

Computer Graphics: Rendering

Lecture 2: Radiometry, Photometry



Kartic Subr

Computer Graphics

Real  photography

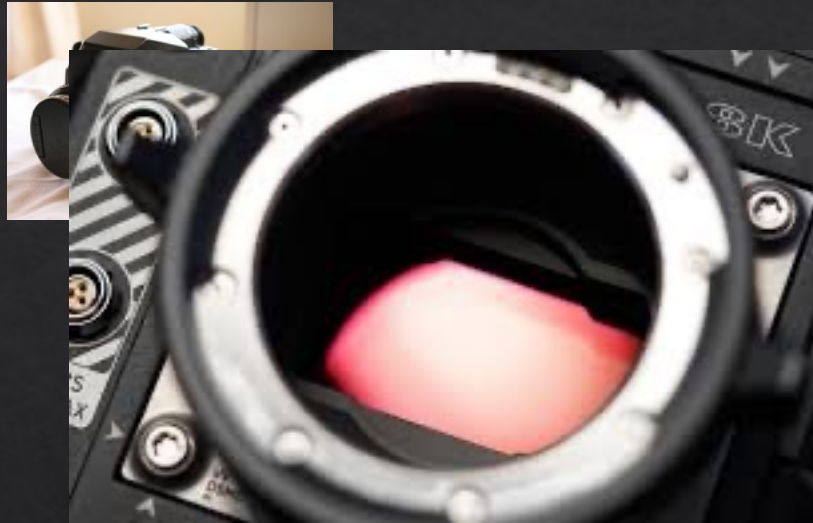
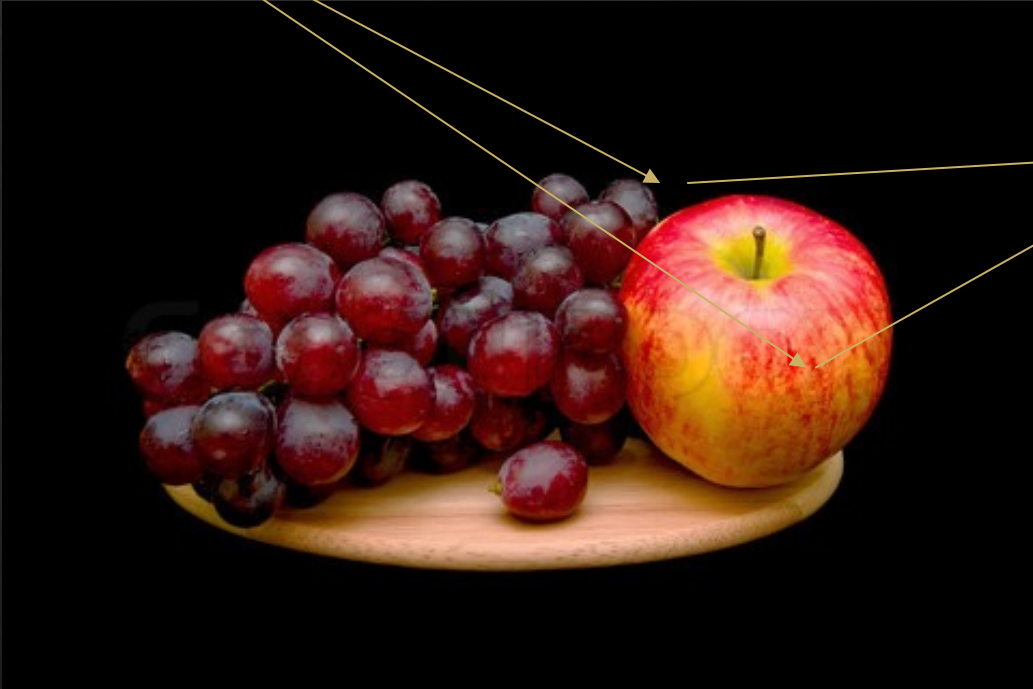
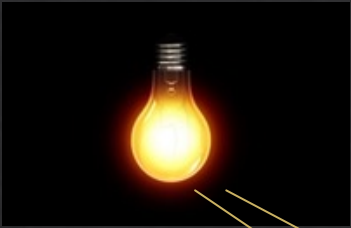


image manipulation



Virtual  rendering

Energy in the scene



What do cameras record?



shadows

Obviously, it is
...ehmm

... 'light stuff'?



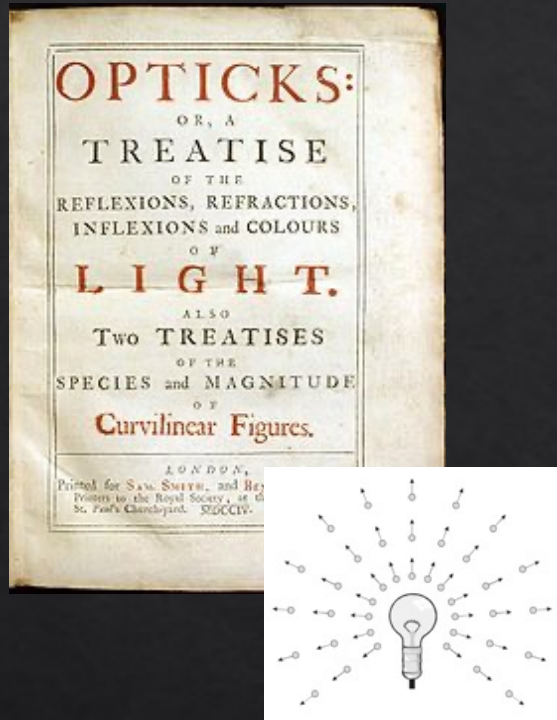
light
density
reflection

photons

wavelength

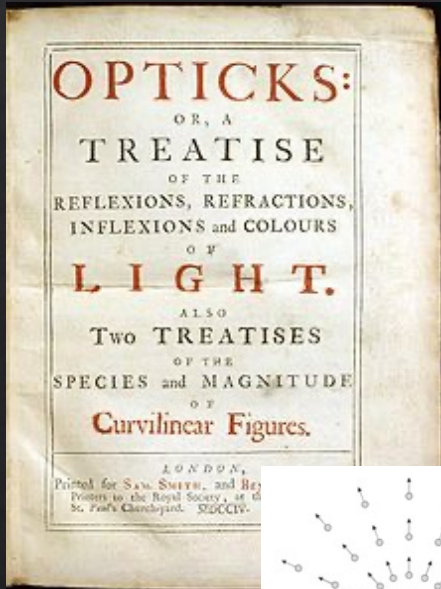
What is light?

What is light?

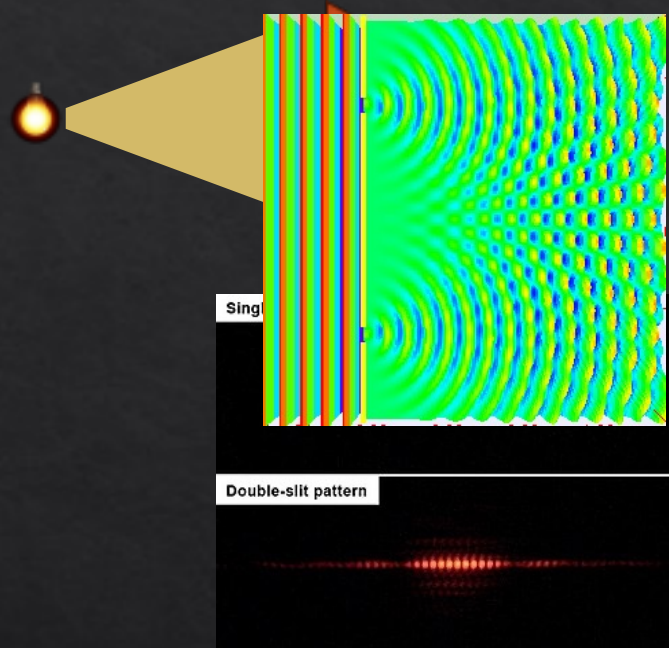


Isaac Newton 1704

What is light?

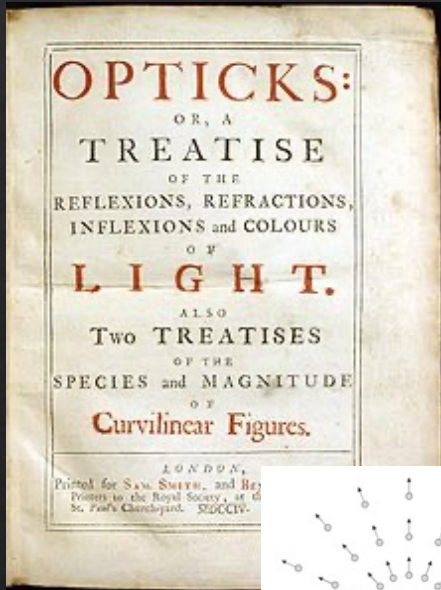


Isaac Newton 1704

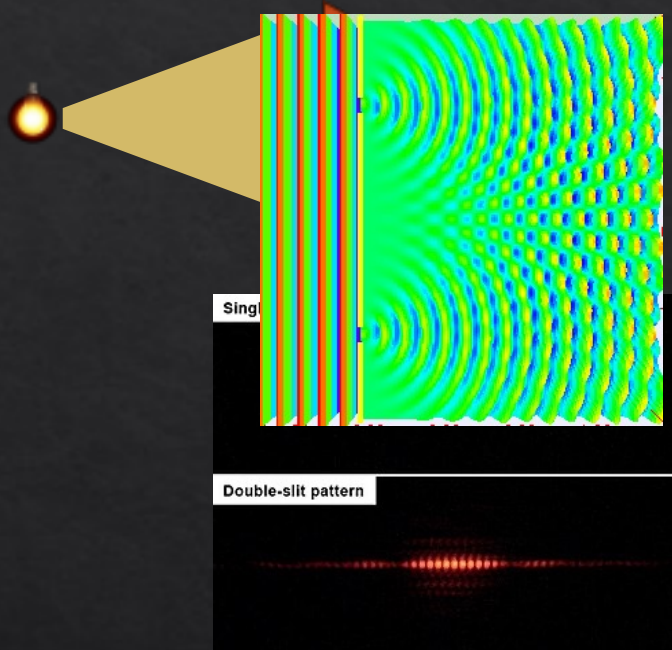


Thomas Young 1801

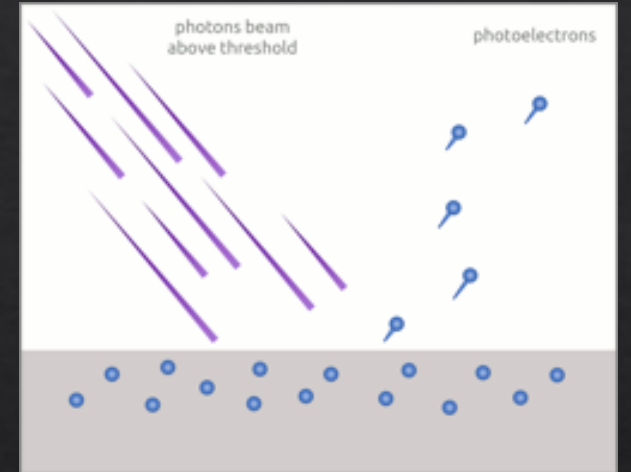
What is light?



Isaac Newton 1704

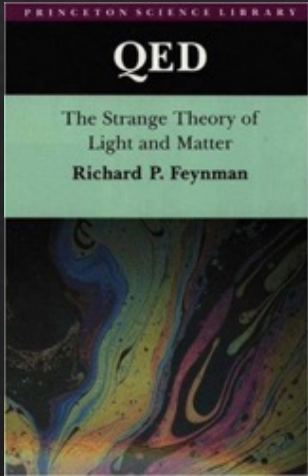
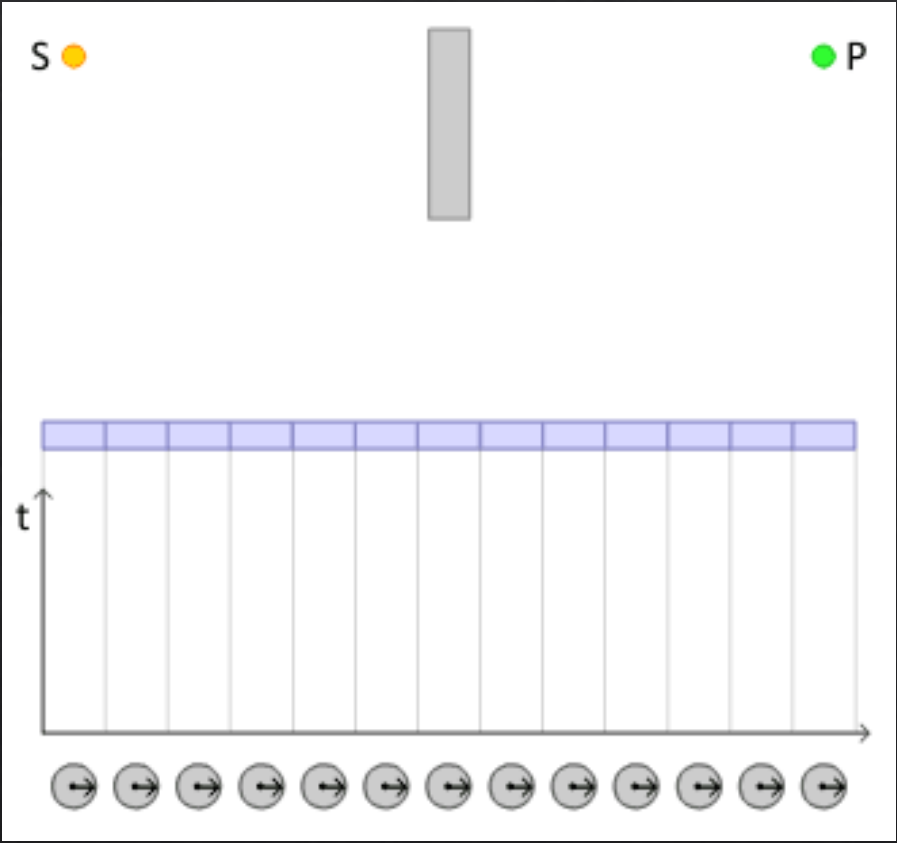


Thomas Young 1801

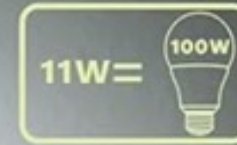


1887 Hertz, 1902 Lenard, 1905 Einstein

Straight lines?



Feynman 1985, read [this](#)



ROTTYI Light Bulbs
100W Equivalent, 6500K Bulbs, 11W 1210LM LED





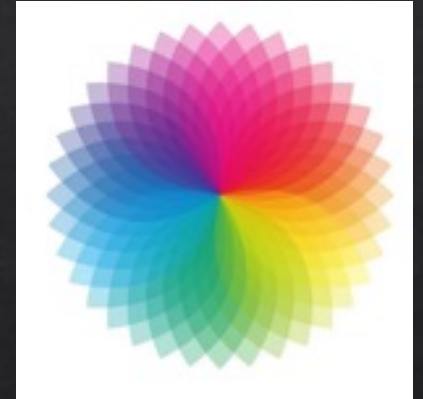
The study of light



radiometry



photometry



colorimetry

Interested in knowing more? Read [this](#)



11W = 



1210lm
Lumen

6500K
KEYLIN

220°
BEAM ANGLE

NON-DIMMABLE



Radiometry

thermodynamics

Spectrum
Frequency
Wavelength

magnitude
amplitude

Energy

power

Radiation

intensity

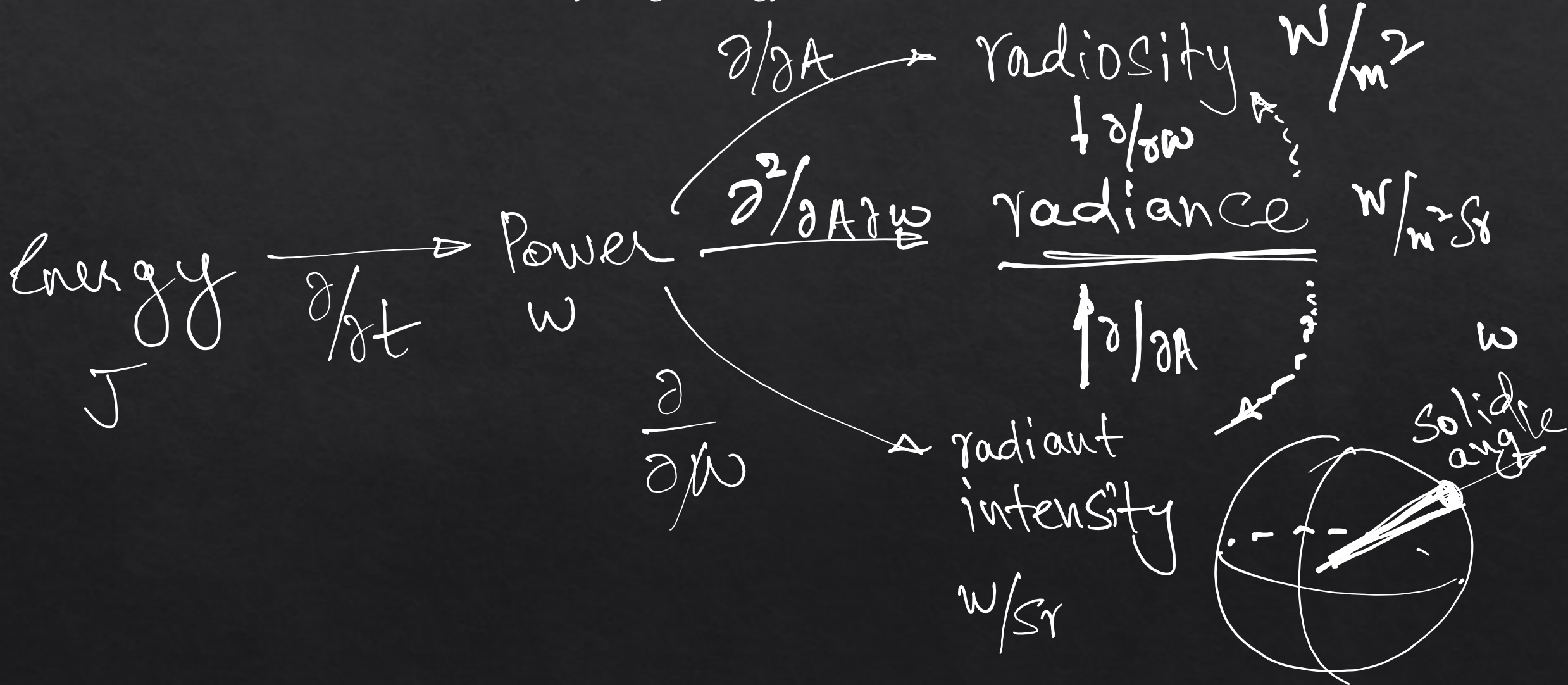
area



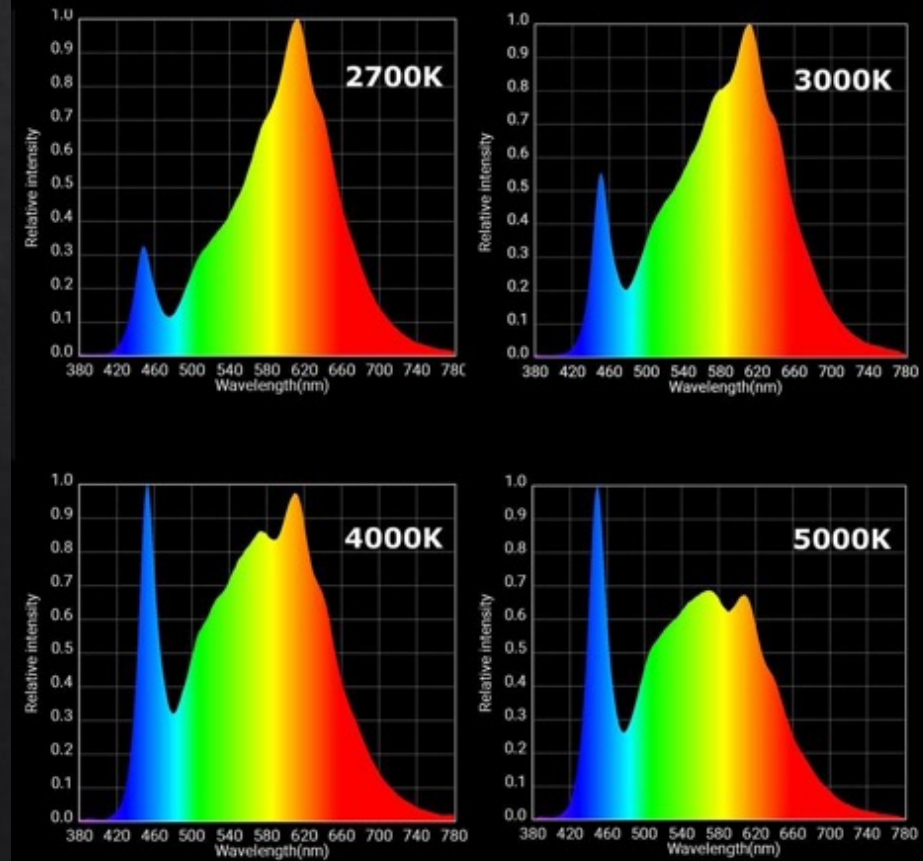
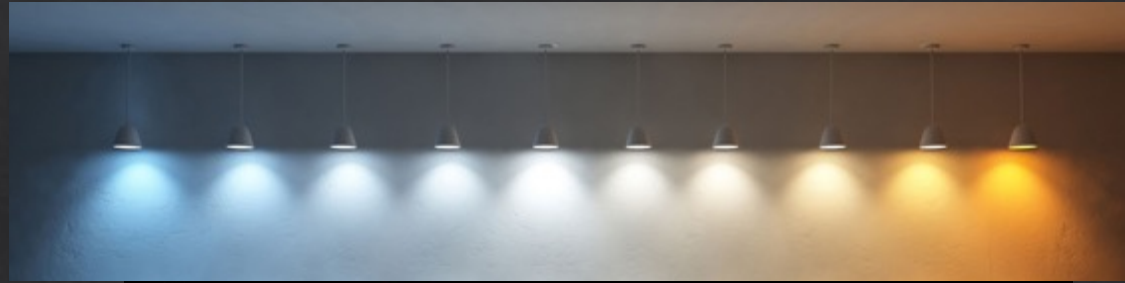
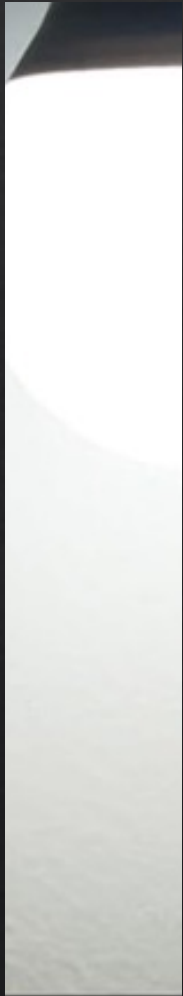


Radiometry

Study of light energy in a scene



Spectrometry: radiometric qty. per wavelength



<https://www.softlights.org/chapter-11-color-temperature/>

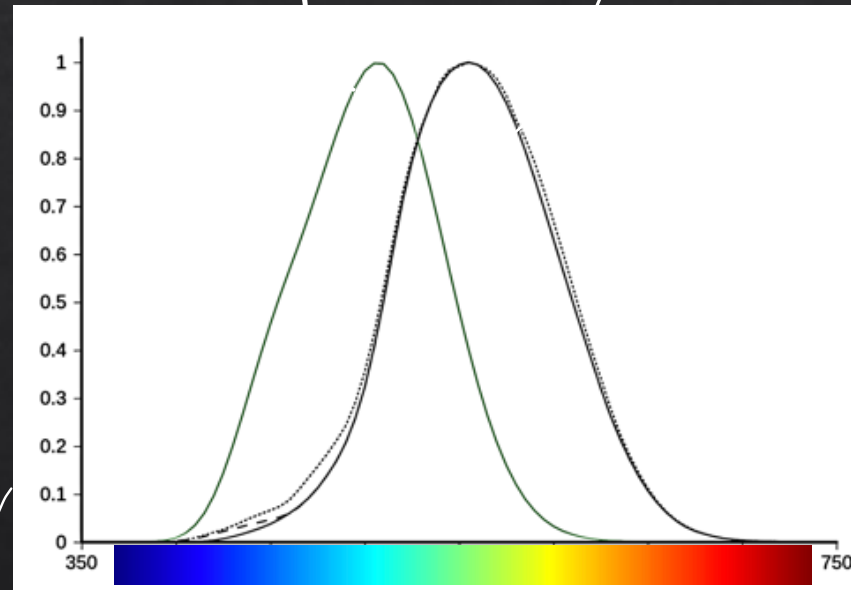
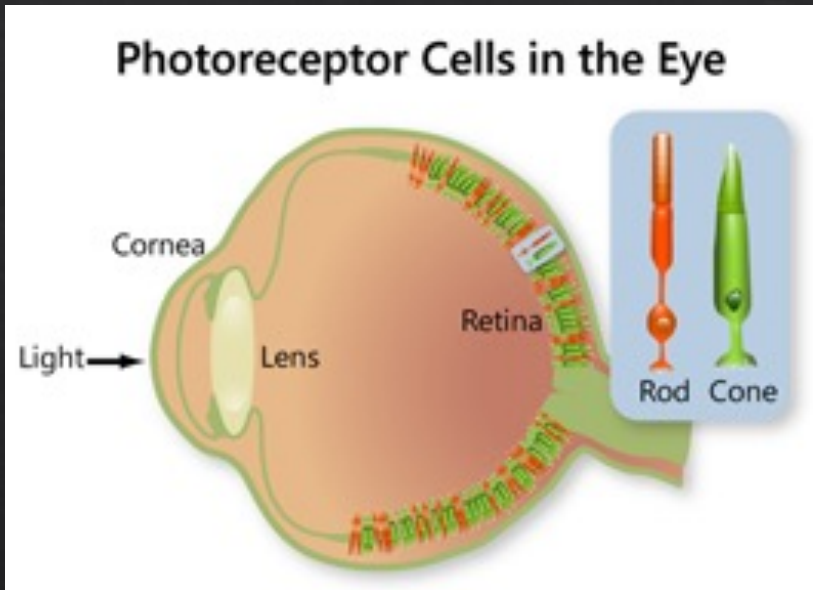
Interested in modelling this? Look [here](#)



Photometry

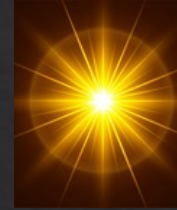
Study of perceived light energy in a scene

rods cones



$$\phi_p(\lambda) = \int \phi(\lambda) \cdot v(\lambda) d\lambda$$

luminous sensitivity
 $v(\lambda)$



QUANTITY	RADIOMETRIC	PHOTOMETRIC
Power	W	Lumen (lm) = cd·sr
Power Per Unit Area	W/m ²	Lux (lx) = cd·sr/m ² = lm/m ²
Power Per Unit Solid Angle	W/sr	Candela (cd)
Power Per Unit Area Per Unit Solid Angle	W/m ² ·sr	cd/m ² = lm/m ² ·sr = nit

BRIGHTNESS IN LUMENS

220+



400+



700+



900+



1300+



STANDARD

25W

40W

60W

75W

100W



HALOGEN

18W

28W

42W

53W

70W



CFL

6W

9W

12W

15W

20W



LED

4W

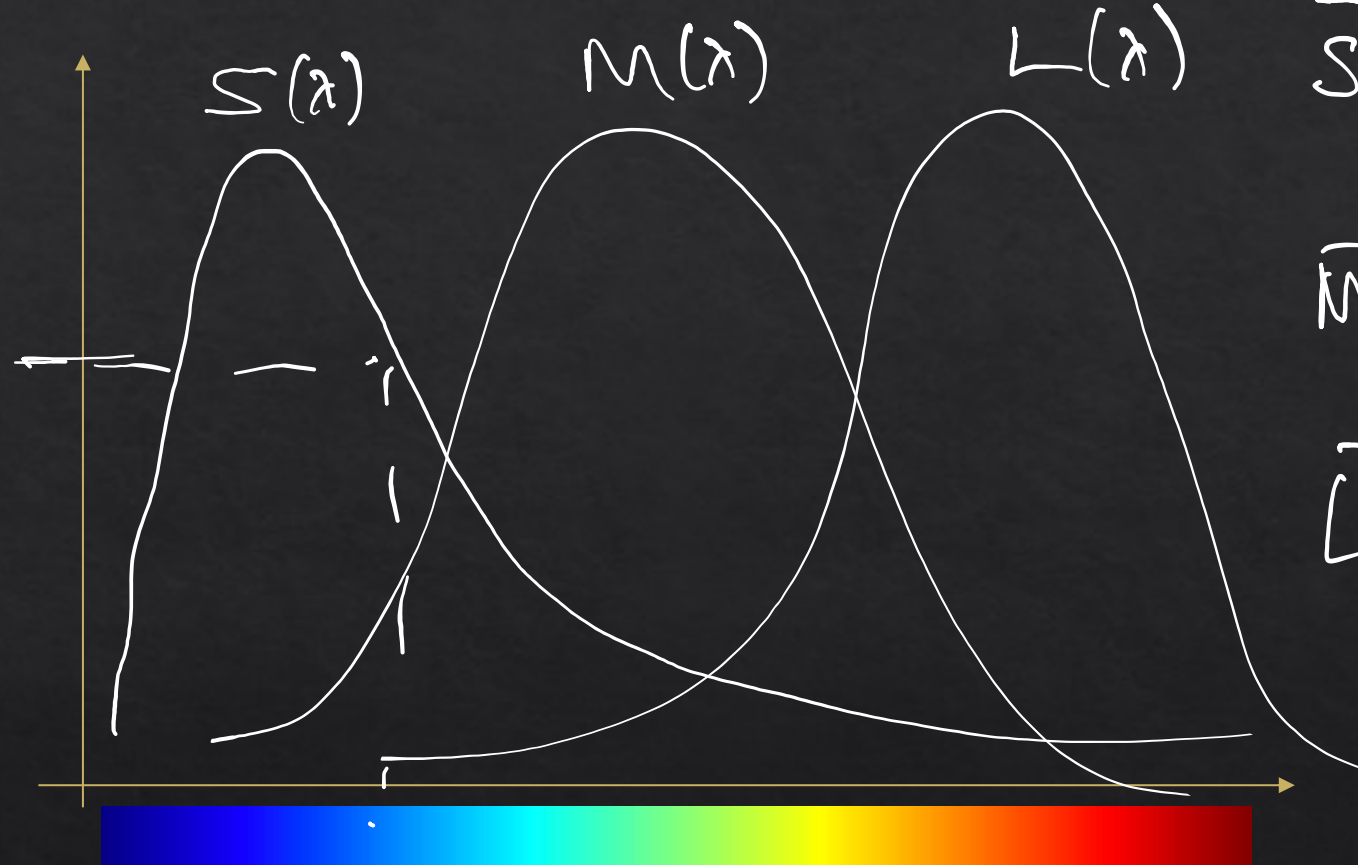
6W

10W

13W

18W

Spectral sensitivity of our eyes



$$\bar{S} = \int \phi(\lambda) S(\lambda) d\lambda$$

$$\bar{M} = \int \phi(\lambda) M(\lambda) d\lambda$$

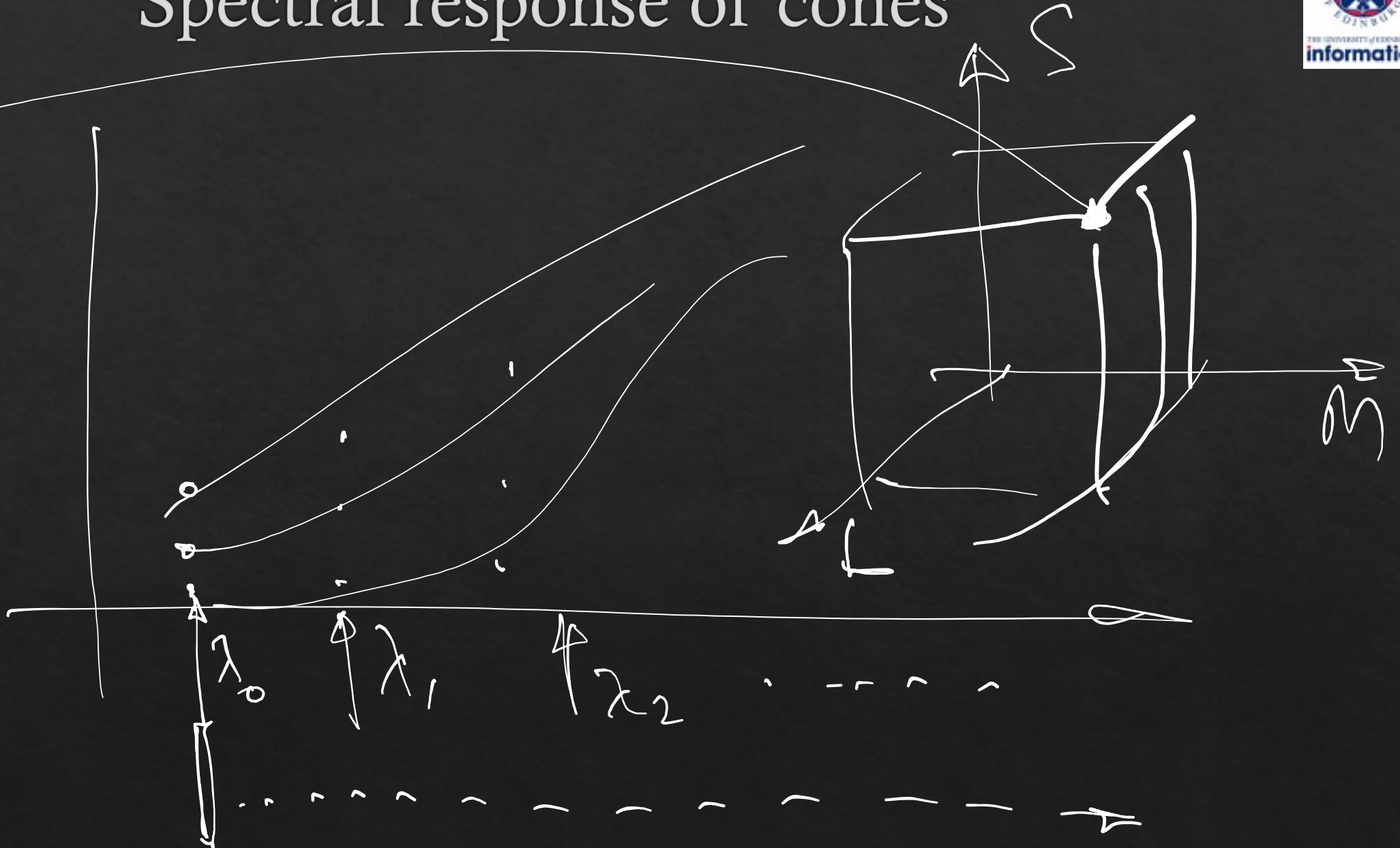
$$\bar{L} = \int \phi(\lambda) L(\lambda) d\lambda$$

Spectral response of cones

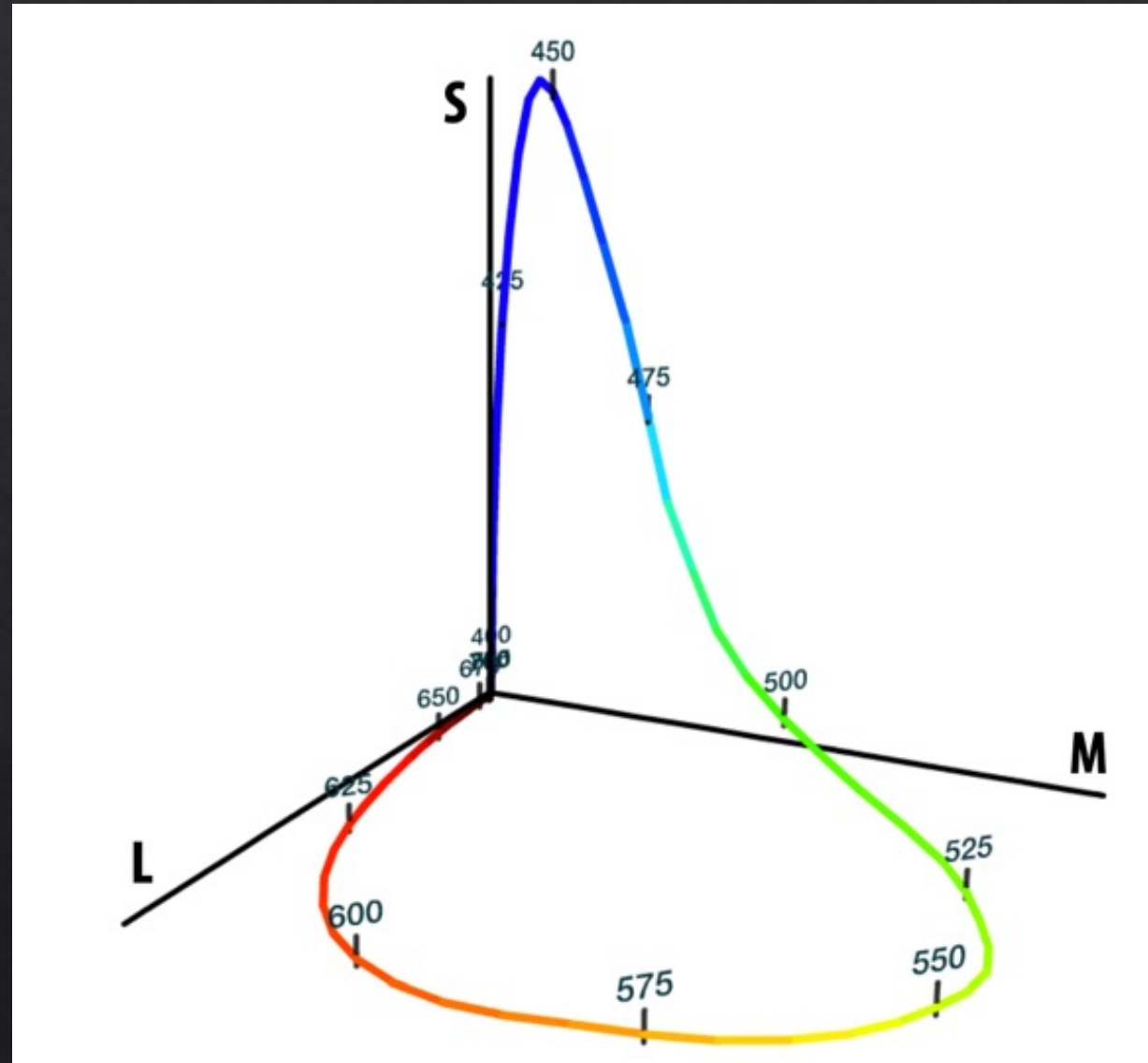
$$\begin{bmatrix} S \\ M \\ L \\ e \end{bmatrix}$$

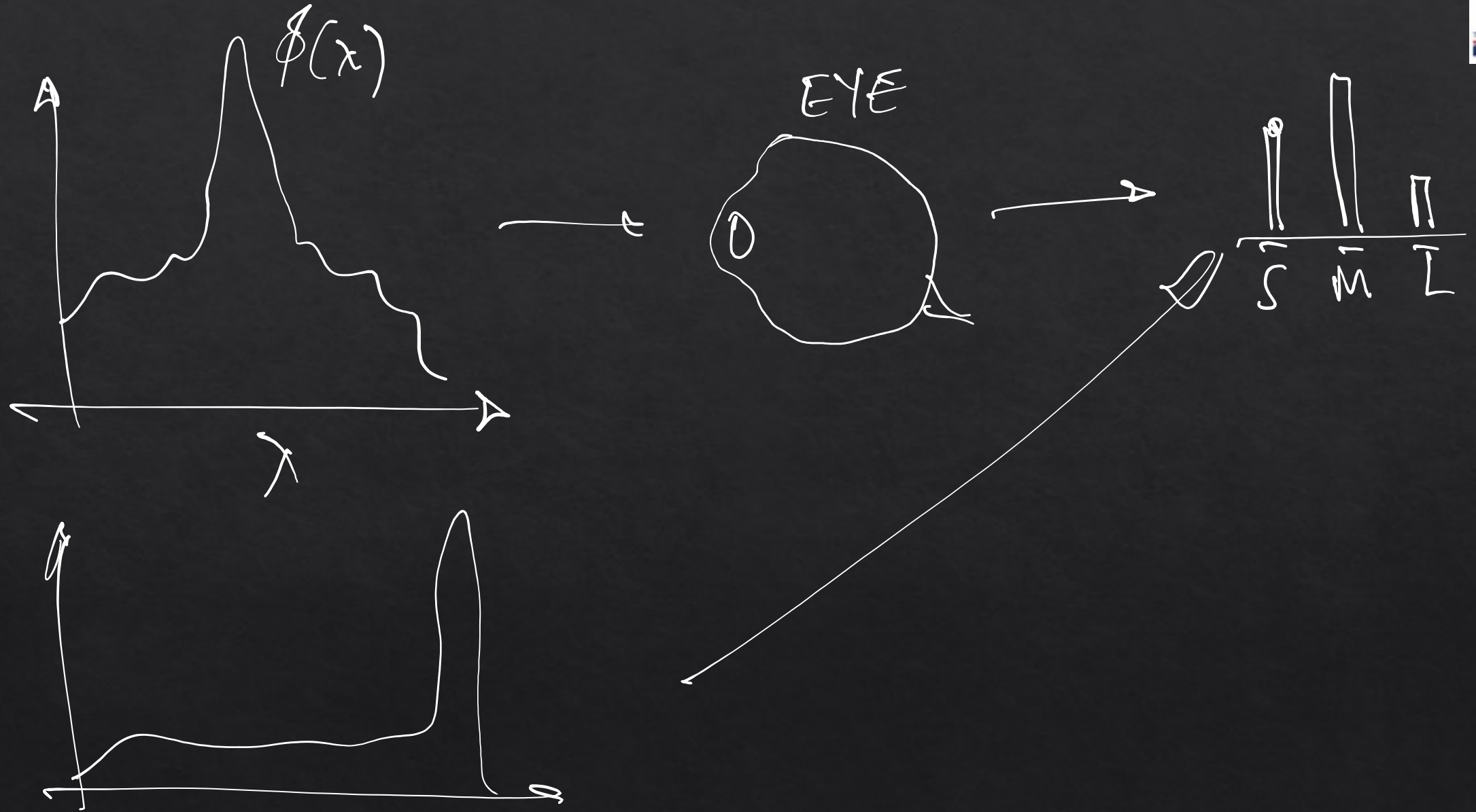
$$\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}_1$$

$$\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}_2$$



plotting S,M,L as 3D points as a function of wavelength





Metamers



http://persci.mit.edu/people/adelson/checkershadow_proof

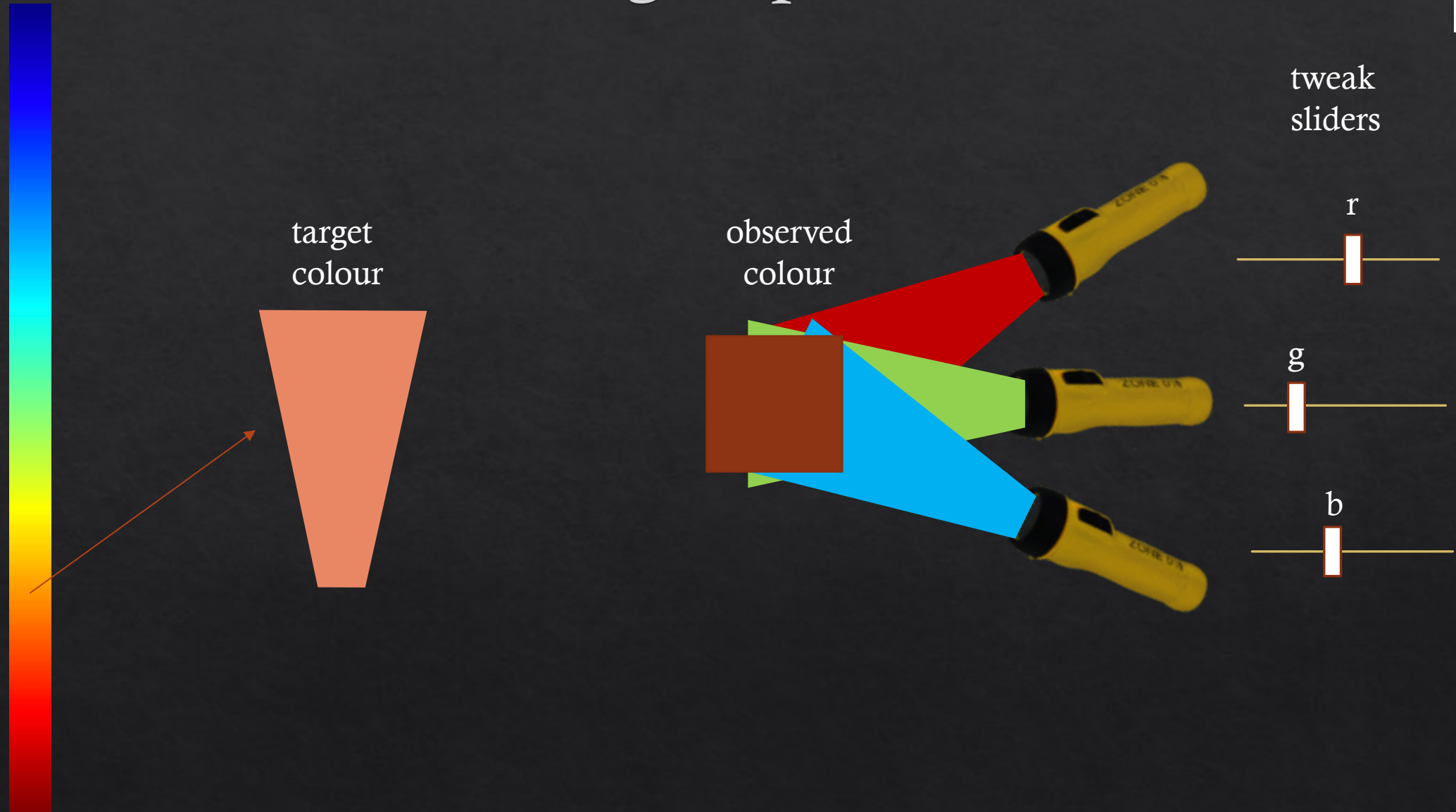
Trichromatic theory of light



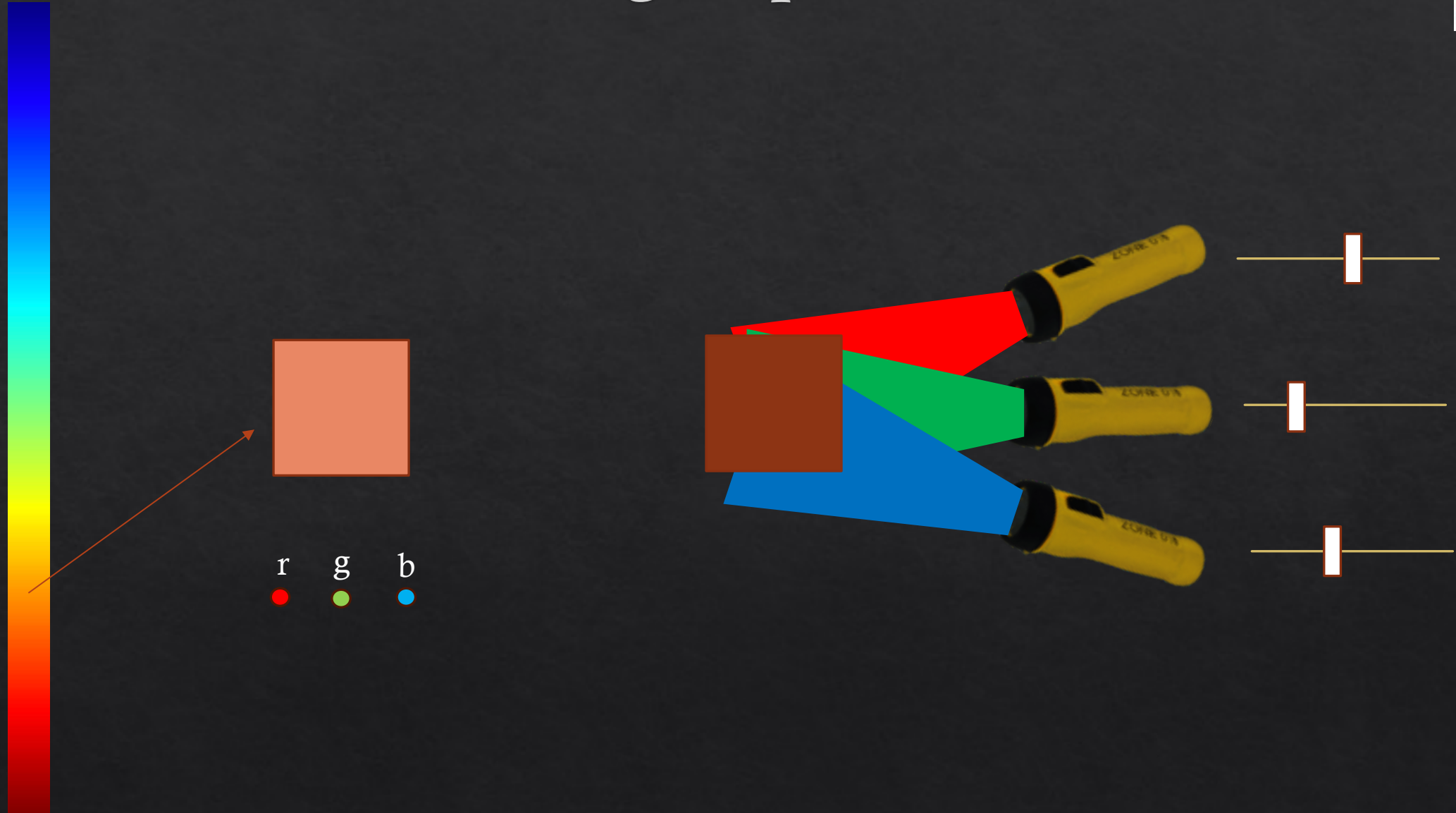
Trichromatic theory of light



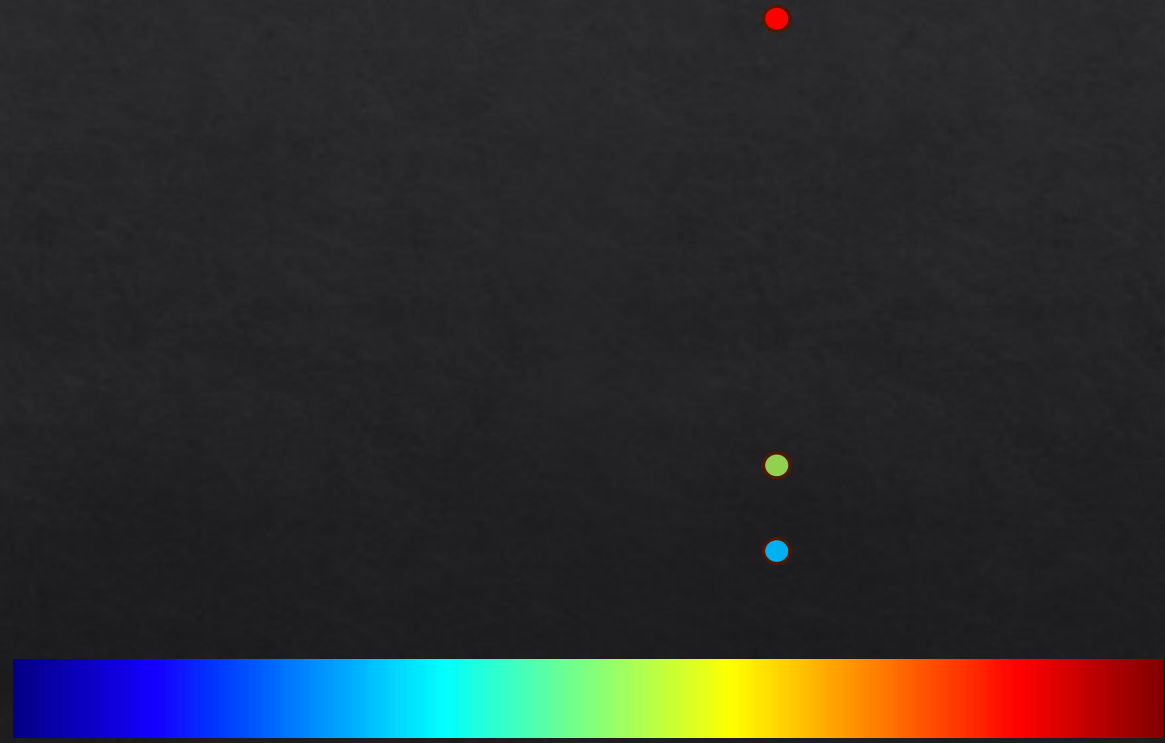
Matching Experiment



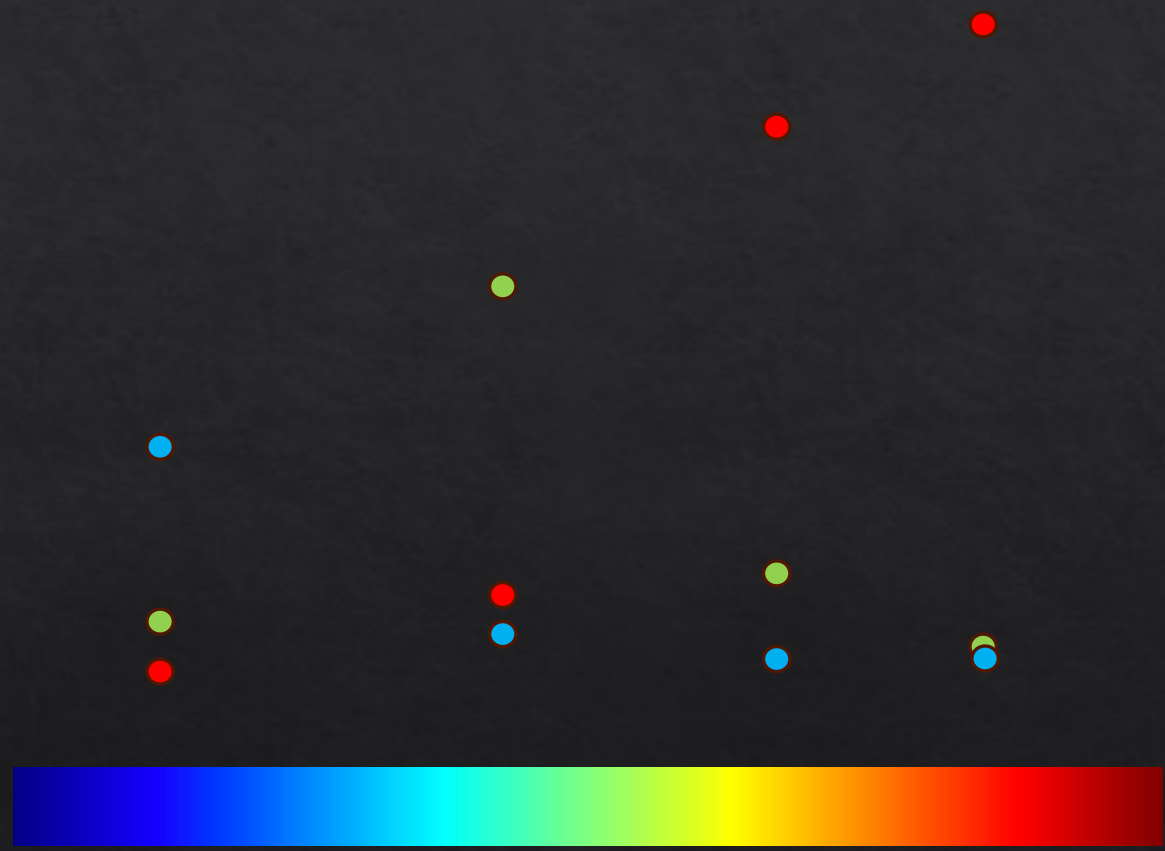
Matching Experiment



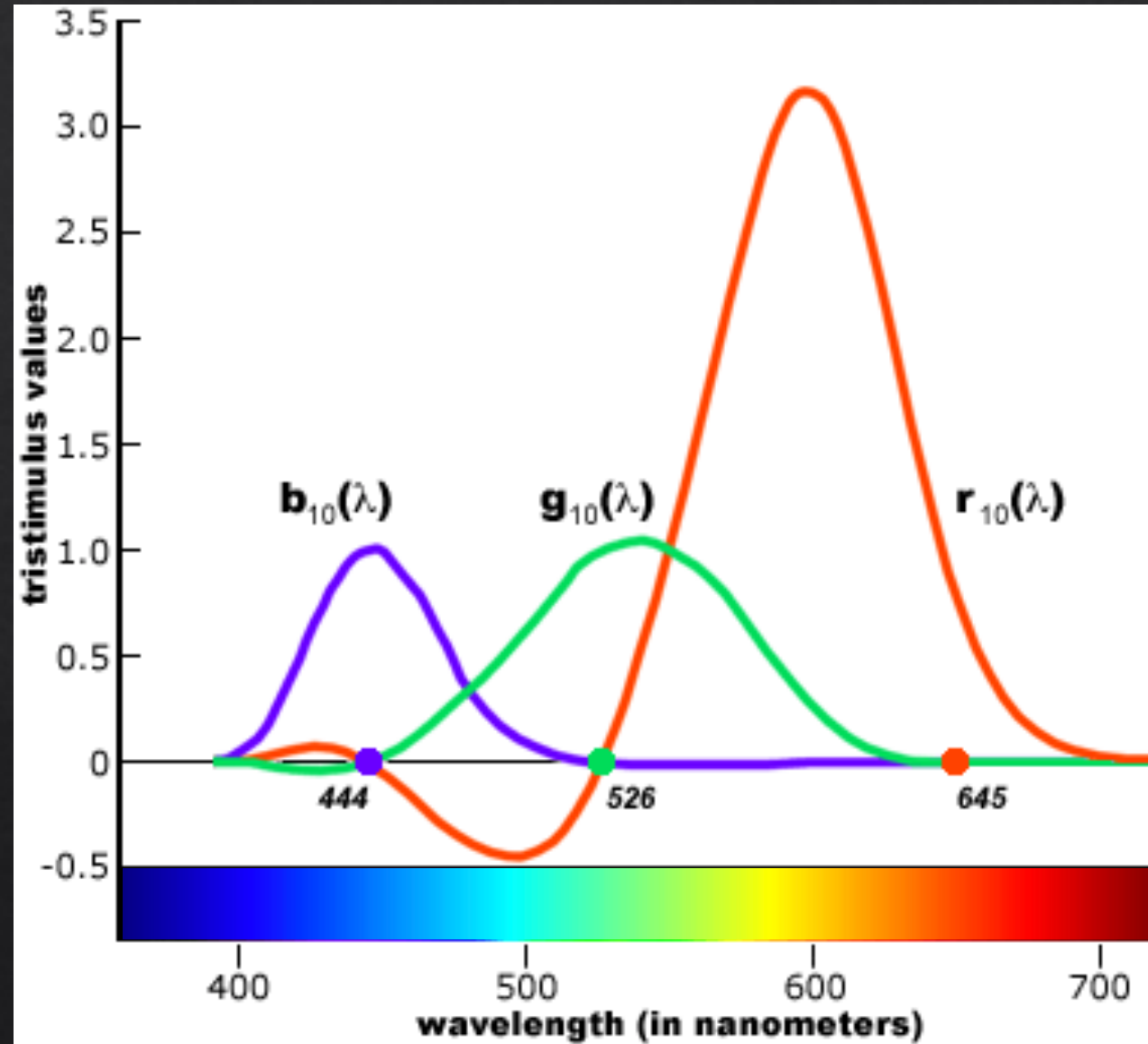
Tristimulus values



Tristimulus values



Tristimulus values



Confusing? Read more [here](#)
(search for 'Maxwell' on the page)
or [here](#)

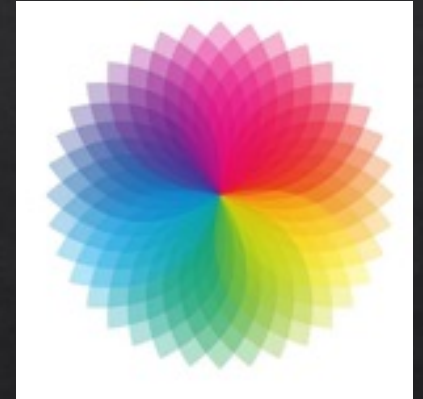
The study of light



radiometry



photometry



colorimetry

Interested in knowing more? Read [this](#)

