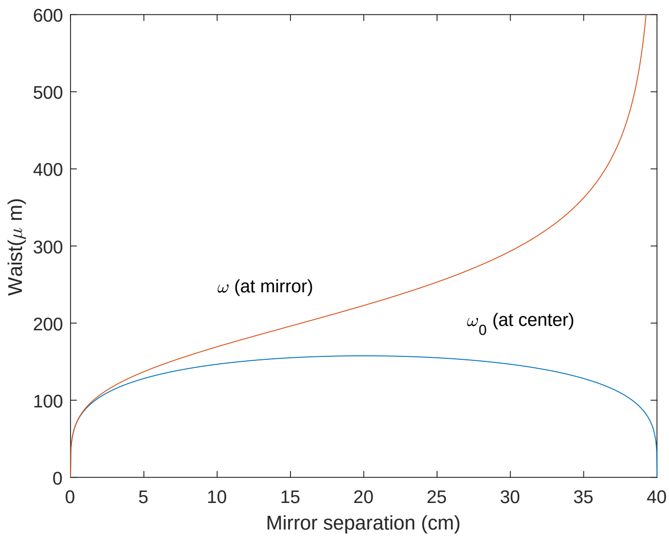

Figure 1: Figure of ω

2 Problem 2

(a) Find the stability condition in terms of $d_3, d_1 + 2d_2$, and R. (b) Find the small waist within d_3 range and the large waist within d_1 in terms of g_1 $(= 1 - (d_1 + 2d_2)/R)$, $g_2 (= 1 - d_3/R)$ and R.

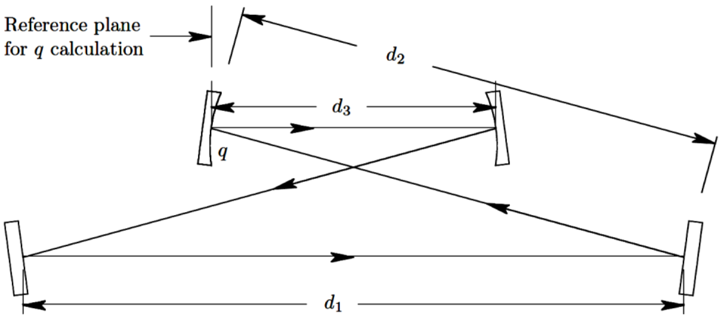

Figure 2: Optical cavity

Solution

According to figure 2 we could get the ABCD matrix as,

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ -\frac{2}{R} & 1 \end{pmatrix} \begin{pmatrix} 1 & d_1 + 2d_2 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ -\frac{2}{R} & 1 \end{pmatrix} \begin{pmatrix} 1 & d_3 \\ 0 & 1 \end{pmatrix}$$
$$= \begin{pmatrix} 2g_1 - 1 & R(g_1 + g_2 - 2g_1 g_2) \\ -\frac{4g_1}{R} & 4g_1 g_2 - 2g_1 - 1 \end{pmatrix} \tag{2}$$

where

$$g_1 = 1 - \frac{d_1 + 2d_2}{R}$$
$$g_2 = 1 - \frac{d_3}{R} \tag{3}$$

It is the same as what have sloved in two mirror situation which means we could get the stablity condition as,

$$|A + D| \leq 2 \Rightarrow |4g_1 g_2 - 2| \leq 2 \Rightarrow |0 \leq g_1 g_2 \leq 1 \tag{4}$$