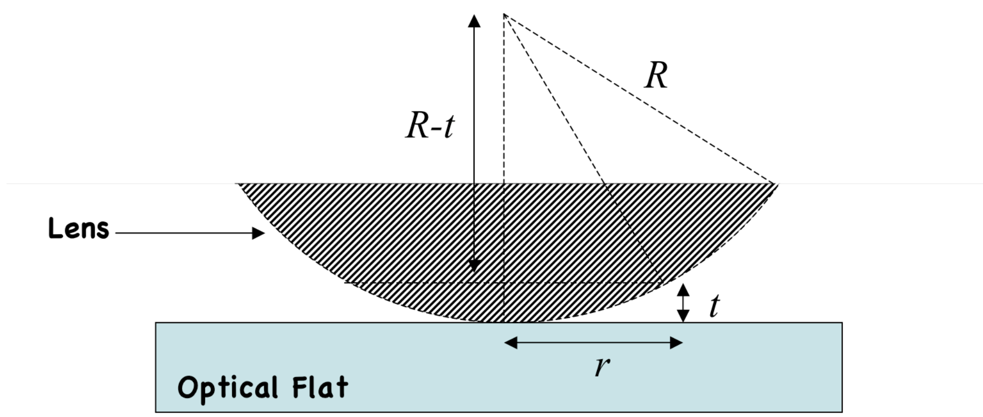
Optics Lab 6: Newton's Rings

In order to prepare for this lab, it is essential that you review your textbook. See pages 180-182 in Pedrotti[3].

The essential geometry for producing Newton's rings is shown in the figure below.



An air wedge, formed between the spherical surface and an optically flat surface, is illuminated with normally incident monochromatic light, such as from a laser, or from a sodium or mercury lamp with a filter.

Equal-thickness contours for a perfectly spherical surface, and therefore the fringes viewed, are concentric circles around the point of contact with the optical flat. At that point, $t=0$, and the path difference between reflected rays is $\lambda/2$, as a result of reflection. The center of the fringe pattern thus appears dark, and gives $m=0$ for the order of the destructive interference.

Irregularities in the surface of the lens show up as distortions in the concentric ring pattern. This arrangement can also be used as an optical means of measuring the radius of curvature of the lens surface. A geometrical relation exists between the radius r_m of the m-th order dark fringe, the corresponding air-film thickness t_m, and the radius of curvature R of the air film or lens surface. Referring to the figure above and making use of the Pythagorean Theorem, we have

$$R^2 = r_m^2 + (R - t_m)^2 \text{ or } R = \frac{r_m^2 + t_m^2}{2t_m}$$

The radius of the m-th dark ring is measured and the corresponding thickness of the air wedge is determined from the interference condition. Thus, R can be found. A little thought should convince one that light transmitted through the film and the optical flat will also show circular interference fringes.

A simplification, which is usually quite acceptable, can be made if the thickness of the air wedge is small compared to *R*. You should demonstrate that for constructive (i.e., bright fringes), the relationship between the radius of the bright fringes and the radius of curvature is:

$$r_m^2 = (m + \frac{1}{2})\lambda R.$$

In addition, show that under the above simplification, the radius for the dark fringes is connected with the radius of curvature, *R*, by $r_m^2 = m\lambda R$.

Measurement of the radius of curvature of a lens using Newton's Rings for the sodium D line.

1. Measure the radii of the first bright rings using the traveling microscope and determine the radius of curvature of the lens.

2. Now use the same plano-convex lens and determine the radius of curvature using the direct approach laid out in Lab 3: Thin lenses and mirrors. Compare and discuss your results from these two measurements of the radius of curvature. Don't forget to add your error on measurements.