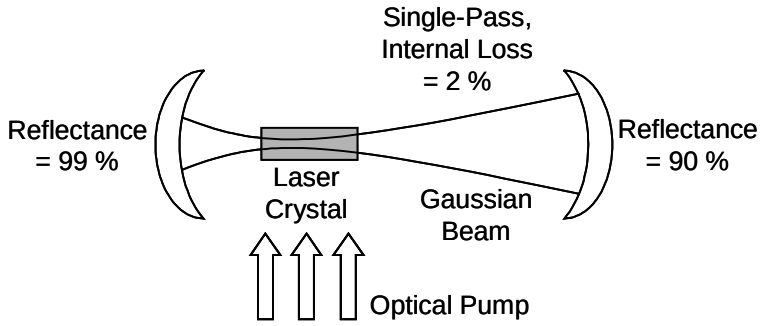
OPTI 500 D, Spring 2012, Homework #1
Due February 6th, 2012

1.



The optical loss inside the cavity of a solid state laser, illustrated above, is 2 % per pass due to light scattering in the laser crystal. The optical beam in the laser has a spot size much smaller than the cross-section of the crystal. The gain coefficient in the crystal is 0.13 cm^{-1}. Find the minimum length of the crystal for lasing. (10 points)

2. In the absence of an applied electric field, GaAs is isotropic and the index ellipsoid is given by:

$$\frac{x^2}{n^2}+\frac{y^2}{n^2}+\frac{z^2}{n^2}=1,$$

where x, y, and z coincide with crystal axes. The r matrix for GaAs is:

$$\vec{\vec{r}}=\begin{bmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0 & 0\\ r_{41} & 0 & 0\\ 0 & r_{41} & 0\\ 0 & 0 & r_{41}\end{bmatrix}.$$

a. Sketch the projection of the index ellipsoid in the x-y plane for GaAs when an electric field is applied in the z-direction. (10 points)

b. Show that a new set of axes x', y', and z' defined by:

$$x=x'\cos\left(45^\circ\right)+y'\sin\left(45^\circ\right)$$

$$y=-x'\sin\left(45^\circ\right)+y'\cos\left(45^\circ\right)$$

$$z=z'$$

are the principal axes for GaAs with an electric field applied along the z-axis. (10 points)