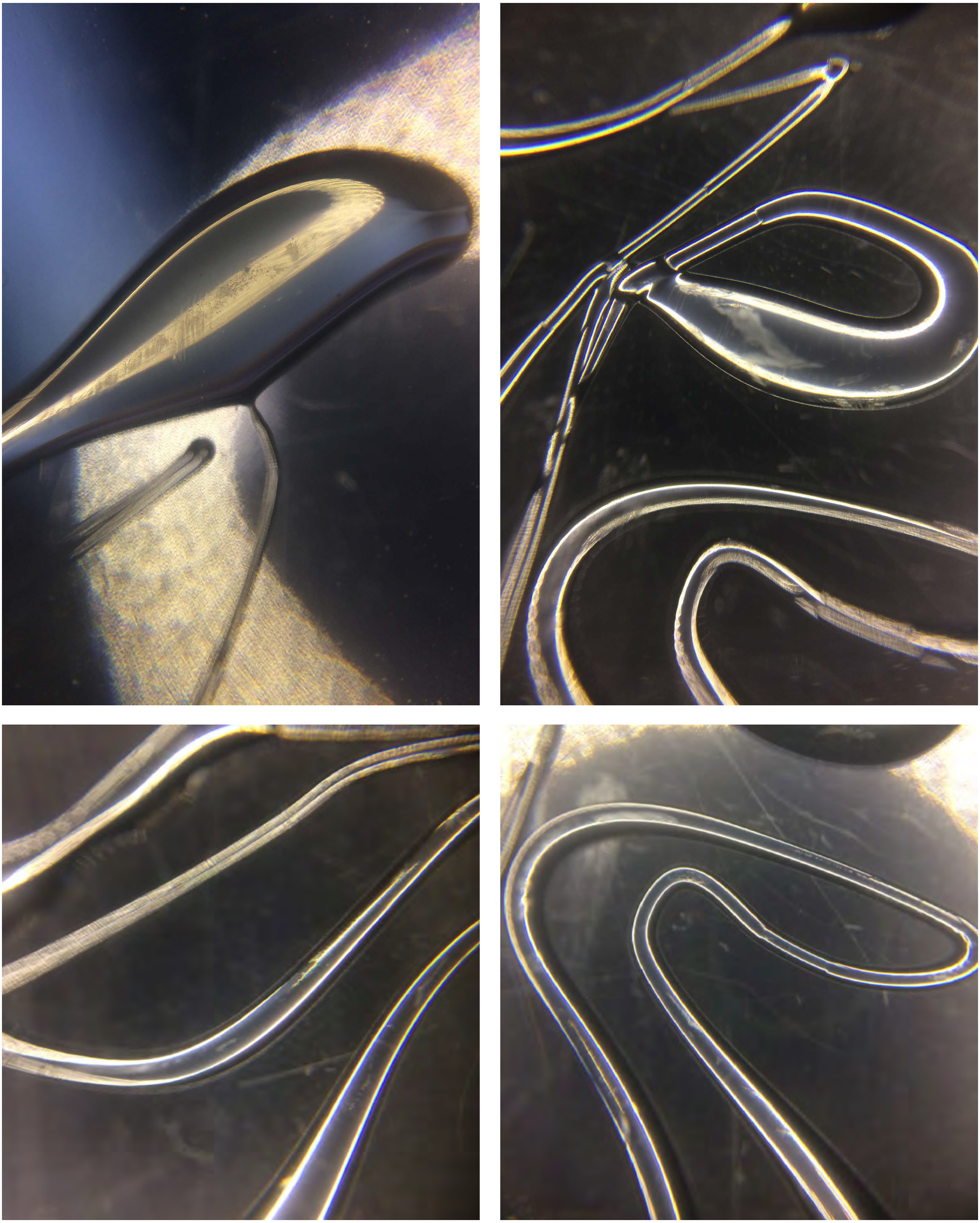
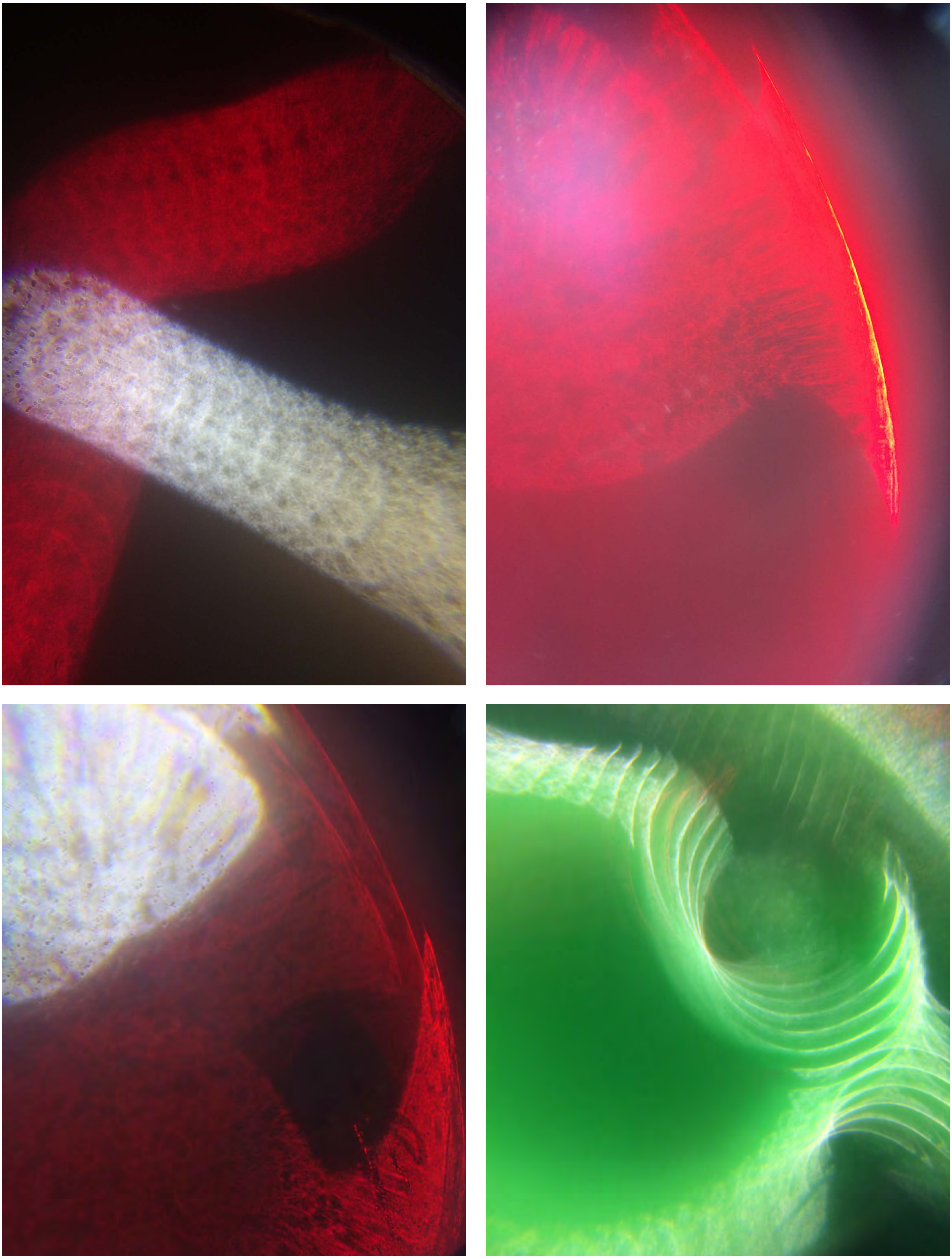
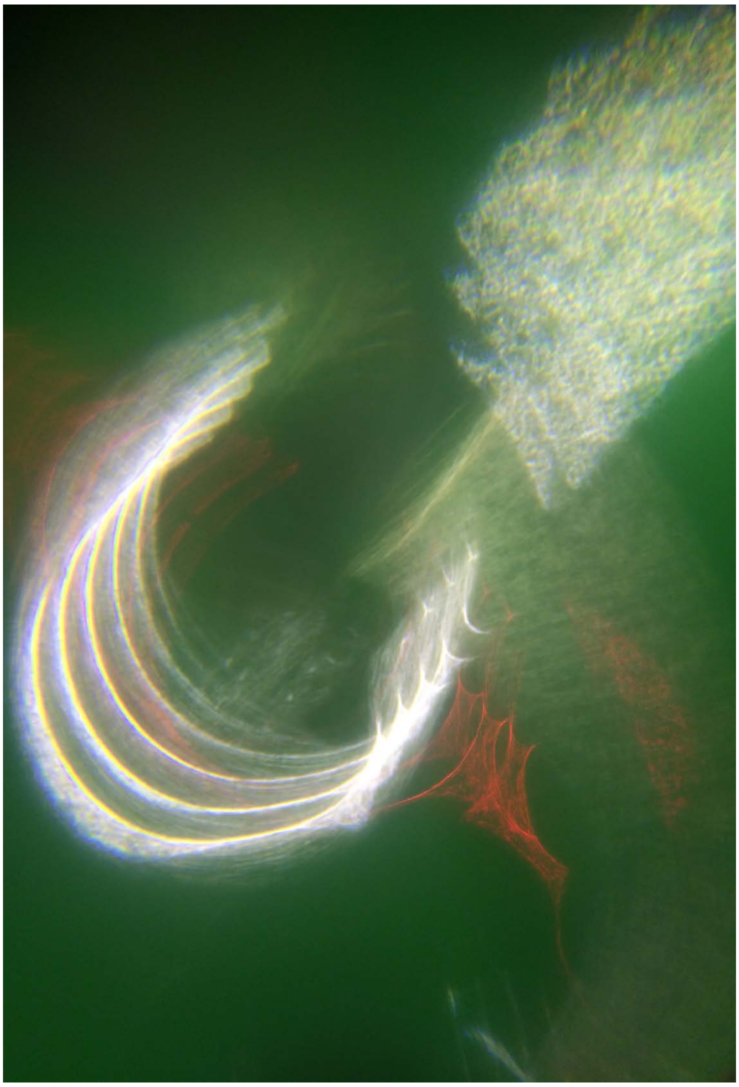
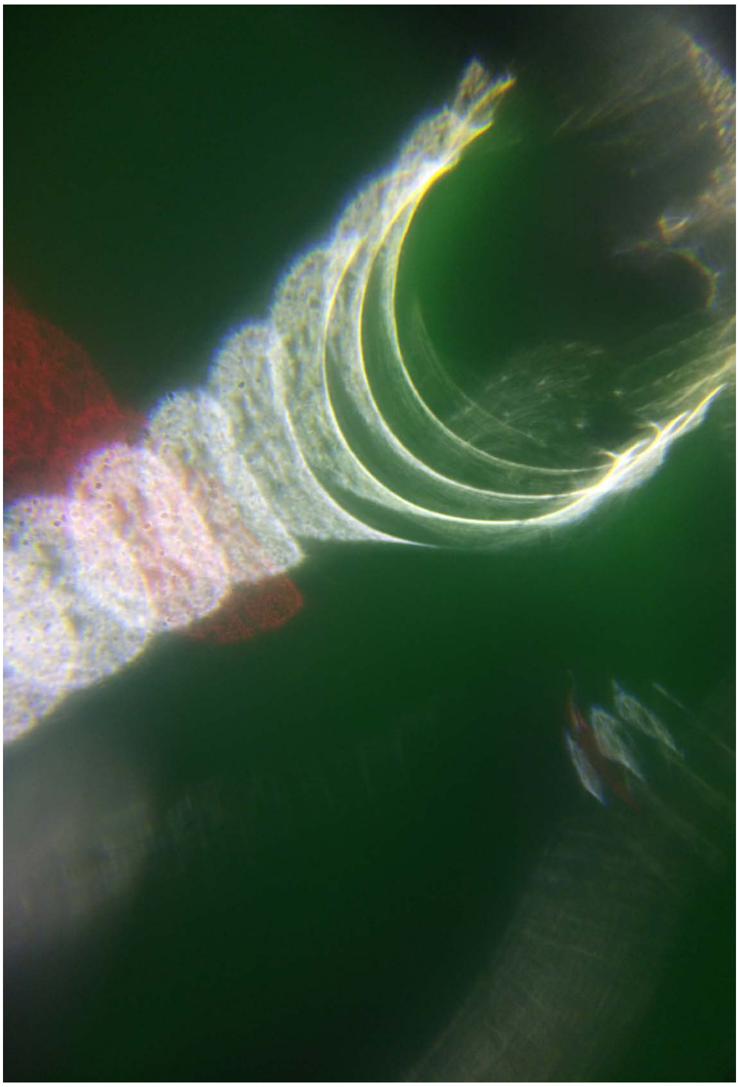
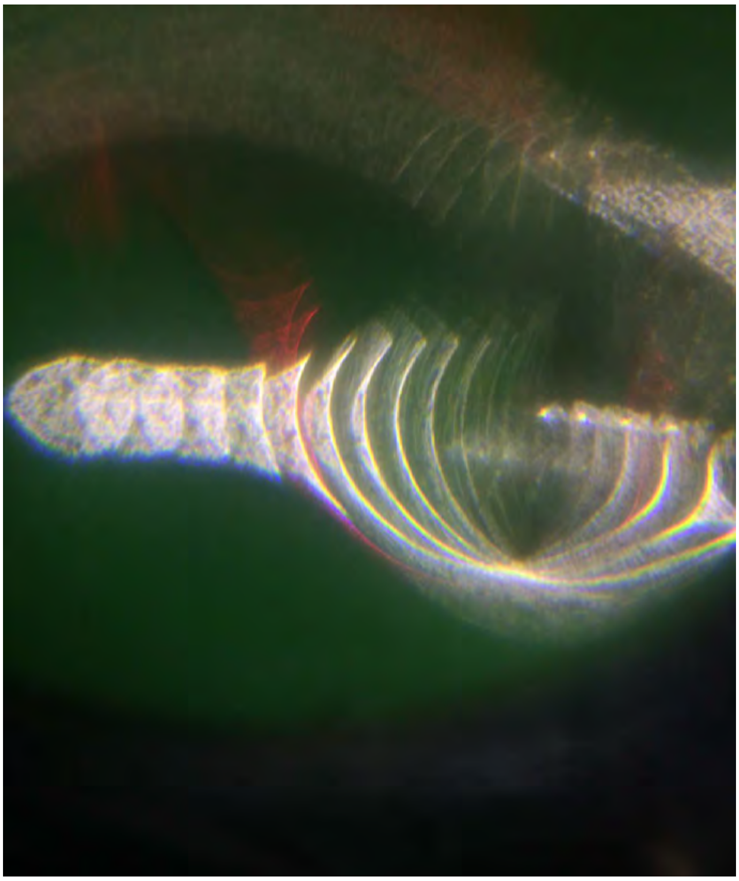


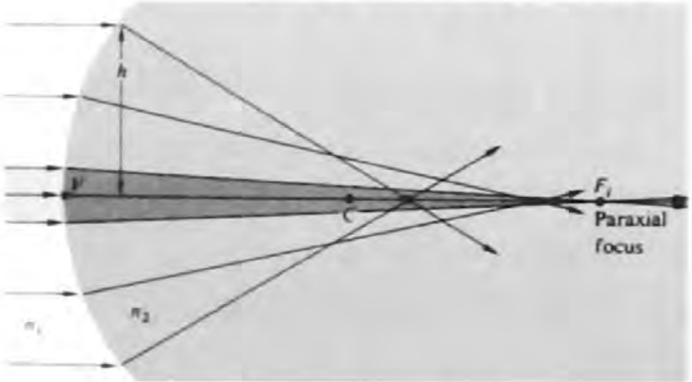
EXPERIMENT WITH GLUE



COLORED PAPER / LED EXPERIMENTS

Spherical Aberration



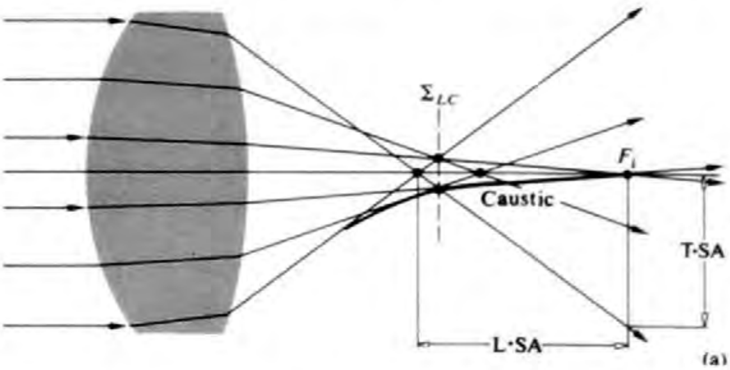
Paraxial approximation:

$$\frac{n_1}{s_o} + \frac{n_2}{s_i} = \frac{n_2 - n_1}{R}$$

Third order approximation:

$$\frac{n_1}{s_o} + \frac{n_2}{s_i} = \frac{n_2 - n_1}{R} + \underbrace{h^2 \left[\frac{n_1}{2s_o}\left(\frac{1}{s_o} + \frac{1}{R}\right)^2 + \frac{n_2}{2s_i}\left(\frac{1}{R} - \frac{1}{s_i}\right)^2 \right]}_{\text{Deviation from first-order theory}}$$

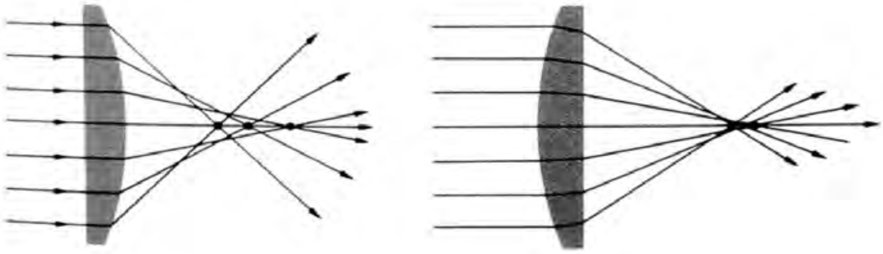
Spherical Aberrations



- Longitudinal Spherical Aberration: $\mathrm{L \cdot SA}$
  - Image of an on-axis object is longitudinally stretched
  - Positive $\mathrm{L \cdot SA}$ means that marginal rays intersect the optical axis in front of F_i (paraxial focal point).
- Transverse Spherical Aberration: $\mathrm{T \cdot SA}$
  - Image of an on-axis object is blurred in the image plane
- Circle of least confusion: Σ_{LC}
  - Smallest image blur

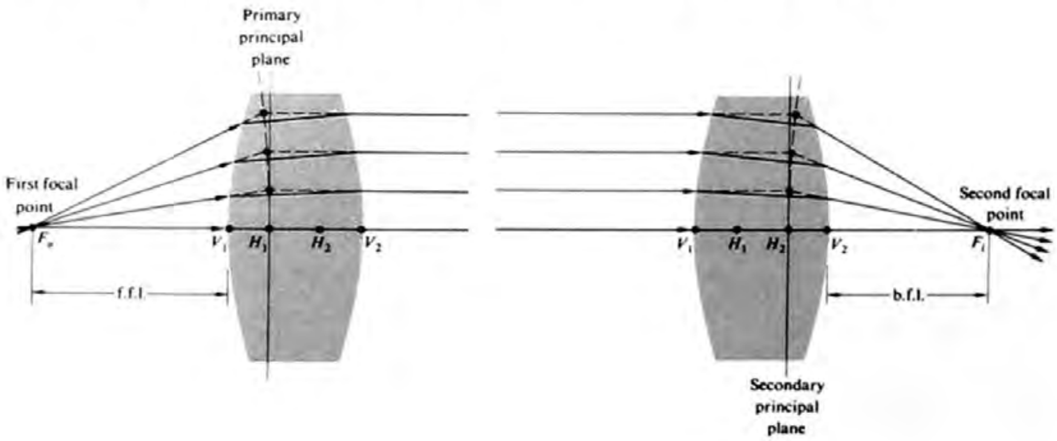
Spherical Aberration

- In third-order optics, the orientation of the lenses does matter
- Spherical aberration depends on the lens arrangement:

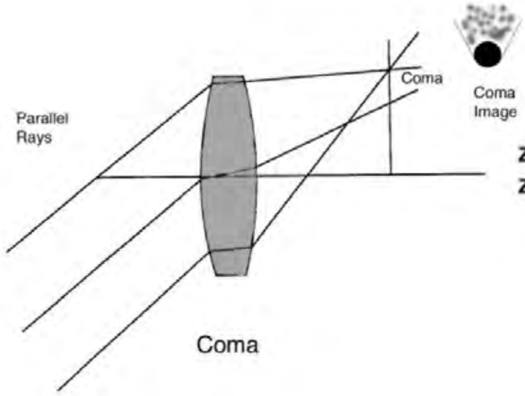


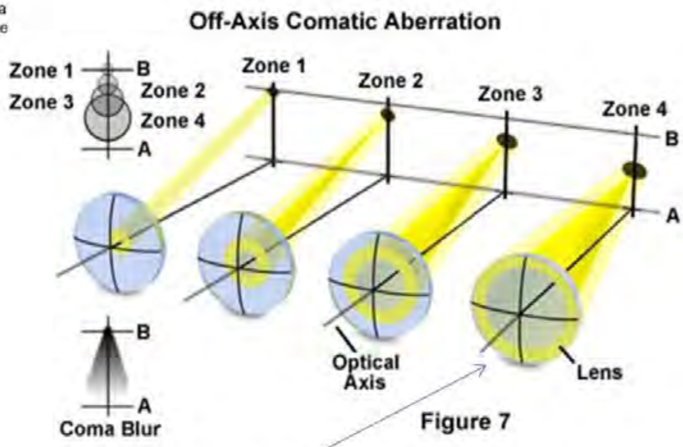
Coma (comatic aberration)

- Principle planes are not flat – they are actually curved surfaces.
- Focal length is different for off-axis rays



Coma

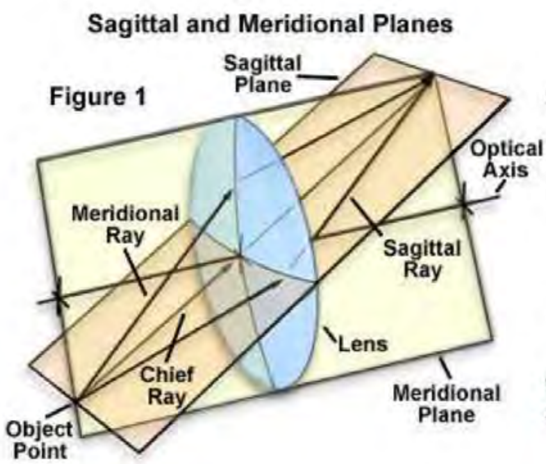


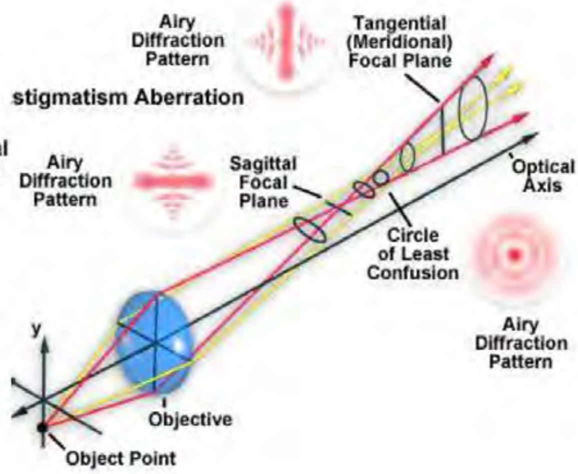


- Negative coma: meridional rays focus closer to the principal axis

Astigmatism

- Parallel rays from an off-axis object arrive in the plane of the lens in one direction, but not in a perpendicular direction:

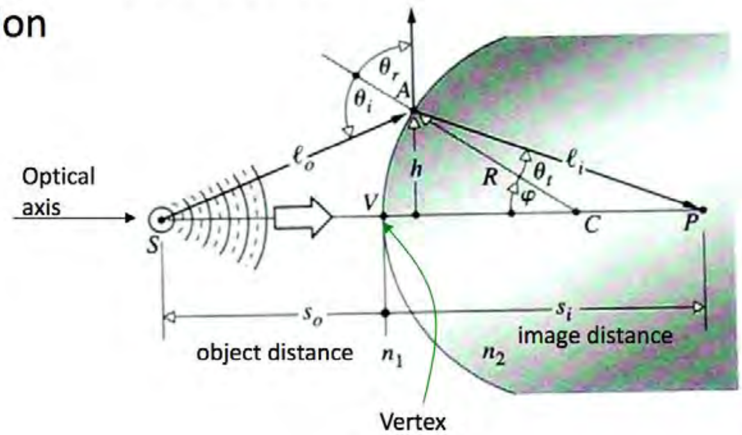




Chromatic Aberration

Aberrations

- Departure from the linear theory at third-order were classified into five types of ***primary aberrations*** by Phillip Ludwig Seidel (1821-1896):
  - Spherical aberration
  - Coma
  - Astigmatism
  - Field curvature
  - Distortion



Chromatic Aberration

(aka **dispersion**)

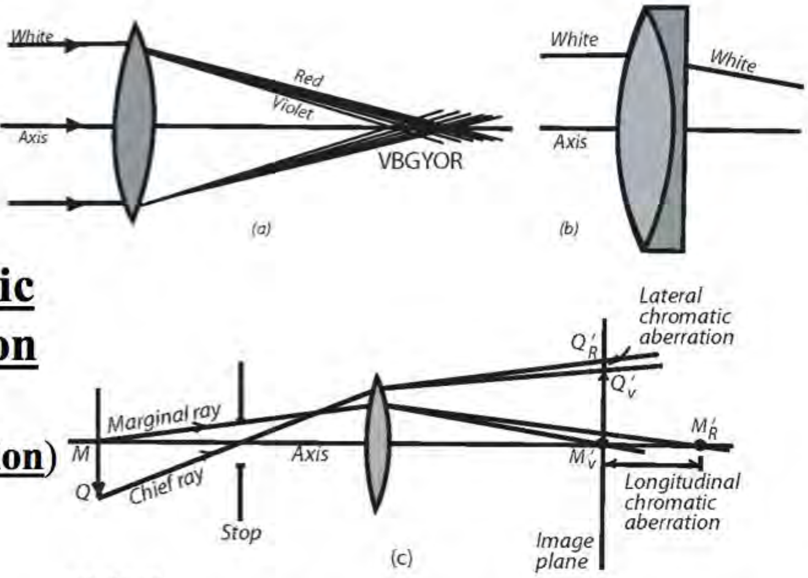


FIGURE 9X
(a) Cromatic aberration of a singel lens. (b) Acemented doublet corrected for chromatic aberration. (c) Illustrating the difference between longitudinal chromatic aberration and lateral chromatic aberration.

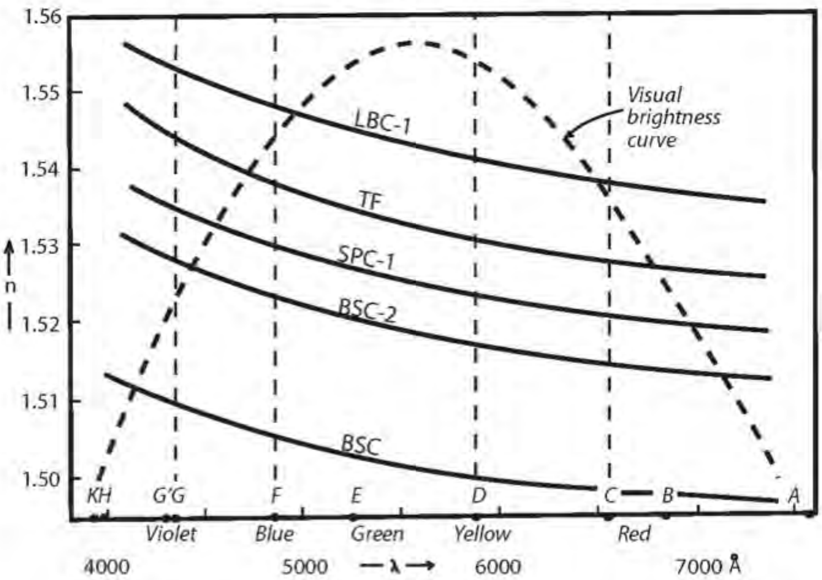
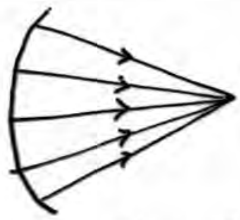


FIGURE 9Y
Graphs of the refractive indices of several kinds of optical glass. Theseare called dispersion curves.

Geometrical aberrations

- Deviation of the wavefront from its "ideal" spherical shape due to imperfect refraction by the optical elements



perfect spherical wavefront (focuses to a point)

aberrated wavefront does not come to a focus → image is blurred

Optical elements (lenses, mirrors) produce perfect (non-aberrated) wavefronts only in the paraxial approximation (i.e., for angles of propagation near the optical axis).
At larger angles, 5 kinds of aberrations (called "Seidel" aberrations) occur

Coma

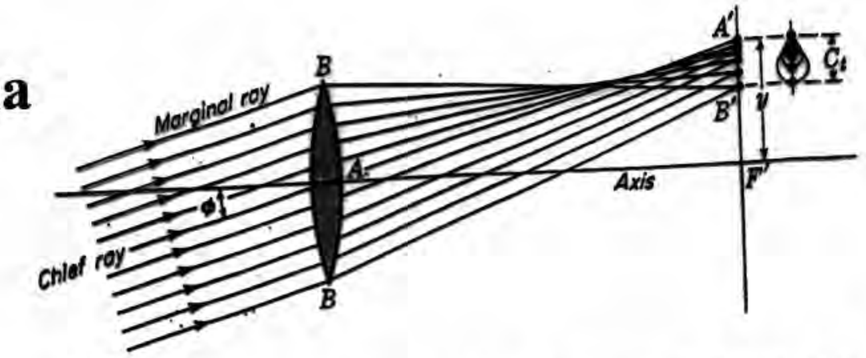


FIGURE 9I
Coma, the second of the five monochromatic aberrations of a lens. Only the tangential fan of rays is shown.

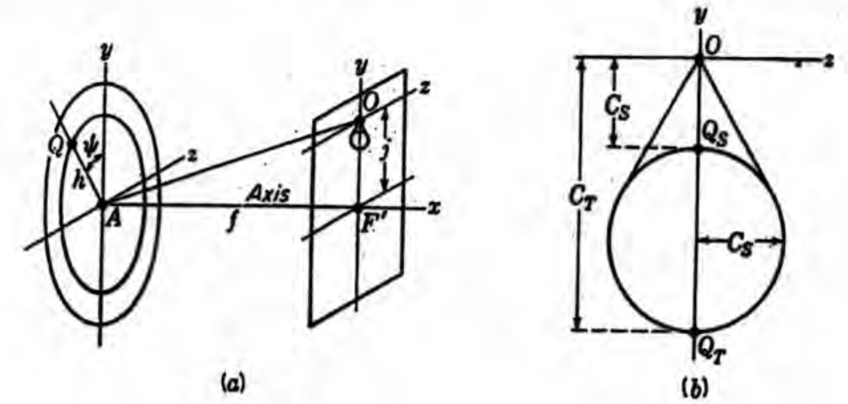


FIGURE 9K
Geometry of coma, showing the relative magnitudes of sagittal and tangential magnifications.

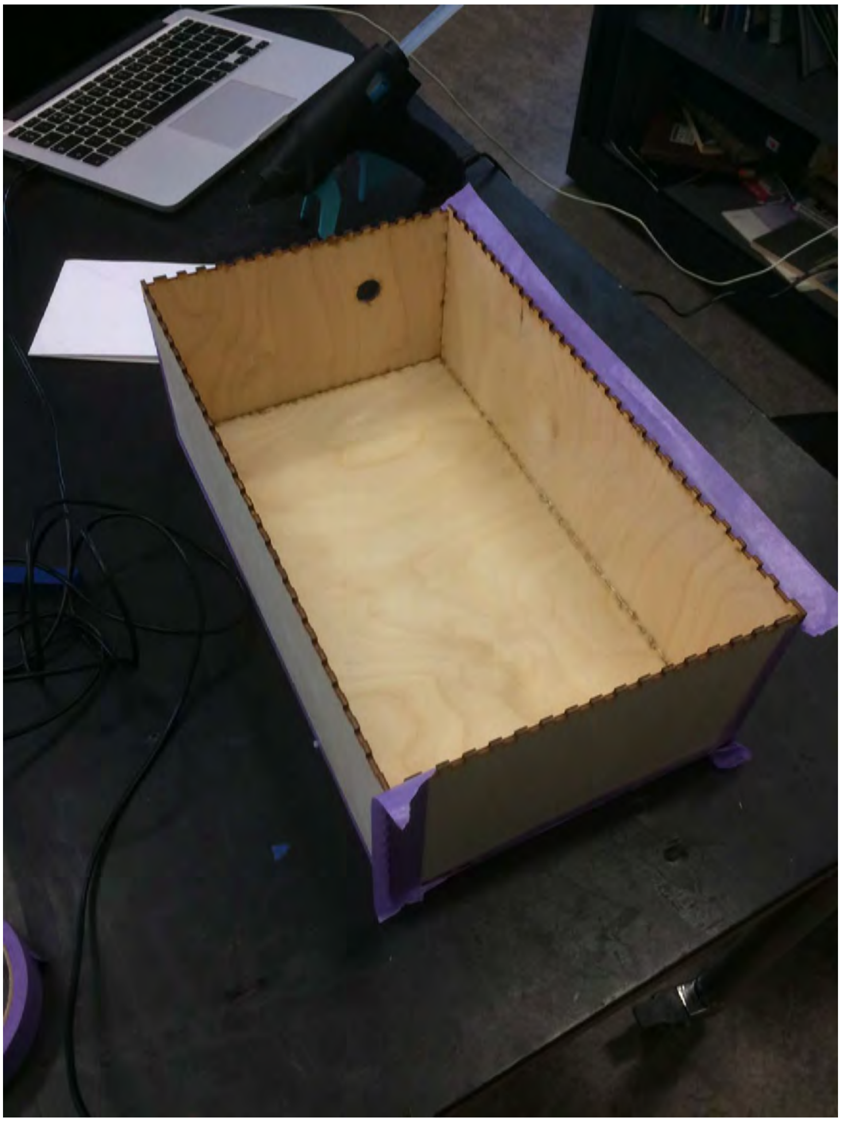
$C_T = 3C_s$

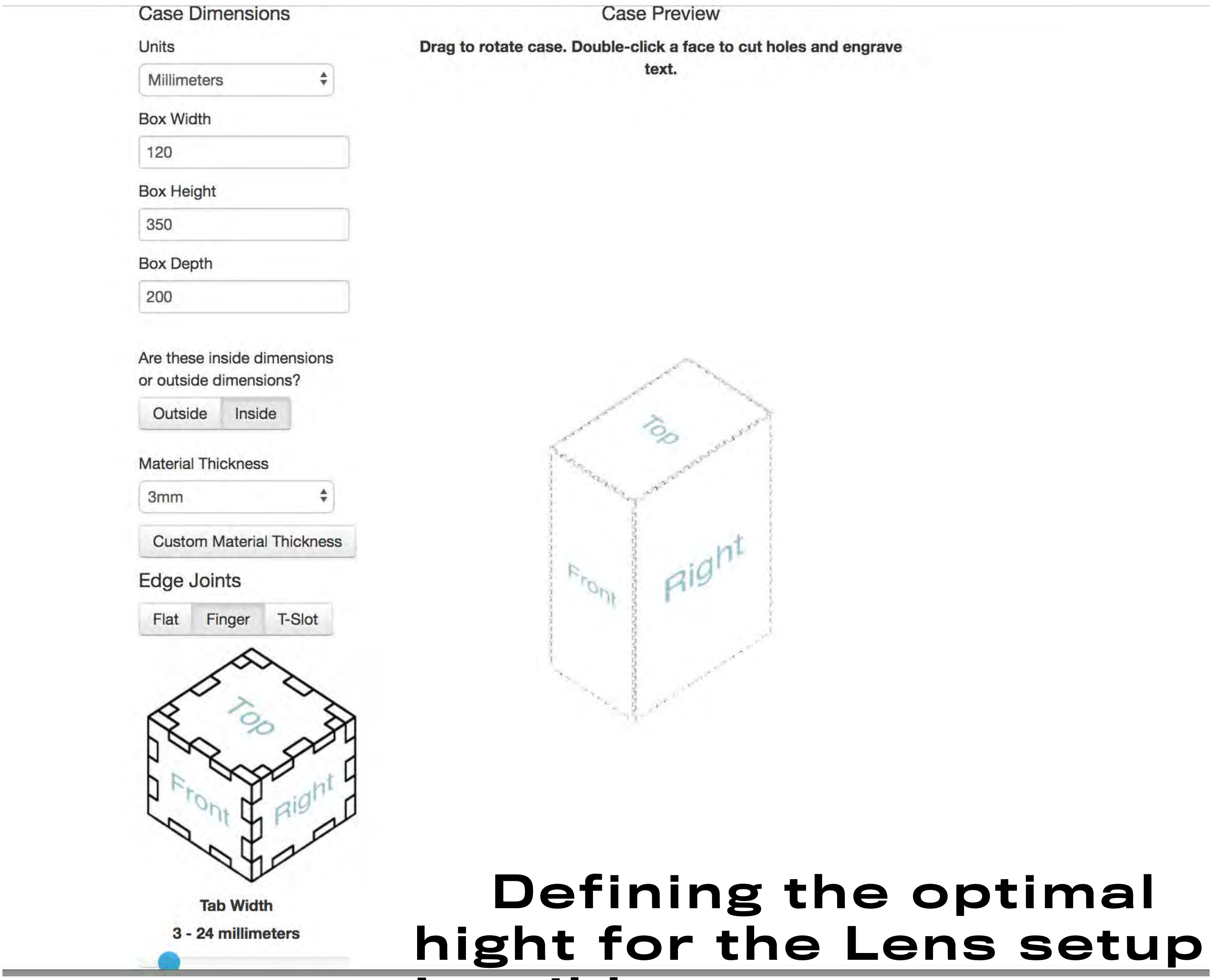
equation of comatic figure

$y = C_s(2 + \cos 2\psi)$

$z = C_s \sin 2\psi$

The main issue is to create these images is I have to use both hands for the setup. To Create better imagery I have to Incorparate direct lenses together.

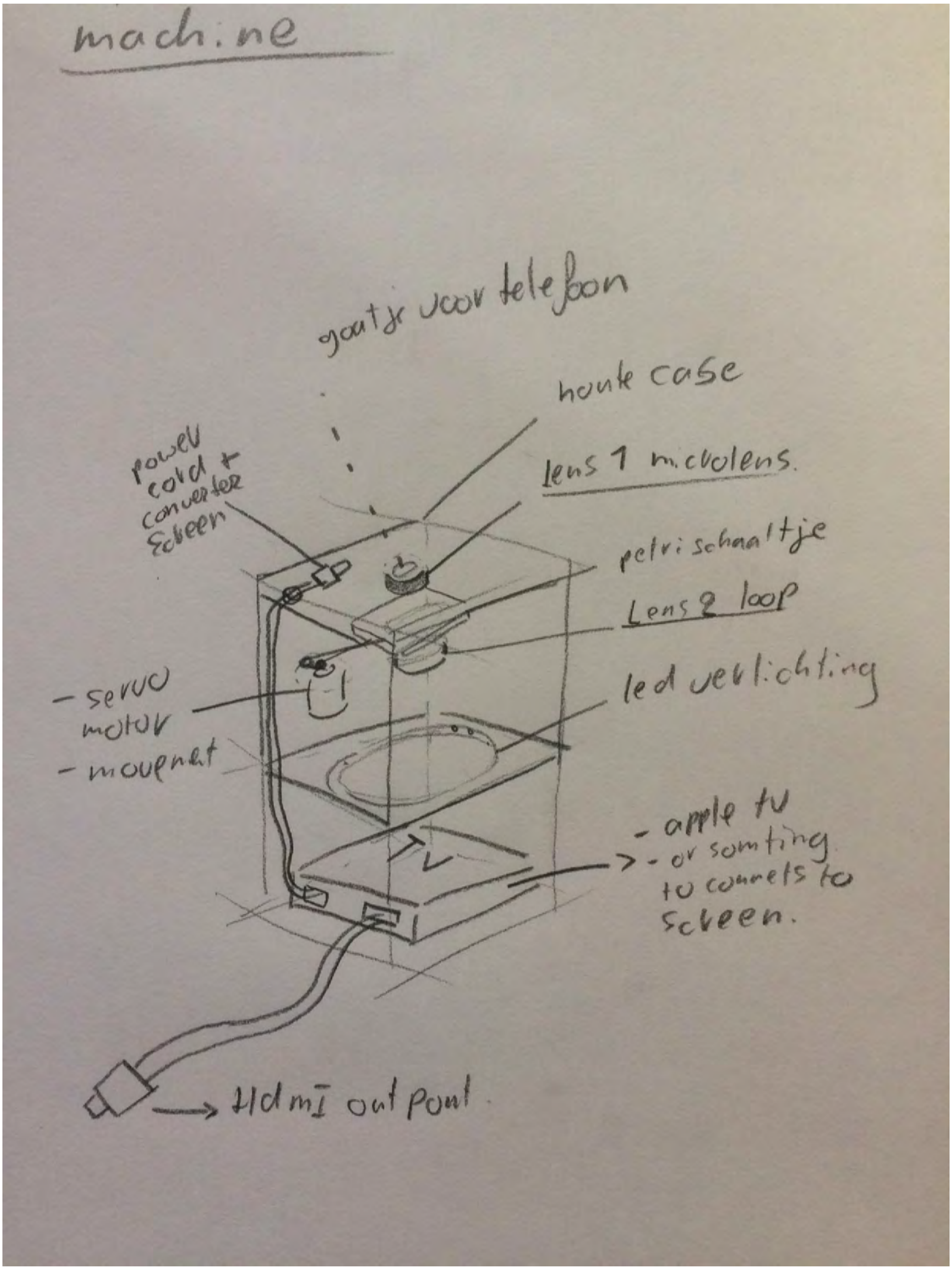


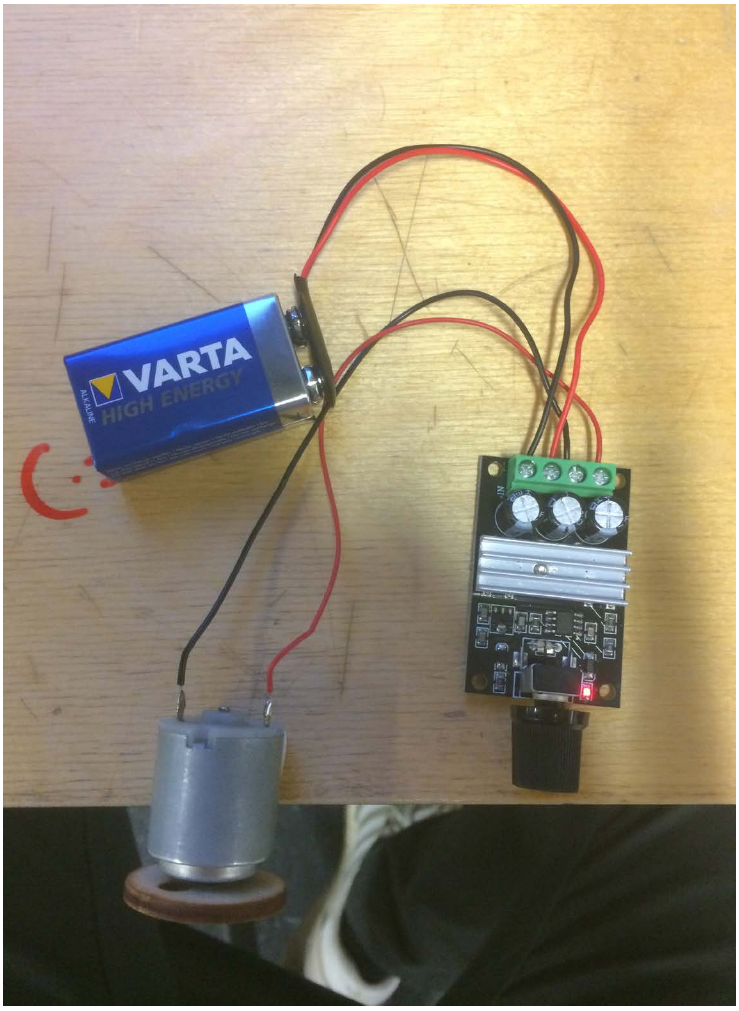


Defining the optimal hight for the Lens setup Is trikky.

To test this the first box will be a hight of 35cm wich is more than I used In the other images.

THE BLUE PRINT PLAN FOR THE BOX



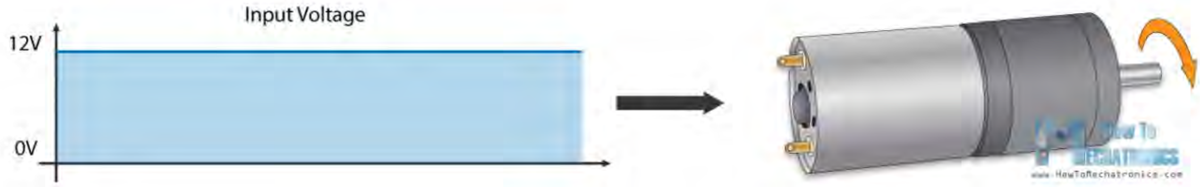


Making a rotating disk for the “animation” to varry

Using a pwm

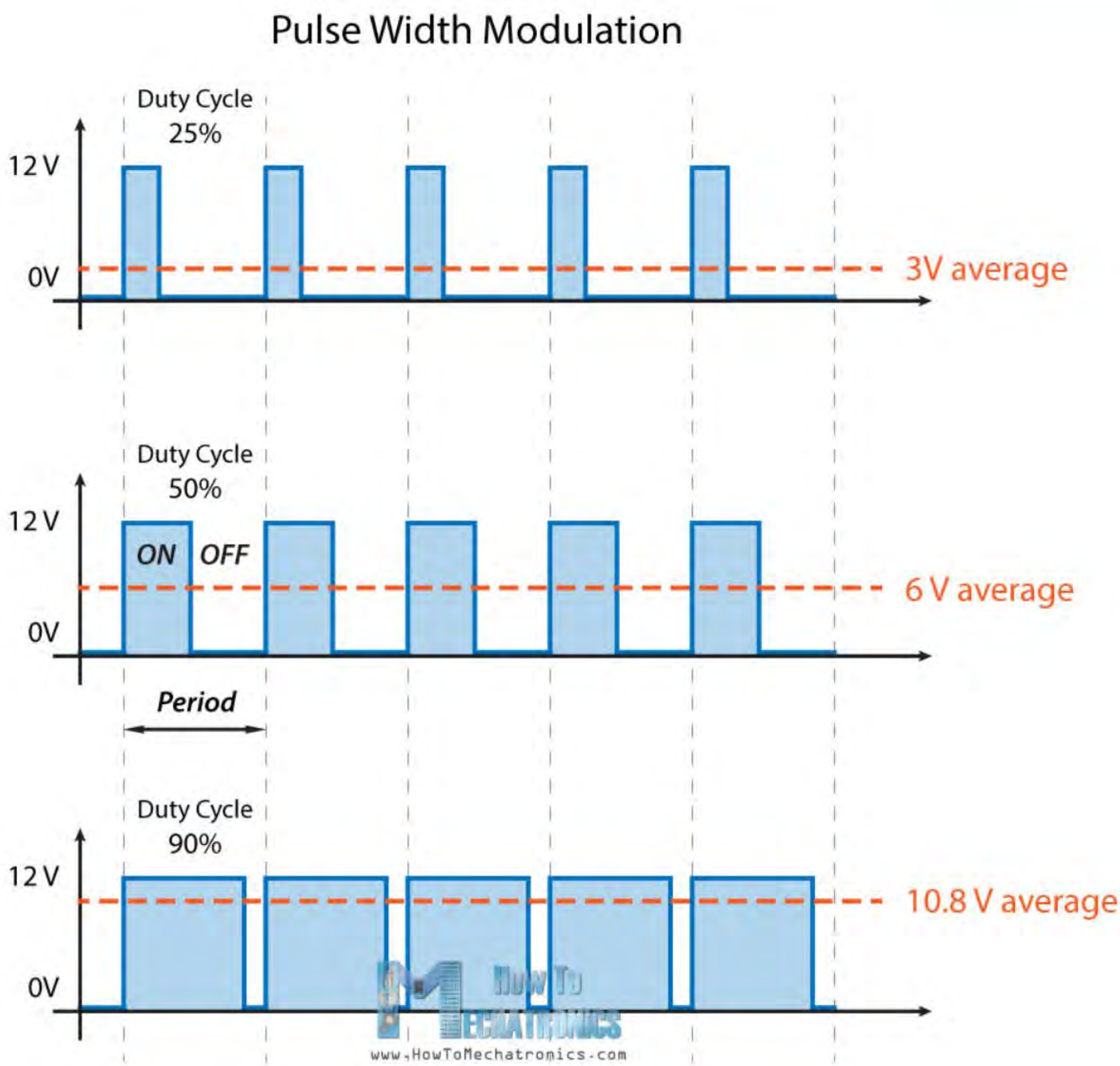
Overview

We can control the speed of the DC motor by controlling the input voltage of the motor. For that purpose we can use PWM, or pulse width modulation.



PWM DC Motor Speed Control

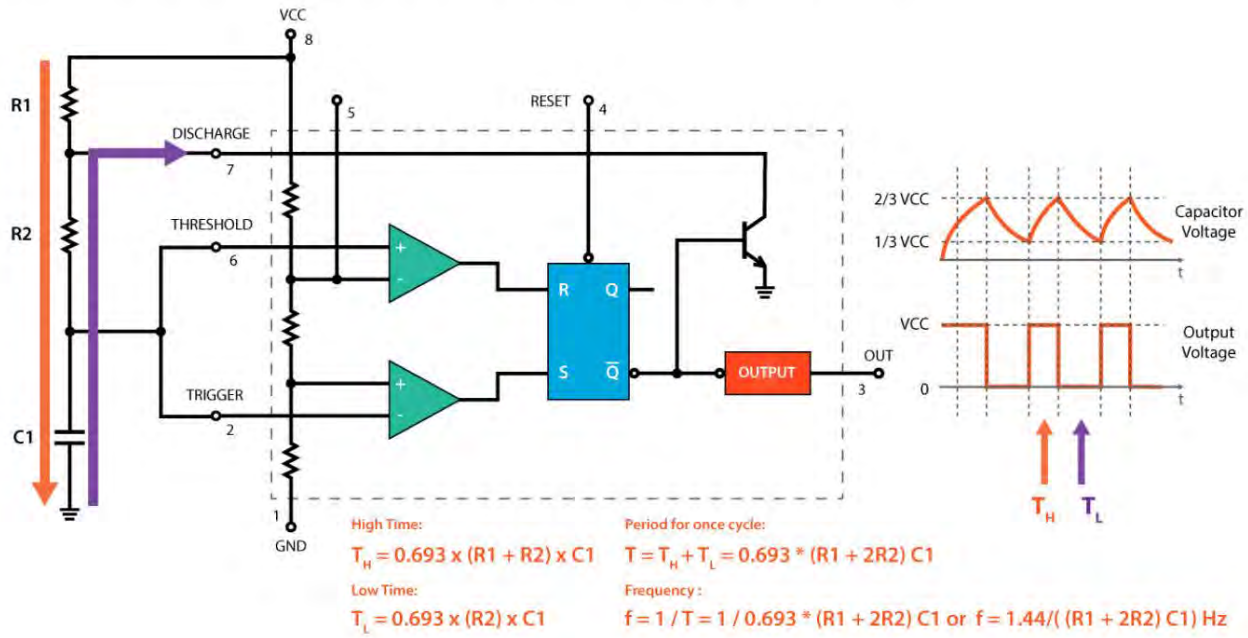
PWM is a method through which we can generate variable voltage by turning on and off the power that’s going to the electronic device at a fast rate. The average voltage depends on the duty cycle of the signal, or the amount of time the signal is ON versus the amount of time the signal is OFF in a single period of time.



555 Timer PWM Generator Circuit

The 555 Timer is capable of generating PWM signal when set up in an astable mode. In you are not familiar with the 555 Timer you can check my previous tutorial where I explained in details what's inside and how the 555 Timer IC work.

Here's a basic circuit of the 555 Timer operating in an astable mode and we can notice that the output is HIGH when the capacitor C1 is charging through the resistors R1 and R2.



tionally add two diodes in the circuit.