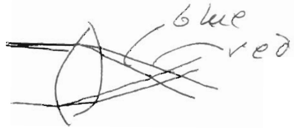
spherical aberrations

→ occur in lenses (or with mirrors) when rays not paraxial

spherical aberration

- a parabolic surface makes focus at all angles

chromatic aberration



$n(\lambda)$

violet refracted more than red rays - different focus

$f_{red} > f_{violet}$

→ can reduced with combination of diverging + converging lenses

Camera

→ lens(es) in front of aperture, shutter, then film

→ move lenses to get for objects at different distances

→ shutter opening gives time film exposed

→ nowadays CCD's

→ arrays of semiconductor

→ charge freed when light strikes pixel

CCD

much higher "quantum efficiency" than film.

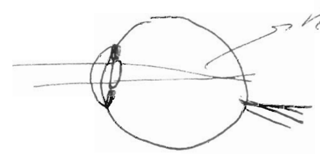
film grains

f/# → a measure of width of field compared to f. Means low f/ are "fast" i.e. integrate light rapidly

1304/1404 223, 153

The Eye

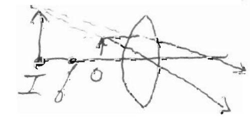
→ similar to camera in that
- → lens (cornea + AH + crystalline lens)
- → aperture : pupil (controlled)
- → photo sensor : retina
- → shutter : eyelid



→ can address with a diverging lens

→ discuss accomodation
→ discuss near-point

Simple Magnifier :



- near point limits how closely we can examine something (i.e. maximum angular size).

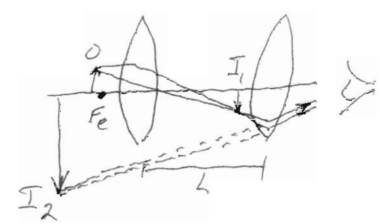
→ by using 1 converging lens
- can make object < 25cm have $i \geq 25\,m$ + so see bigger

$m = \theta/\theta_0$ @ $i = 25cm$ $m_{max} = 1 + \frac{25cm}{f}$

Compound Microscope :

objective : very short focal length (< 1cm)

eyepiece : $f \sim$ few cm

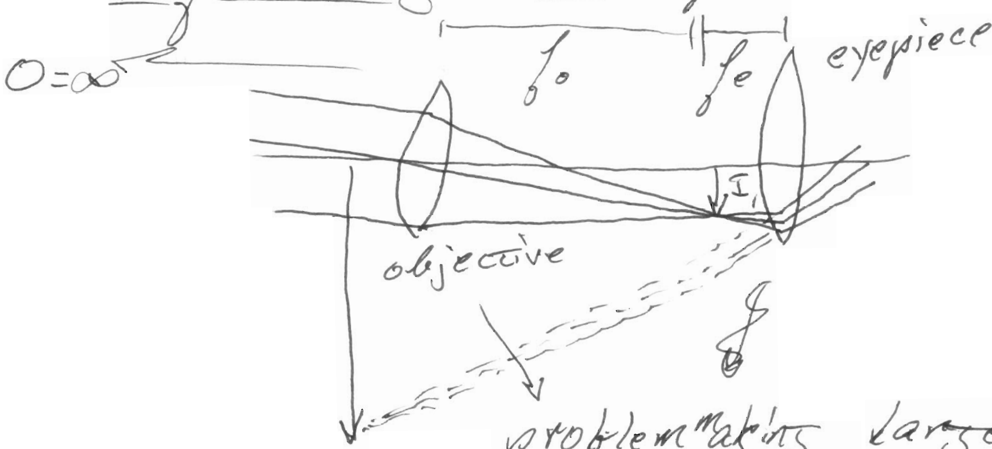


total magnification

$$M = -\frac{L\,(25cm)}{f_o f_e}$$

Telescopes

refracting telescope

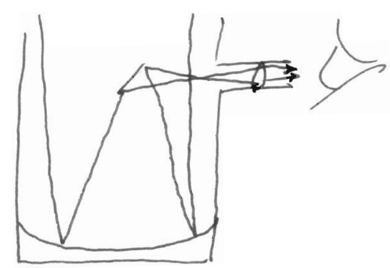


Source @ ∞

$$m = -\frac{f_o}{f_e}$$

problem making large: sagging
(but larger = more light-gathering ability)

reflecting telescope



support for mirror

use converging objective mirror to produce same behavior as objective lens above

problem: atmospheric distortion
→ essentially rapidly changing "n" in sky

Adaptive Optics

→ actuators use information from "fake" star to adust mirror shape in real-time
→ can get near-HST quality in some cases