Chapter 25

Optical Instruments
Magnifying lens

• You normally look at objects places at the **near point** (25 cm), angular size of objects at this point

\[ \theta = \frac{y}{25\text{ cm}} \]

• See something better = increase its angular size

• Can bring it closer to the eye, but difficult to focus
Magnifying lens

• Use a lens! Put the object at focal point, then the (virtual) image is at $s' = -\infty$ for a comfortable view.

Angular magnification

$$\theta' = \frac{y}{f}$$

$$M = \frac{\theta'}{\theta} = \frac{y/f}{y/25\text{ cm}} = \frac{25\text{ cm}}{f}$$

practical limits to $M$: x3—x4 without aberration corrections, up to x20 with corrections

not to be confused with lateral magnification! (=\infty in this case)
The Microscope

\[ M_2 = \frac{25 \text{ cm}}{f_2} \quad \text{same as magnifying lens} \]

\[ m_1 = -\frac{s_1'}{s_1} \approx -\frac{s_1'}{f_1} \]

ignoring the sign,

\[ M = m_1 M_2 = \frac{s_1'}{f_1} \frac{25 \text{ cm}}{f_2} \]
The Telescope

Object is seen at angle

\[ \theta = \frac{-y'}{f_1} \]

First image is at the objective’s focal point, serves as object for the second lens (eyepiece).

The eye sees the (second) image at angle

\[ \theta' = \frac{y'}{f_2} \]

OK for a telescope, need a prism for binoculars!

\[ M = \frac{\theta'}{\theta} = \frac{-y'/f_2}{y'/f_1} = -\frac{f_1}{f_2} \]

Want it big

Want it small