Experiment 2: Thin Divergent Lens Phys 431

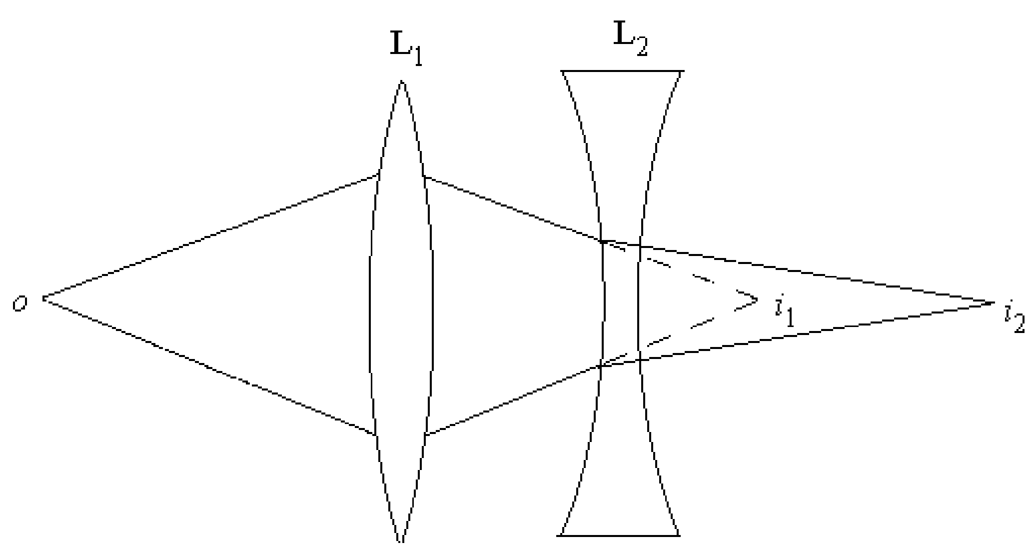
For a divergent lens, all the principles and conventions we use for the convergent lens apply equally well. The key difference is that a divergent lens cannot by itself form a real image of a real object. Hence, in this experiment we will measure f using a virtual object. The virtual object and real image are on the *same* side of the lens. Just like last week, you will measure the radius of curvature and focal length, and then calculate the index of refraction of the glass. Don't forget to calculate errors in your measurements.

In this experiment you will also gain some familiarity with another tool of the trade, the laser. Remember, never look directly into the laser. We all know that a laser has a well-defined wavelength. This will remove a source of blurring known as chromatic aberration, and allow for more precise measurements. The laser also appears to produce a well-defined beam of parallel rays. That is to say, it appears to be a collimated source. You will see if this is really the case. Then you will use a telescope to expand or reduce the beam.

Procedure:

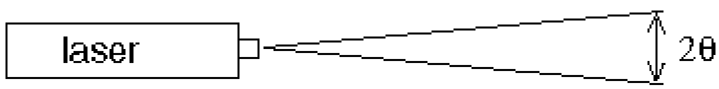
A. Use a spherometer to measure the radius of curvature for your divergent lens.
B. Use a convergent lens L_1 to form a sharp image i_1 of your object on a screen using the lamp as a source. Next, place a divergent lens L_2 between L_1 and i_1 as indicated below. Measure the distances to i_1 and i_2 to calculate f for the divergent lens. Repeat this for 3 positions of the i_2 by changing the lens-screen separation in units of about 1 cm. Find your best value for the focal length using the thin-lens equation.

Q1 How does your best value for f compare to the value from A?



C. Calculate the index of refraction (including uncertainty) for the glass of your lens using the lensmaker's equation. Compare this to the value you found last week.

D. Now switch your light source to the laser. If the beam from the laser is not perfectly collimated, the diverging rays must spread over some angle θ. Project the beam from your He-Ne laser on to a distant screen and measure the radius of the maximum spot size that can be discerned.



Q2 Is the spot of uniform brightness? Calculate θ in degrees and radians.

E. Using your converging and diverging lenses and the equation for a Galilean telescope make a laser beam expander/reducer. Measure the beam diameter before and at several distances beyond the lenses.

Q3 Does the beam diverge?

Q4 What is the magnification?

Appendix: Misc Equations

The image position for a two lens combination is

$$s_i = \frac{f_2 d - \dfrac{f_2 s_o f_1}{(s_o - f_1)}}{d - f_2 - \dfrac{s_o f_1}{(s_o - f_1)}}$$

Where s_o is the position of the object (before either lens), d is the distance between the lenses. If $s_o = \infty$, $d = f_1 + f_2$, then $s_i = \infty$. This is a Galilean telescope.