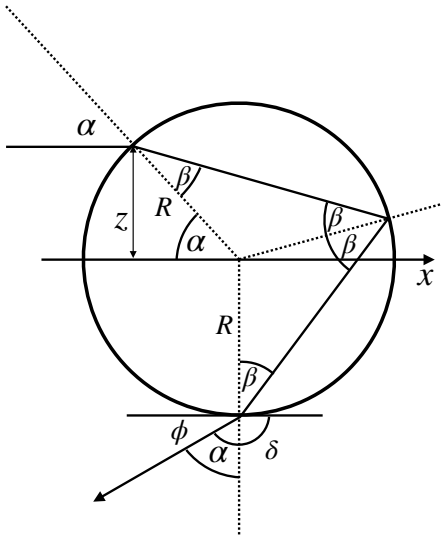
Experimental Physics 3 - Em-Waves,Optics, Quantum mechanics

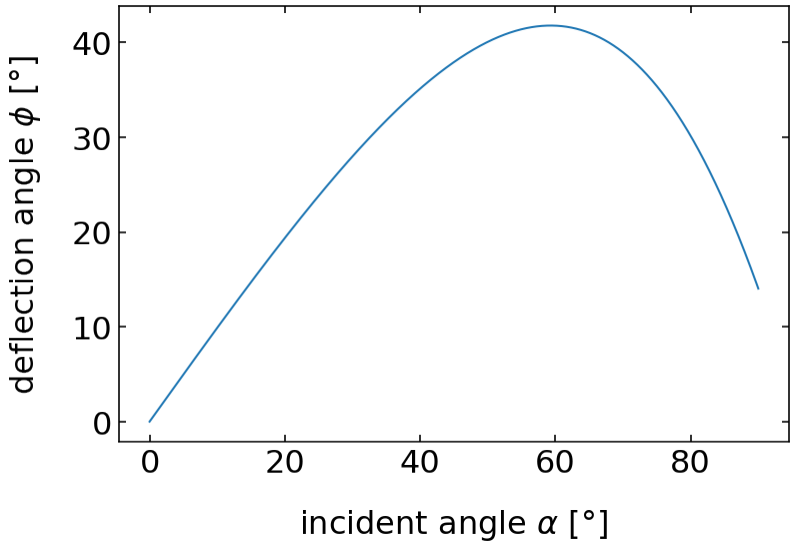
Lecture 4

Prof. Dr. Frank Cichos
WS 2022/23

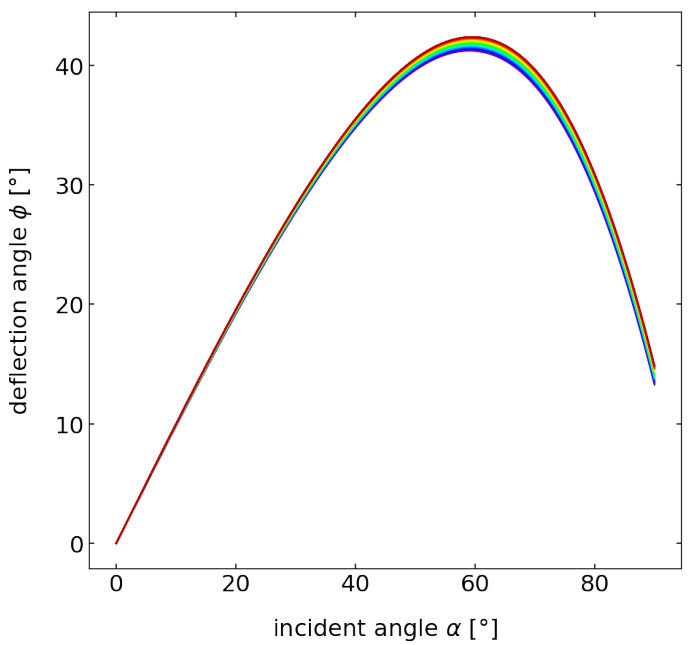
Rainbow

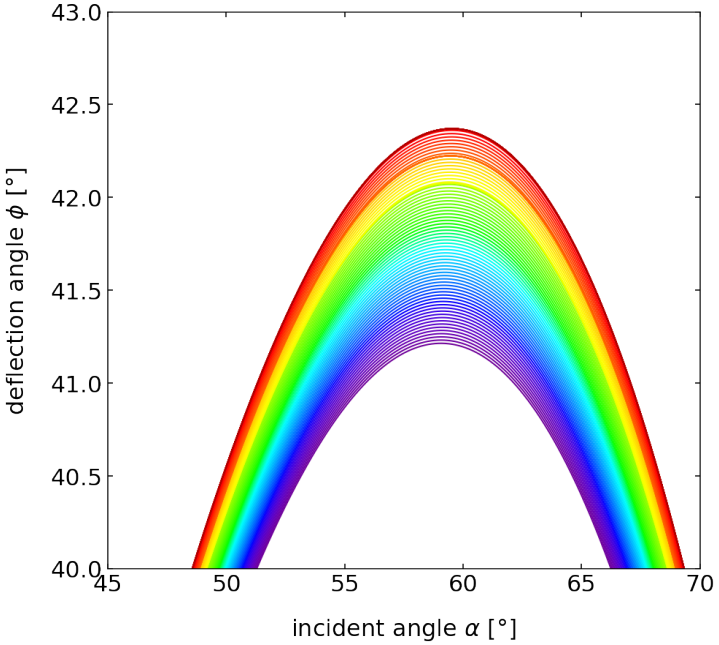
single water drop

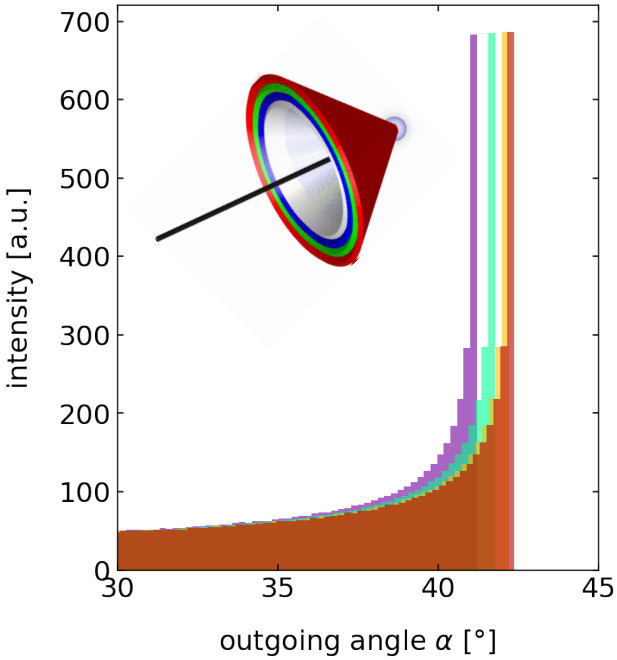




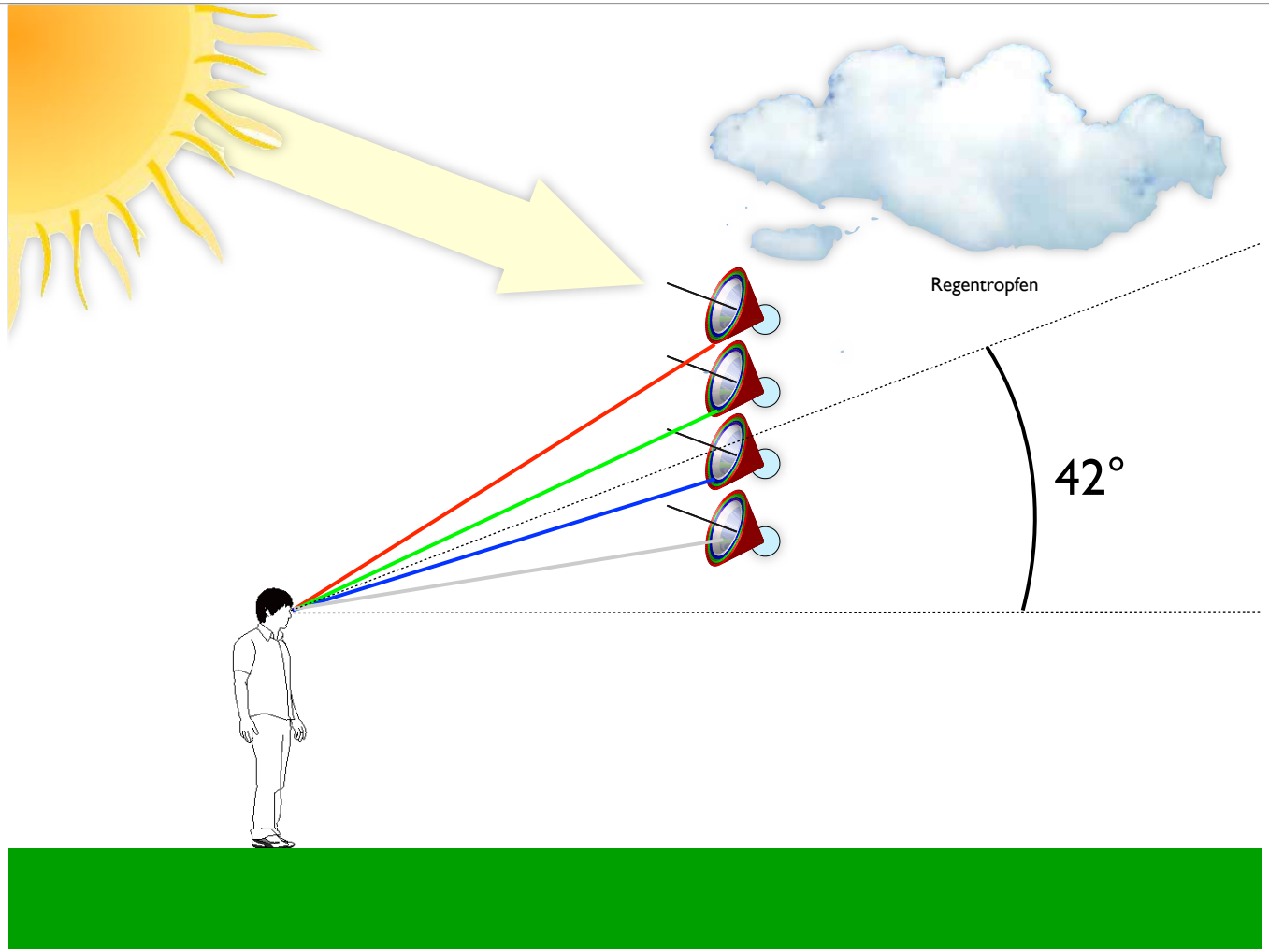
Dispersion of water





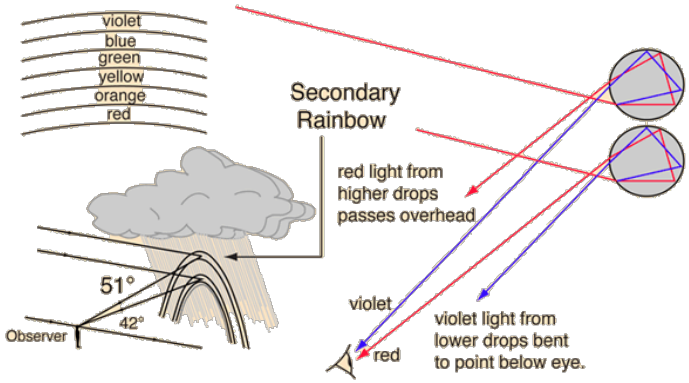


Rainbow



Rainbow over Grand Canyon

Rainbow Zoom in

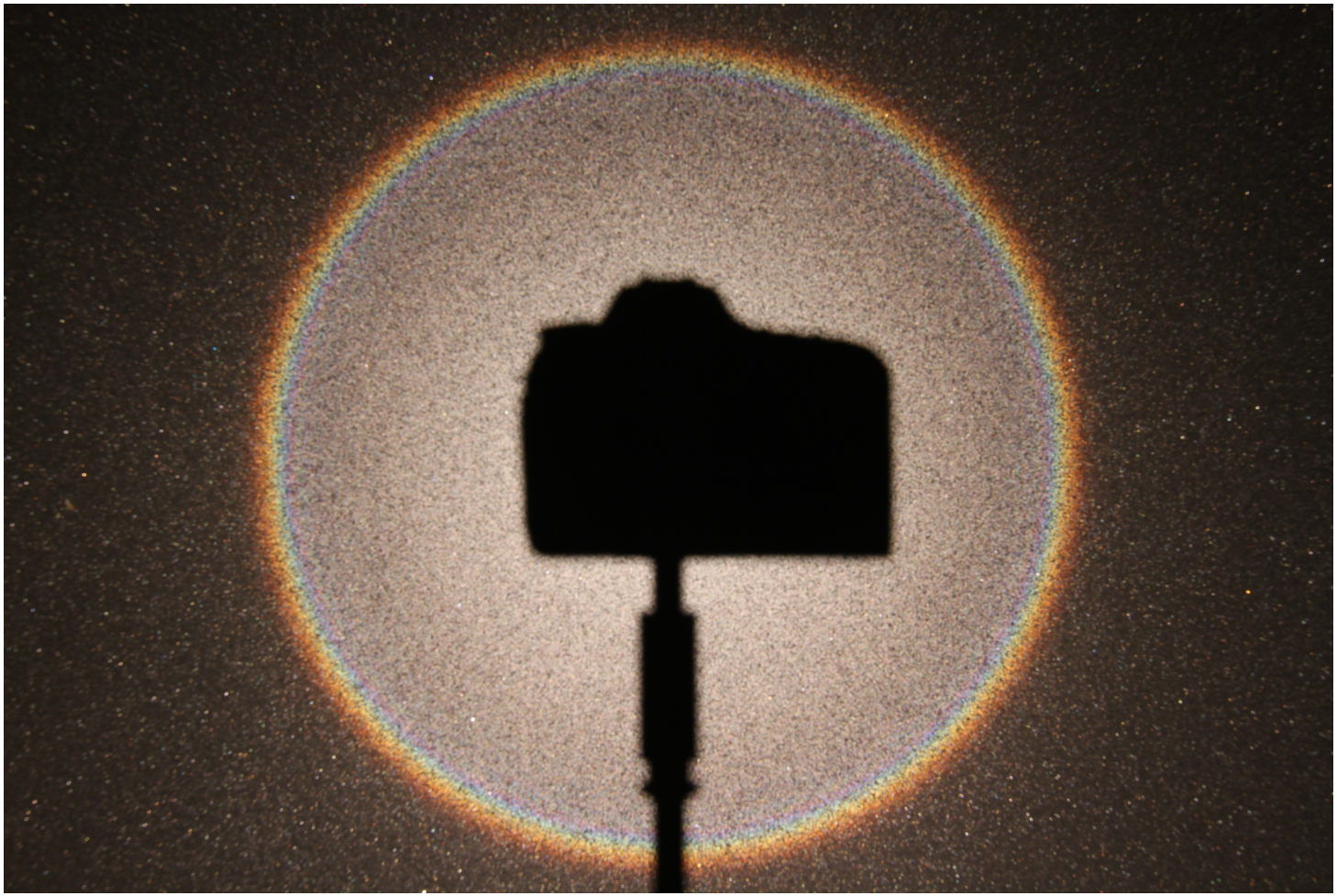


Supernumerary Rainbows

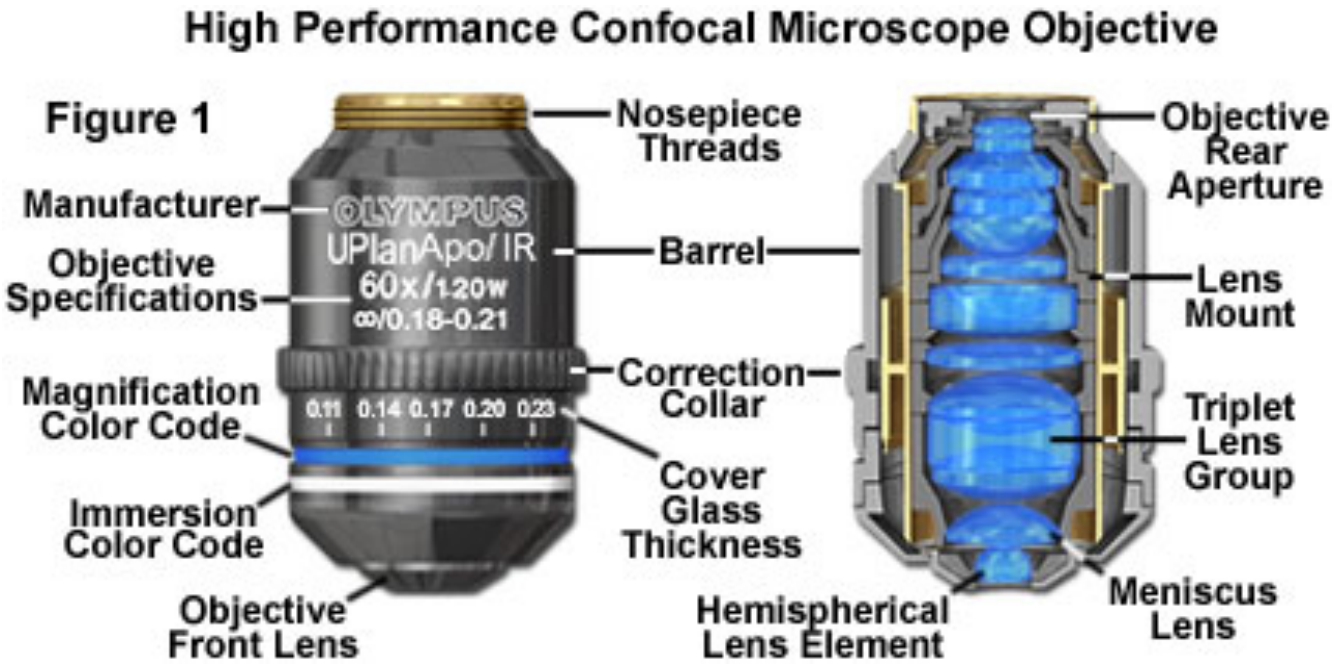
not explainable by
geometrical optics

interference due to
different path length

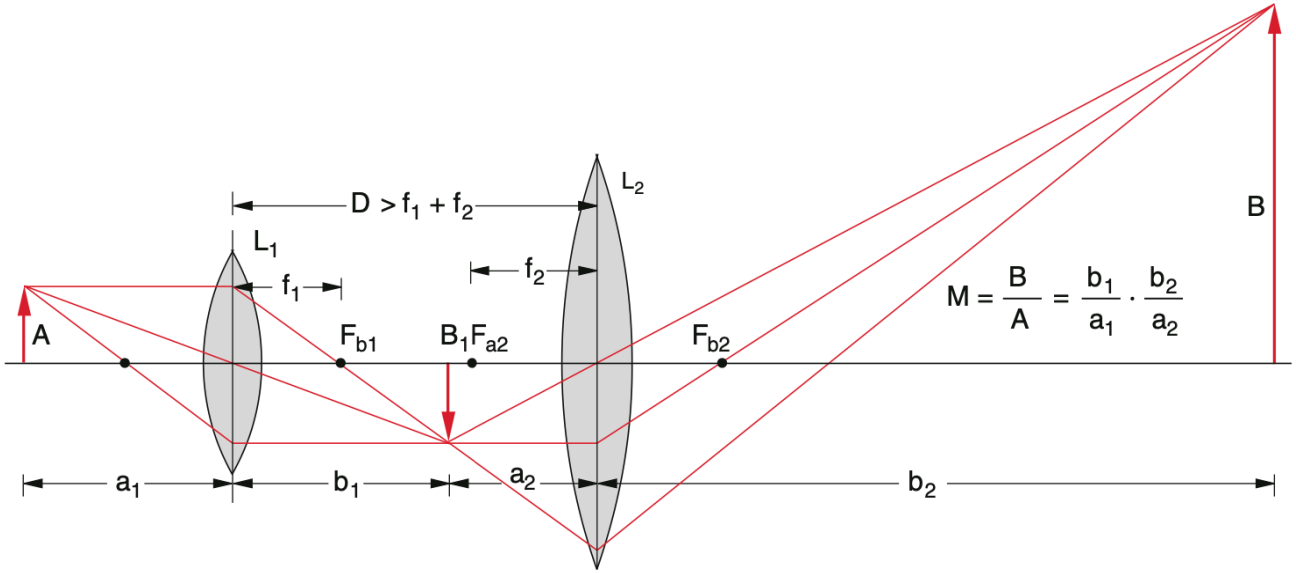
Glassbow - Challenge



Lens systems

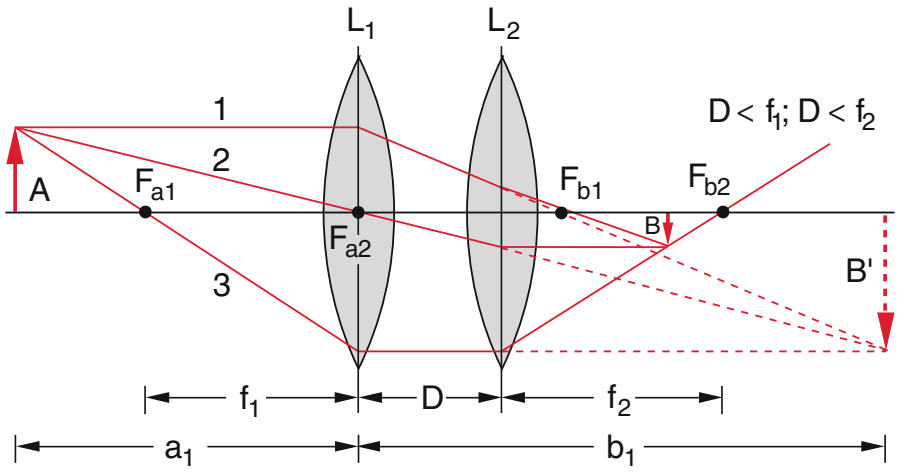


Bi-convex lenses at large distance



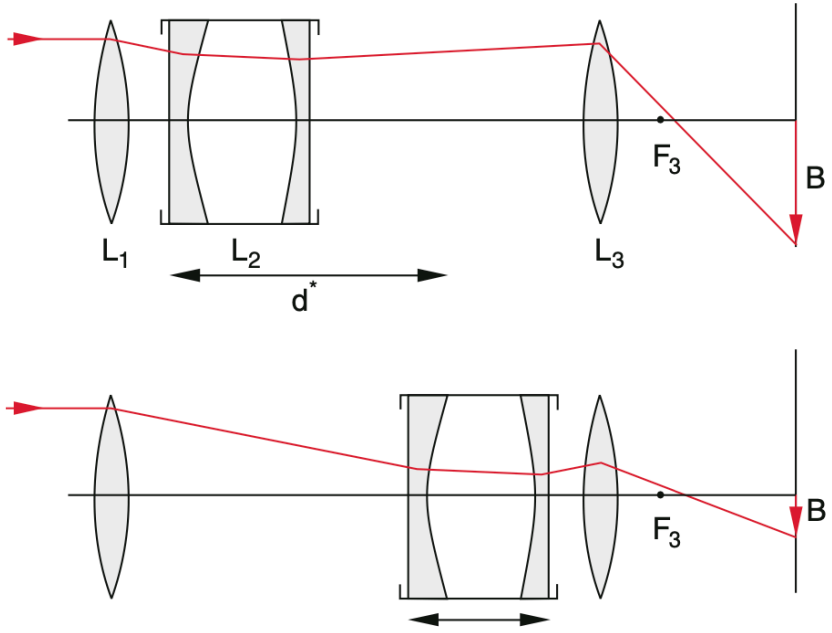
$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{D}{f_1 f_2}$$

Bi-Convex lenses at close distance



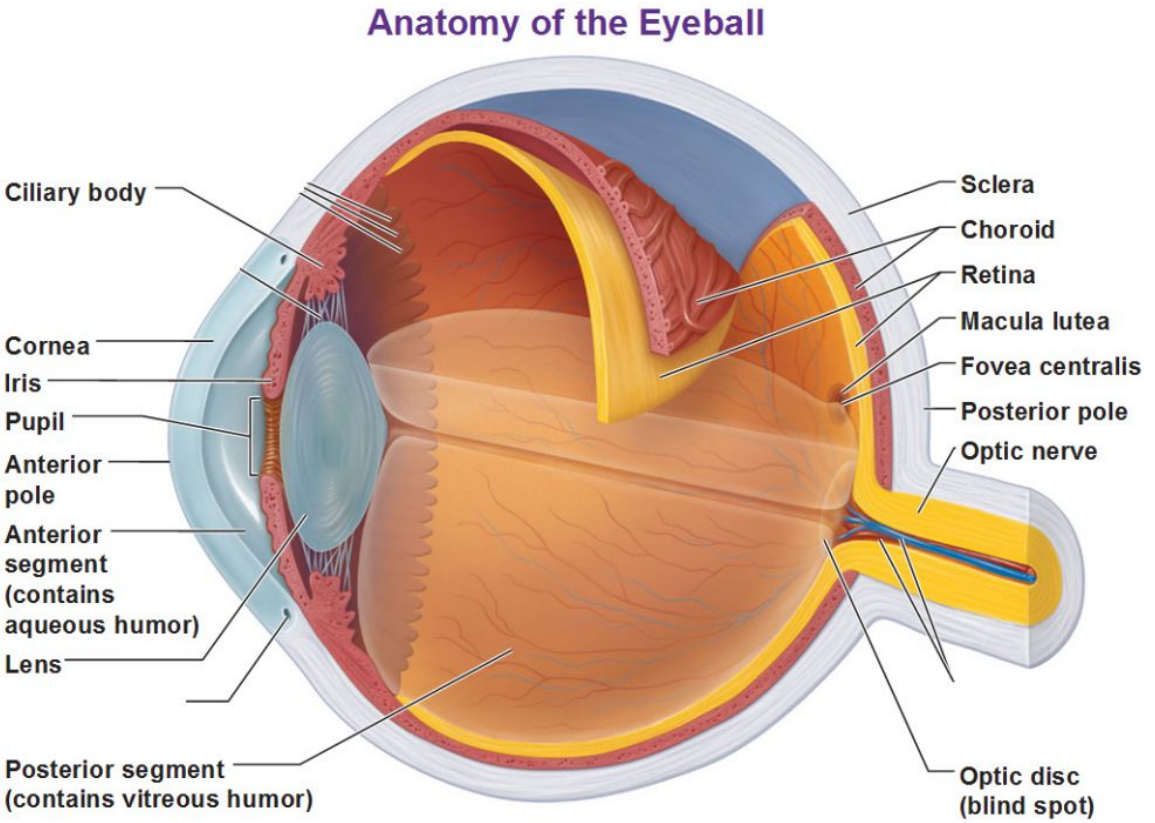
$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{D}{f_1 f_2}$$

Zoom Lens

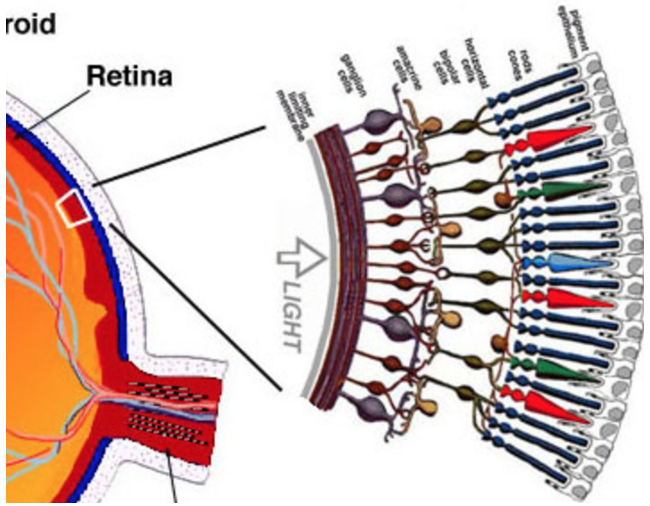


Optical Instruments

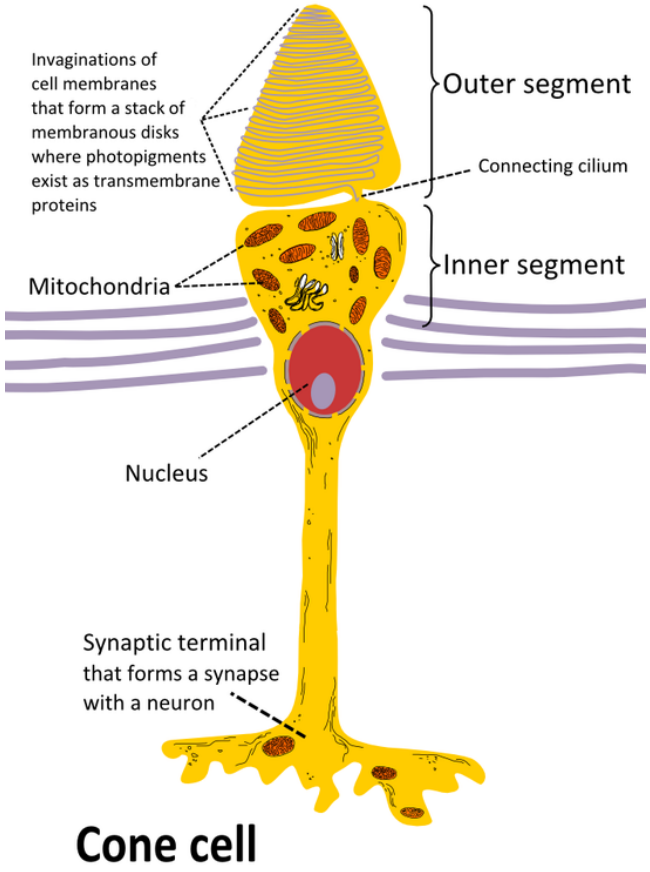
The Eye

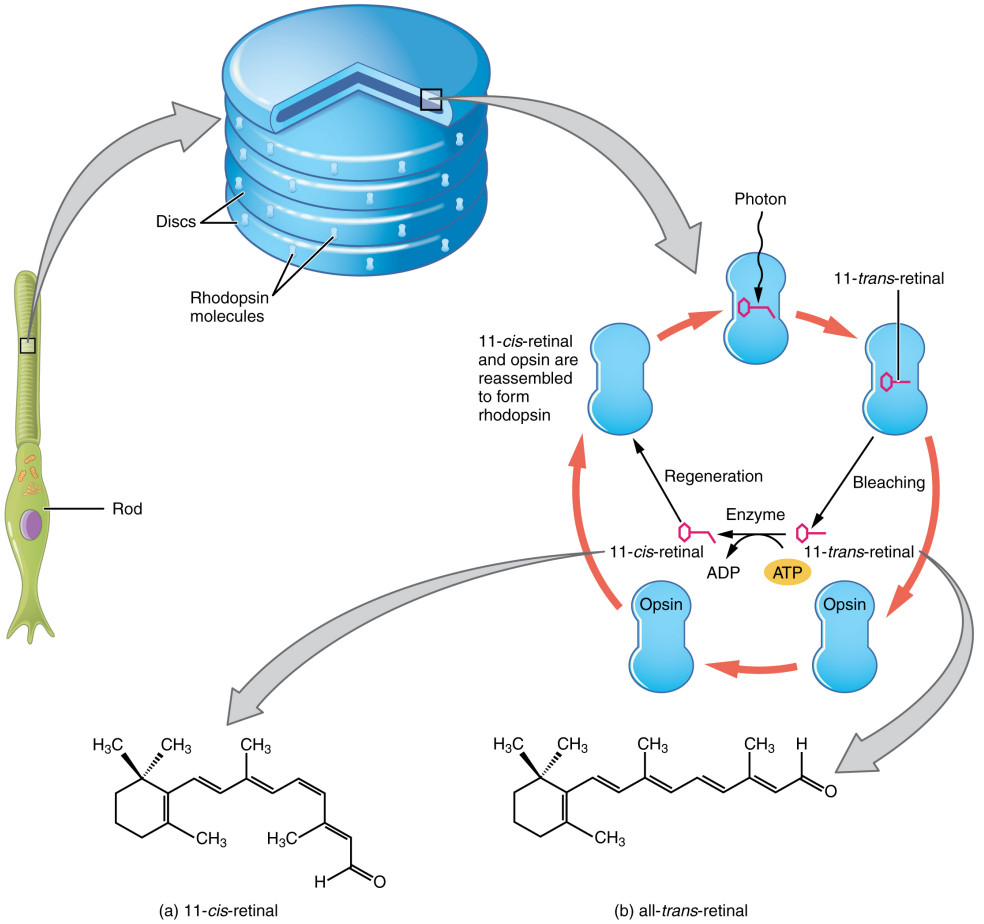


Diagrammatic view. The vitreous humor is illustrated only in the bottom part of the eyeball.

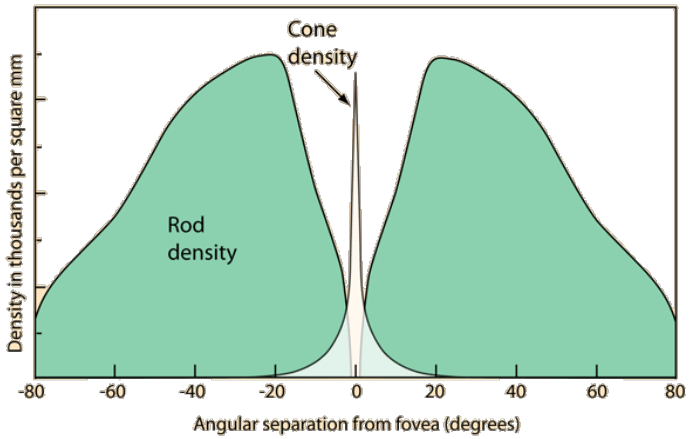


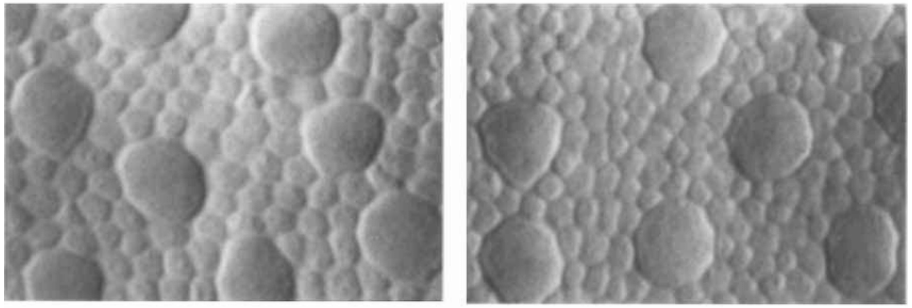
Vision

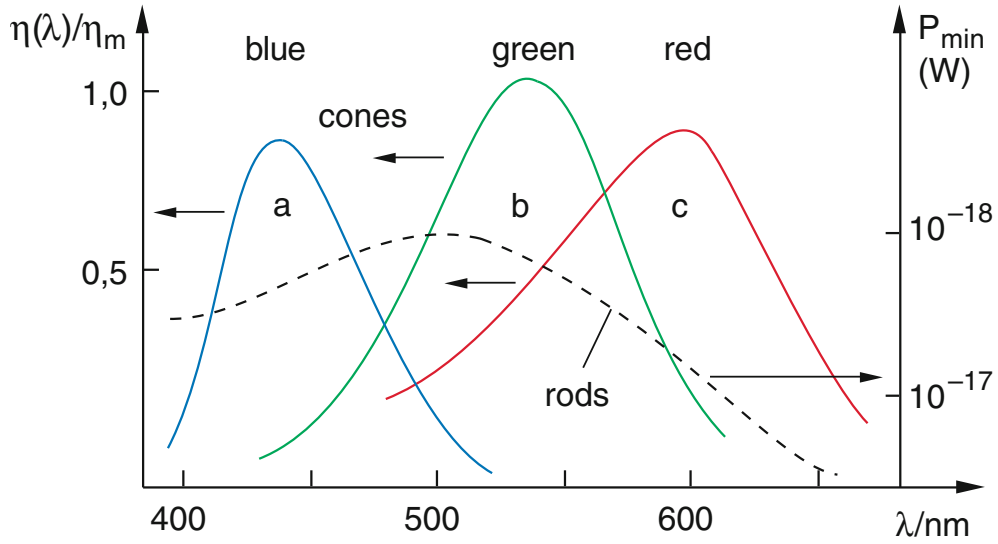

Invaginations of cell membranes that form a stack of membranous disks where photopigments exist as transmembrane proteins
Outer segment
Connecting cilium
Inner segment
Mitochondria
Nucleus
Synaptic terminal that forms a synapse with a neuron
Cone cell


Discs
Rhodopsin molecules
Rod
Photon
11-trans-retinal
11-cis-retinal and opsin are reassembled to form rhodopsin
Regeneration
Bleaching
Enzyme
11-cis-retinal
11-trans-retinal
ADP
ATP
Opsin
Opsin
(a) 11-cis-retinal
(b) all-trans-retinal

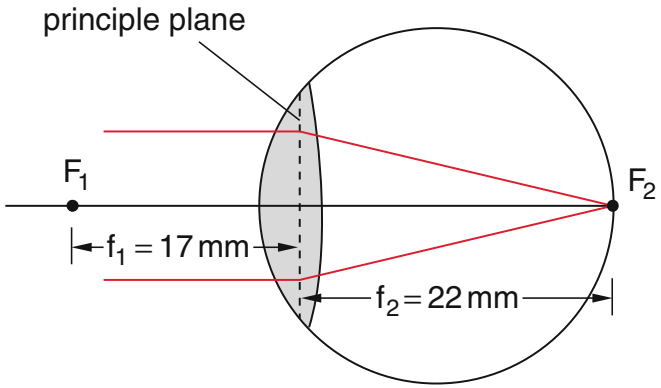
Rod and Cone density - Color Vision



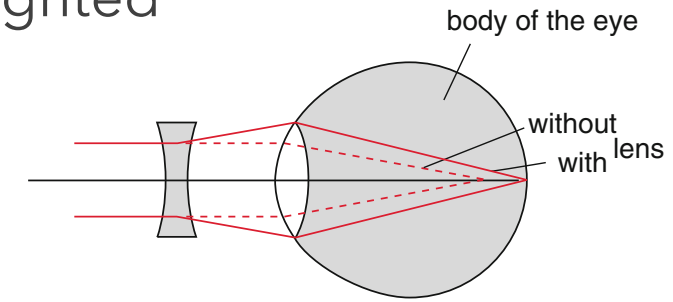




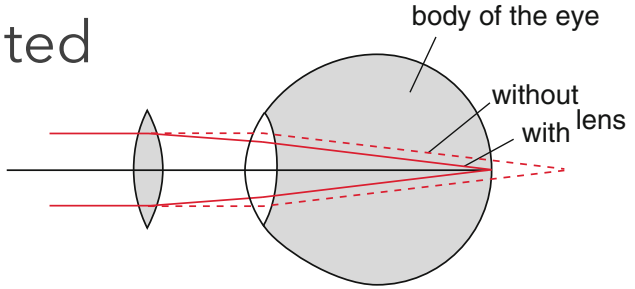
Optical System



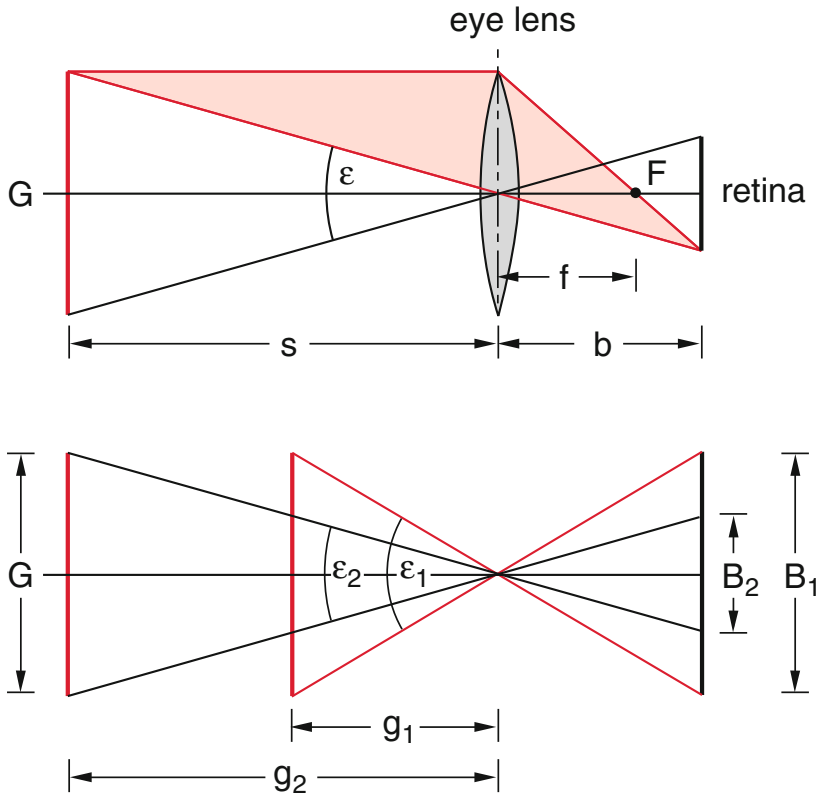
Short sighted



Far sighted

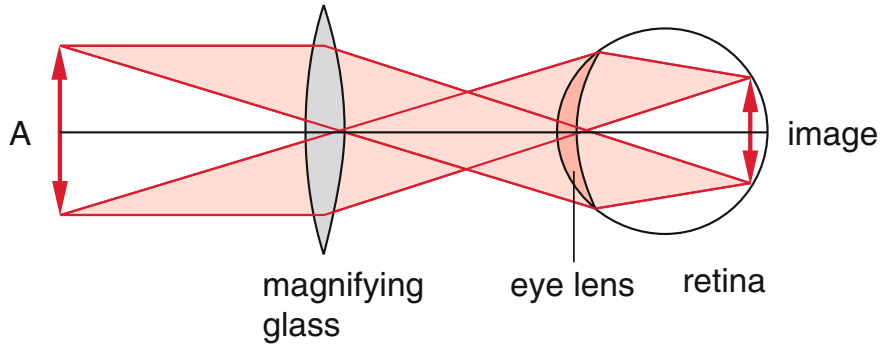


Visual Angle



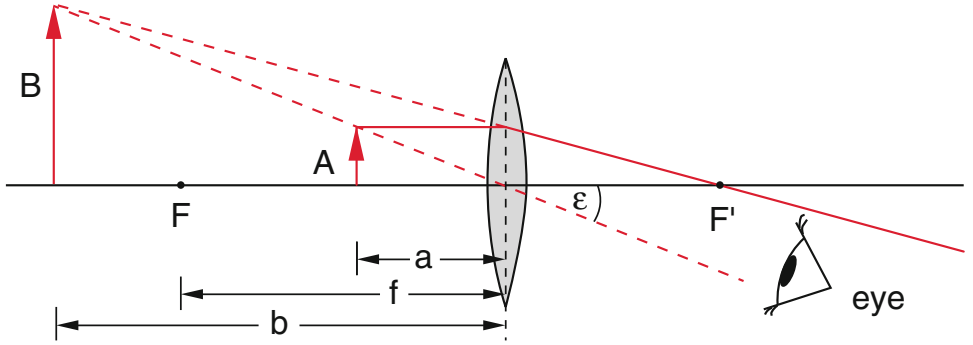
Magnifying Glass

In focus



$$V_M = \frac{\tan(\epsilon)}{\tan(\epsilon_0)} = \frac{s_0}{f}$$

within focal range



$$V_M = \frac{\tan(\epsilon)}{\tan(\epsilon_0)} = \frac{s_0}{a} = \frac{s_0}{f} + 1$$