Biomicroscopy I - Exercise 06

October 15, 2024

1 Köhler illumination

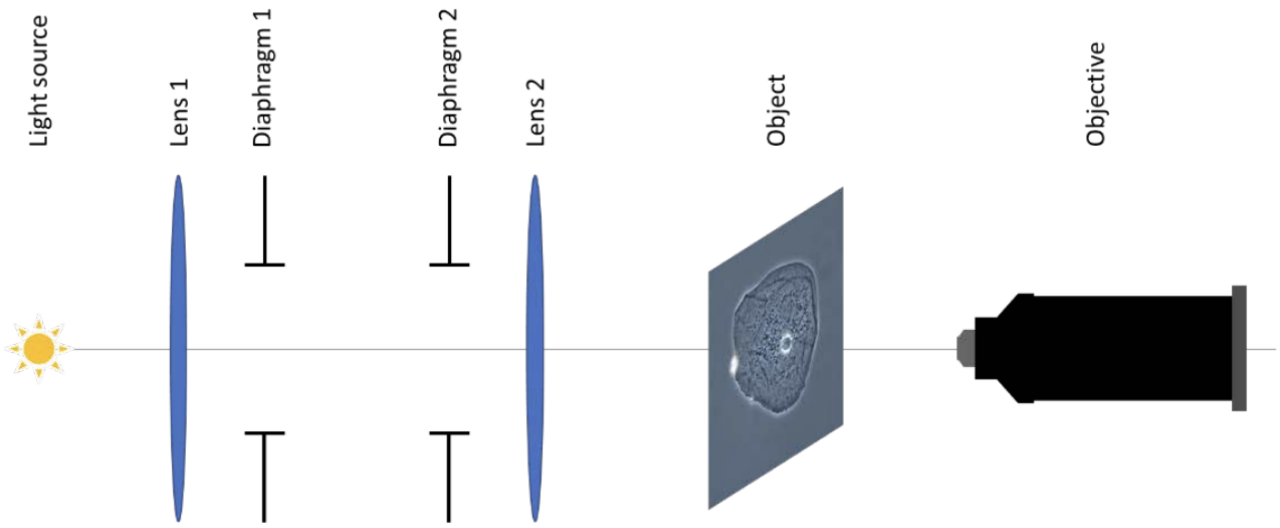

Figure 1: **Köhler illumination setup**

A. Explain in a few short sentences why modern microscopes use Köhler illumination.

B. What is the diaphragm 1 used for (major task(s))?

   a. Control the illumination polarization.
   b. Control the illumination area/field.
   c. Control the numerical aperture of the illumination.
   d. Control the illumination color/spectrum.
   e. Control the illumination intensity.

C. What is the diaphragm 2s used for (major task(s))?

   a. Control the illumination polarization.
   b. Control the illumination area/field.
   c. Control the numerical aperture of the illumination.
   d. Control the illumination color/spectrum.

e. Control the illumination intensity.

D. The object plane is conjugated with which element shown in the setup? What about the light source?

2 Achromatic doublet

An achromatic doublet is utilized to compensate for chromatic aberrations of the lens occurring due to the material dispersion. Typically it consists of low- and high-dispersion glass lenses cemented together. In this problem we would like to build an achromatic doublet focusing collimated blue ($\lambda = 400$ nm) and red ($\lambda = 700$ nm) light at the same point on the optical axis (Fig. 2).

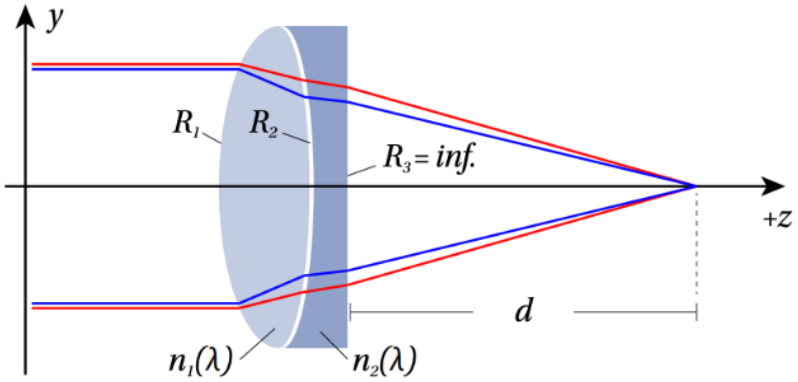

Figure 2: Achromatic doublet consisting of two lenses with different dispersion.

You can assume that the lenses are thin (it is possible to neglect ray propagation inside of the lenses) and the refractive index of the surrounding is $n_0 = 1$.

A. What is the ABCD-matrix describing the system of the lenses followed by propagation distance d? (Be accurate with sign conventions for the radii of the curved boundaries.)

B. Derive the equation for the focusing distance d (remember focusing condition for ABCD-matrix).

C. Given that $n_1(400\text{ nm}) = 1.4$, $n_1(700\text{ nm}) = 1.2$, $n_2(400\text{ nm}) = 2.2$, $n_2(700\text{ nm}) = 1.4$ and $d = 500$ mm, find the radii of curvature R_1 and R_2.