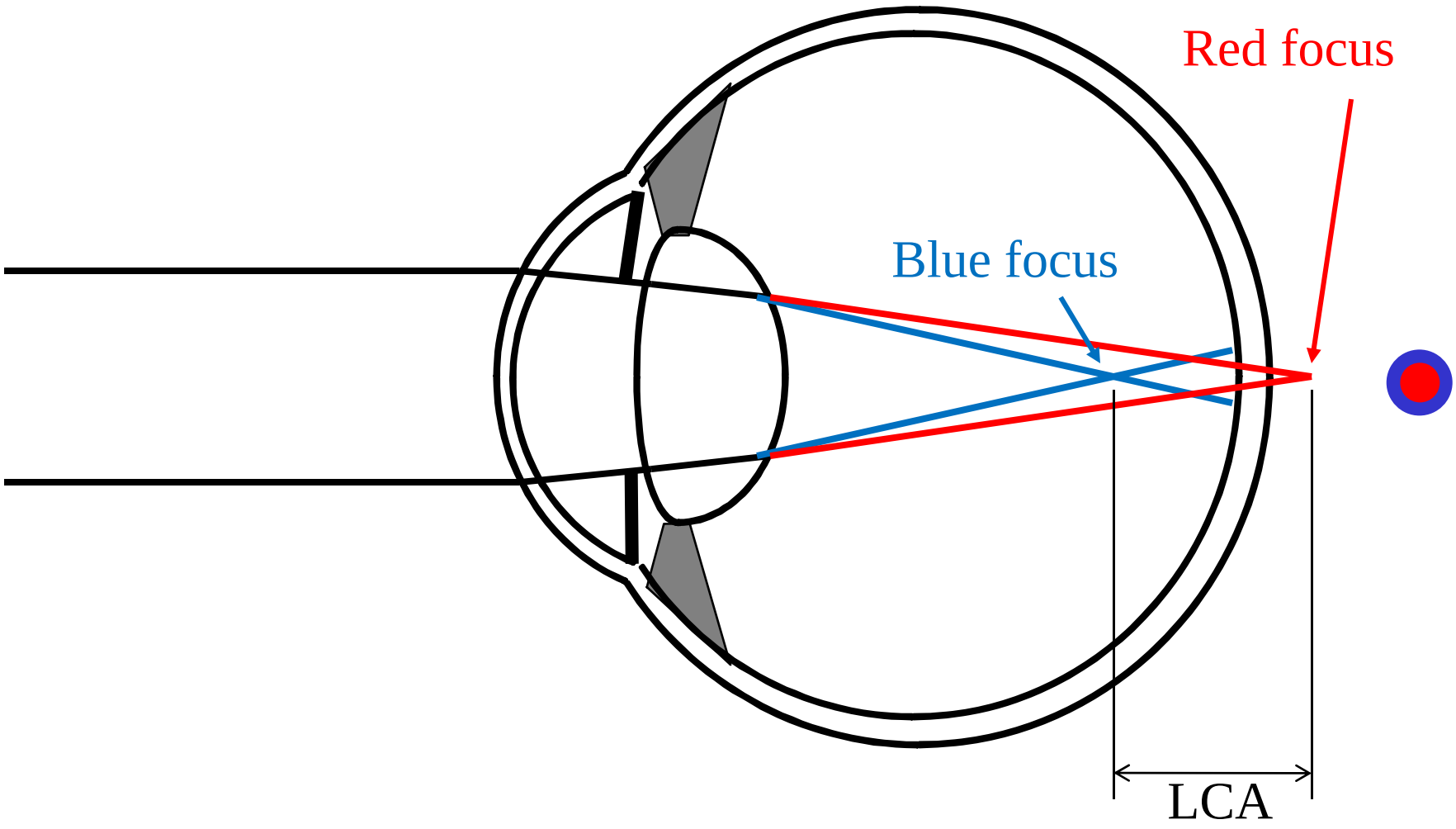
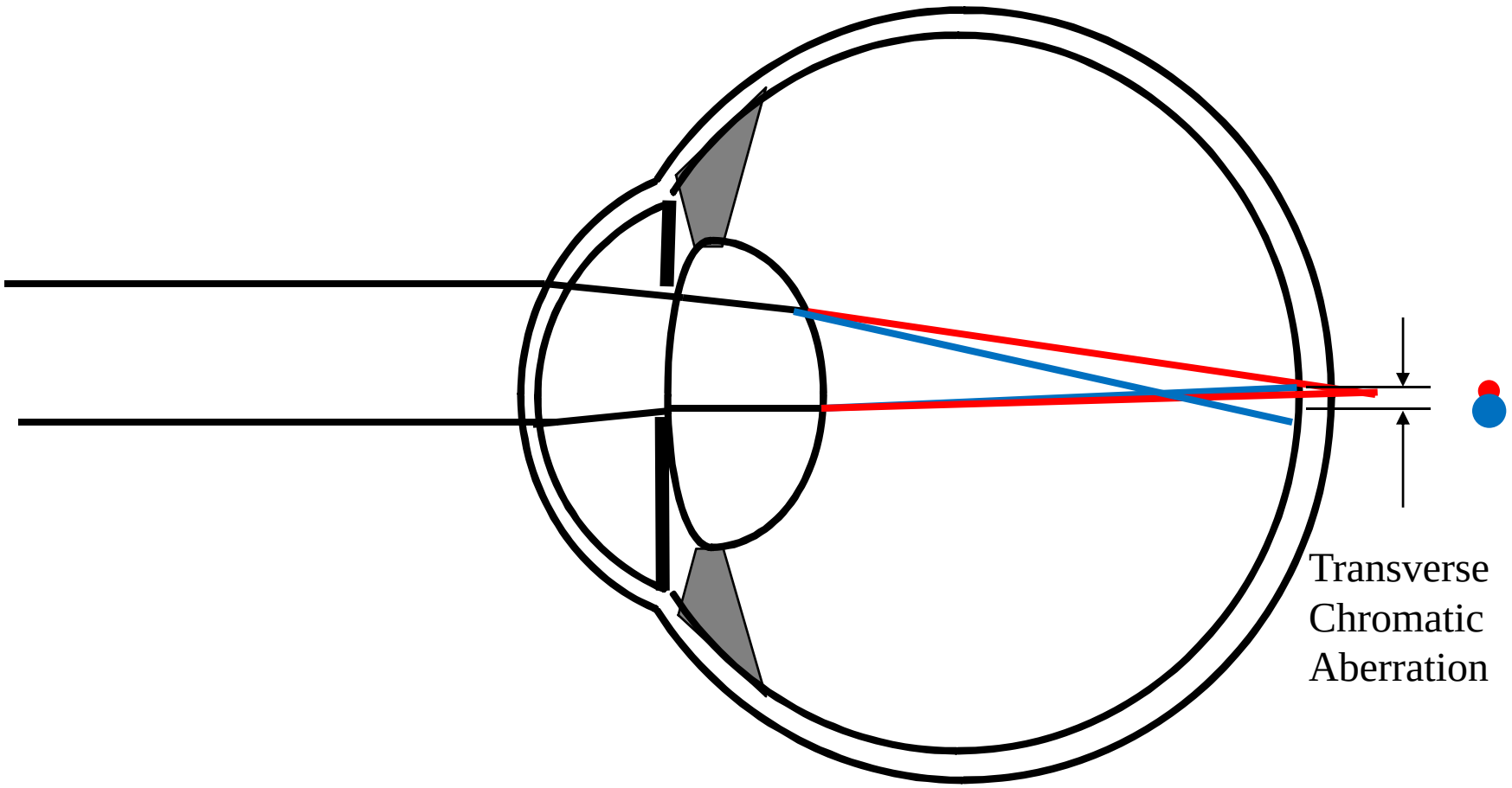
Longitudinal Chromatic Aberration

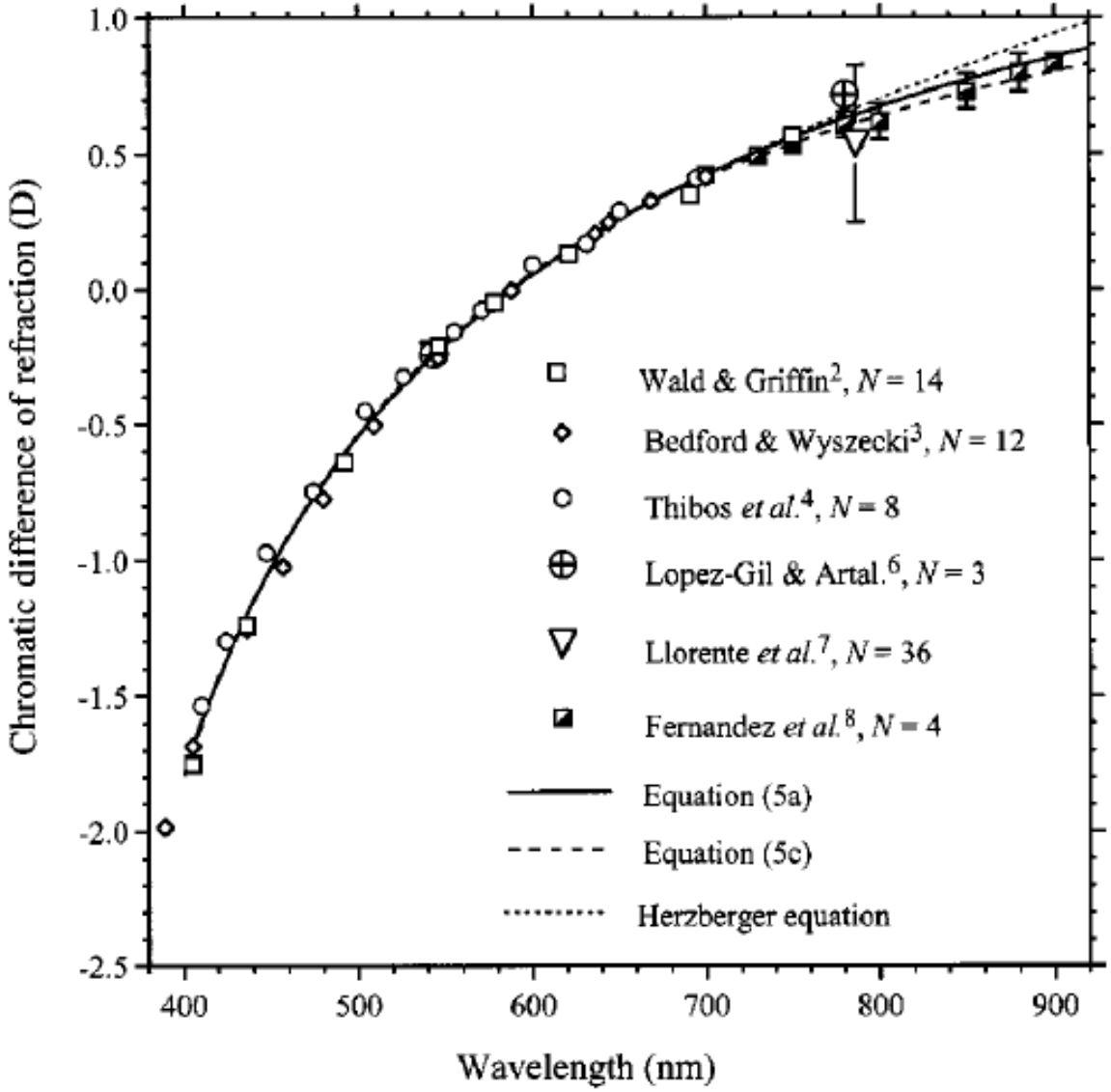


Transverse Chromatic Aberration

Decentered pupil



Chromatic Difference of Refraction



Atchison and Smith, JOSA A, 2005

Why is LCA not really a problem?

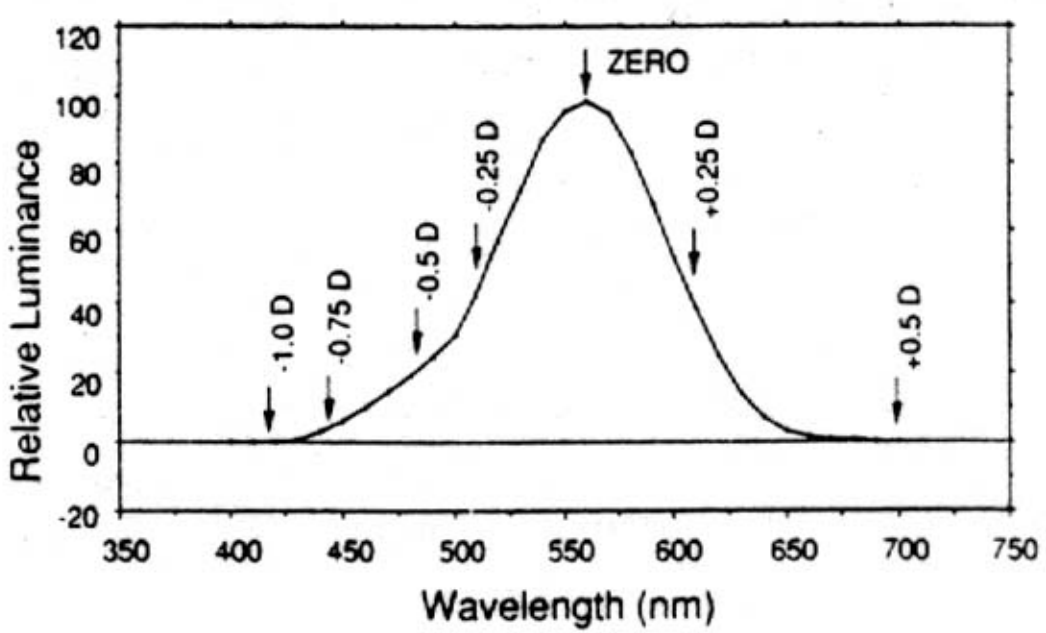
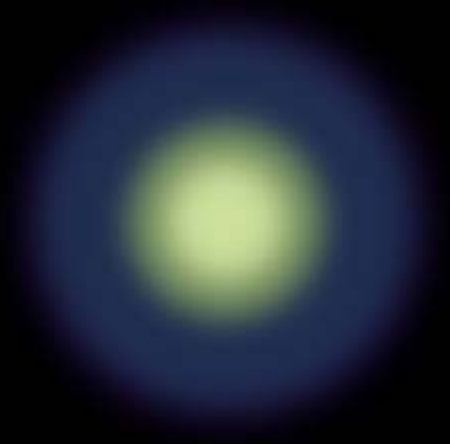


Figure 3. The significance of chromatic defocus depends on luminance. The solid curve shows the luminance spectrum of white-light emitted by the P4 phosphor of cathode ray tubes and arrows mark the amount of defocus if the eye accommodates for 550 nm. When the peak of the luminance spectrum is in focus, most of the light is less than 0.25 D out of focus.

Chromatic Aberration

Halos (LCA)

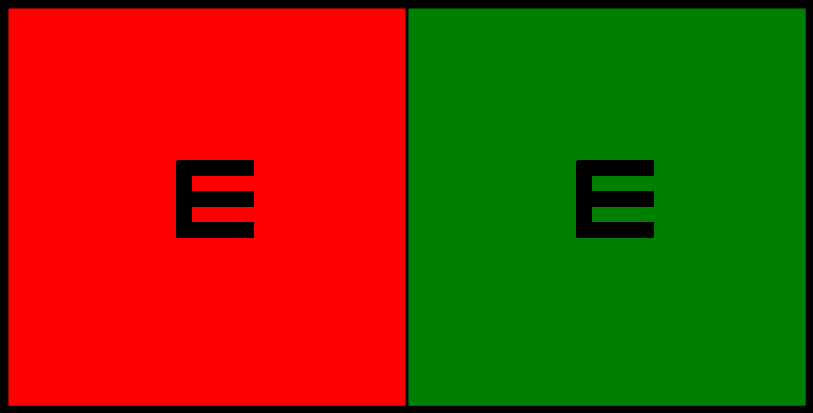


www.starizona.com

Fringes (TCA)

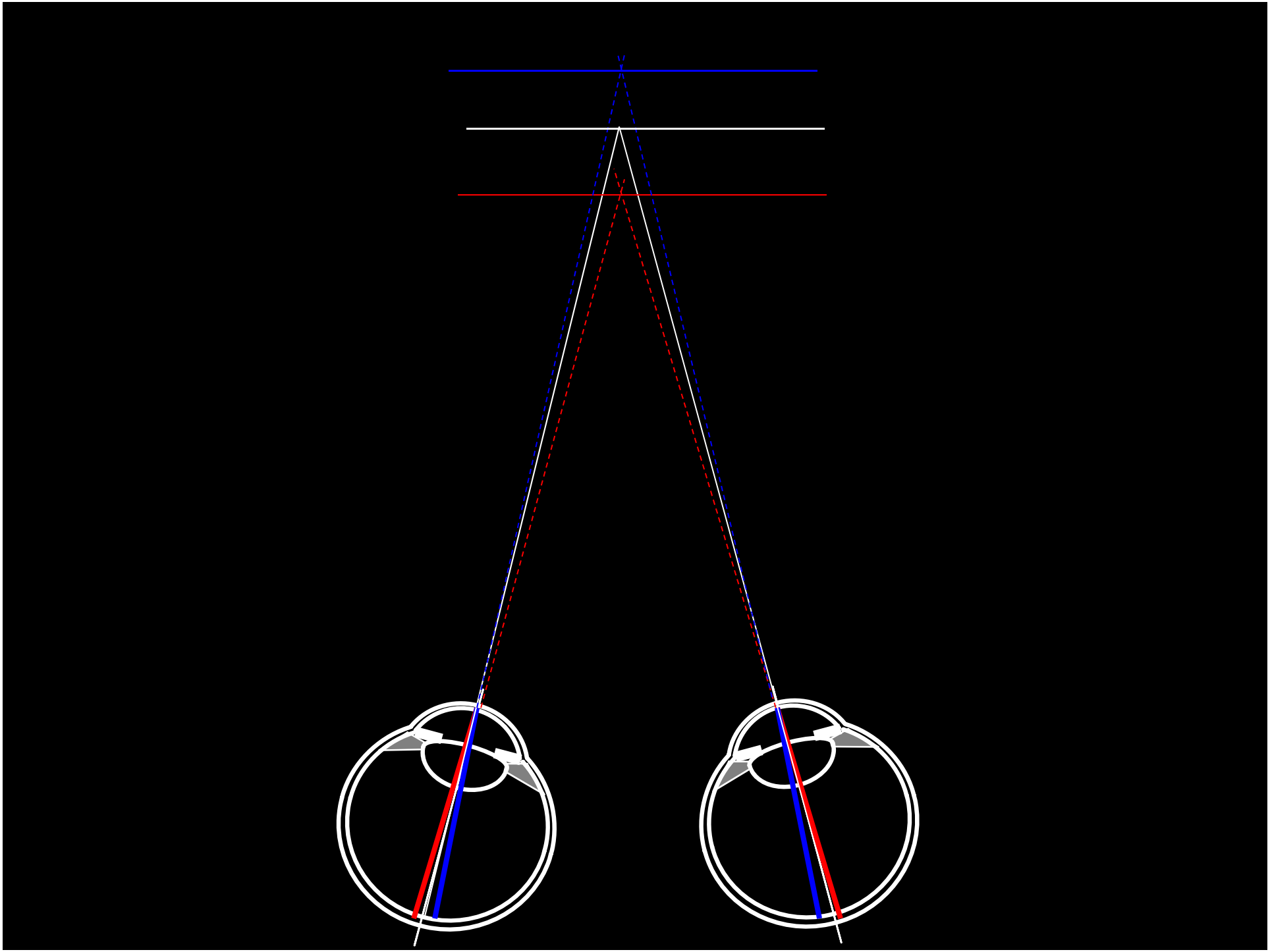
digitaldailydose.wordpress.com

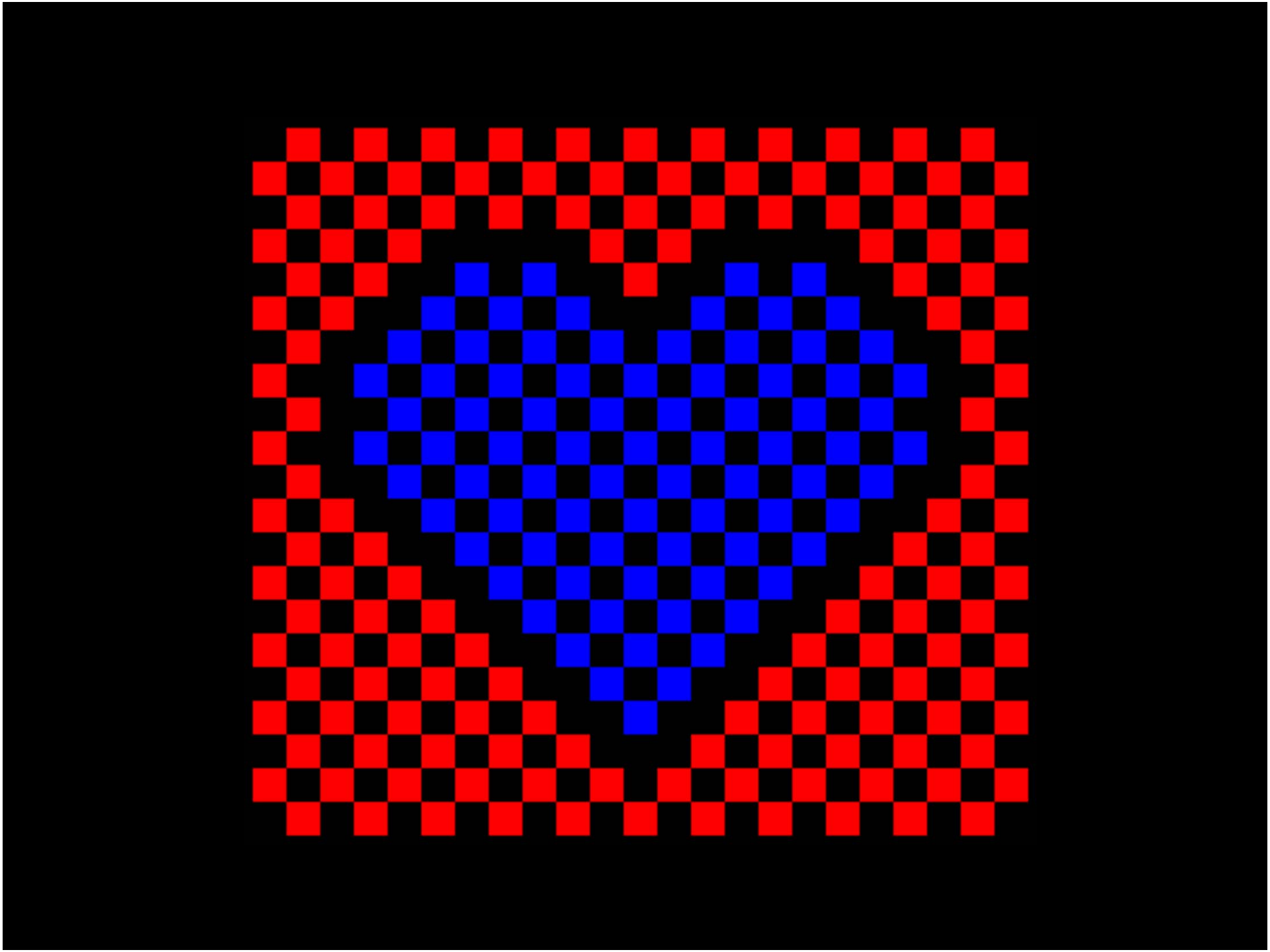
Red-Green Duochrome test

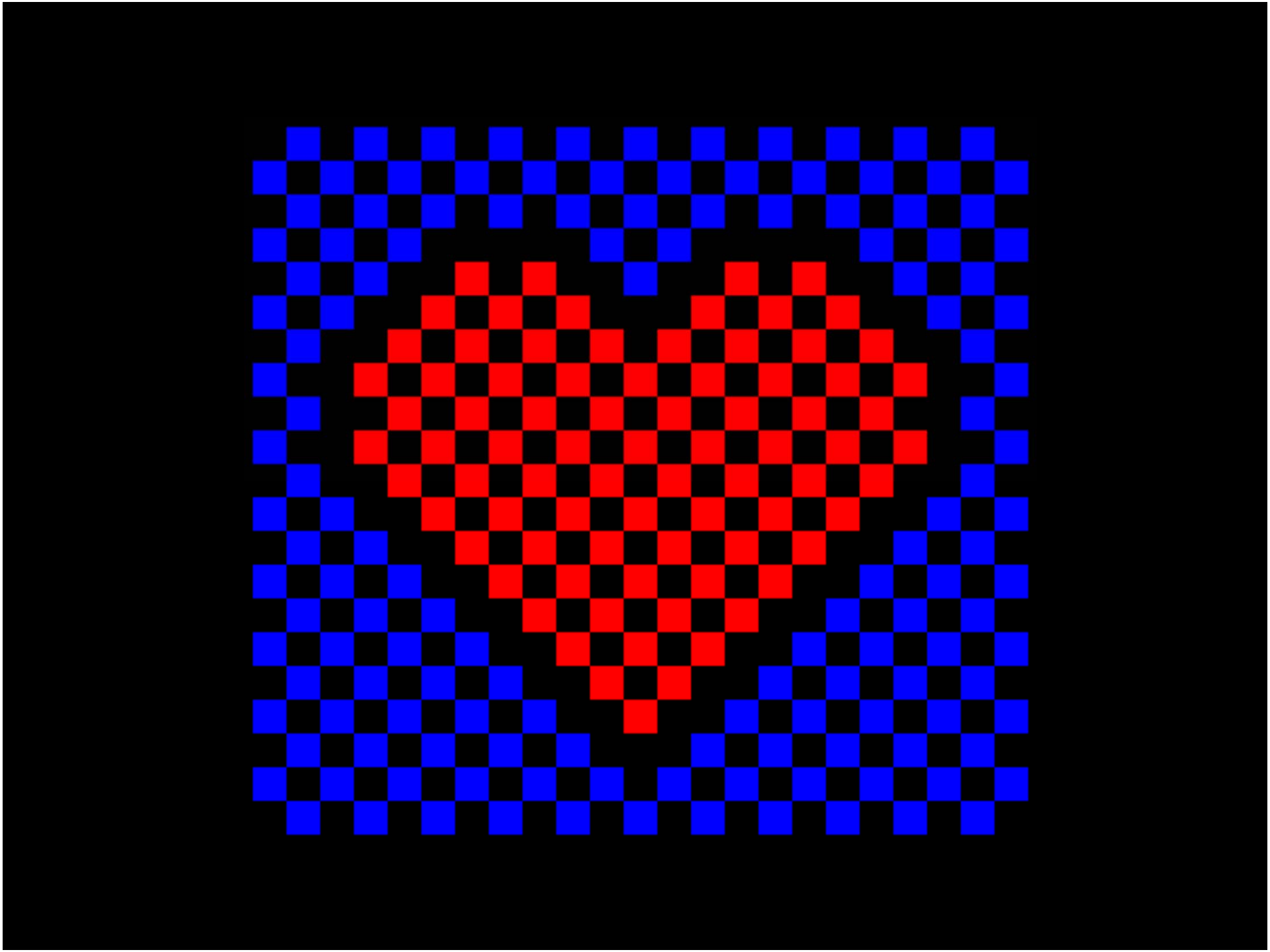


- If the letters on the red side stand out more, add minus power; if the letters on the green side stand out more, add plus power.
- Neutrality is reached when the letters on both backgrounds appear equally distinct.

Colligon-Bradley P. J Ophthalmic Nurs Technol. 1992 11(5):220-2.





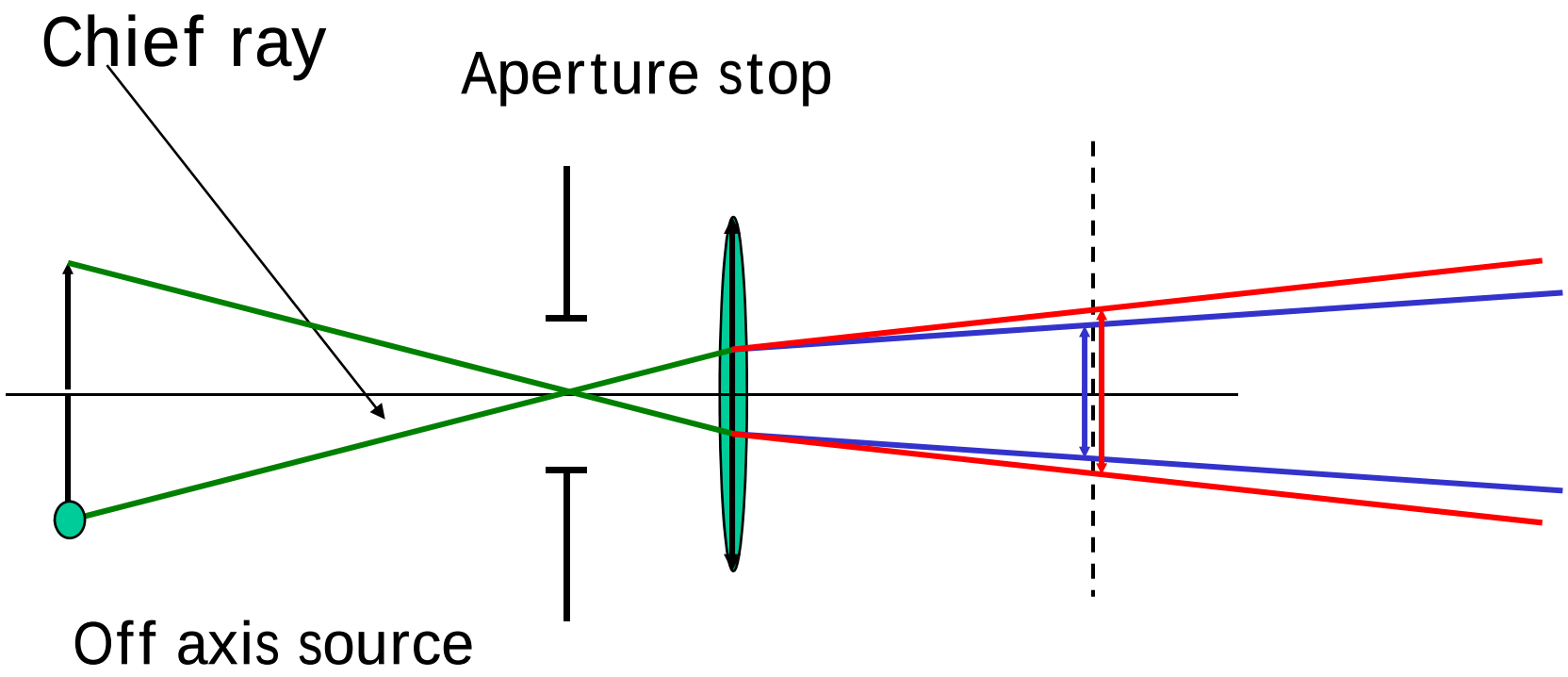


Lab #7 April 15th

Look at a red and blue target through a 1 mm pinhole. Move the pinhole from one edge of the pupil to the other.

What happens to the red and blue images?

Chromatic Difference of Magnification



Abbe Number

- Also known as
  - Refractive efficiency
  - nu-value
  - V-value
  - constringence

Refractive efficiencies for common materials

water	55.6
alcohol	60.6
ophthalmic crown glass	58.6
polycarbonate	30.0
dense flint glass	36.6
Highlite glass	31.0
BK7	64.9

Example

- Given the following indices of refraction for BK7 glass (n_D = 1.519; n_F = 1.522; n_C = 1.514) what is the refractive efficiency?

- What is the chromatic aberration of a 20D thin lens made of BK7 glass?

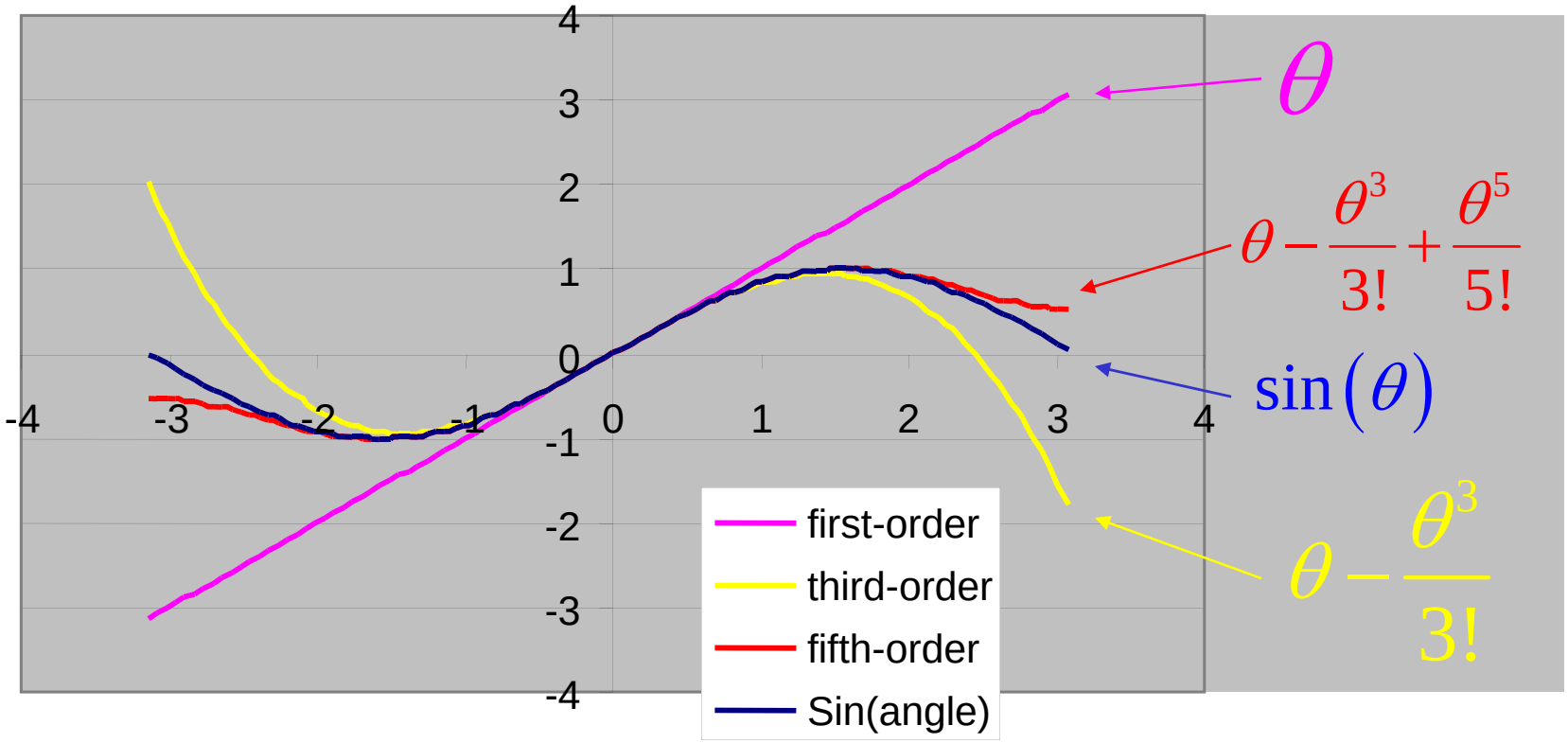
Problem

- Design a 10.00 D achromatic doublet using ophthalmic crown glass and dense flint glass

Carl Friedrich Gauss 1777-1855

Heinrich Seidel 1842-1906

Approximations to the sin function



θ [in radians]

Spherical Aberration

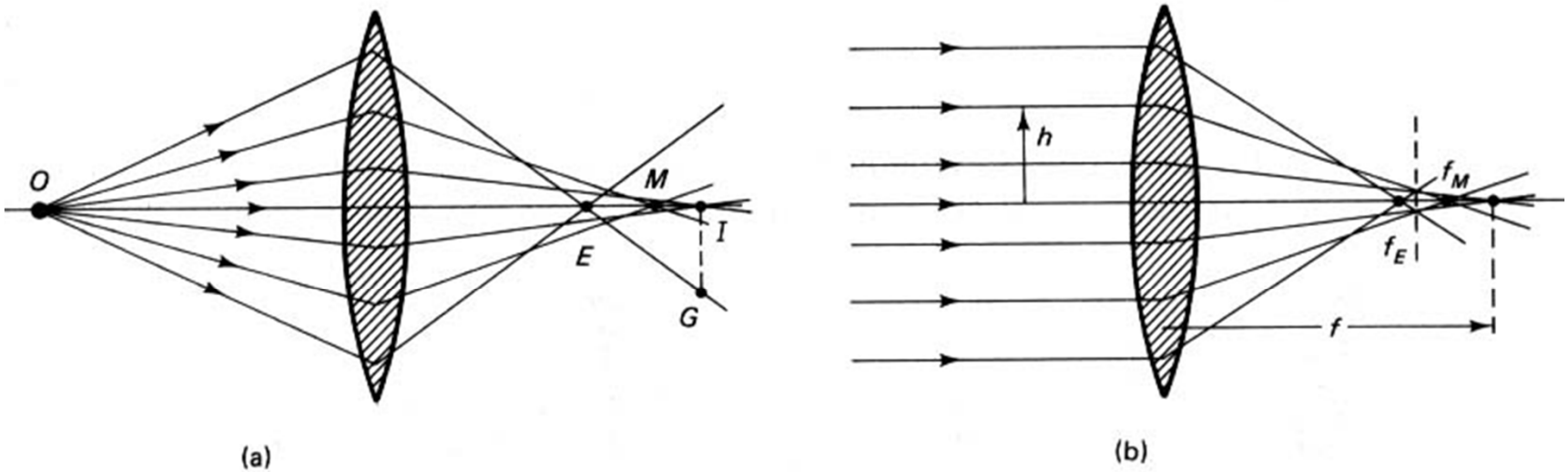
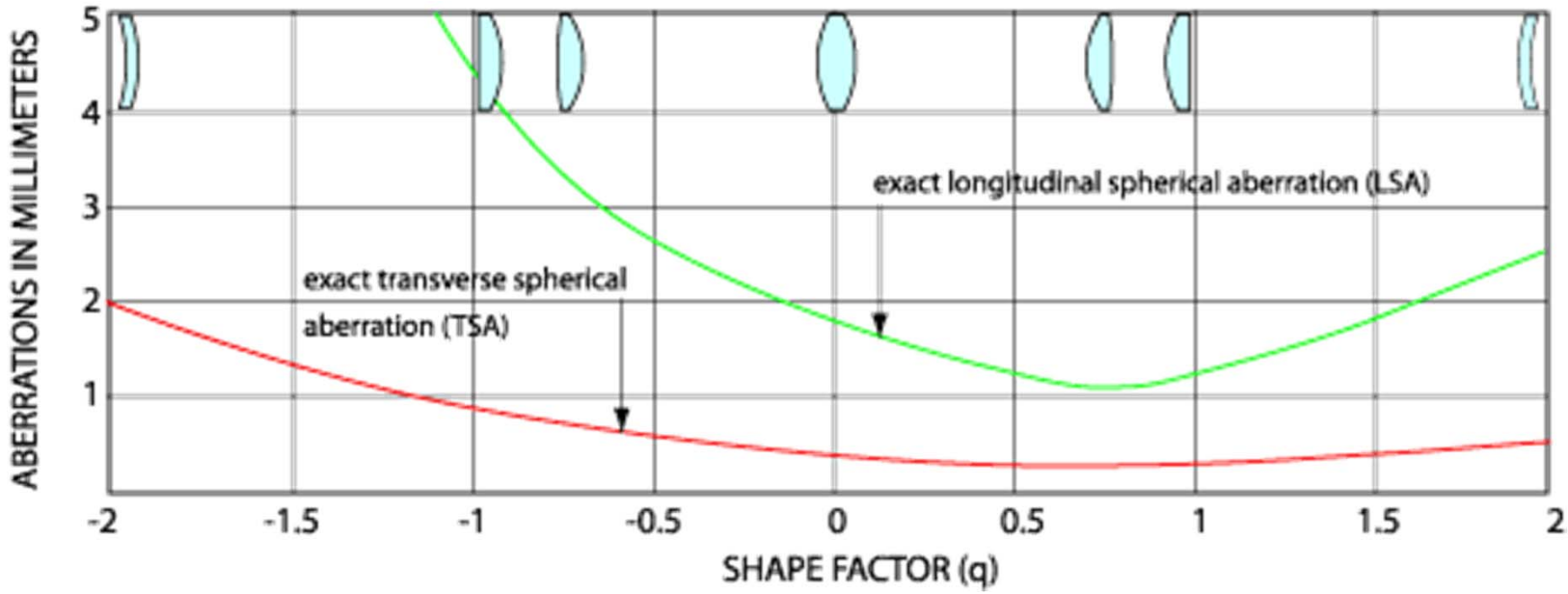
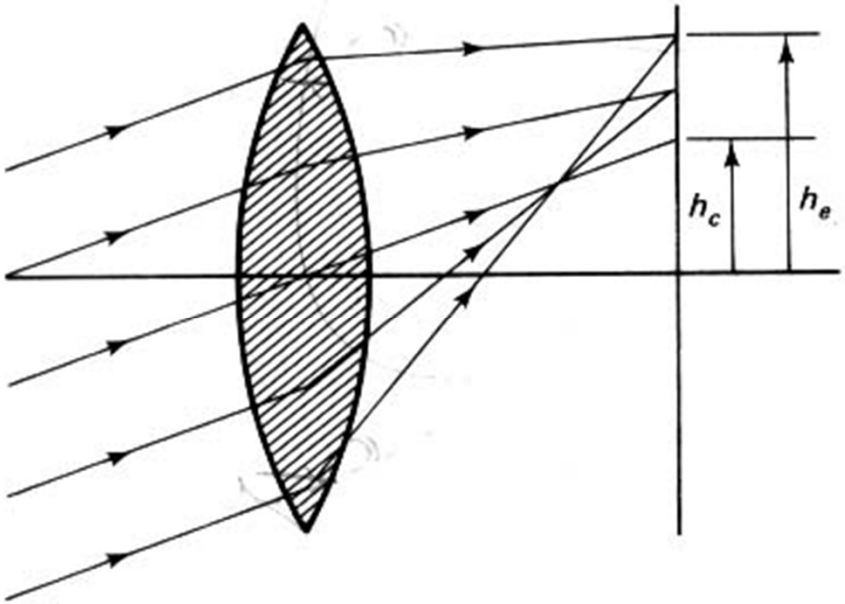


Figure 5-6 Spherical aberration of a lens, producing in (a) different image distances and in (b) different focal lengths, depending on the lens aperture.

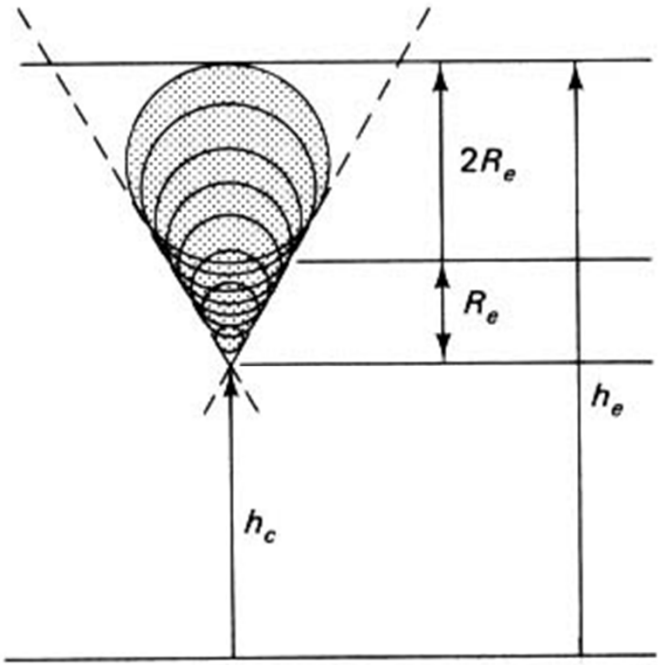
The shape of a lens affects its aberrations



Coma

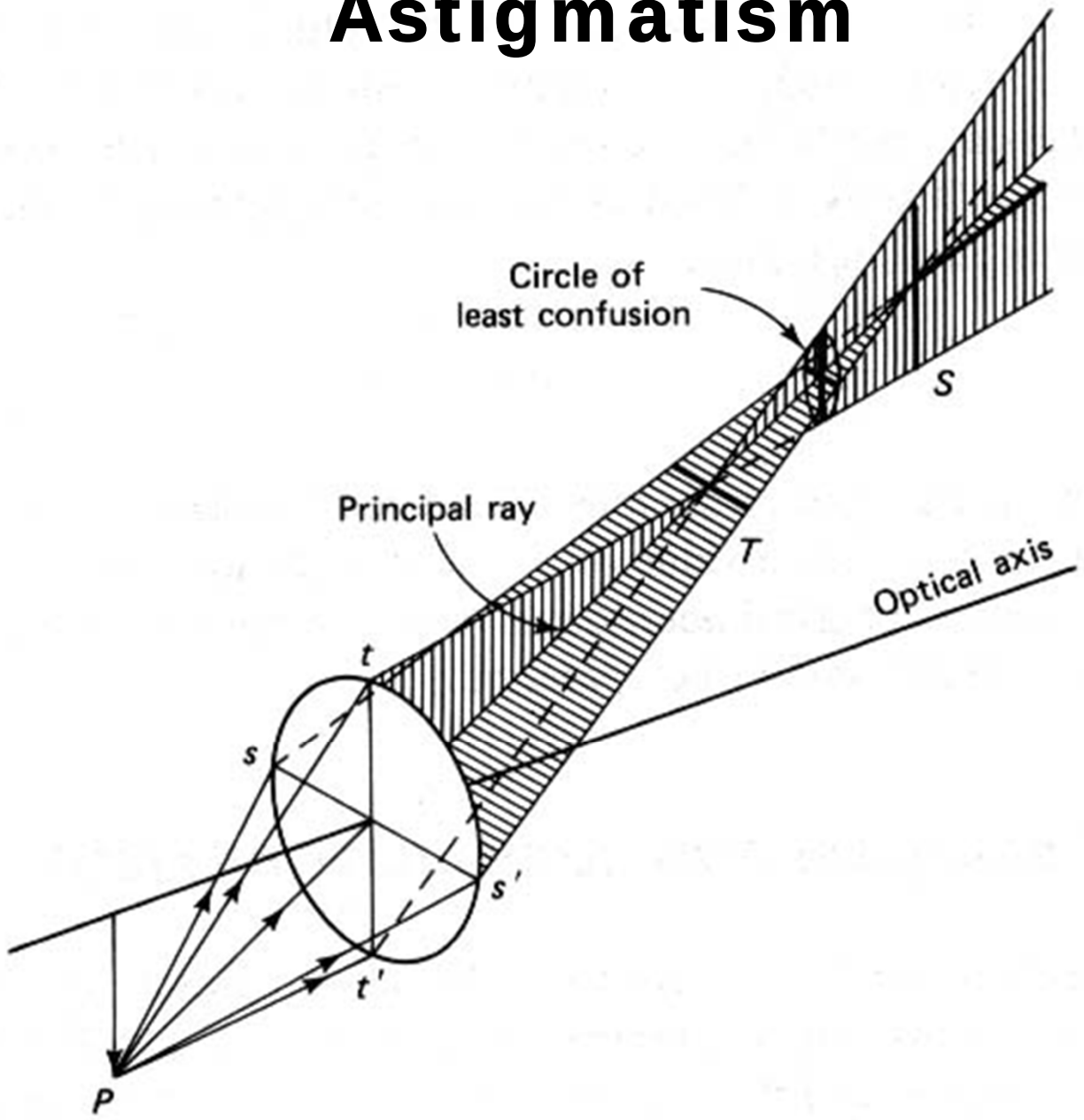


(a)



(b)

Astigmatism



Example

What is the change in astigmatism when you look through a 5D lens (n=1.5) tilted at a downward angle of 15 degrees?

Curvature of Field
(due to radial astigmatism)

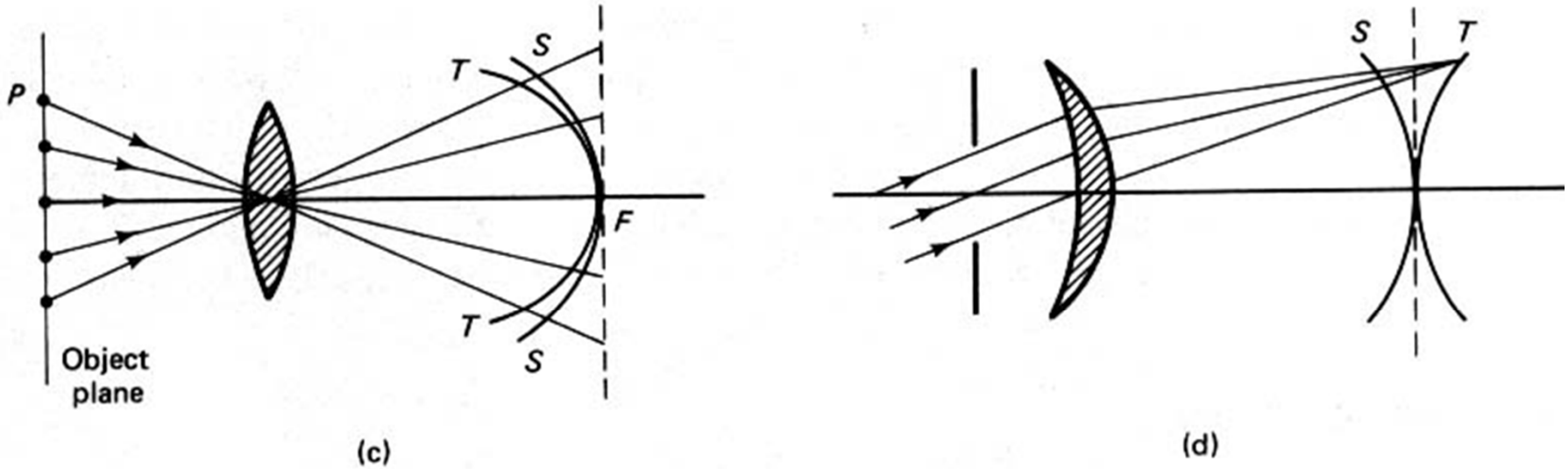
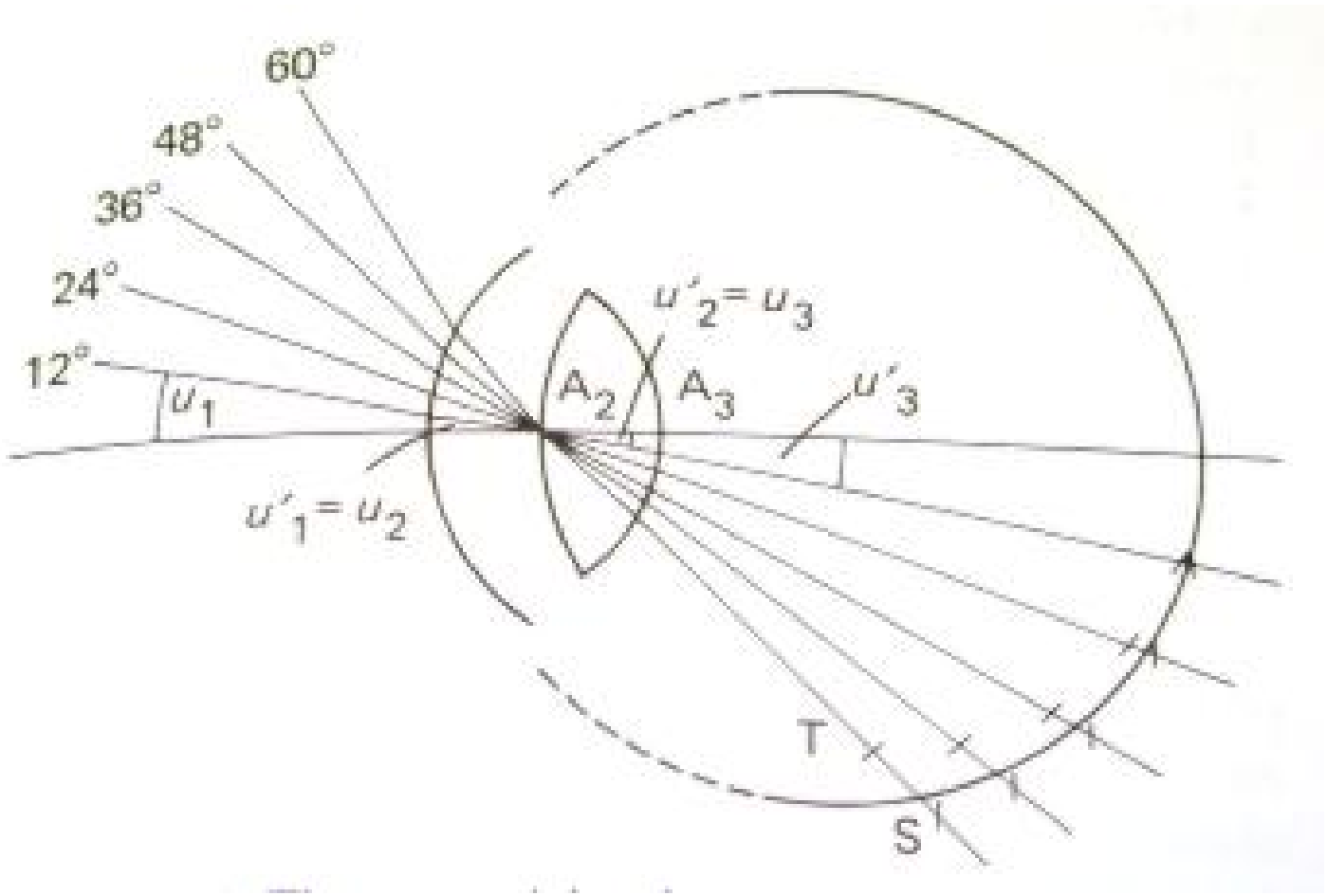


Figure 5-9 (Continued) (c) Astigmatic surfaces in the field of a lens. (d) Use of a stop to artificially "flatten" the field of a lens. The compromise surface between the *S* and *T* surfaces is indicated by the dashed line.

Oblique Astigmatism in the Eye



Petzval's Condition

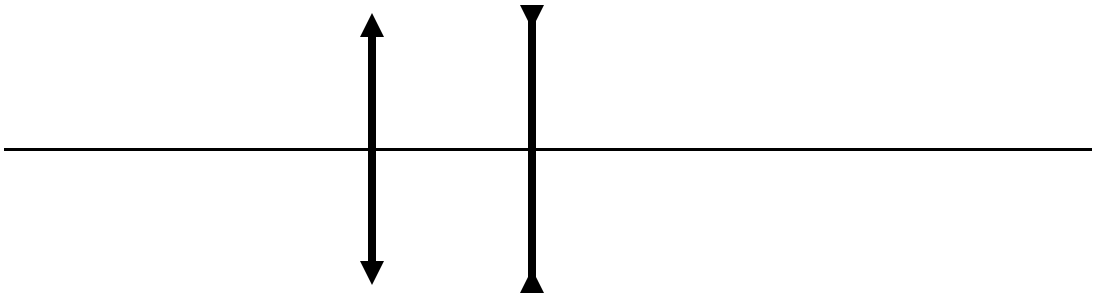
for a series of thin lenses

$$K = \sum_j F_j / n_j$$

for the final image curvature to be zero, set

$$\sum_j F_j / n_j = 0$$

A 2 lens system with a +5 D lens and -5 D lens of the same index will have 0 Peztval curvature



Distortion

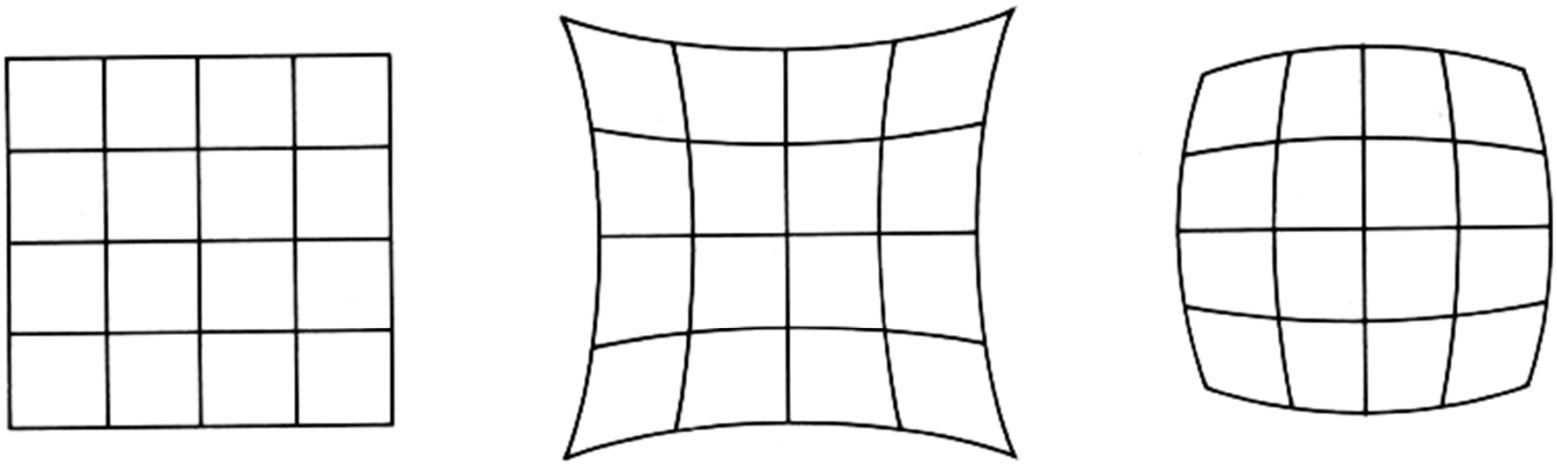
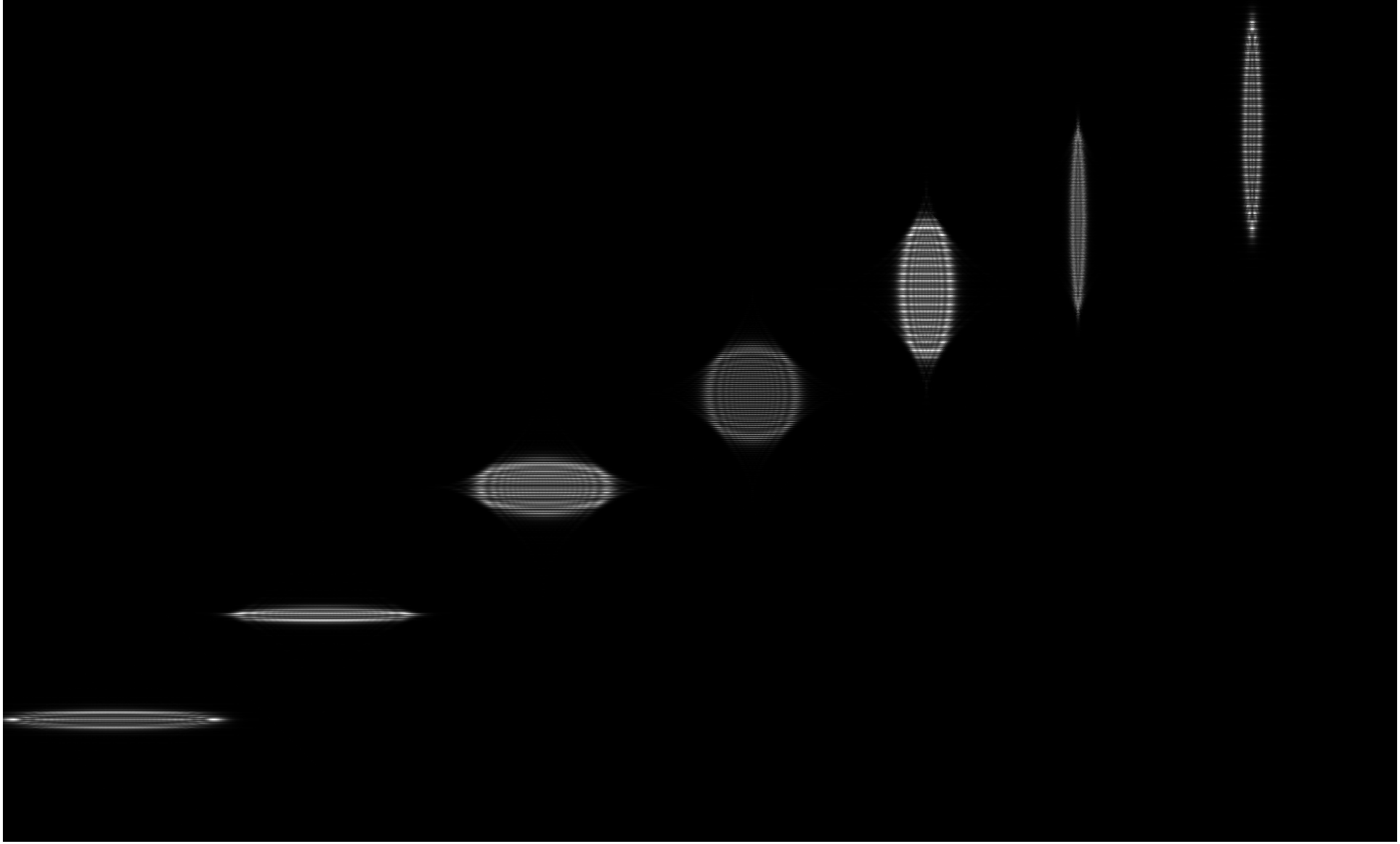


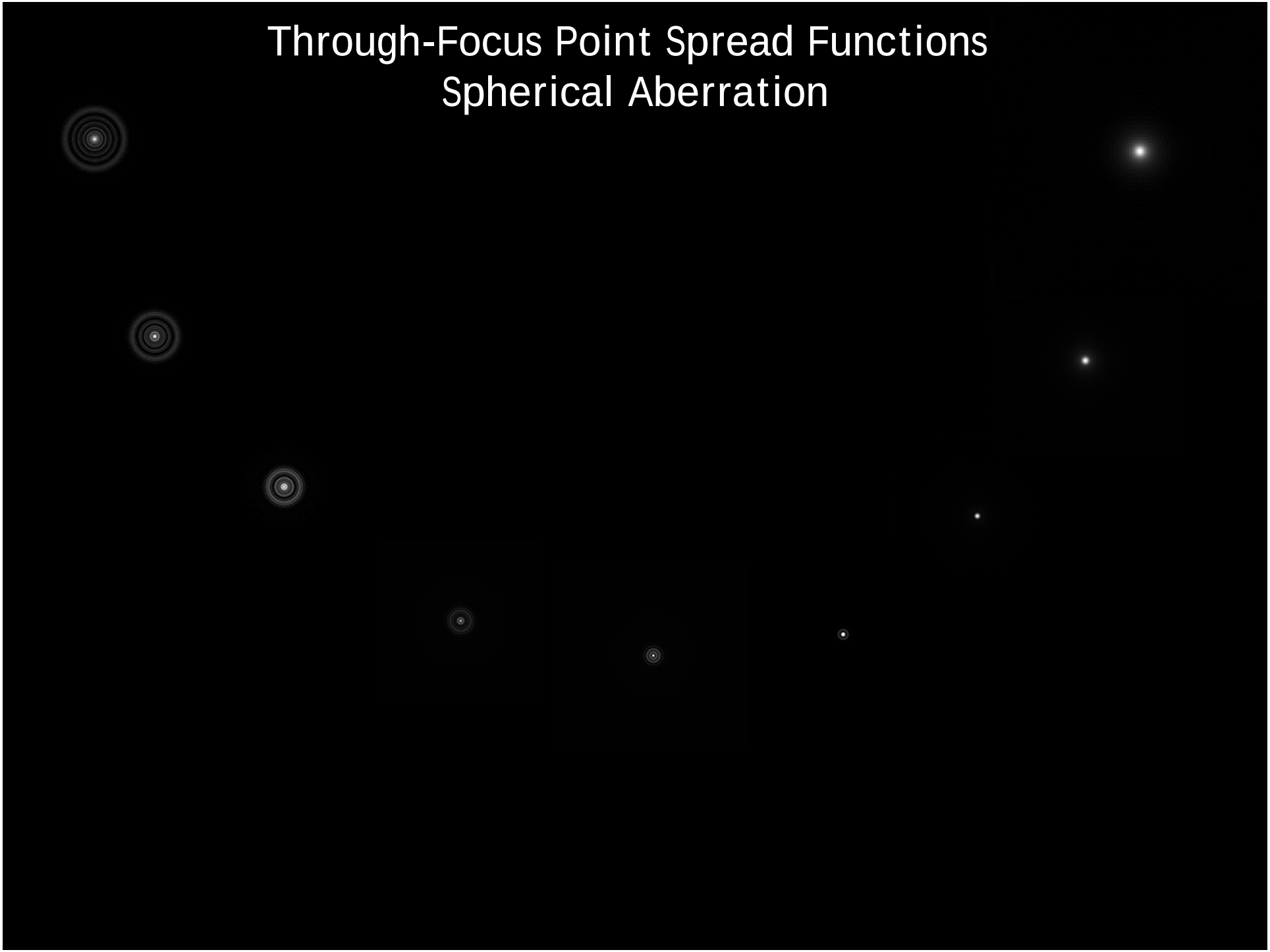
Figure 5-10 Images of a square grid (a) showing pincushion distortion (b) and barrel distortion (c) due to nonuniform magnifications.

Demo: Observe your own point spread function

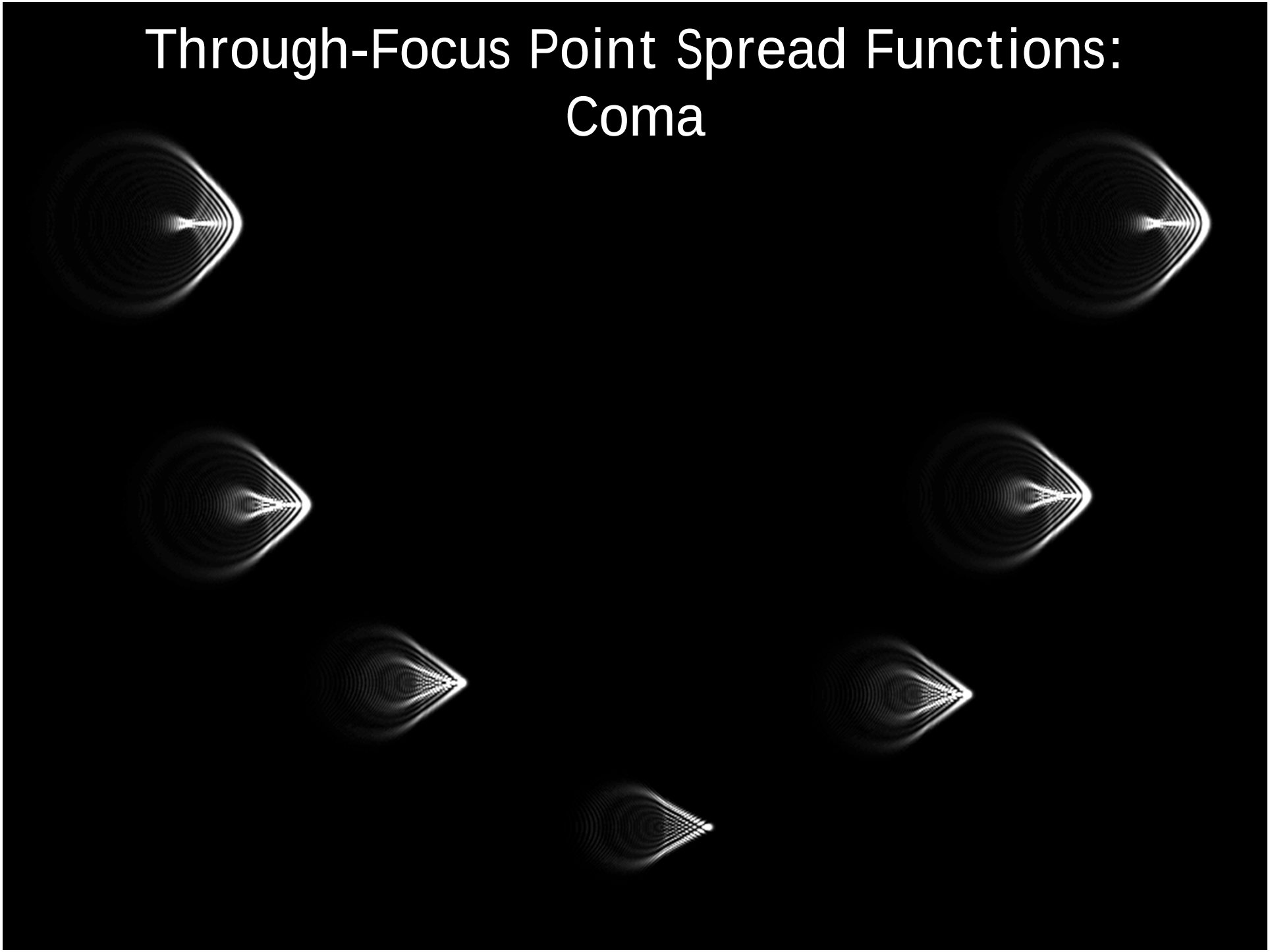
Through-Focus Point Spread Functions: Astigmatism



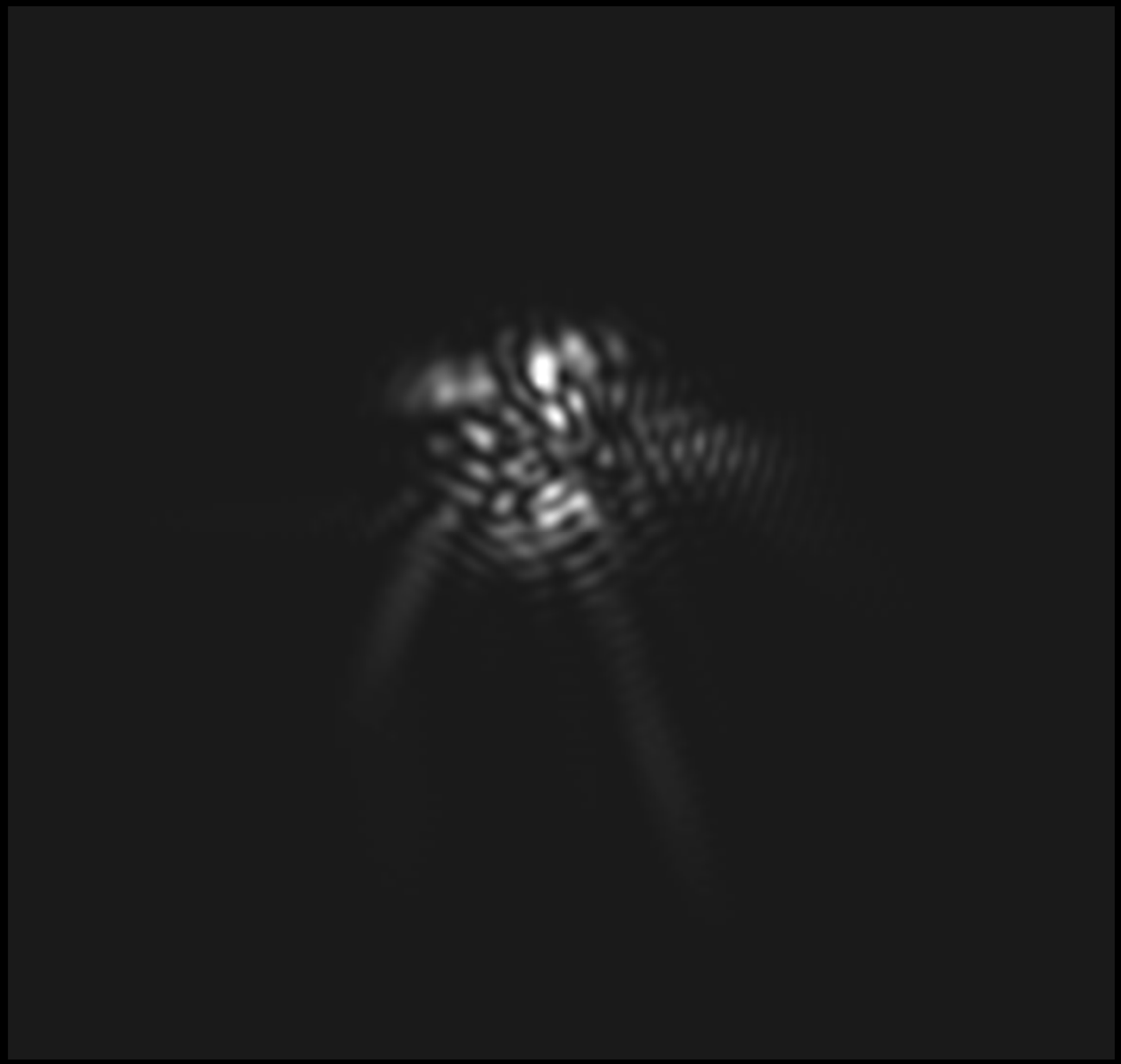
Through-Focus Point Spread Functions
Spherical Aberration



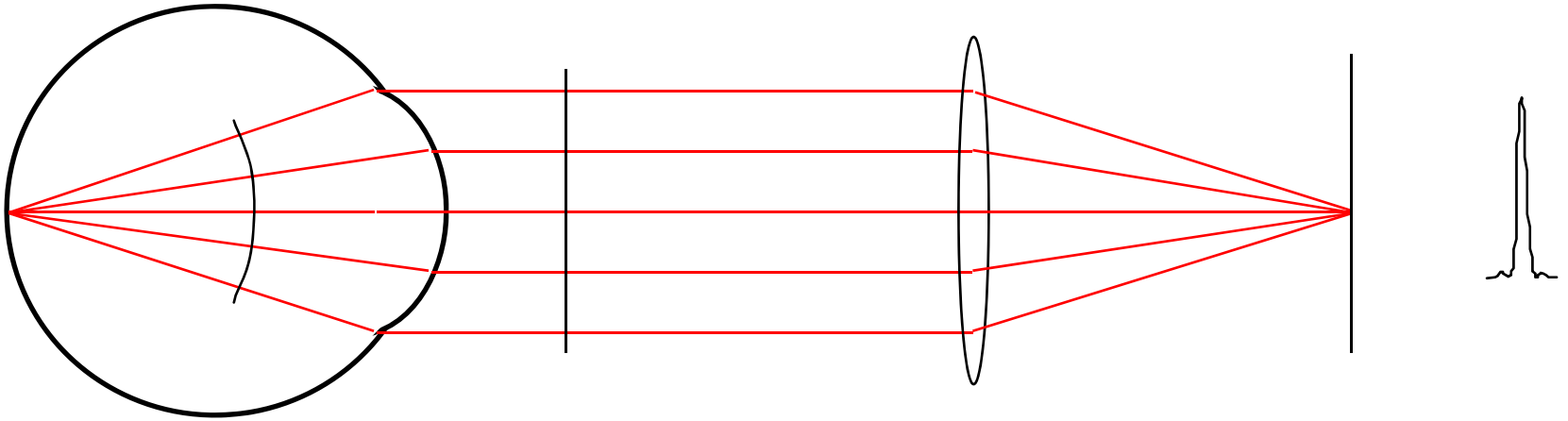
Through-Focus Point Spread Functions: Coma



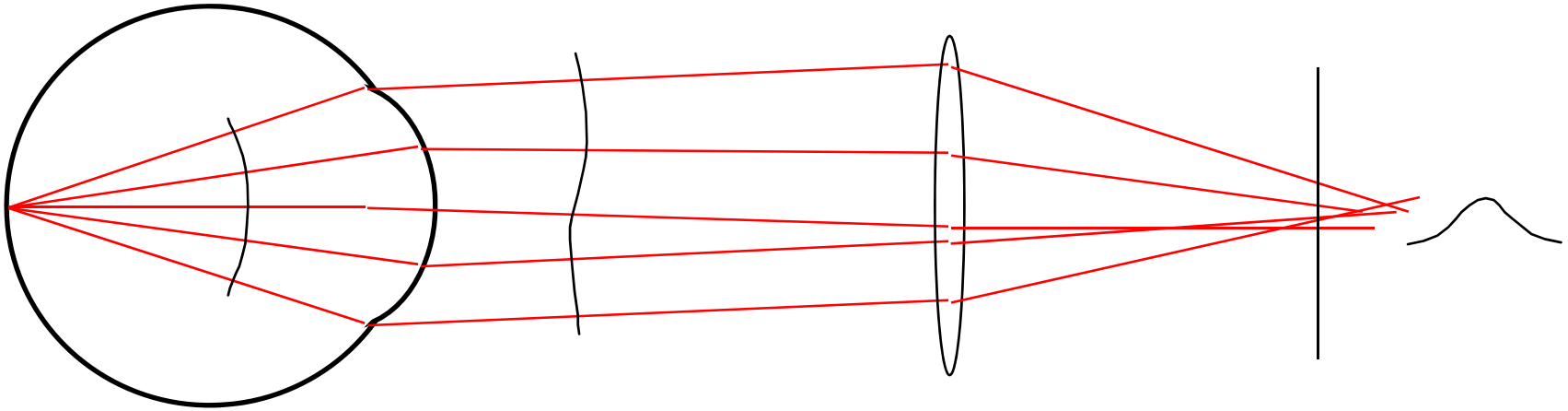
Point Spread Function



Perfect Eye



Aberrated Eye



The Deformable Mirror

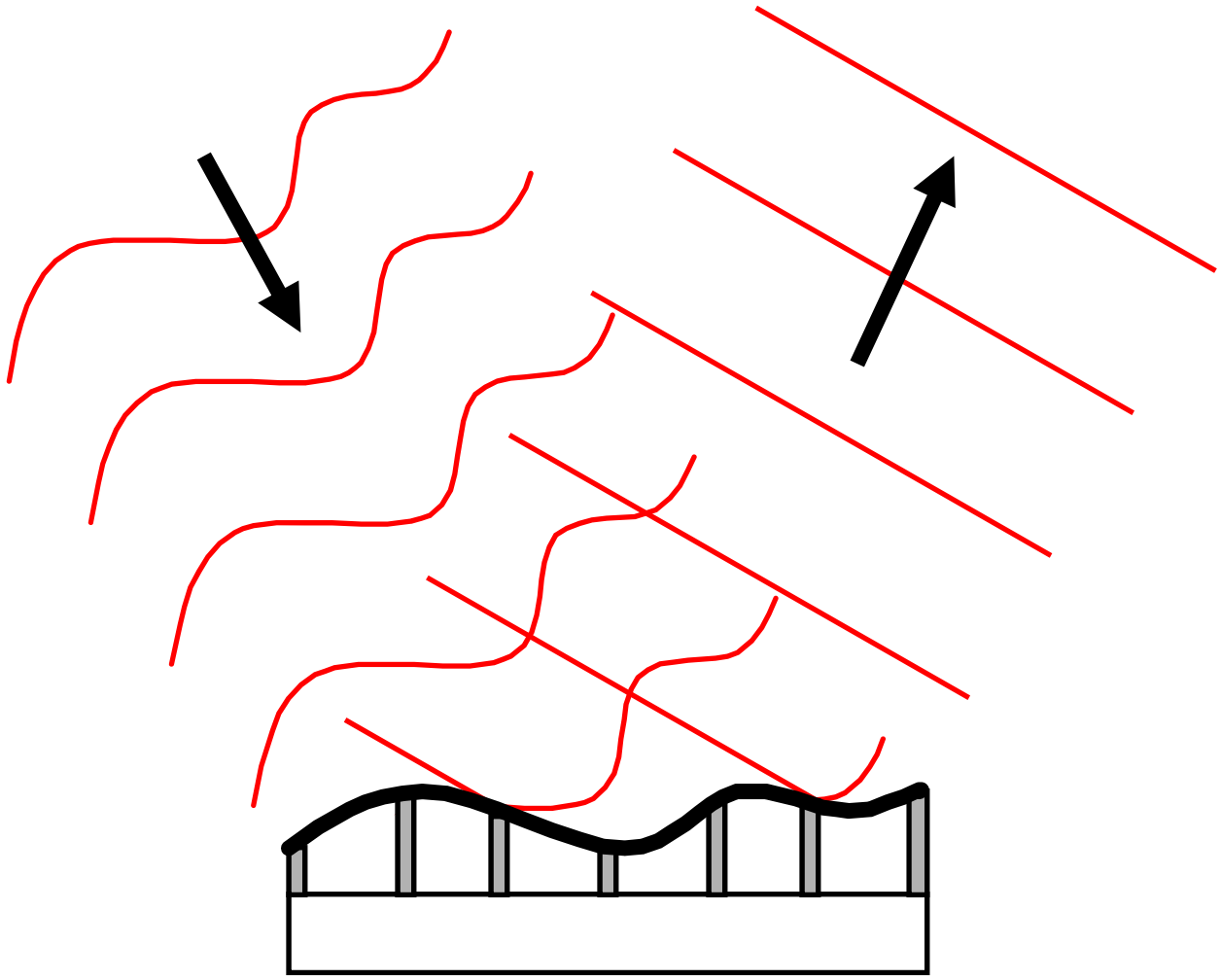


Image of retina through eye with aberrations

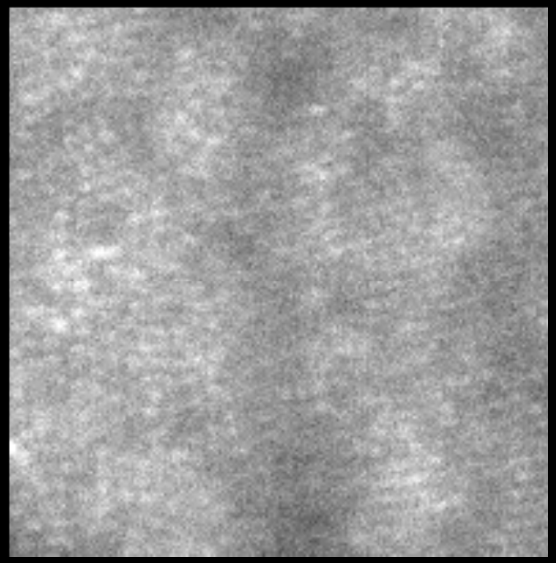
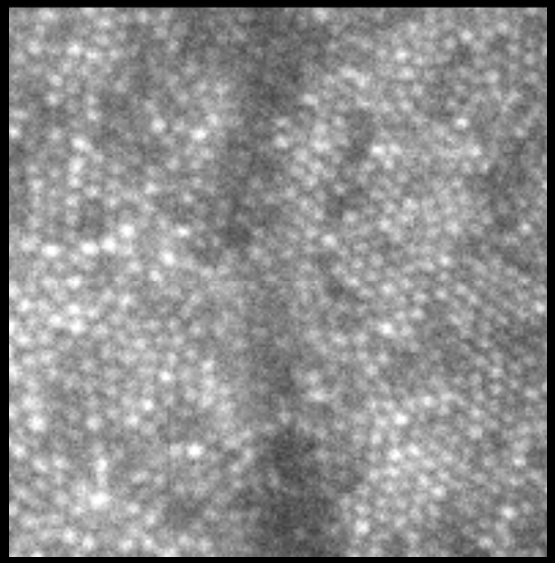
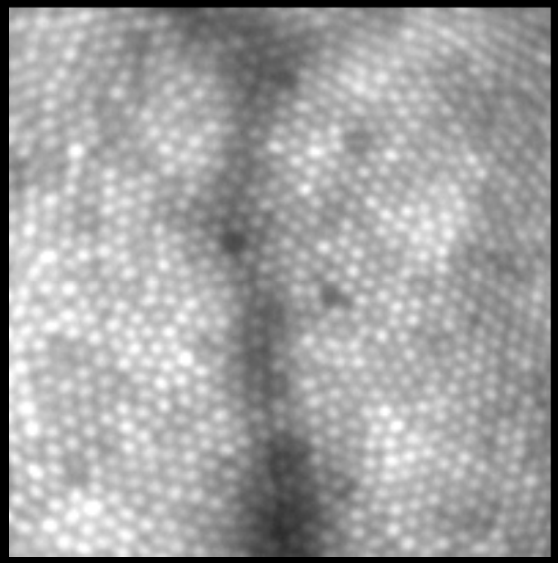


Image of retina with aberrations corrected

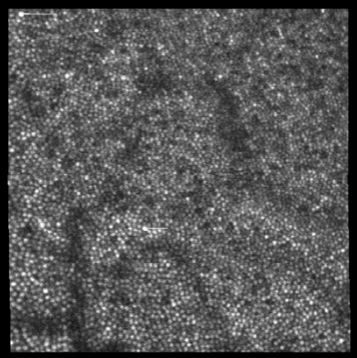


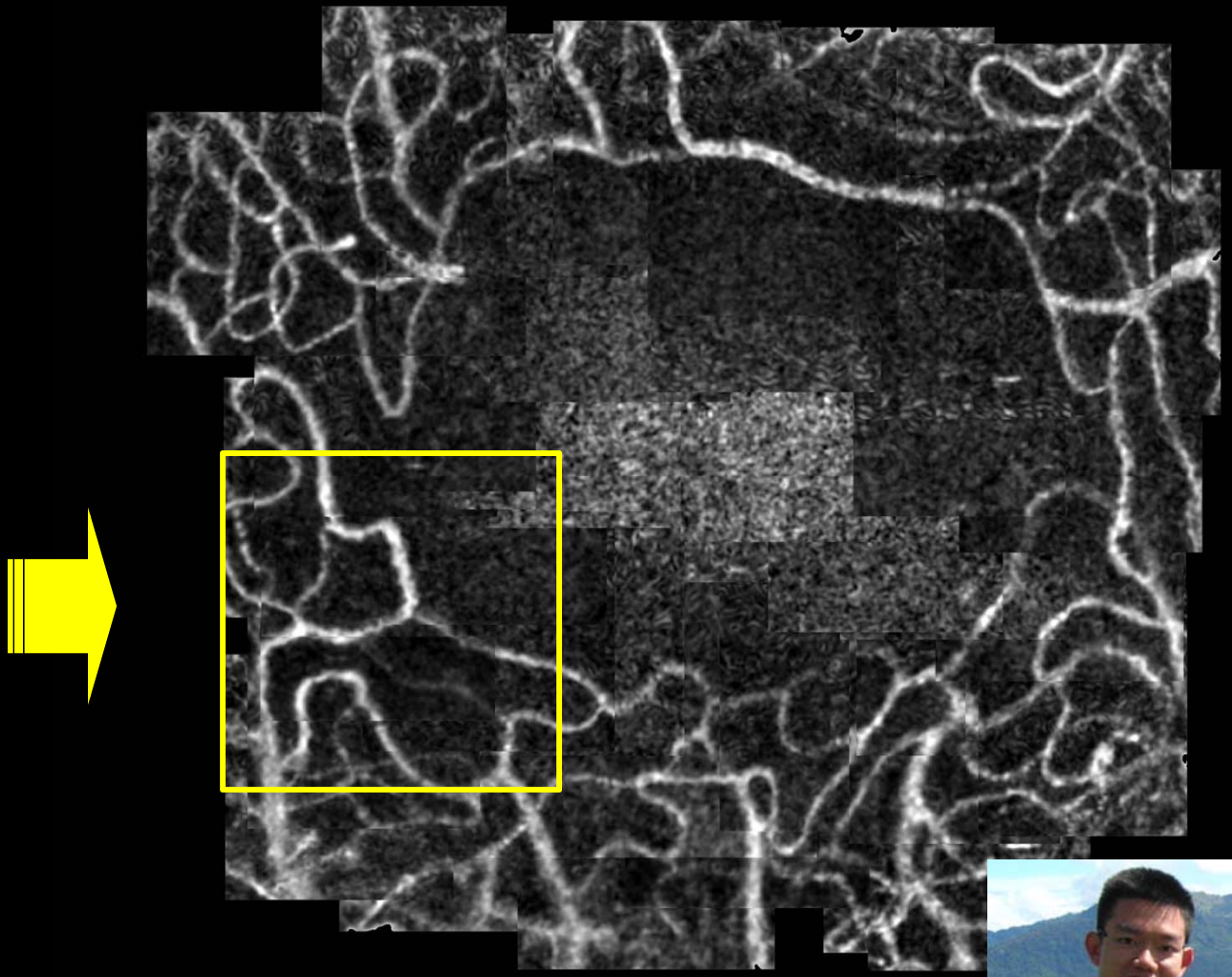
Average corrected image



Motion Contrast Imaging

Stabilized video facilitates automated, fluorescein-free capillary mapping and cell tracking



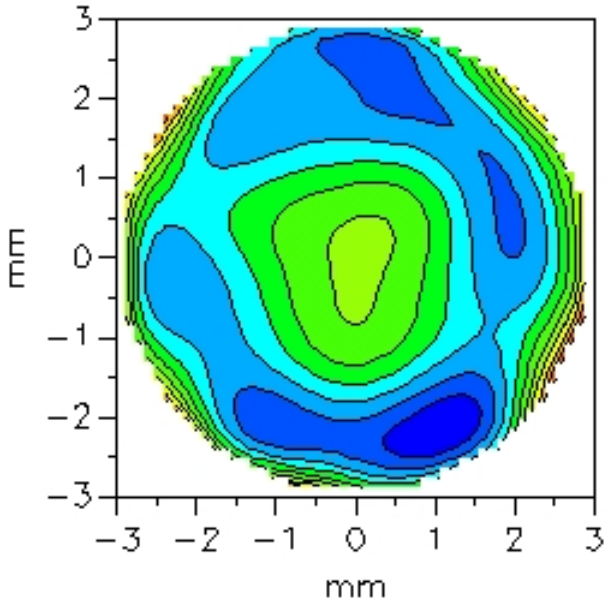


Tam & Roorda, IOVS, 2010

Wavefront Maps

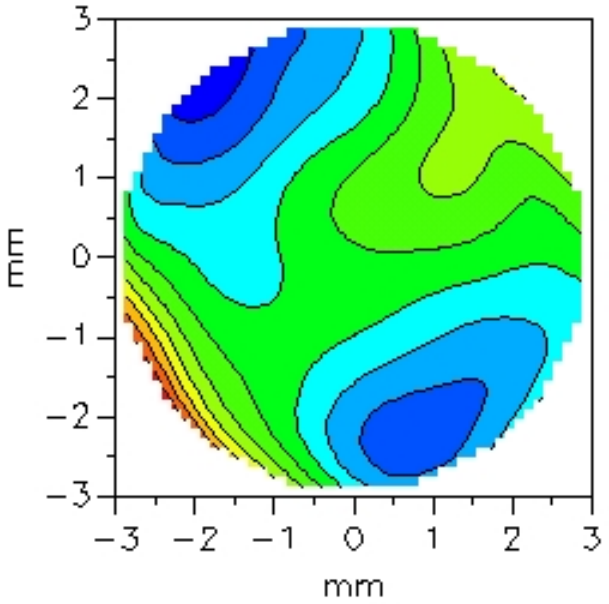
(at best focal plane)

BD



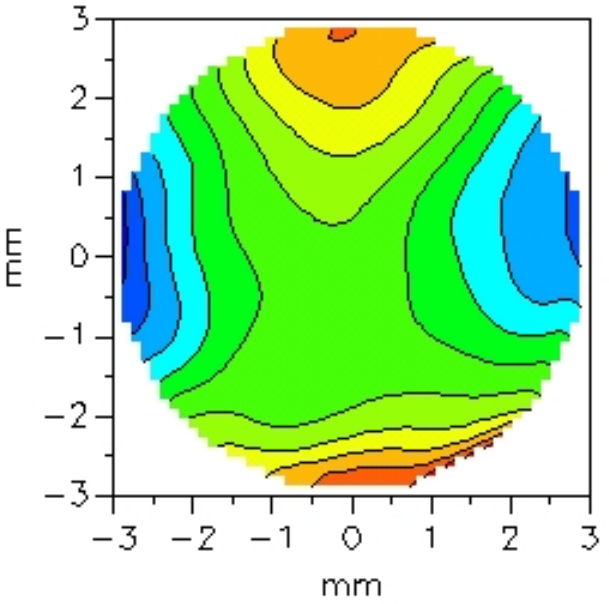
0.33 DS
–0.17 DC X 90

KW



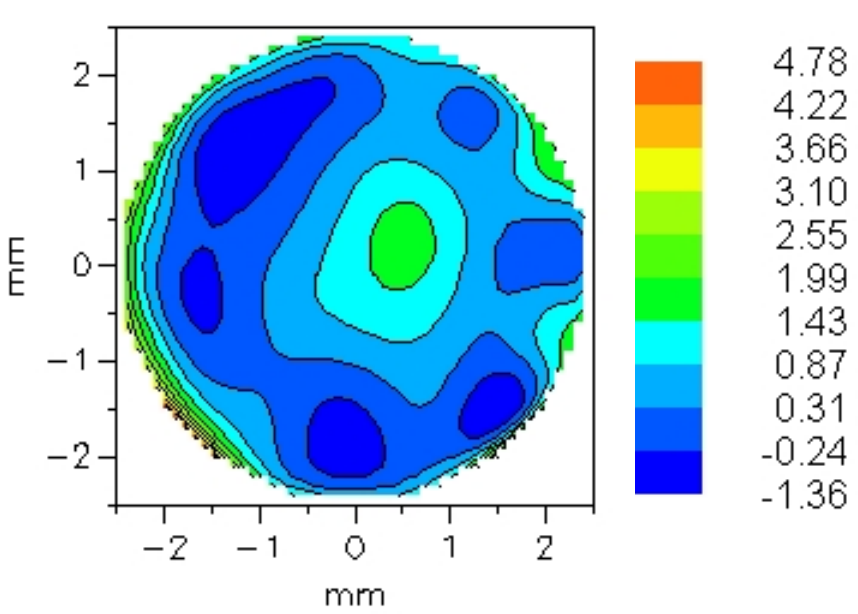
6.42 DS
–0.6 DC X 90

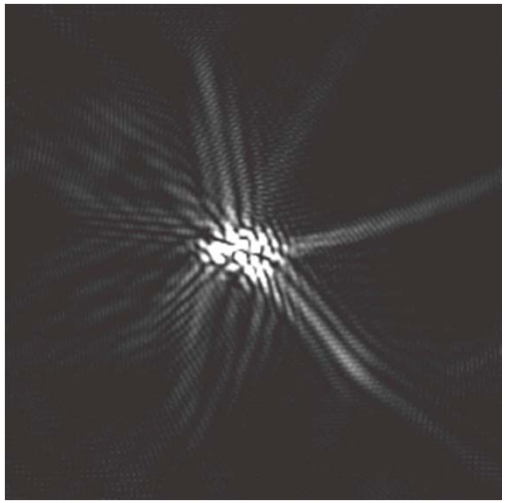
SM



0 DS
–1 DC X 90

Post - RK





Post - LASIK