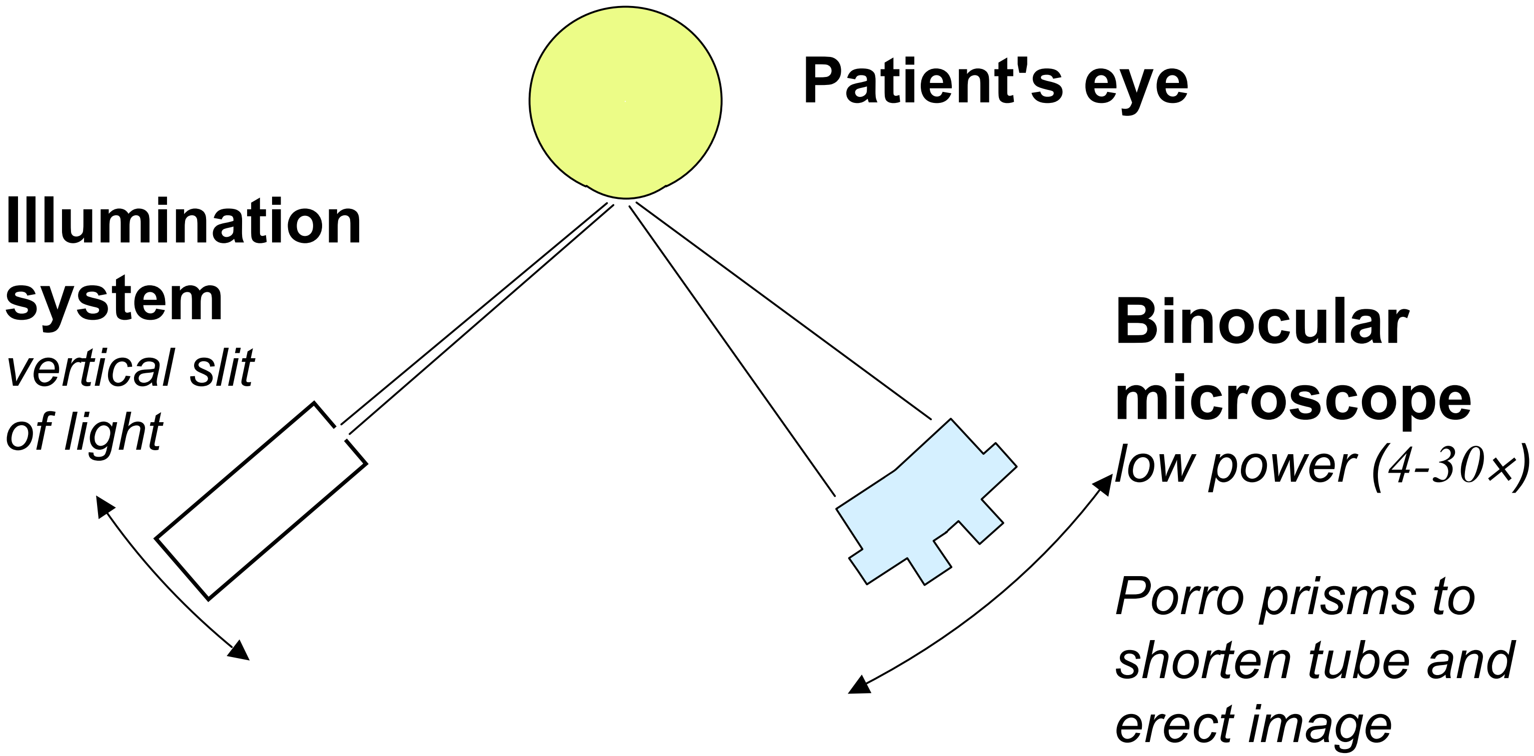
TOPICS

- 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

Lecture 11

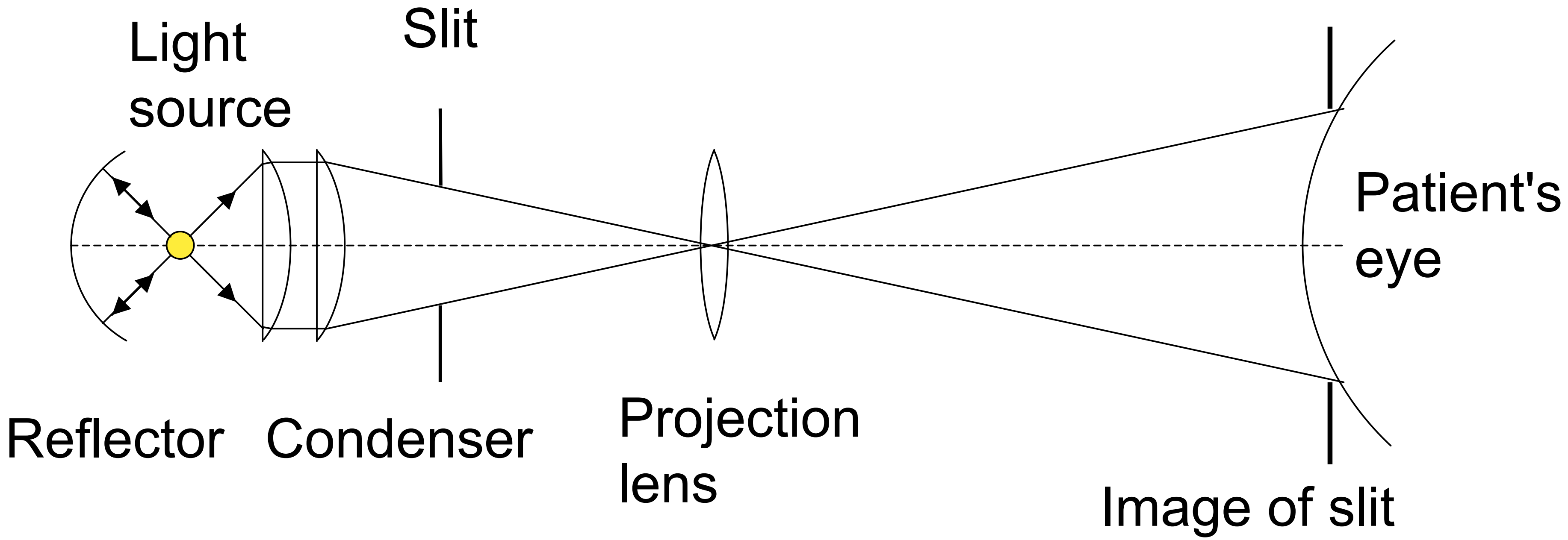
- Instruments for examining the anterior eye
  - Slit-lamp biomicroscope
  - Operating microscope
  - Tonometer
  - Keratoscope
  - Keratometer

Slit-lamp biomicroscope



- Focal points of light source and microscope coincide
- Large distance (≈ 10 cm) between microscope and eye
- Allows additional optical elements between microscope and eye

Projection system *(Kohler illumination)*



- Condenser focuses image of the light source on the projection lens
- Projection lens focuses image of the slit on the eye

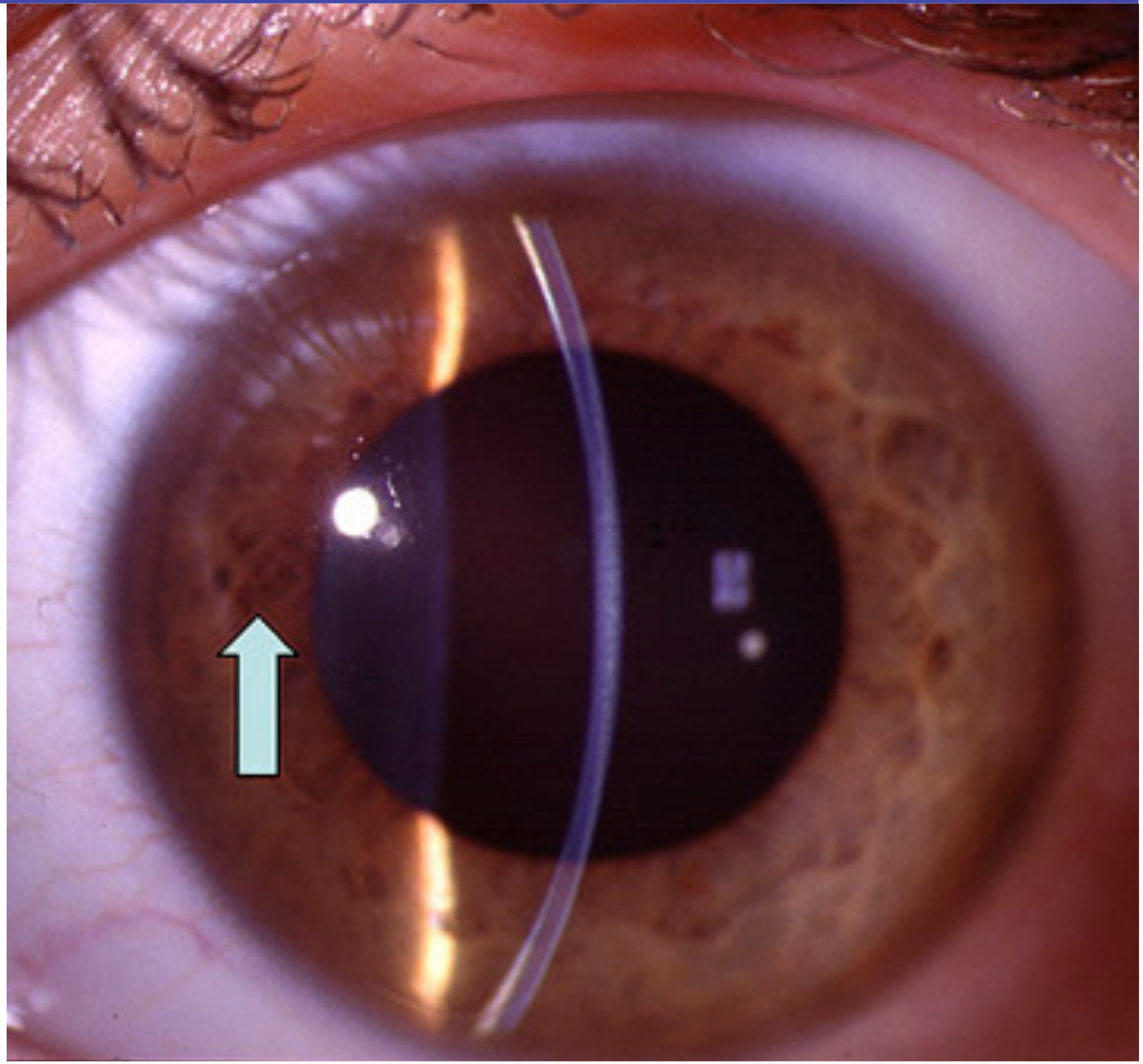
Slit-lamp biomicroscope

Used for investigating anterior eye:

- Cornea
- Iris
- Lens

etc

Requires additional instrumentation to see beyond the lens

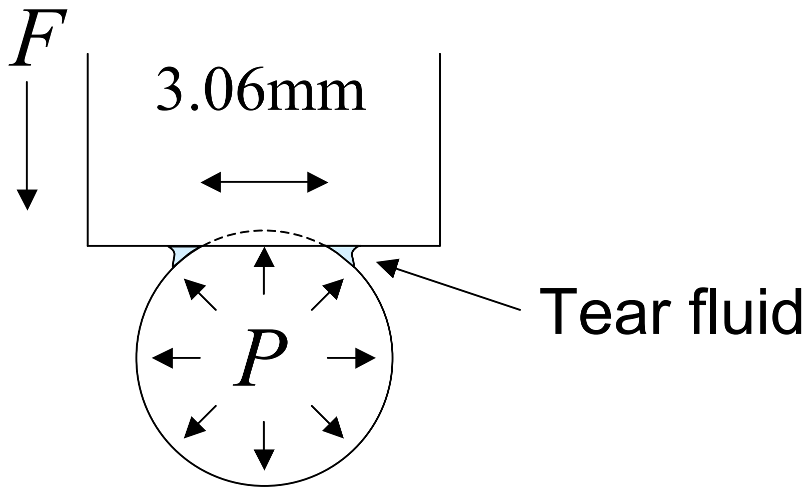


Operating microscope

- Instrument to view the eye while doing surgery
- Variation of the slit-lamp biomicroscope:
  - Circular light beam instead of slit
  - Longer working distance (≈ 20 cm)

Applanation tonometer

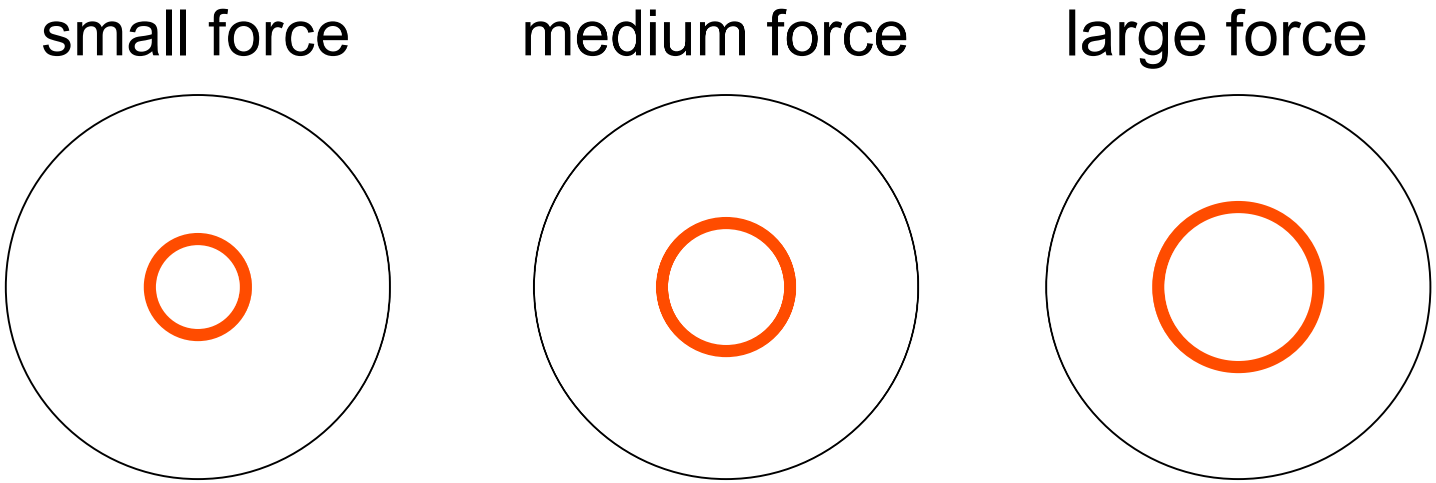
- Measure intraocular pressure P
- Measure the force F needed to flatten a circle of 3.06 mm of the eye



- At 3.06 mm the corneal rigidity and tear fluid surface tension cancel

Applanation tonometer

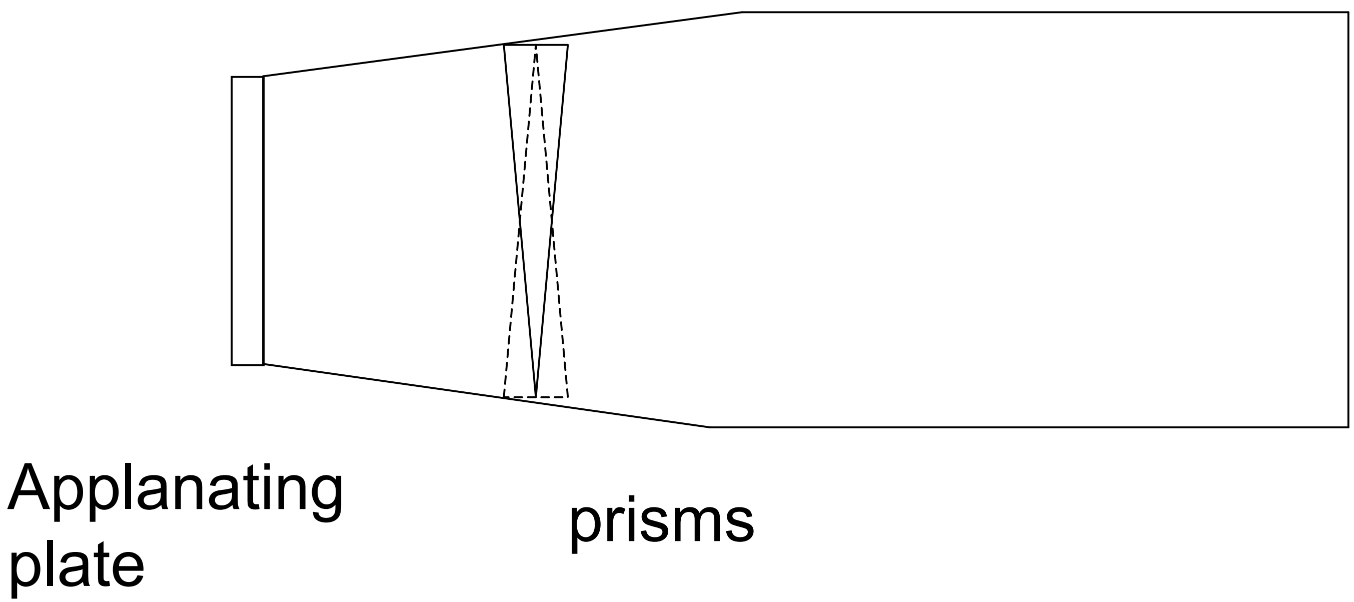
- Image seen through tonometer:



- How to measure the size of the ring?

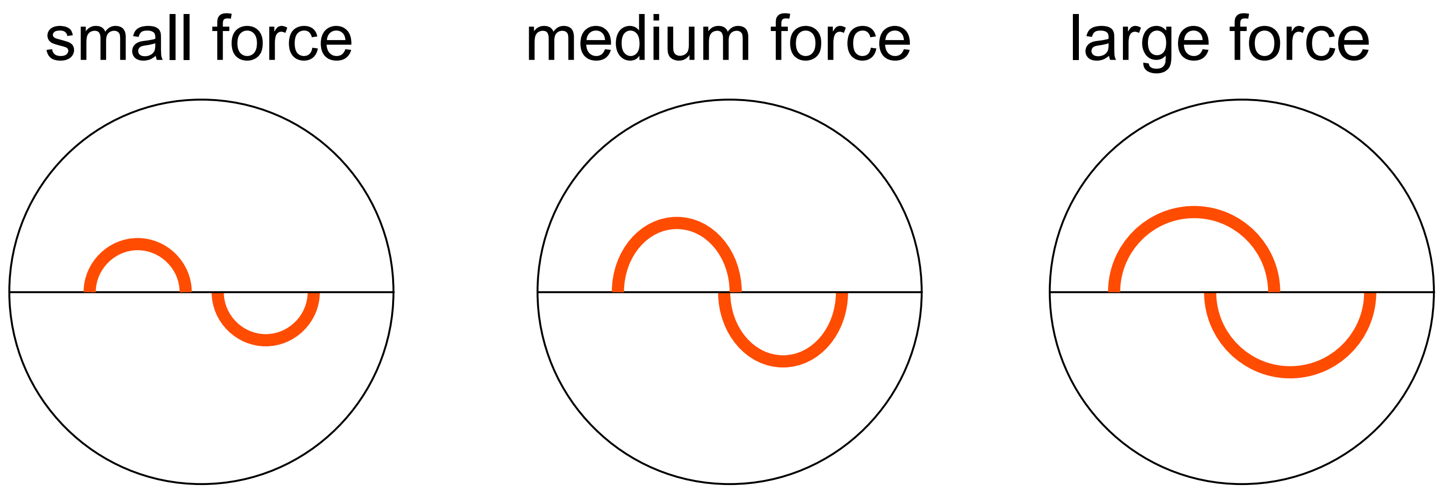
Goldmann-type tonometer

- Image of tear ring size is split into 2 displaced half-circles using prism



Goldmann-type tonometer

- Image seen through Goldmann tonometer:



- Correct applanation area when inner rings of circles intersect

Keratoscope

- Study the shape of the corneal surface
  - Detect astigmatism, irregularities
  - Essential for contact lens fitting
- Small fraction of light reflected by cornea
- Works as a convex mirror
- Study virtual image of bright object

Keratoscope: Placido's disc

- Disc with white reflecting rings and convex lens in the centre
- Held in front of the eye and illuminated
- Examine the shape of the reflected rings

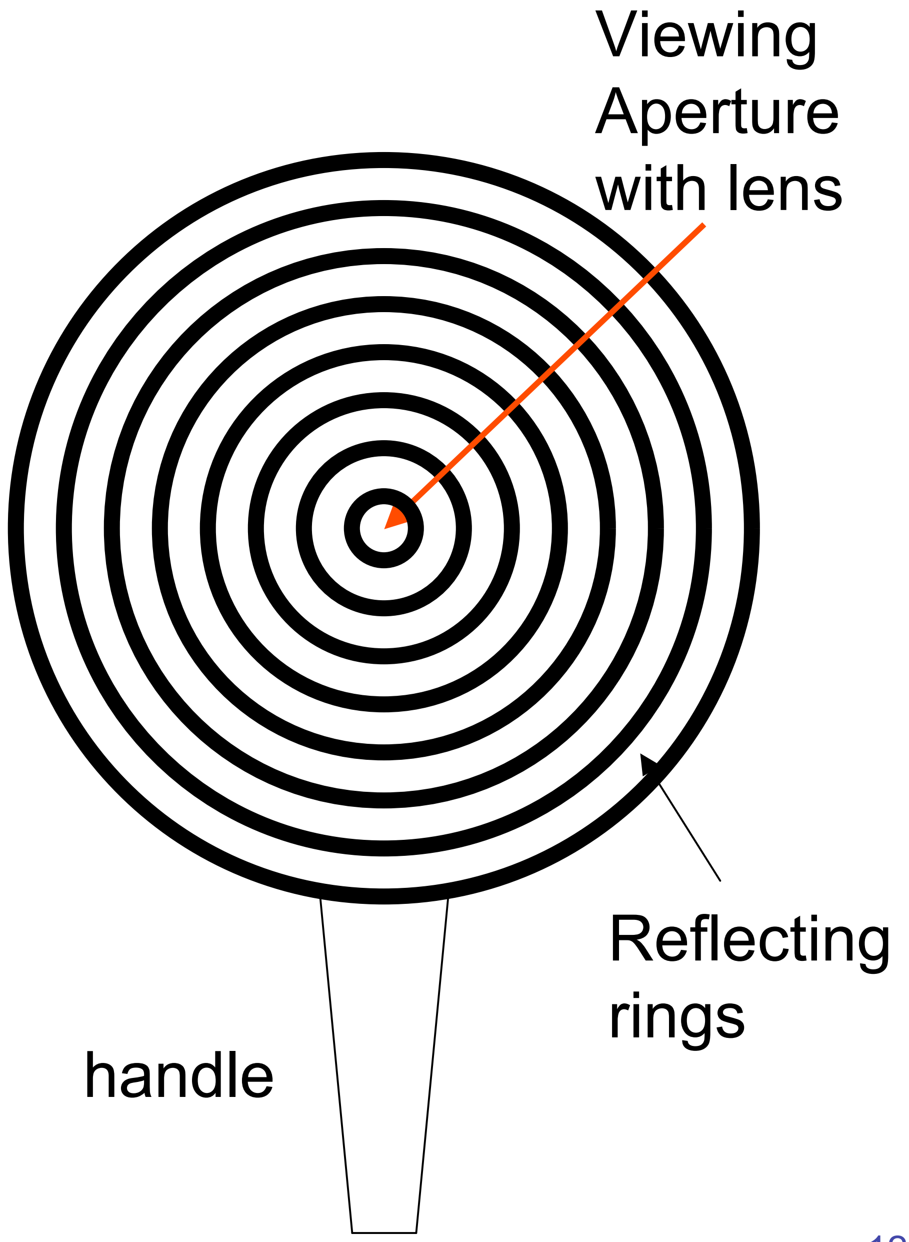
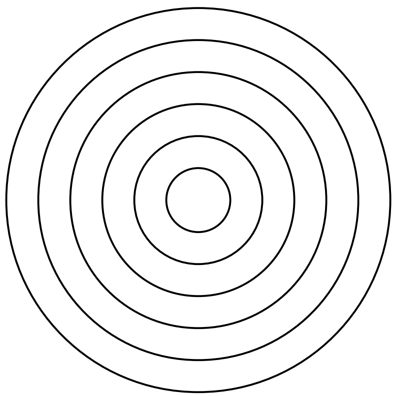


Image of Placido's disc

- Examine the shape of the reflected rings:

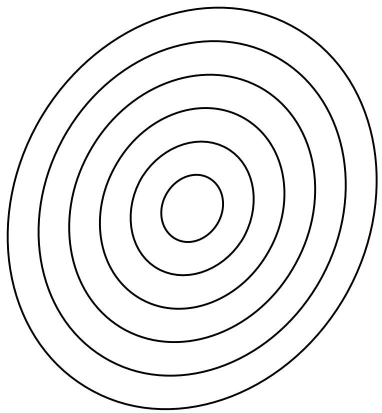
Normal eye

equally spaced symmetrical rings



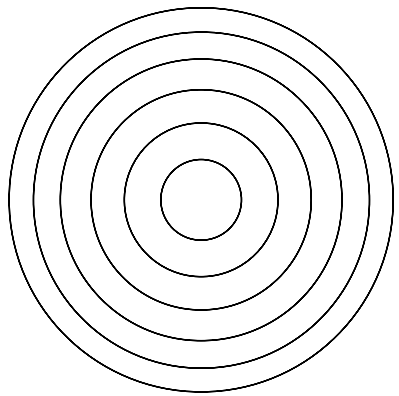
Corneal astigmatism

oval-shaped rings



Aspherical cornea

non-equidistant rings



Small degree of asphericity is normal

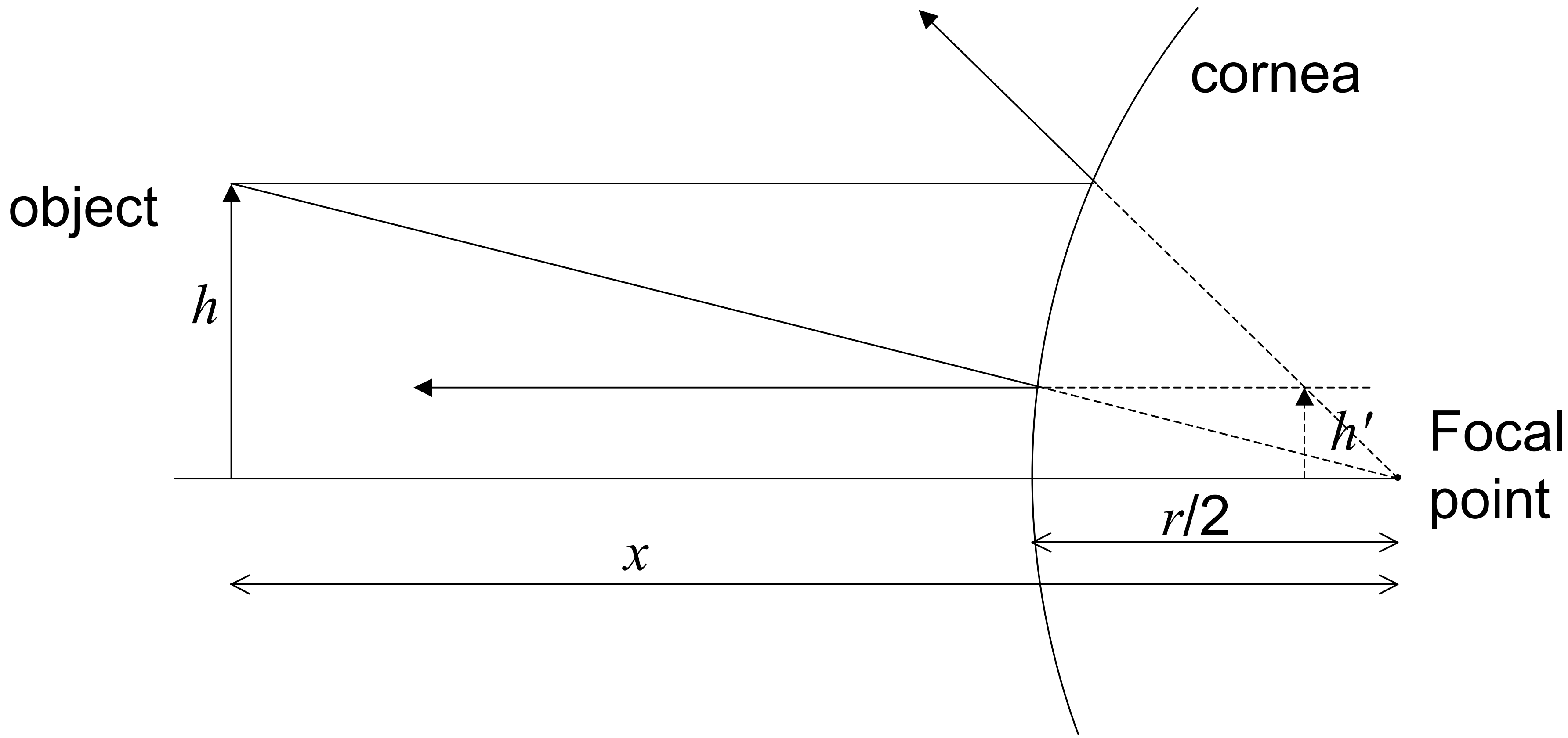
Keratometer

- The keratoscope gives qualitative information only
- A keratometer provides a quantitative measurement of the radius of the cornea
- Vergence power of the corneal surface is directly related to the radius:

$$F = \frac{n_2 - n_1}{R} = \frac{1.3375 - 1.0}{R} = \frac{0.3375}{R}$$

- Principle: measure the image size of an illuminated object in front of the eye

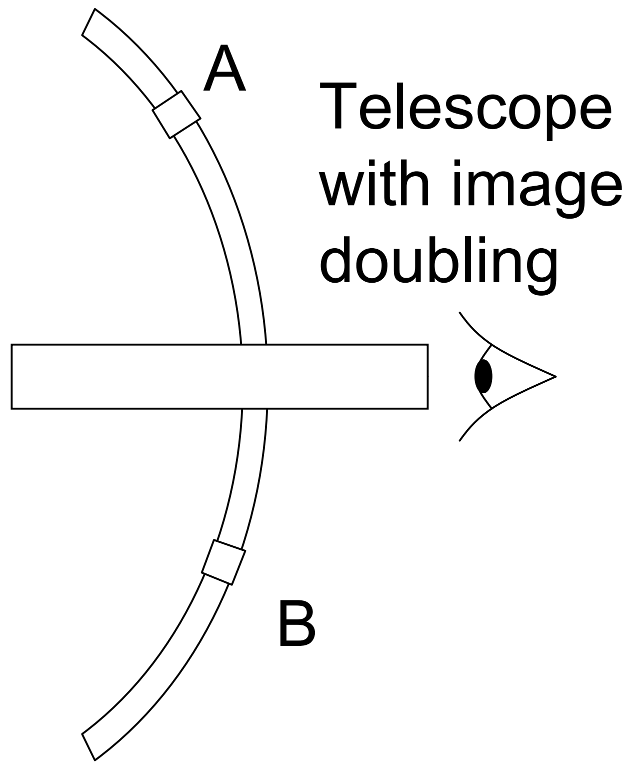
Virtual image from corneal reflection



- Size of virtual image: $$\frac{h'}{h} = \frac{r/2}{x}$$

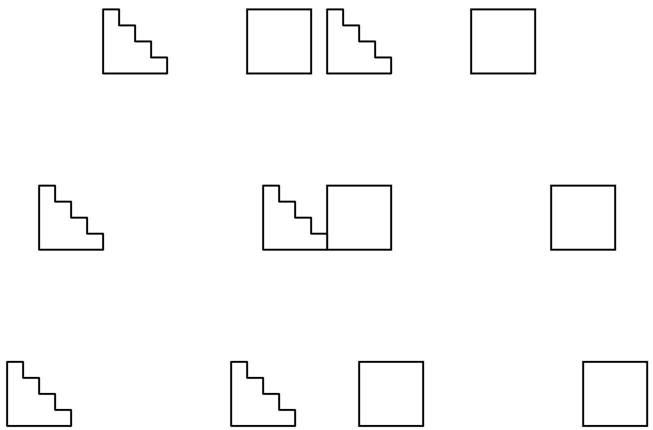
Javal-Schiotz keratometer

- Movement of the eye makes the image 'dance' and difficult to measure
- Use image doubling
- Two objects A, B are moved till the images touch
- The distance between A and B is a measure of the radius of the cornea



Javal-Schiotz keratometer

- One object (A) has a step form
- The other (B) is rectangular
- One step of A corresponds to one Dioptre



object size too small

object size correct

object size too large

Corneal topography

- With a keratometer one typically measures up to 4 points of the central corneal surface
- Computer-analysis of a picture from Placido's disc can measure the curvature at thousands of points on the whole cornea