# 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

# Magnifying lens

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

**Angular magnification**

$$\theta' = y / f$$

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

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

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

# The Microscope

$$M_2 = \frac{25\,\mathrm{cm}}{f_2}$$ same as magnifying lens

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

ignoring the sign,

$$M = m_1 M_2 = \frac{s_1'}{f_1}\frac{25\,\mathrm{cm}}{f_2}$$

# The Telescope

object is seen at angle $\theta = \dfrac{-y'}{f_1}$

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

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 ($f_1$)

want it small ($f_2$)