TOPICS

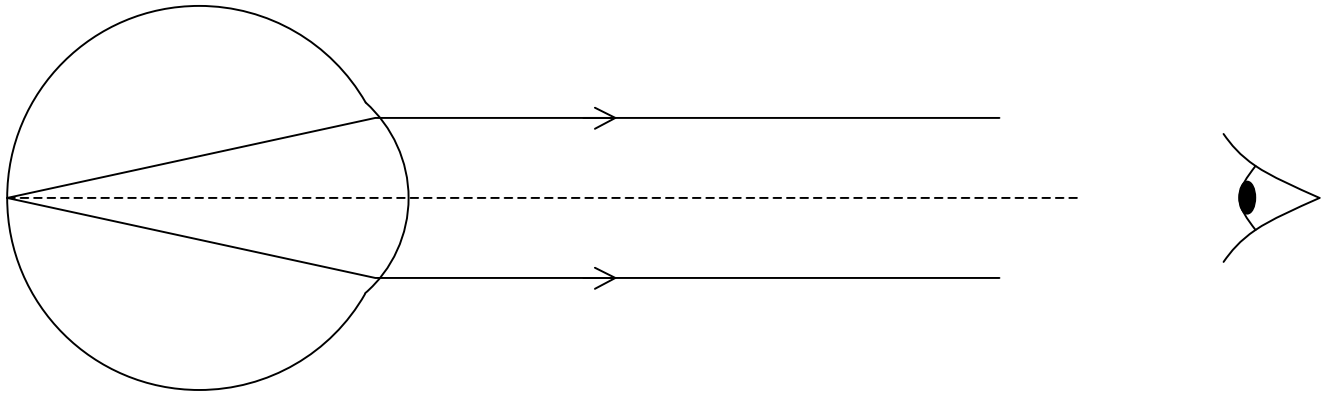
- Recap of PHYS110 *- 1 lecture*
- Physical Optics *- 4 lectures*
  - EM spectrum and colour
  - Light sources
  - Interference and diffraction
  - Polarization
- Lens Aberrations *- 3 lectures*
  - Spherical aberrations
  - Coma, astigmatism, field curvature, distortion
  - Chromatic aberrations
- **Instrumental Optics** *- 4 lectures*
  - Telescope, microscope
  - Stops, eyepieces
  - Instruments for the anterior eye
  - **Instruments for the posterior eye**

Instruments for the posterior eye

- Instruments for examining the retina
  - Direct ophthalmoscope
  - Indirect ophthalmoscope
- Instruments for measuring the refractive state of the eye
  - Retinoscope
- Instruments for measuring lens strength
  - Focimeter

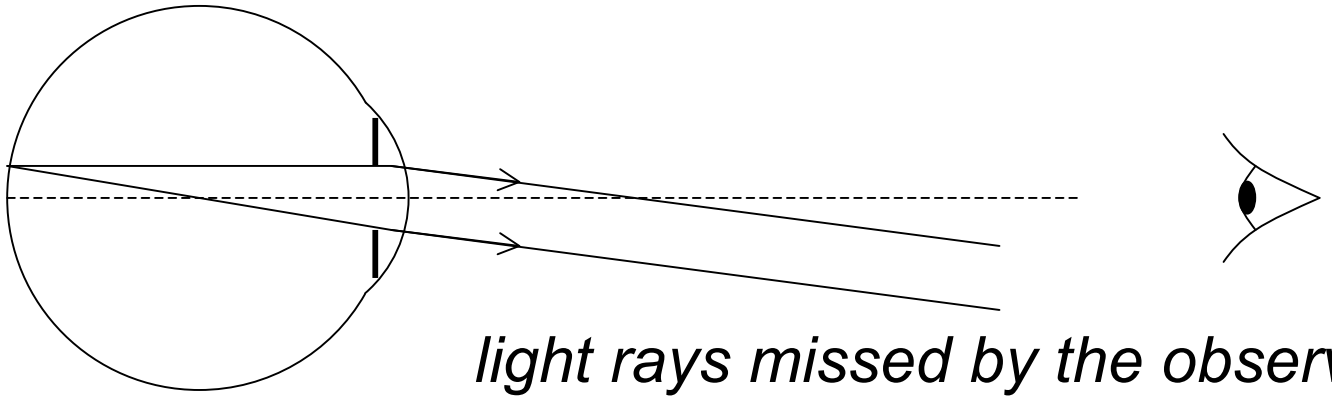
Examining the retina of the eye

- For an emmetropic eye, parallel light rays from infinity focus on the retina
- In the same way, light originating from the retina leave the eye as parallel rays
- The image from the retina is in focus to an unaided external observer.



Examining the retina of the eye

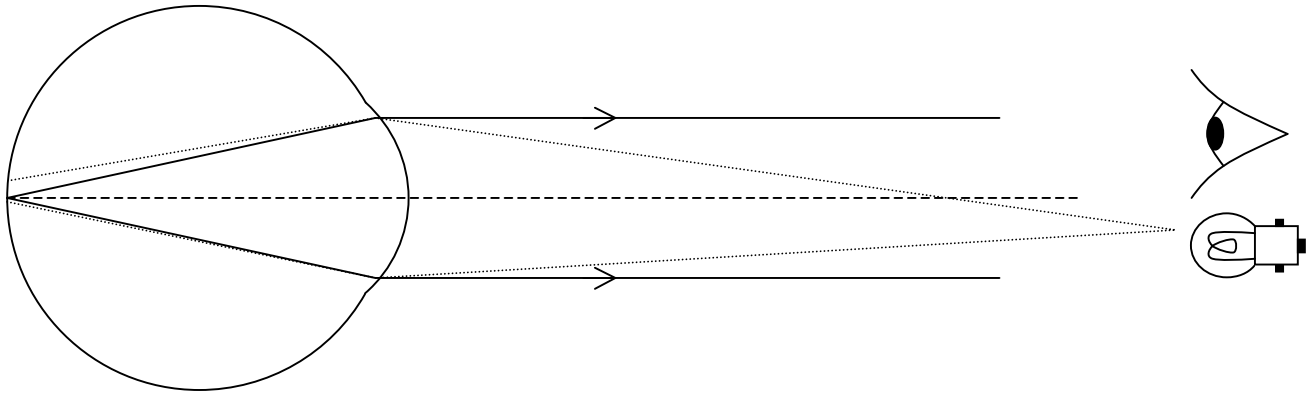
- What prevents the unaided observer from examining a patient's retina?
  1. Light can only enter the eye through the pupil. The observer usually blocks the light.
  2. The pupil limits the field of view. The observer needs to get very close to see more than a few mm.



light rays missed by the observer

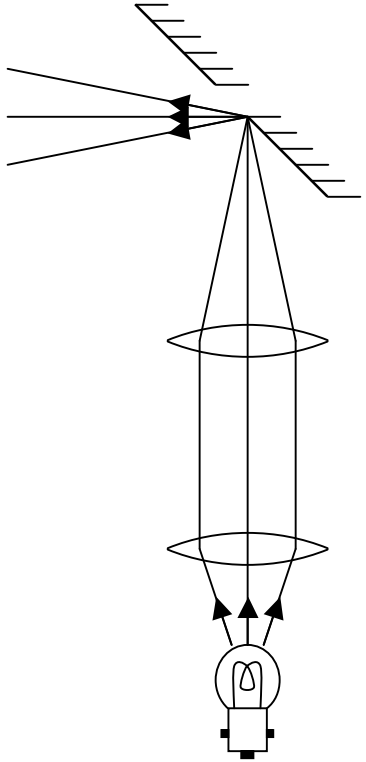
Examining the retina of the eye

- To directly observe the retina, you need to:
  1. Illuminate the retina with a light source close to the observer's eye
     - Example: flash photography with the flash close the lens gives red eyes: the image of the retina
  2. Observe the eye from very close by
  3. Dilate the pupil to increase the field of view



The direct ophthalmoscope

- The direct ophthalmoscope aligns the illumination and viewing axes
- Eye is examined through hole in mirror
- Image of lamp is focused just below hole in mirror
- Divergent beam illuminates patient's eye

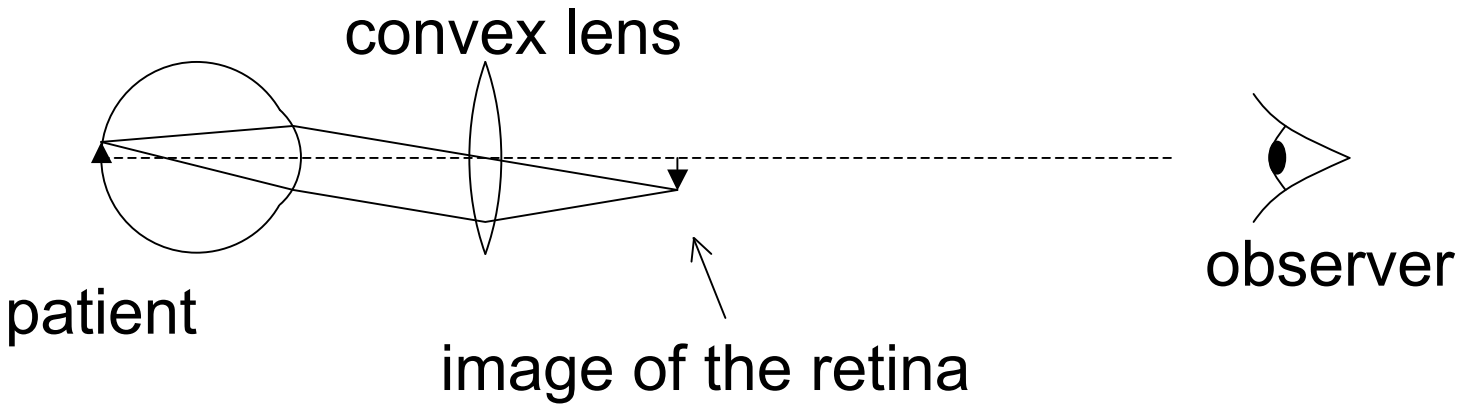


The direct ophthalmoscope

- Lenses can be inserted in front of observer's hole to correct for ametropia of observer and/or patient
- Field of view is smaller for myopic patients
- Field of view is larger for hypermetropic patients

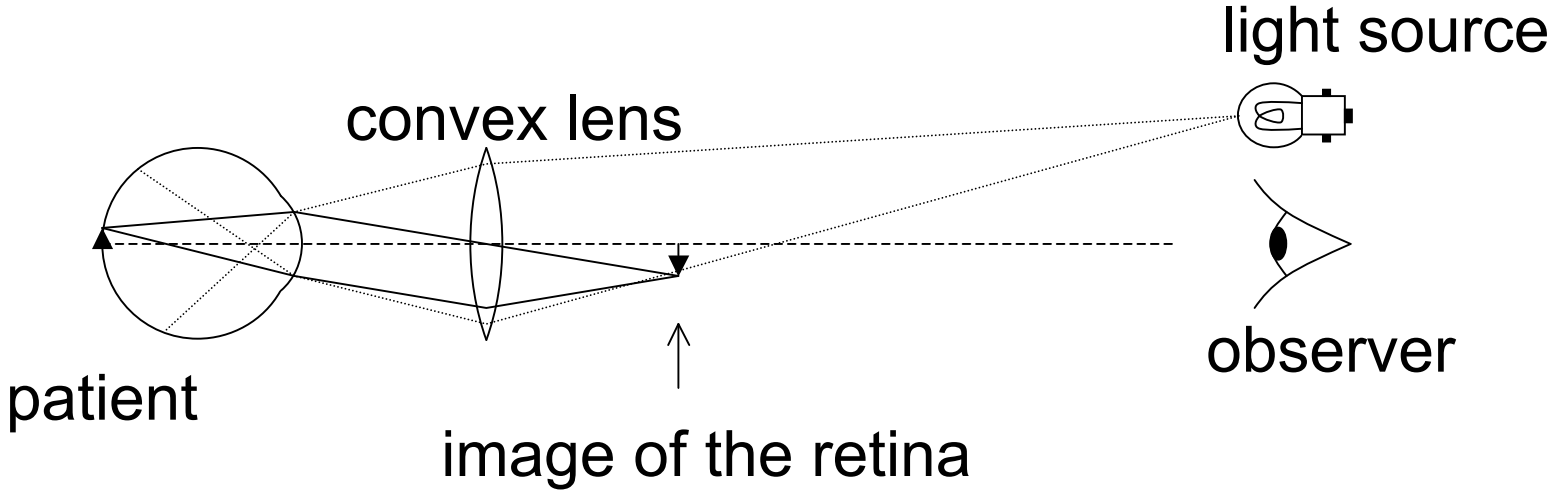
The indirect ophthalmoscope

- Uses a convex lens to produce a real inverted image of the retina.
- The image is formed at the second principal focus of the convex lens.
- The observer holds the lens at arm's length and views the image about 40 to 50 cm away.
- Main advantage: **large field of view**
  - *almost the complete retina can be seen in one view*



Illumination

- Illumination is by light from lamp on the observer's head
- Light passes through the convex lens and is brought to a focus well before the retina.
- At the retina the illumination is uniform.
- The patient's pupil limits the field of illumination.



Comparison

	Direct Ophthalmoscope	***Indirect Ophthalmoscope***
Image	Upright	Inverted (both planes)
Field of view	Small (6^0)	Large (25^0)
Magnification	Large (×15)	Small (×4)
Binocular view	Not possible	Possible
Influence of patient's refractive error	Large	Small

Note also:

- Direct ophthalmoscopes can be smaller and lighter than the indirect ophthalmoscope.
- The indirect ophthalmoscope allows better illumination - important if patient has opacities in the optical media.

Retinoscope

- Measures the refractive state of the eye
- A streak of light is projected behind the patient's eye and moved left-right or up-down
- An image of the light streak is formed on the retina.
- The refractive state of the eye can be determined from the movement of the image on the retina
  - with or against the movement of the projected streak of light

Retinoscope

myopic eye

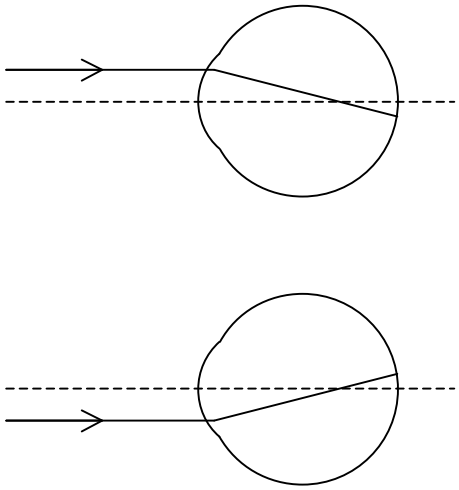


*Image on retina moves **against** direction of the projected light slit*

ametropic eye

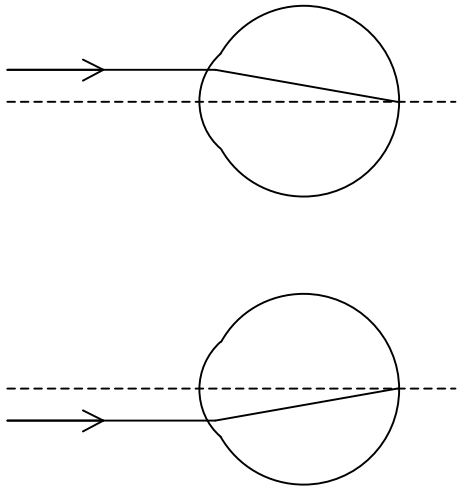


Image on retina does not move

hypermetropic eye

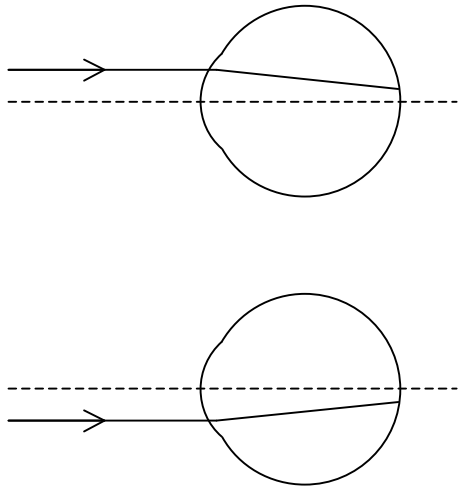


*Image on retina moves **with** direction of the projected light slit*

Retinoscope

myopic eye

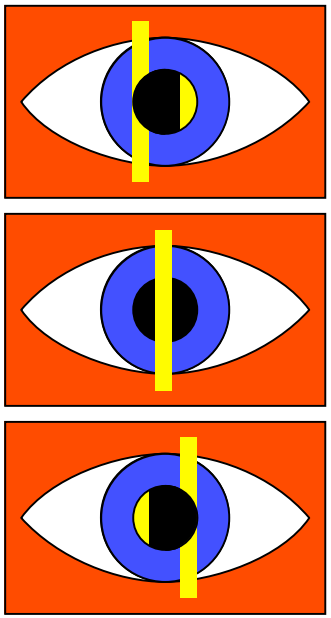


*Image on retina moves **against** direction of the projected light slit*

ametropic eye

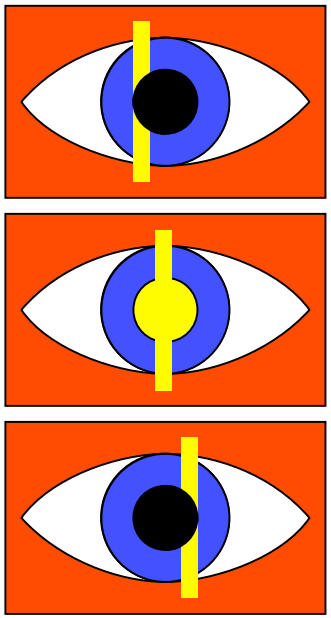


Image on retina does not move

hypermetropic eye

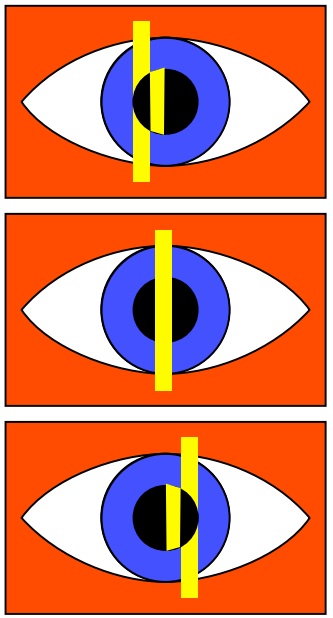


*Image on retina moves **with** direction of the projected light slit*

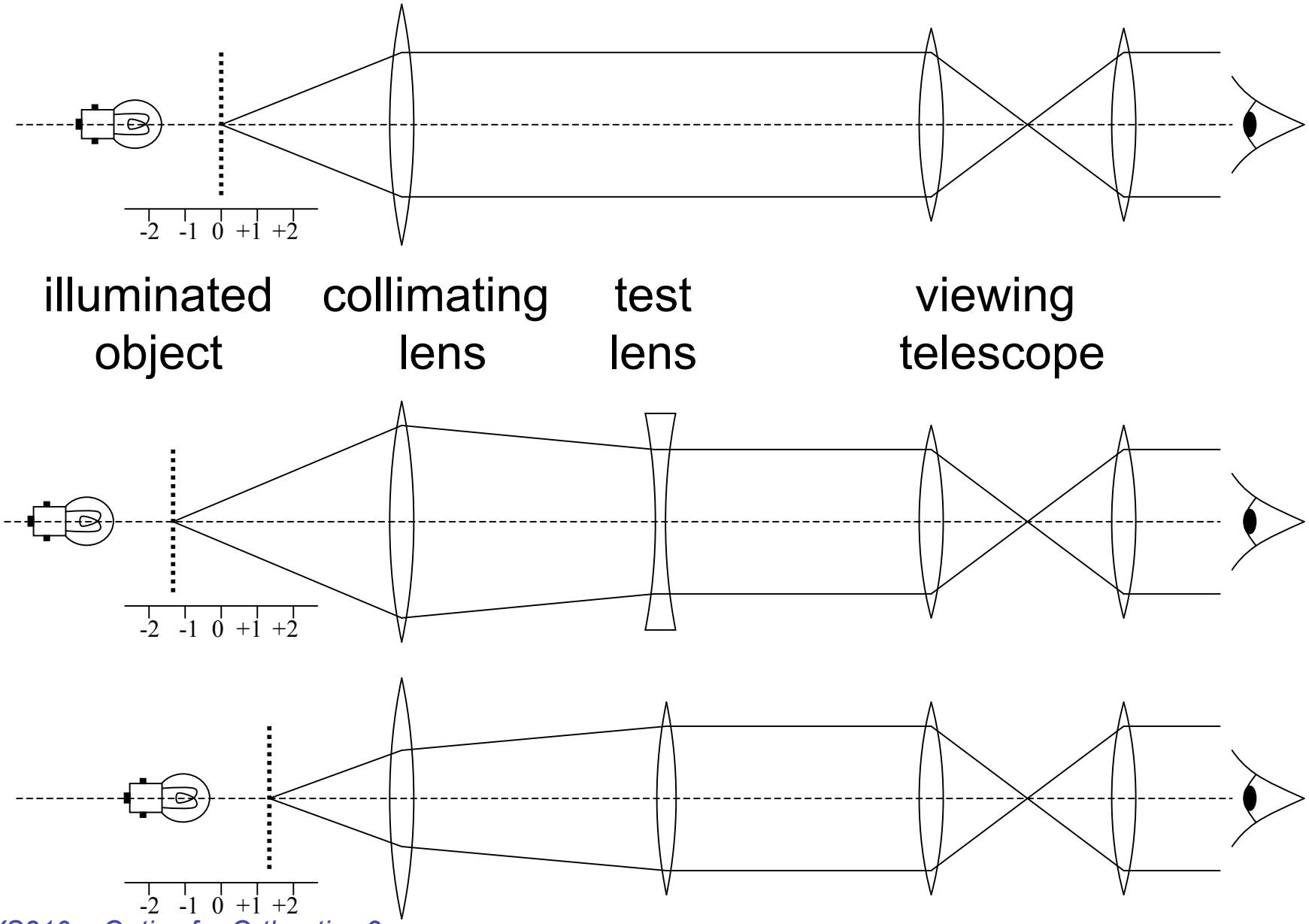
Retinoscope in practice

- A typical working distance is 0.5 metres
- Therefore, a correction lens of $F=2$ Dioptres is held in front of the patient's eye
- If the image moves with the streak, the strength of the lens is increased
- If the image moves against the streak, the strength of the lens is decreased
- When no more movement of the image is observed, the refractive error of the patient equals F-2 Dioptres

Focimeter

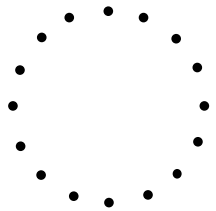
- To measure lens power
- An illuminated target is at the first focal point of a collimating lens and viewed sharply through a telescope
- The lens to be measured is put at the second focal point of the collimating lens
- The target is moved until it appears sharp again
- The target displacement is a measure of the strength of the lens

Focimeter

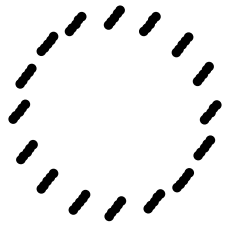

-2 -1 0 +1 +2
illuminated object
collimating lens
test lens
viewing telescope
-2 -1 0 +1 +2
-2 -1 0 +1 +2

Focimeter

- The illuminated target is usually a ring of dots
- For astigmatic lenses this results in a ring of lines pointing in the axis of astigmatism



focimeter target viewed through spheric lens



focimeter target viewed through astigmatic lens