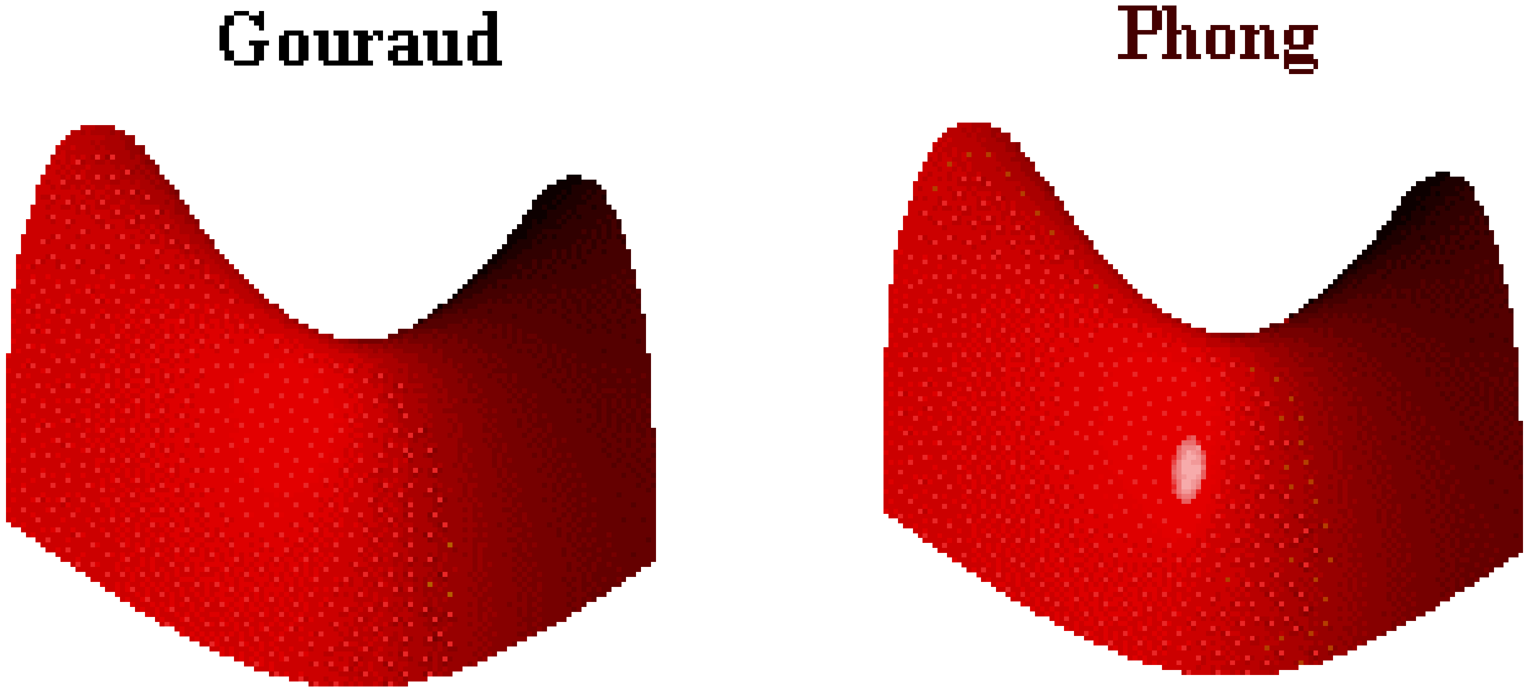
Administrative

- Test on October 22
- Can include material up to the end of the last lecture (naïve color model, basic specularities, Phong shading)
- Thursday will be a review Q & A session



from
http://www.geocities.com/SiliconValley/Horizon/6933/shading.html

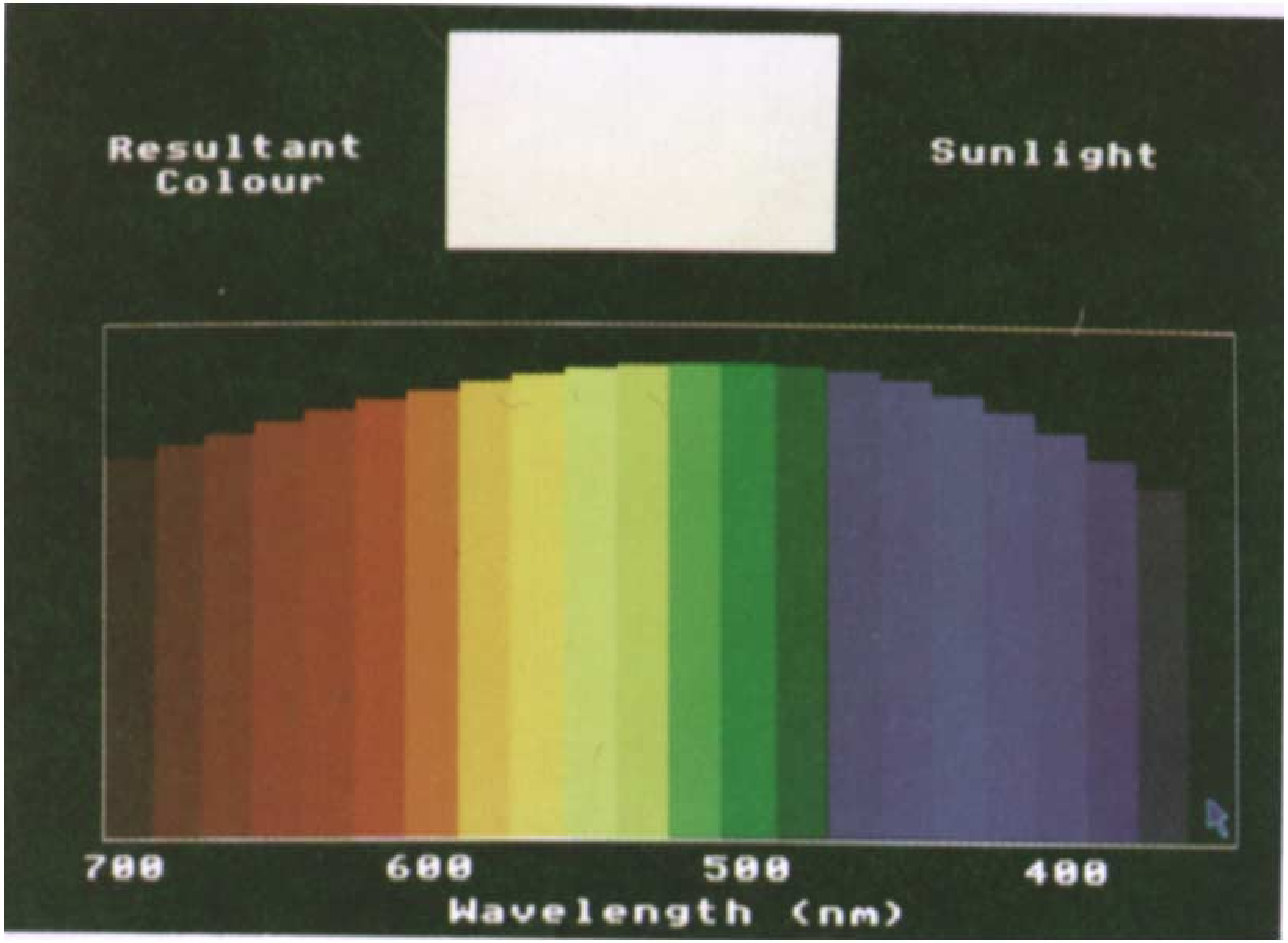
The colors of the rainbow

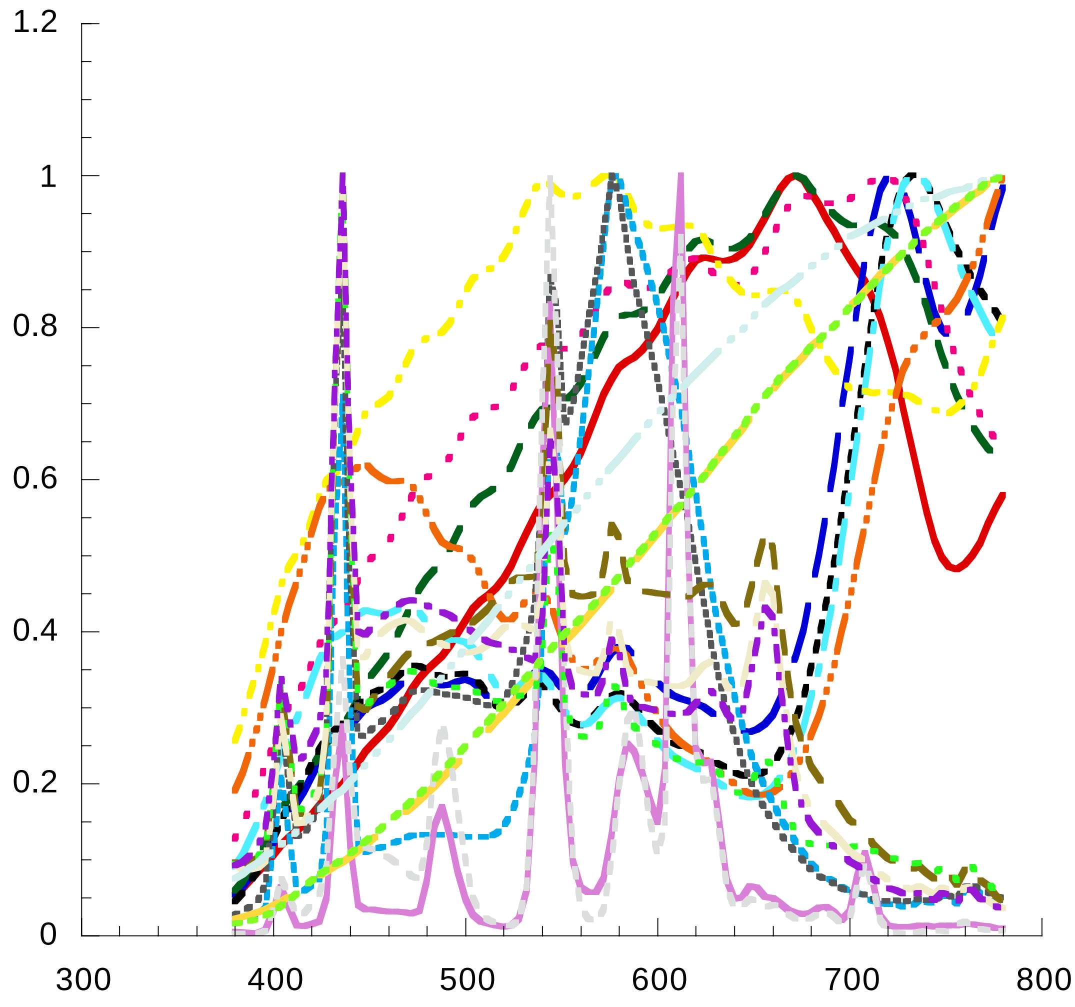
- Light is electromagnetic radiation, occurring at different wavelengths (or photon energies)
- The radiation around us is a mix of these
- Visible portion is about 400 to 700 nm
- Certain applications may require modeling some UV also.
- Light is specified by its spectrum recording how much power is at each wavelength.

Radiometry for colour

- All definitions are now “per unit wavelength”
- All units are now “per unit wavelength”
- All terms are now “spectral”
- Radiance becomes spectral radiance
  - watts per square meter per steradian per unit wavelength
- Radiosity --- spectral radiosity

Sunlight




1.2
1
0.8
0.6
0.4
0.2
0
300
400
500
600
700
800

Two disparate source spectra

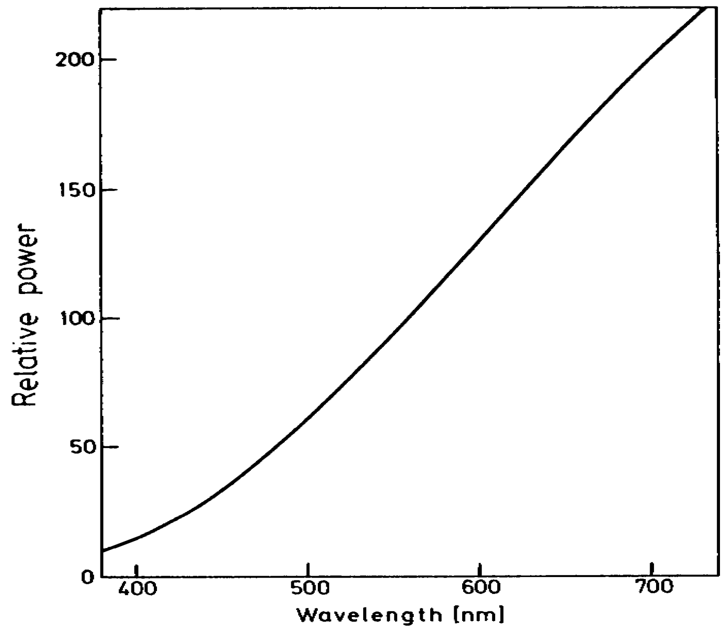


Fig. 4.1. Wavelength composition of light from a tungsten-filament lamp [typified by CIE ILL A (Sect. 4.6)]. Relative spectral power distribution curve. Color temperature: 2856 K

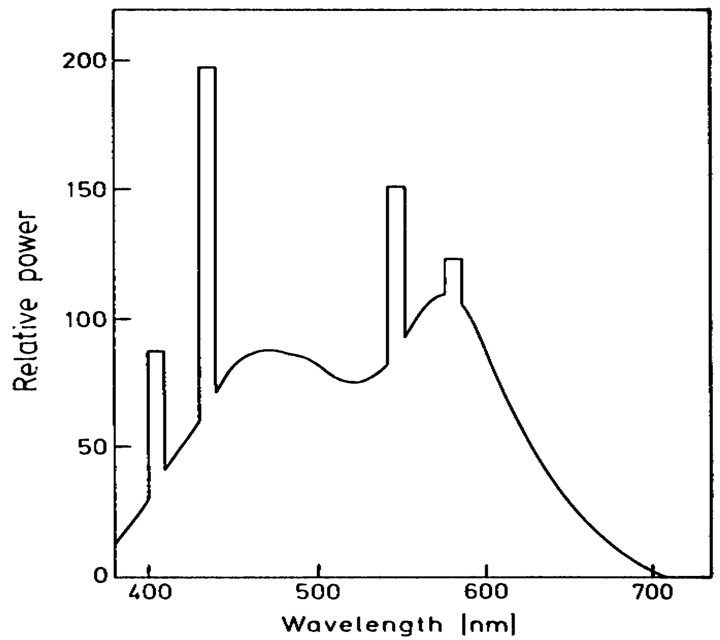


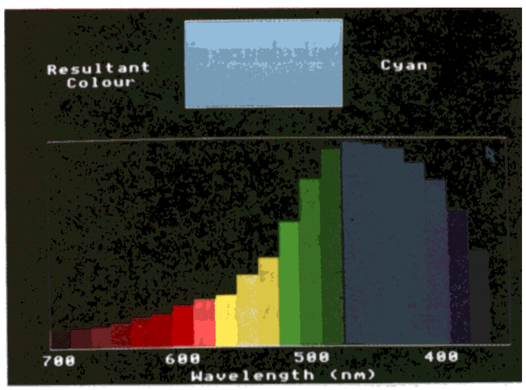
Fig. 4.2. Wavelength composition of light from a daylight fluorescent lamp. Typical relative spectral power distribution curve. Correlated color temperature: 6000 K. (Based on data of Jerome reported in [Ref. 3.14, p. 37])

Causes of colour

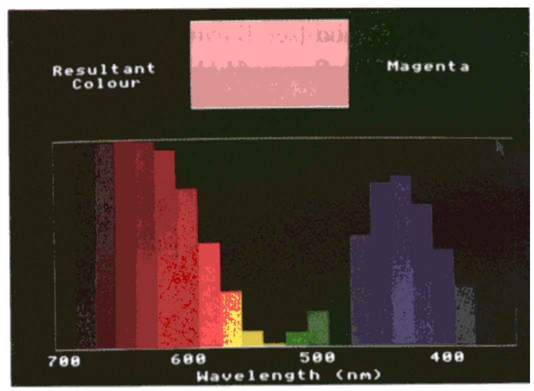
- The sensation of colour is caused by the brain.
- One way to get it is the response of the eye to the presence/absence of light at various wavelengths.
- Light could be emitted with wavelengths absent -e.g. flourescent light vs. incandescent light.
- It could be differentially reflected - e.g. paint on a surface.
- It could be differentially refracted - e.g. Newton’s prism
- Wavelength dependent specular reflection - e.g. shiny copper penny (actually most metals).
- Flourescence - light at invisible wavelengths is absorbed and reemitted at visible wavelengths.
- Dreaming, hallucination, etc.
- Pressure on the eyelids

Absorbtion spectra: real pigments

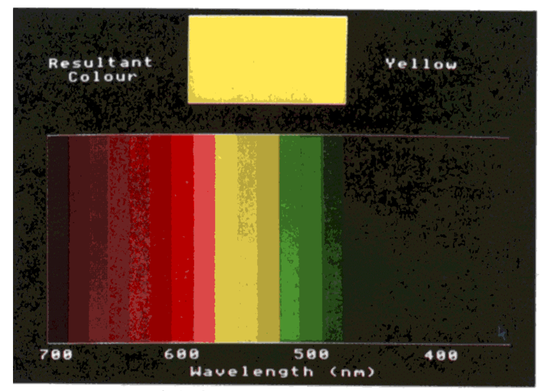
cyan



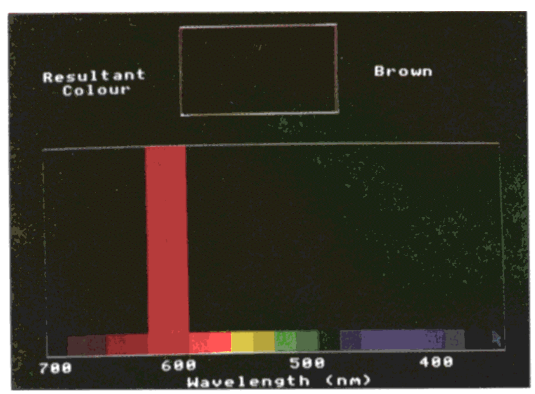
magenta

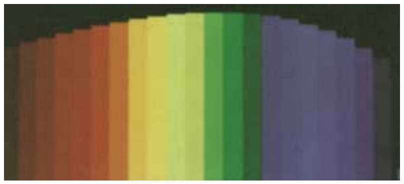


yellow

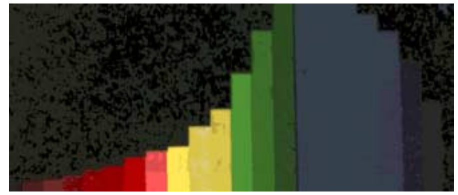


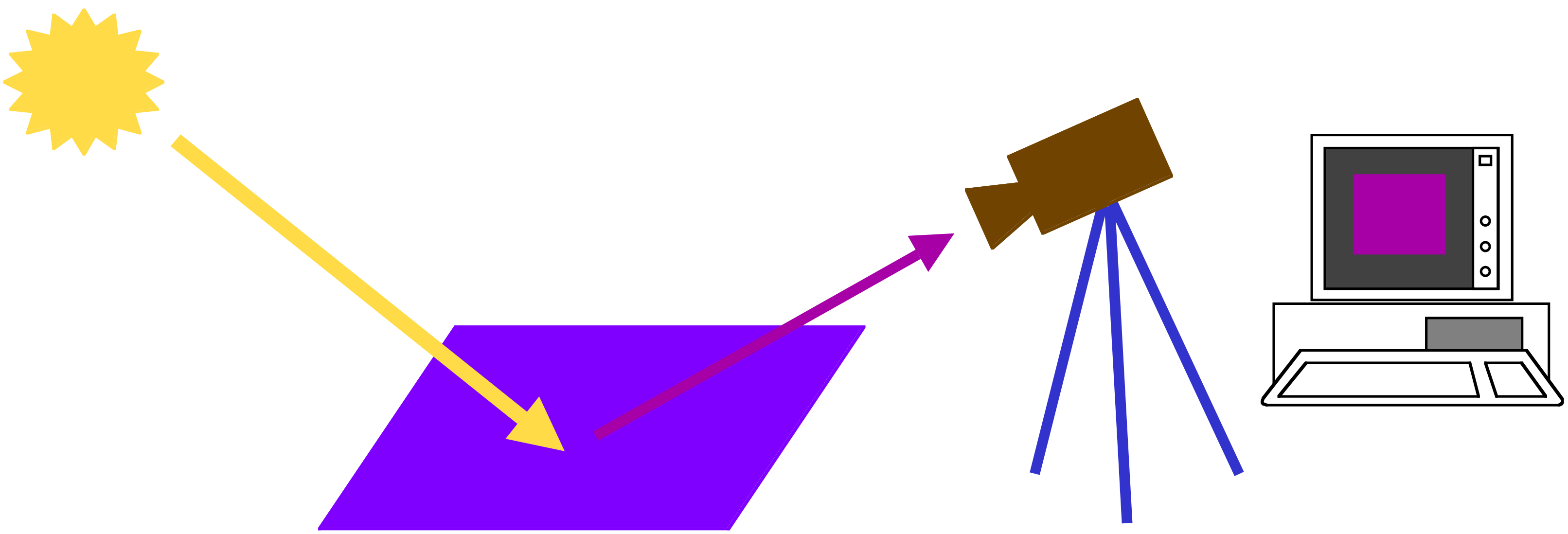
brown





X



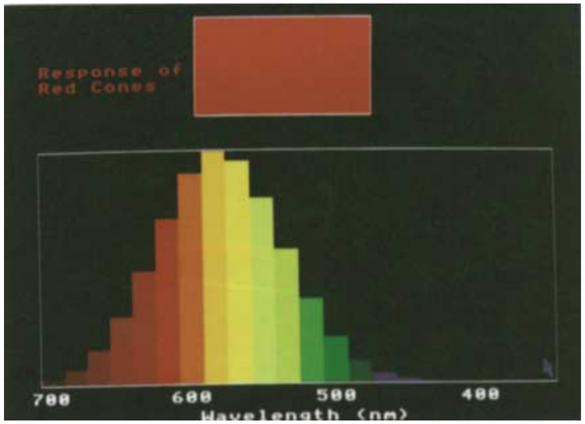


Trichromaticity

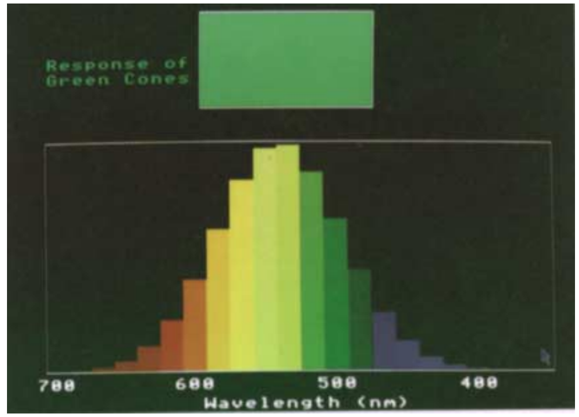
Empircal fact--colors can be approximately described/matched by three quantities (assuming normal color vision).

Need to reconcile this observation with the spectral characterization of light

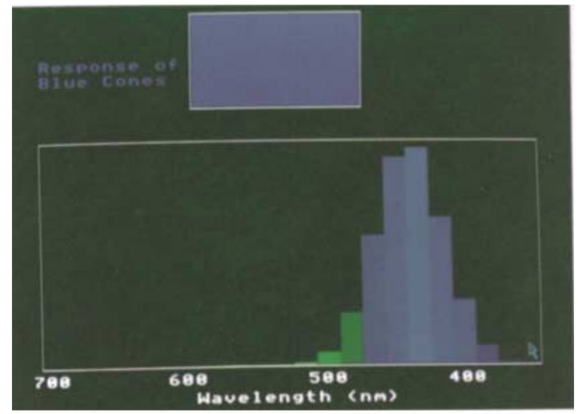
Color receptors



"Red" cone



"Green" cone



"Blue" cone

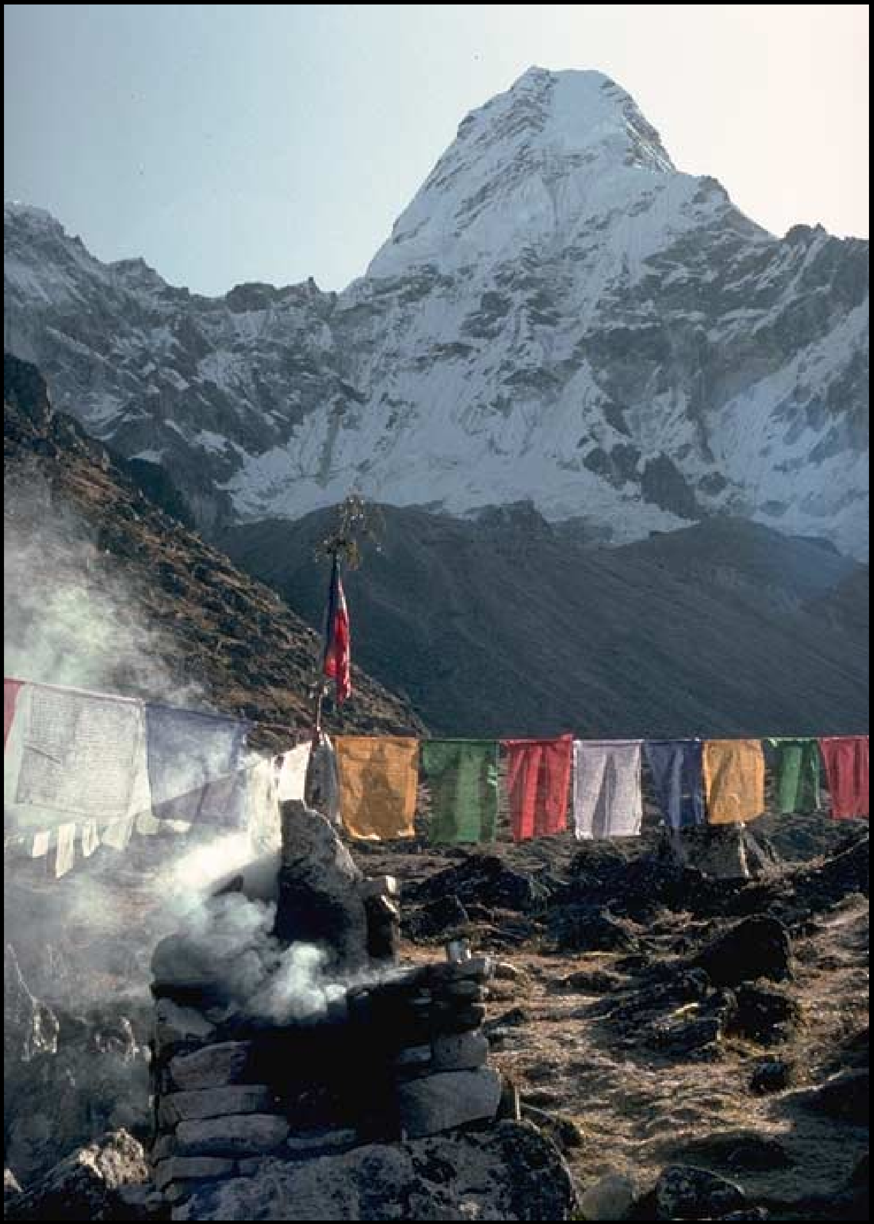
Principle of univariance: cones give the same kind of response, in different amounts, to different wavelengths. Output of cone is obtained by summing over wavelengths.
Responses measured in a variety of ways

Response of k'th cone = $\int \rho_k(\lambda)E(\lambda)d\lambda$

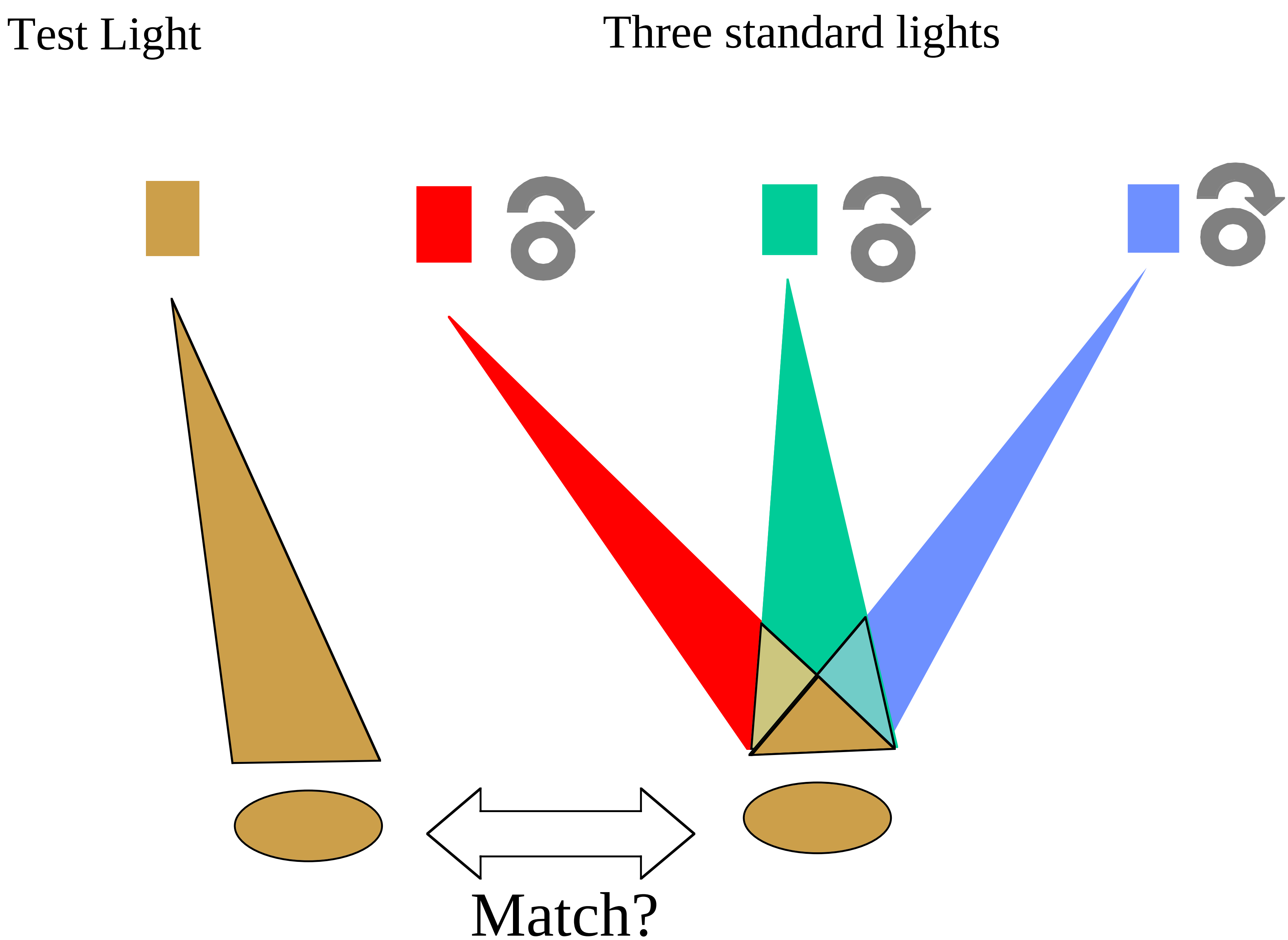
Colour Reproduction

Motivates specifying color numerically (there are other reasons to do this also)

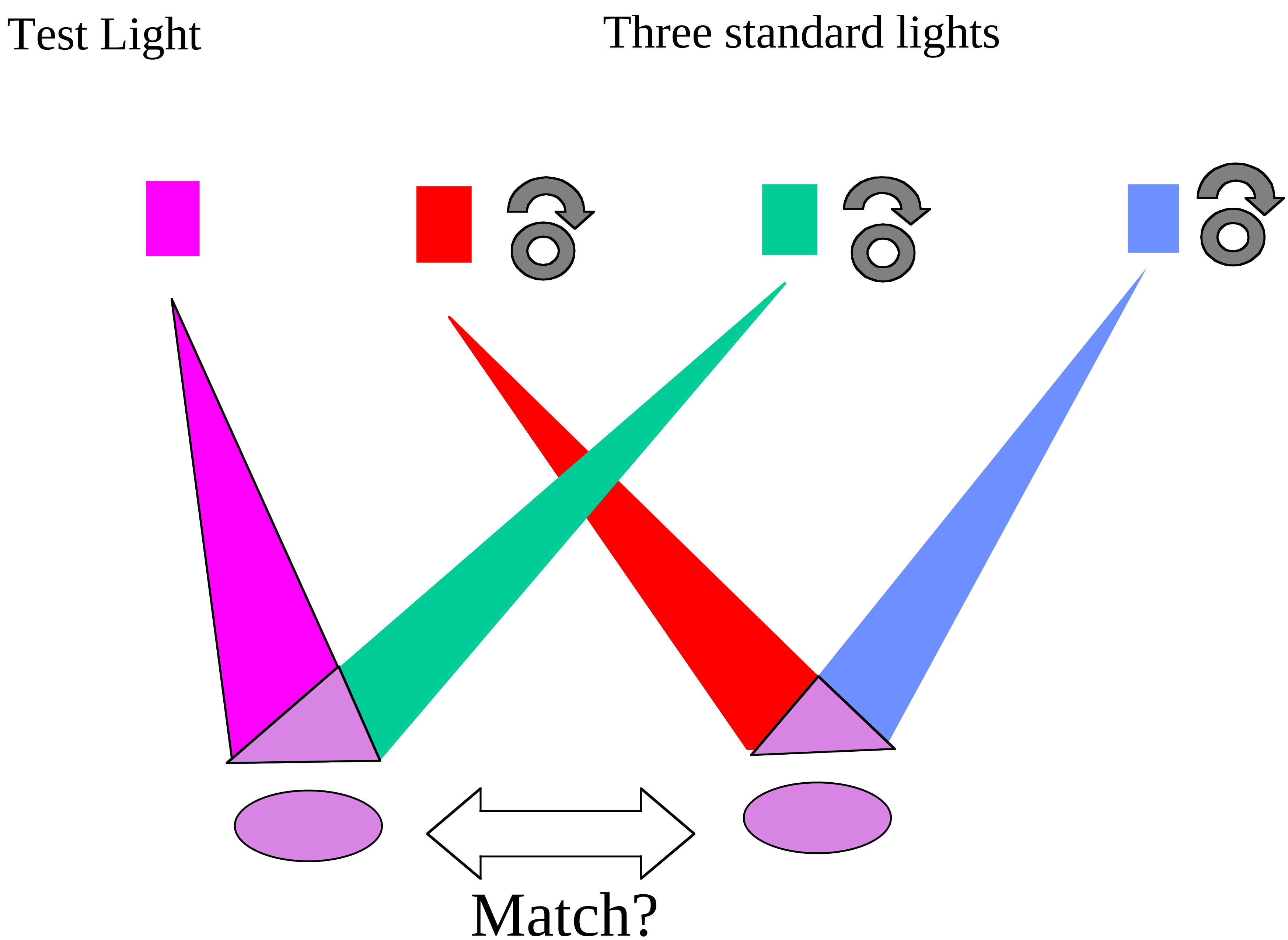
General (man in the street) observation--color reproduction *sort of* works.

Specifying Colour



Test Light
Three standard lights
Match?

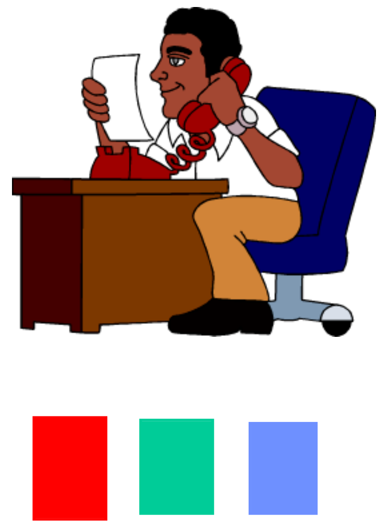

Test Light
Three standard lights
Match?

Trichromacy

Experimental fact about people (with "normal" colour vision)

Specifying Colour

(50,150,75)



(50,150,75)

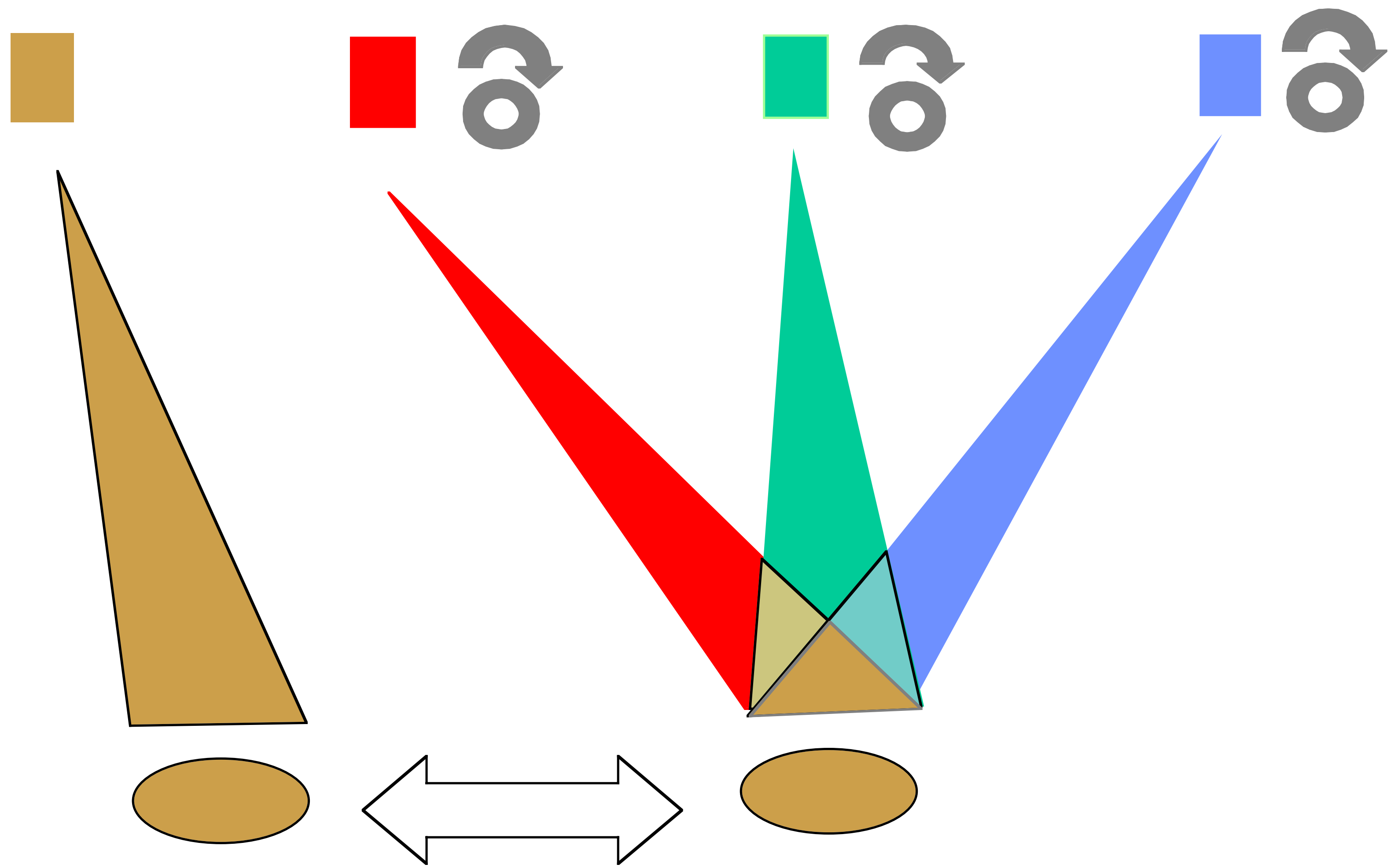
Specifying Colour

We don’t want to do a matching experiment every time we want to use a new color!

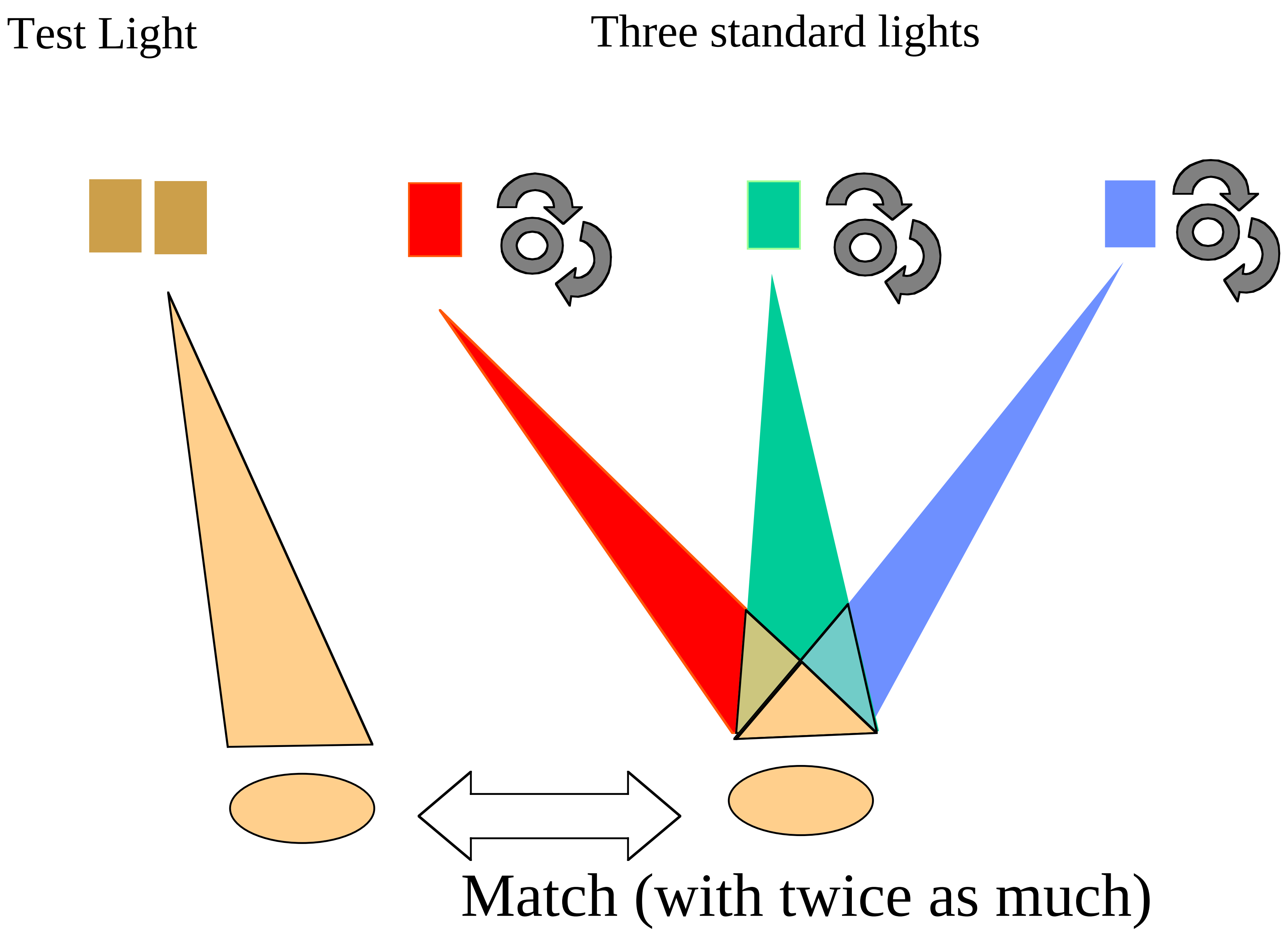
Grassman’s Contribution

Colour matching is linear

Test Light Three standard lights



Match?

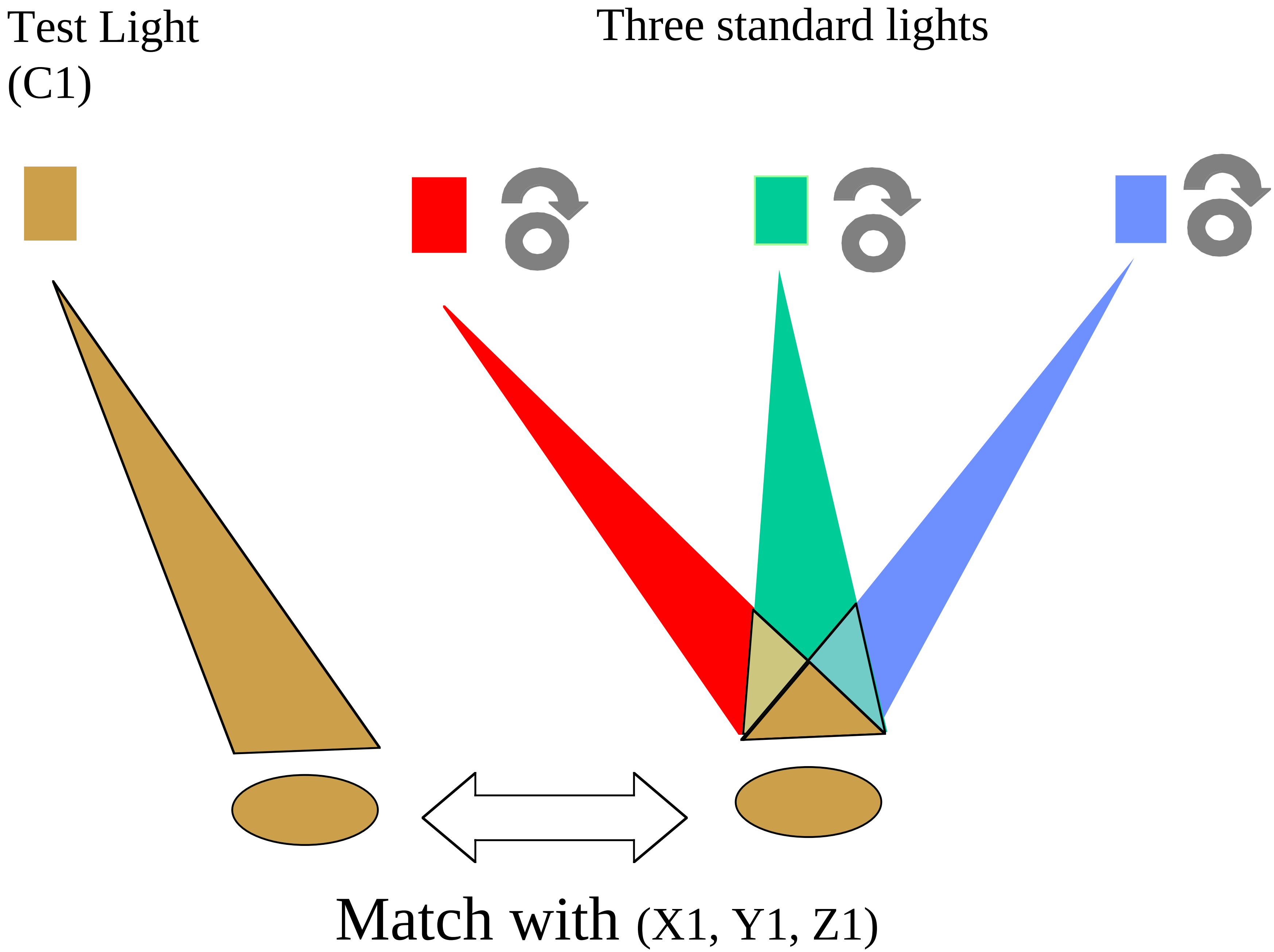

Test Light
Three standard lights
Match (with twice as much)

Matching is Linear (Part 1)

C1 is matched with (X1,Y1,Z1)

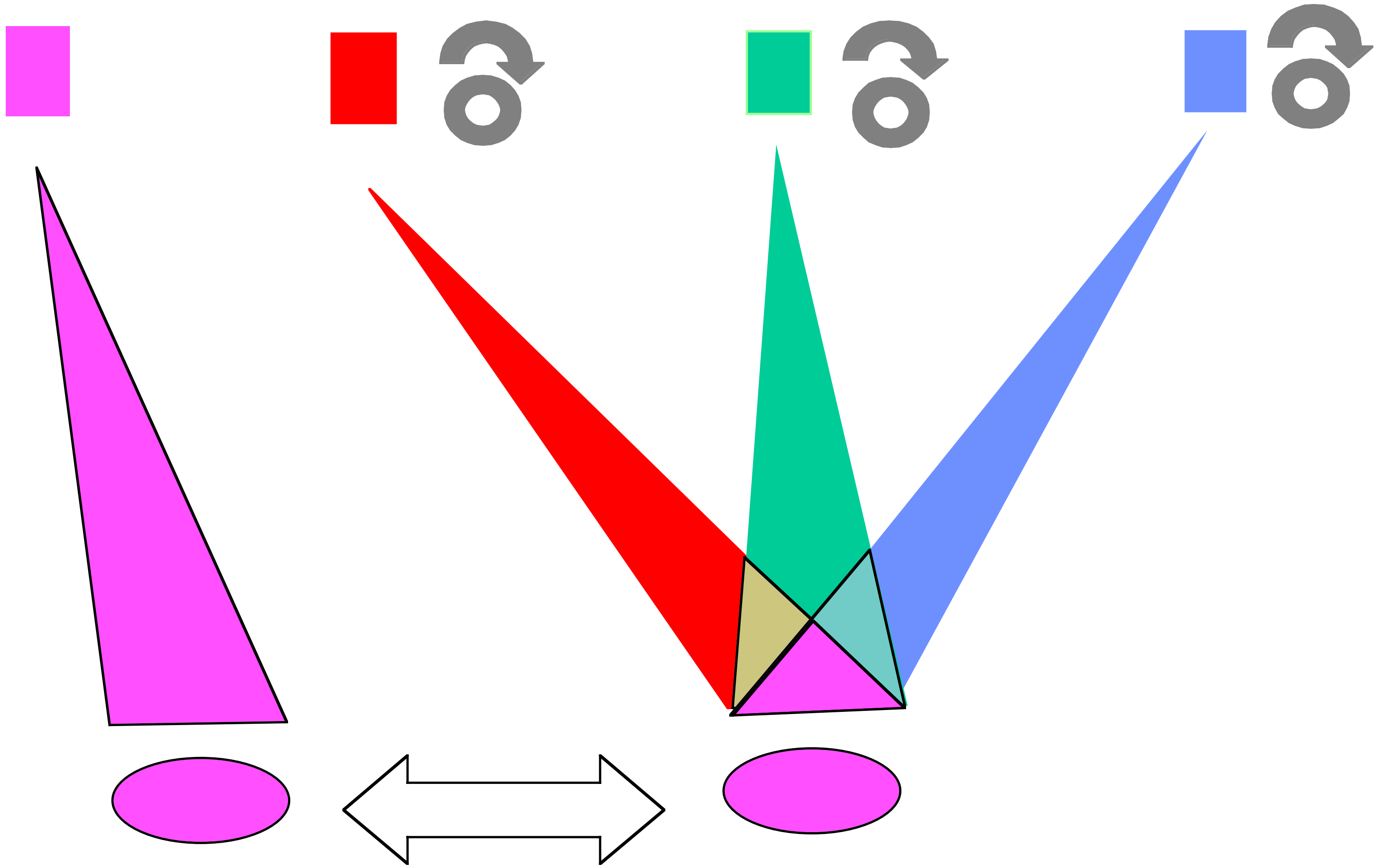
C = a*C1

C is matched with a * (X1, Y1, Z1)

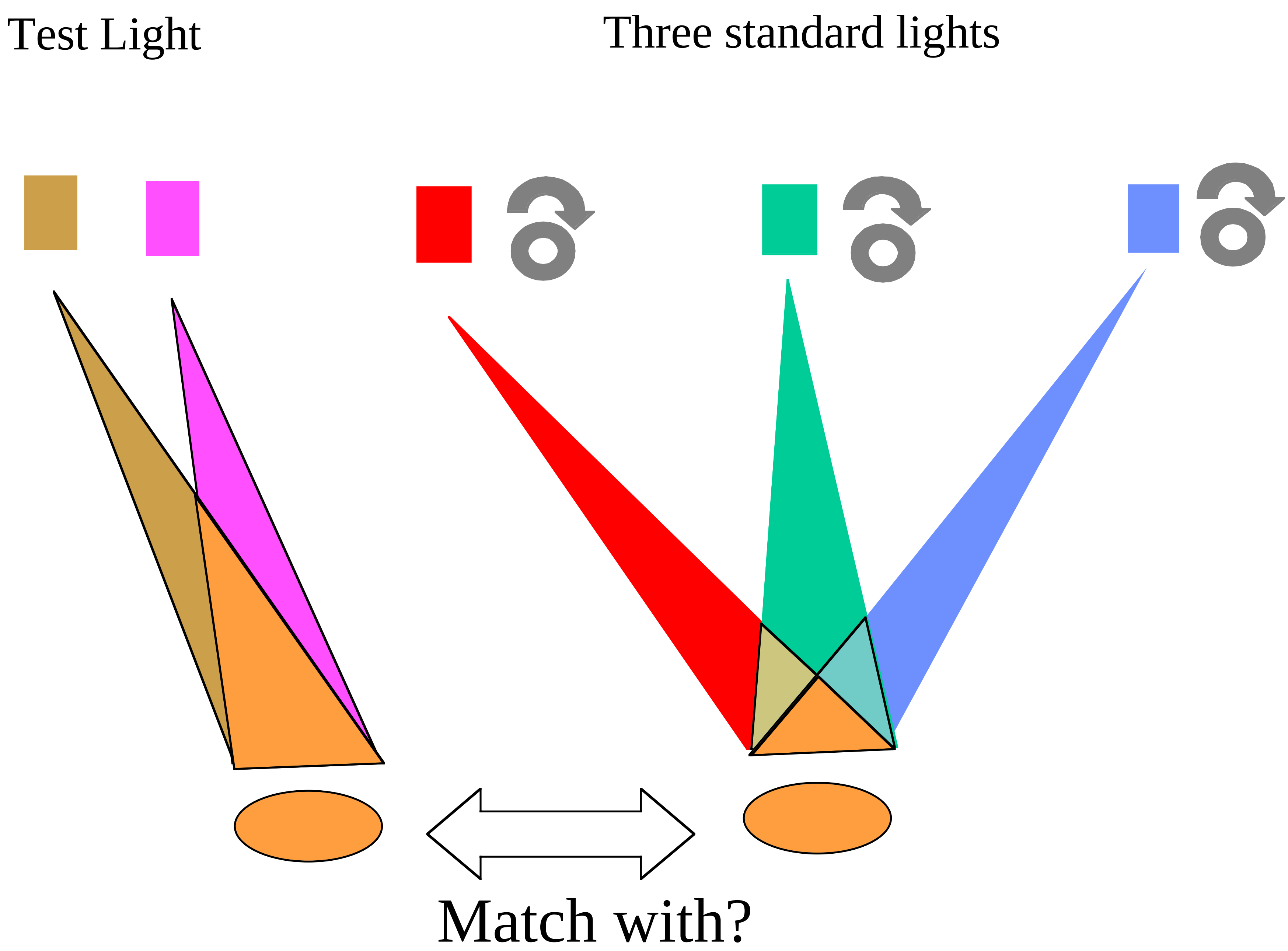

Test Light
(C1)
Three standard lights
Match with (X1, Y1, Z1)

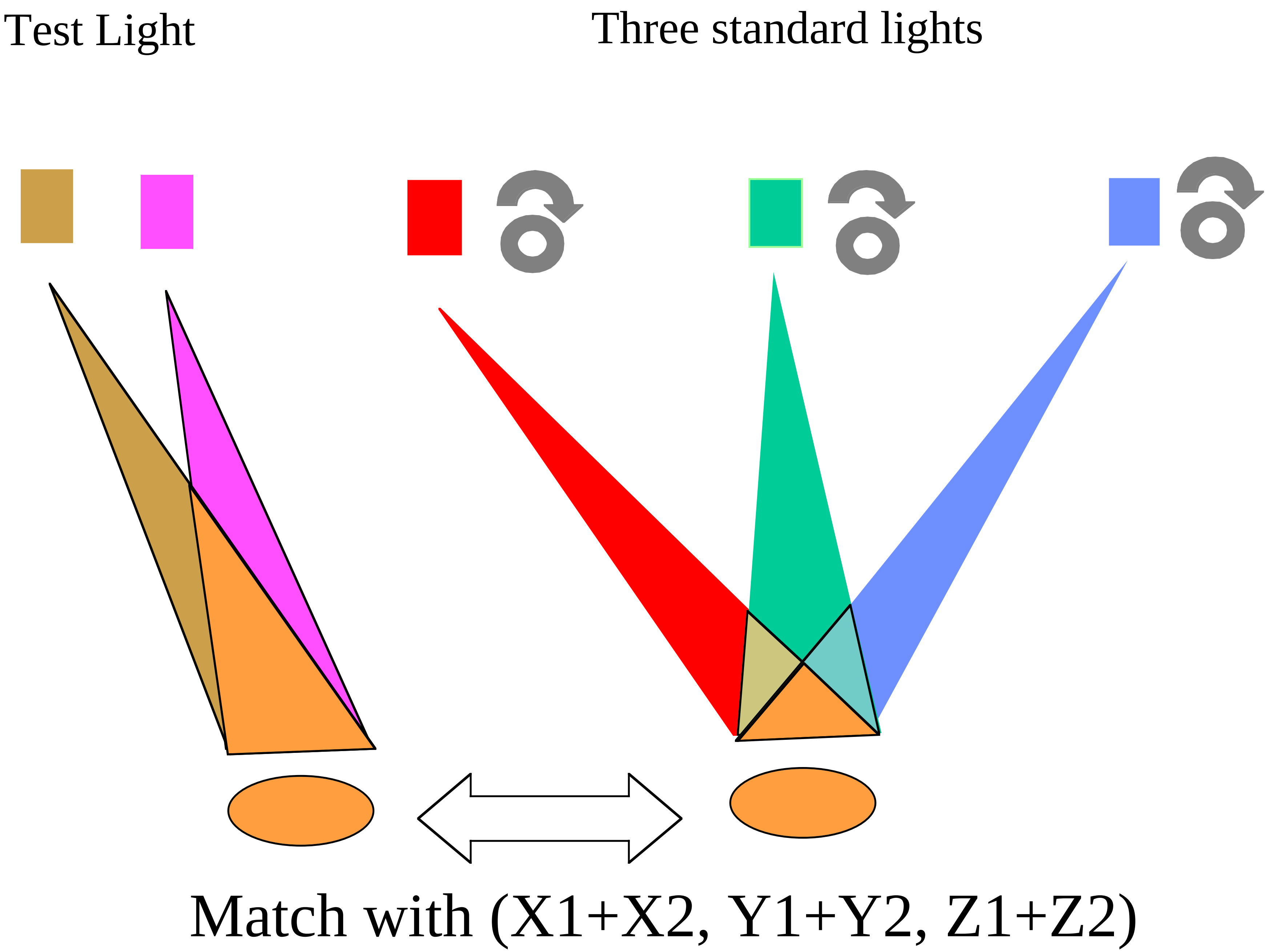
Test Light
(C2)

Three standard lights



Match with (X2, Y2, Z2)


Test Light
Three standard lights
Match with?


Test Light
Three standard lights
Match with (X1+X2, Y1+Y2, Z1+Z2)

Matching is Linear (formal)

C = a*C1 + b*C2

C1 is matched with (X1,Y1,Z1)
C2 is matched with (X2,Y2,Z2)

C is matched by
a*(X1,Y1,Z1) + b*(X2,Y2,Z2)