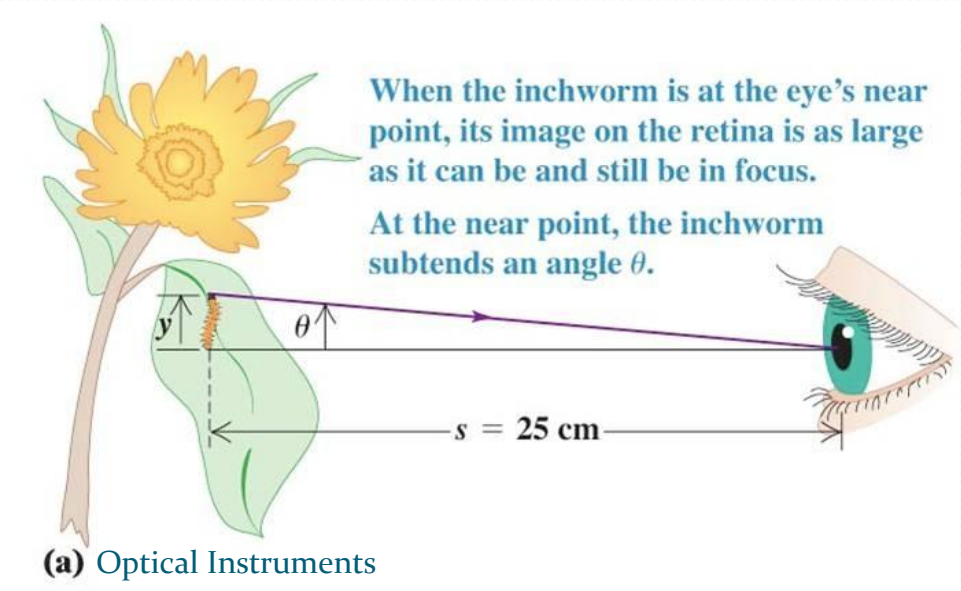
Chapter 25

Optical Instruments

Magnifying lens

- You normally look at objects places at the **near point** (25 cm), angular size of objects at this point $\theta = y / 25\,\text{cm}$
- See something better = increase its angular size
- Can bring it closer to the eye, but difficult to focus



(a) Optical Instruments

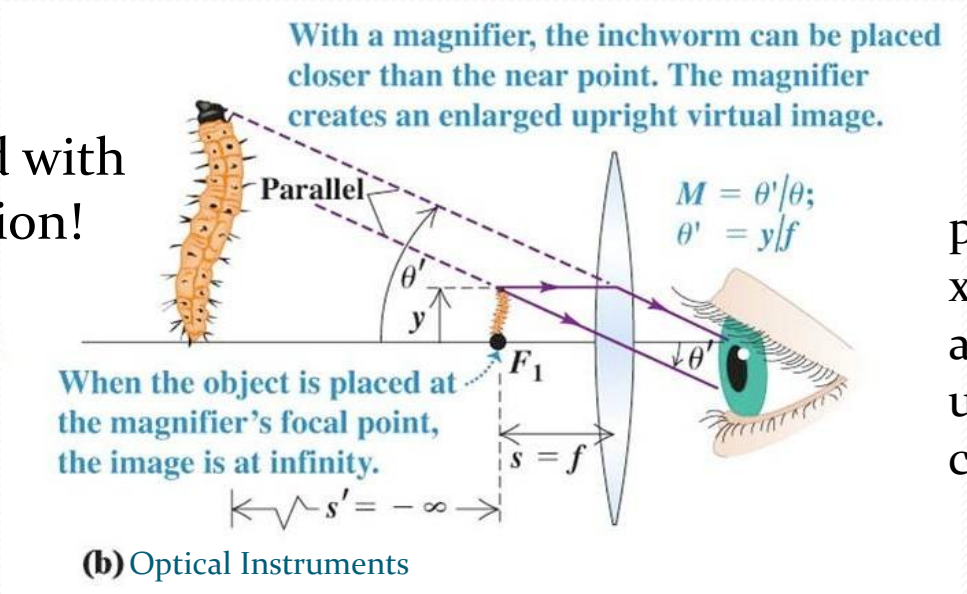
Magnifying lens

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

$$\theta' = y / f$$

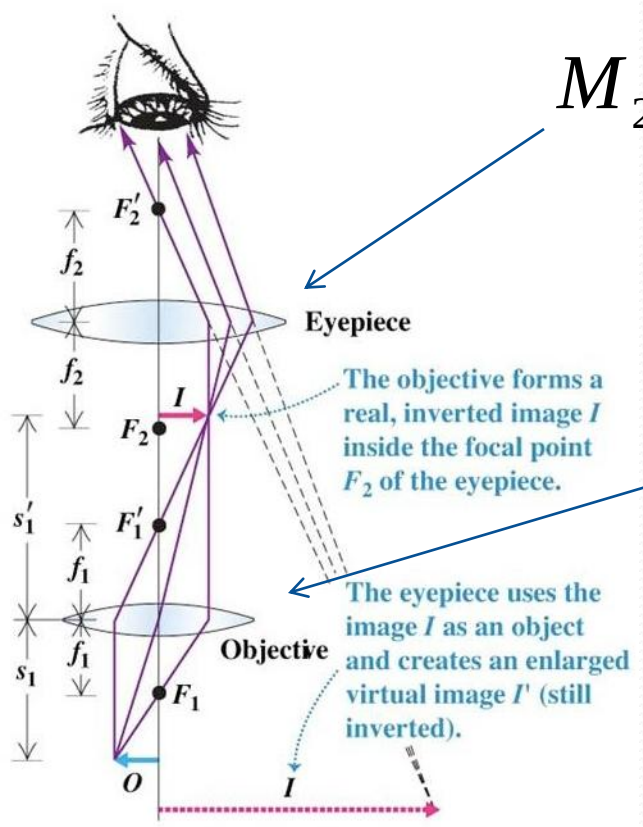
Angular magnification $$M = \frac{\theta'}{\theta} = \frac{y/f}{y/25\,\text{cm}} = \frac{25\,\text{cm}}{f}$$

not to be confused with lateral magnification! (=∞ in this case)



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

The Microscope



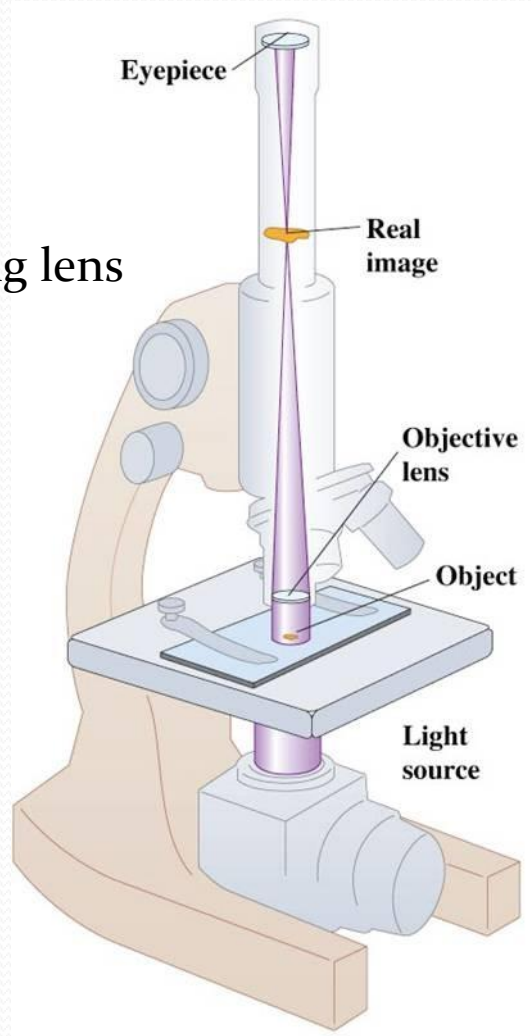
$$M_2 = \frac{25\,\text{cm}}{f_2}$$

same as magnifying lens

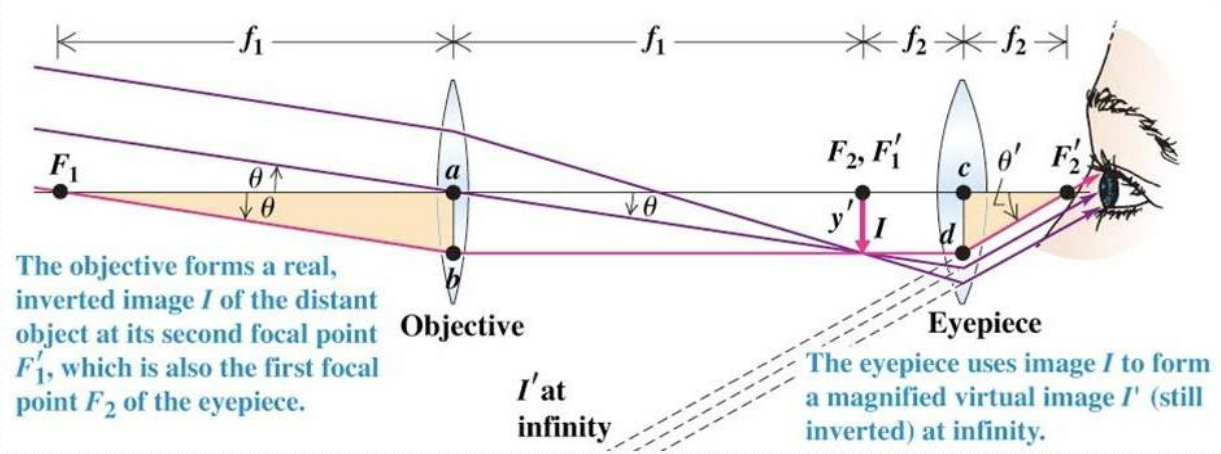
$$m_1 = -\frac{s_1'}{s_1} \approx -\frac{s_1'}{f_1}$$

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 θ

$$\theta = \frac{-y'}{f_1}$$

first image is at the objective's focal point, serves as object for the second lens (eyepiece)

OK for a telescope, need a prism for binoculars!

the eye sees the (second) image at angle θ'

$$\theta' = \frac{y'}{f_2}$$

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

want it big

want it small