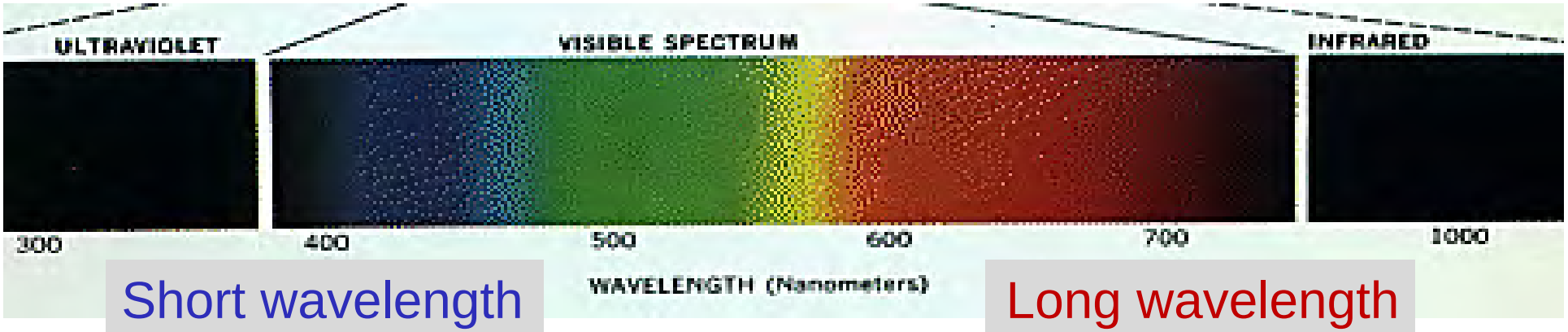
Additive Color
Part 1

Visible Light

Our eyes are sensitive to light waves in a specific range of wavelengths.



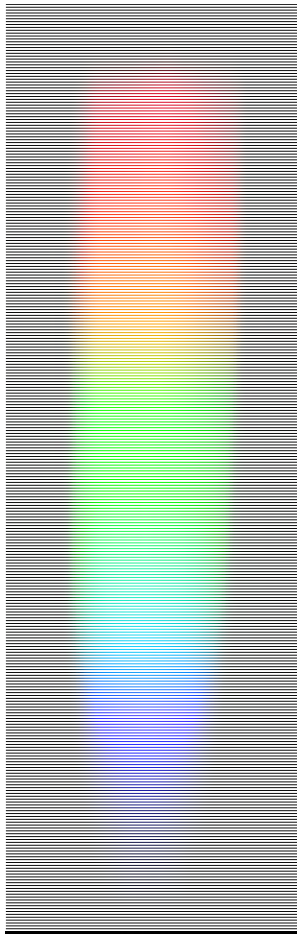
Short wavelength
High frequency

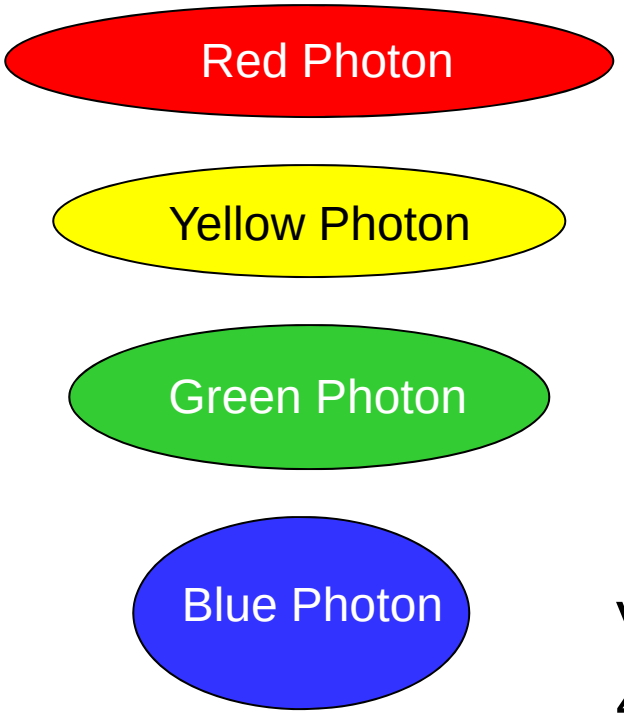
Long wavelength
Low frequency

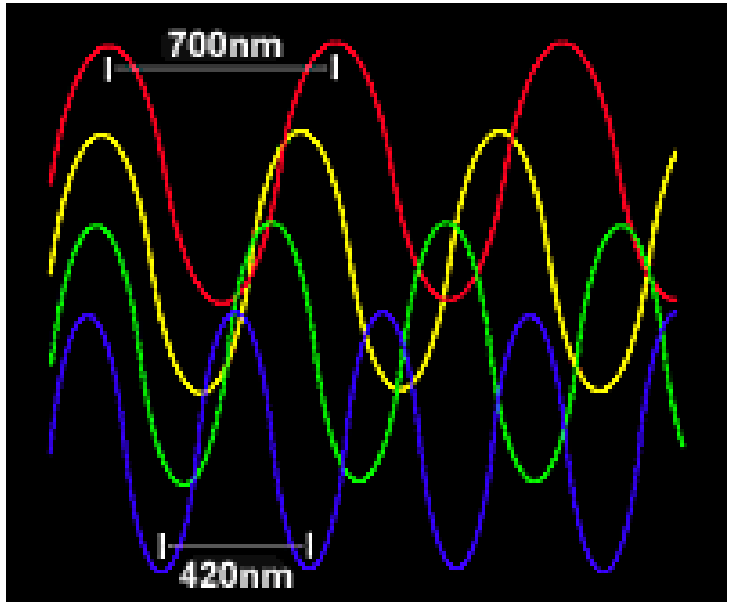
For light waves we traditionally use wavelength while for sound waves we typically use frequency.

Wavelengths & Photons

Particles of light, called photons, are seen as different colors depending on their wavelength.



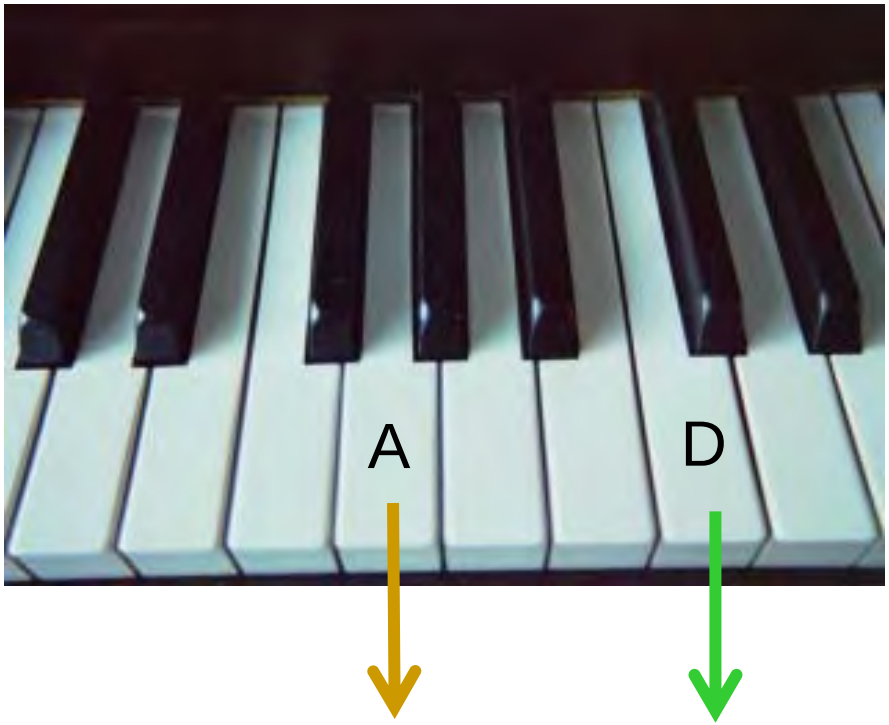


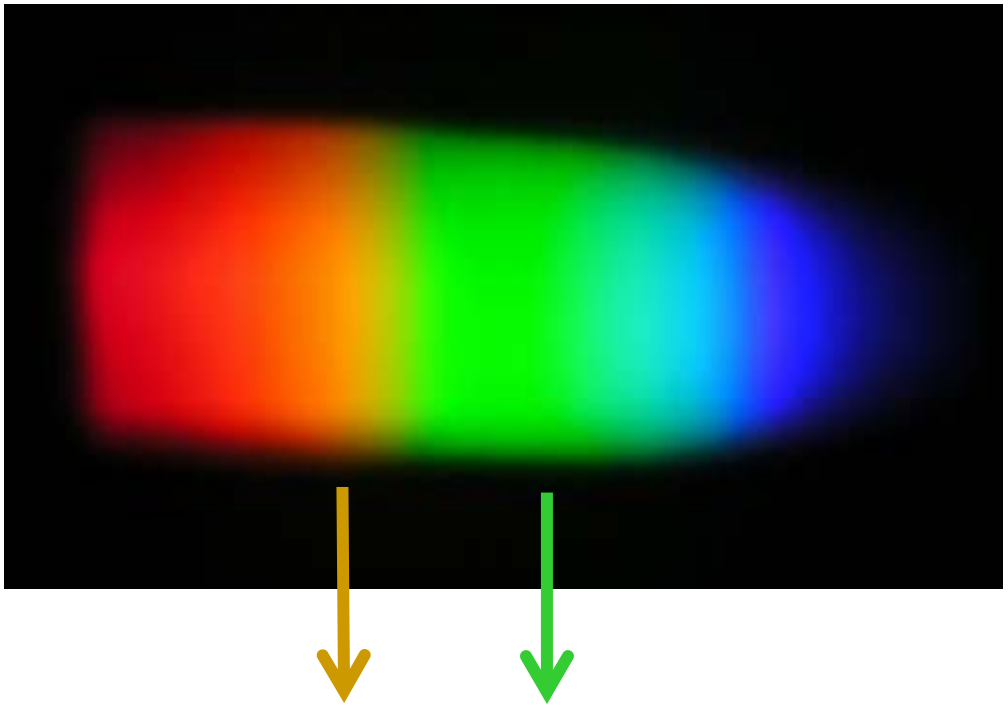


Visible light is roughly from 400 nanometers (blue) to 700 nanometers (red).

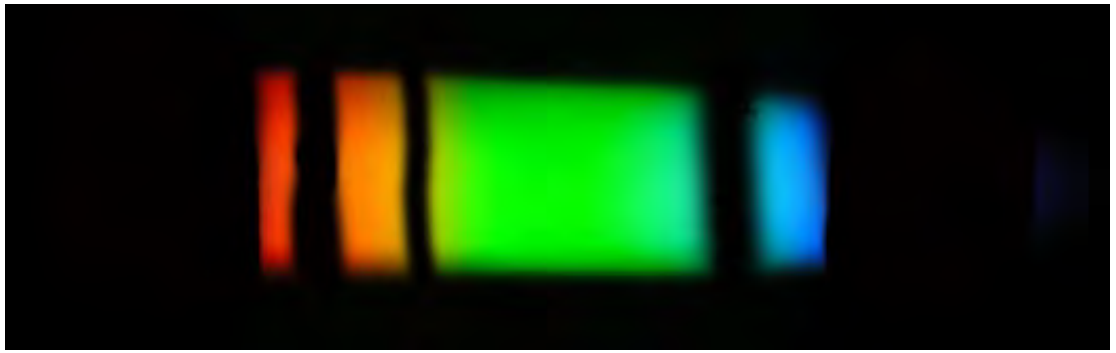
Light and Sound Analogy

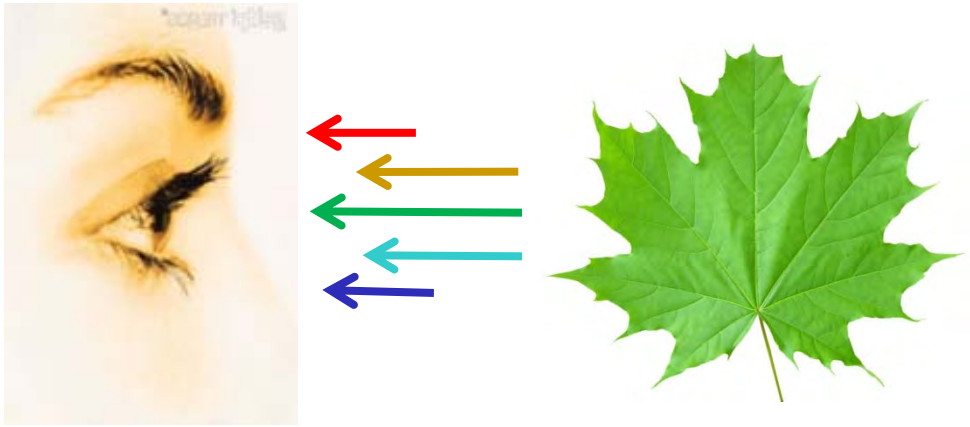
Photons of different wavelengths are like musical notes of different pitch.





Spectrum

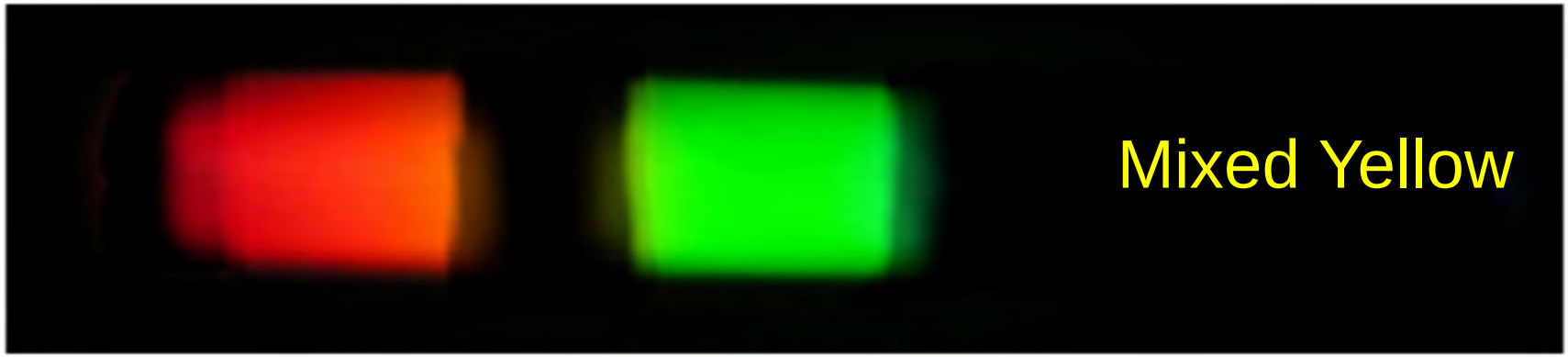




There are many different wavelength photons in a spectrum and the color you see depends on the composition of this mixture.

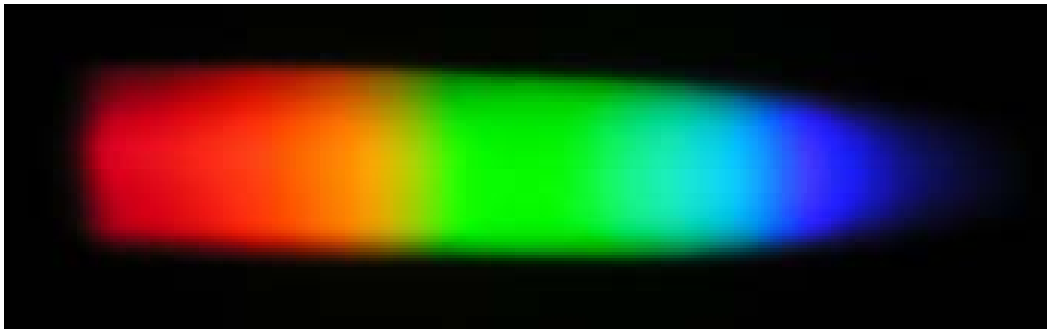
Metamerism & Spectra

These two spectra are very different yet you may see them as *exactly* the same shade of yellow.



Non-Spectral Colors

Some colors, such as magenta and white, have no matching photons in the visible spectrum.

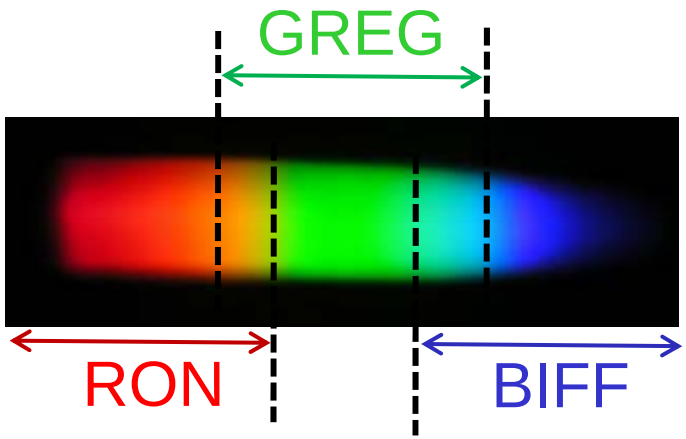


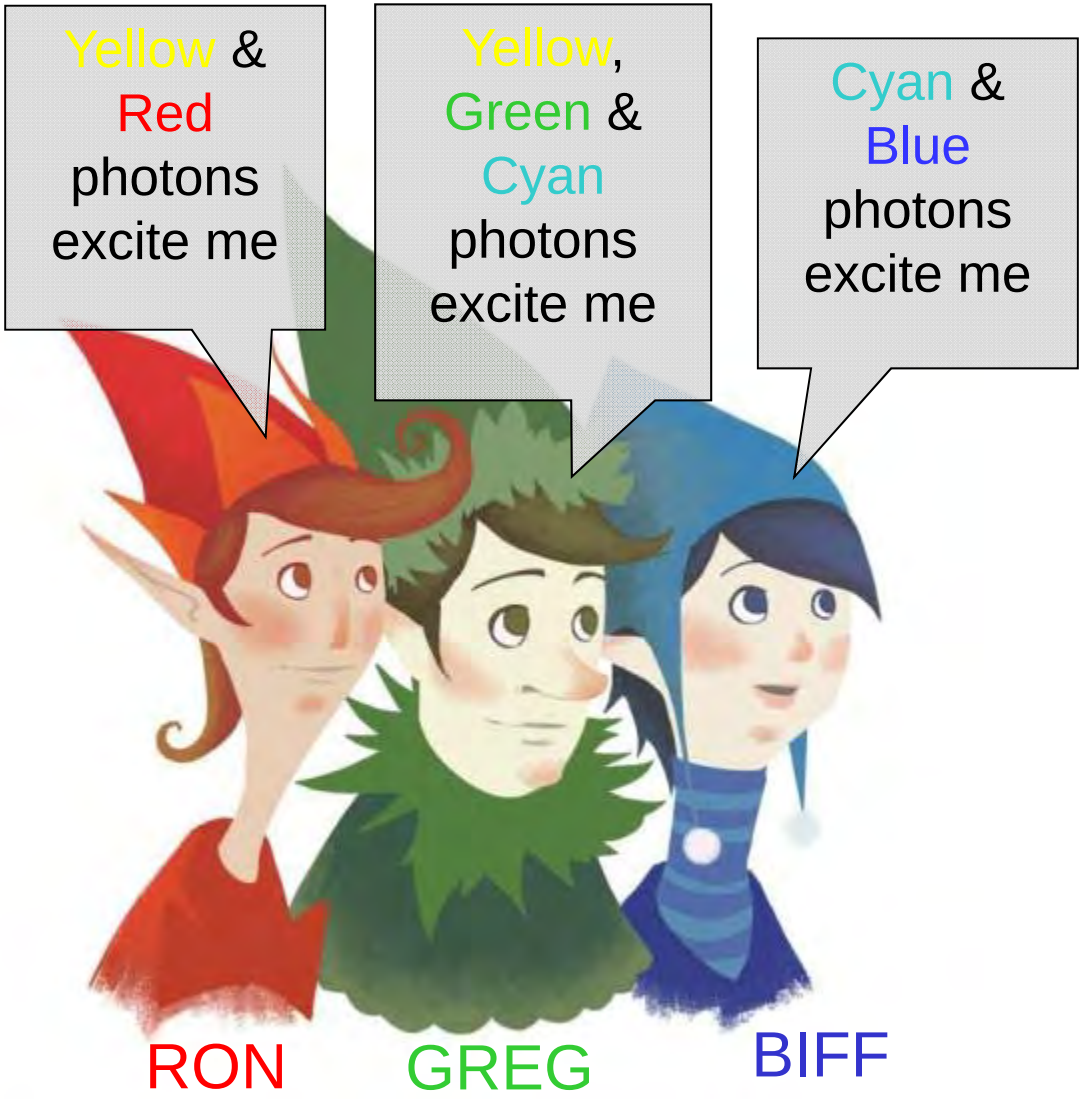
Magenta ?

White ?

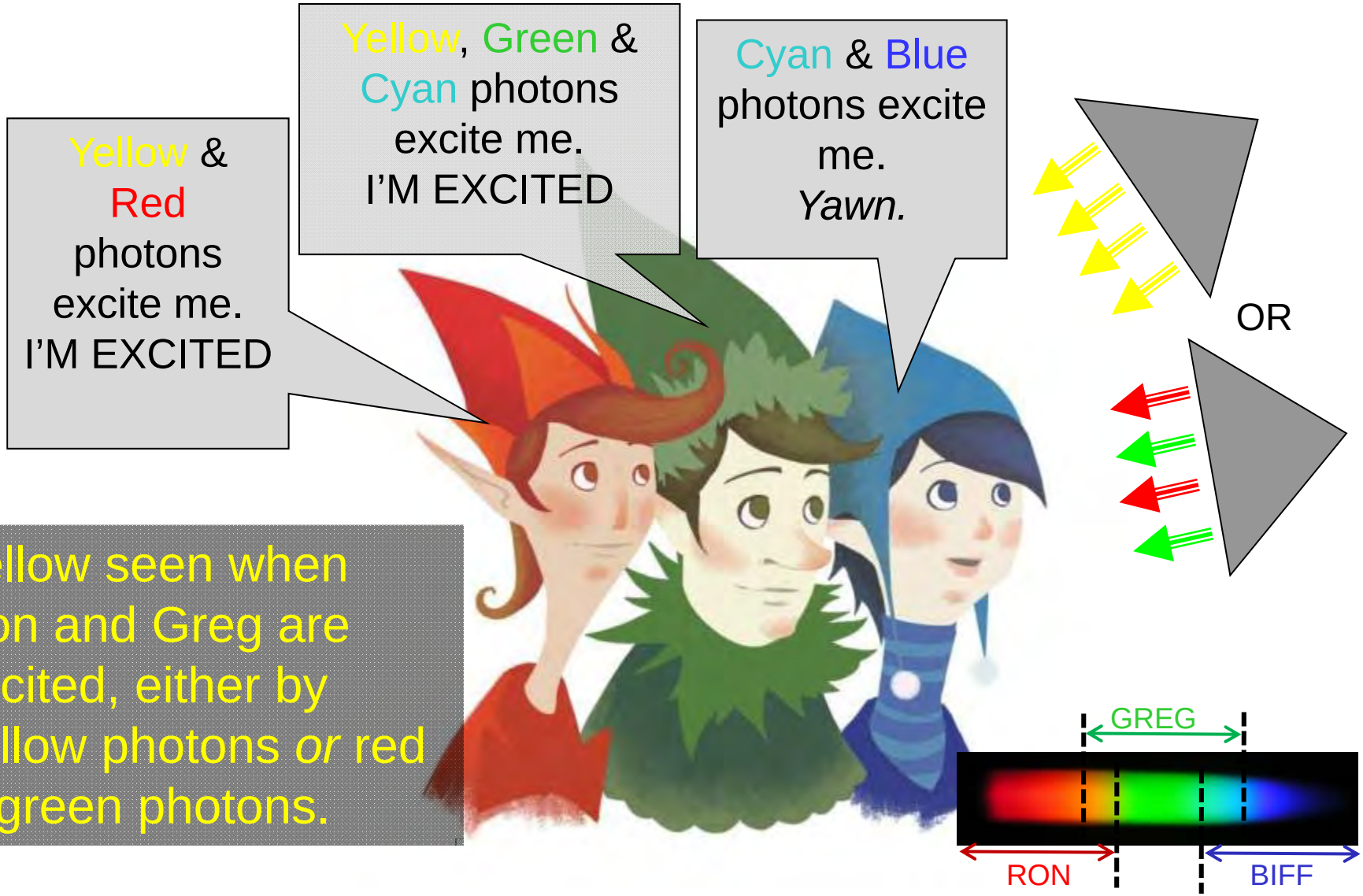
Simple Trichromatic Theory

Imagine that inside your eye are these three guys, who send messages to your brain.





Trichromatic: Seeing Yellow



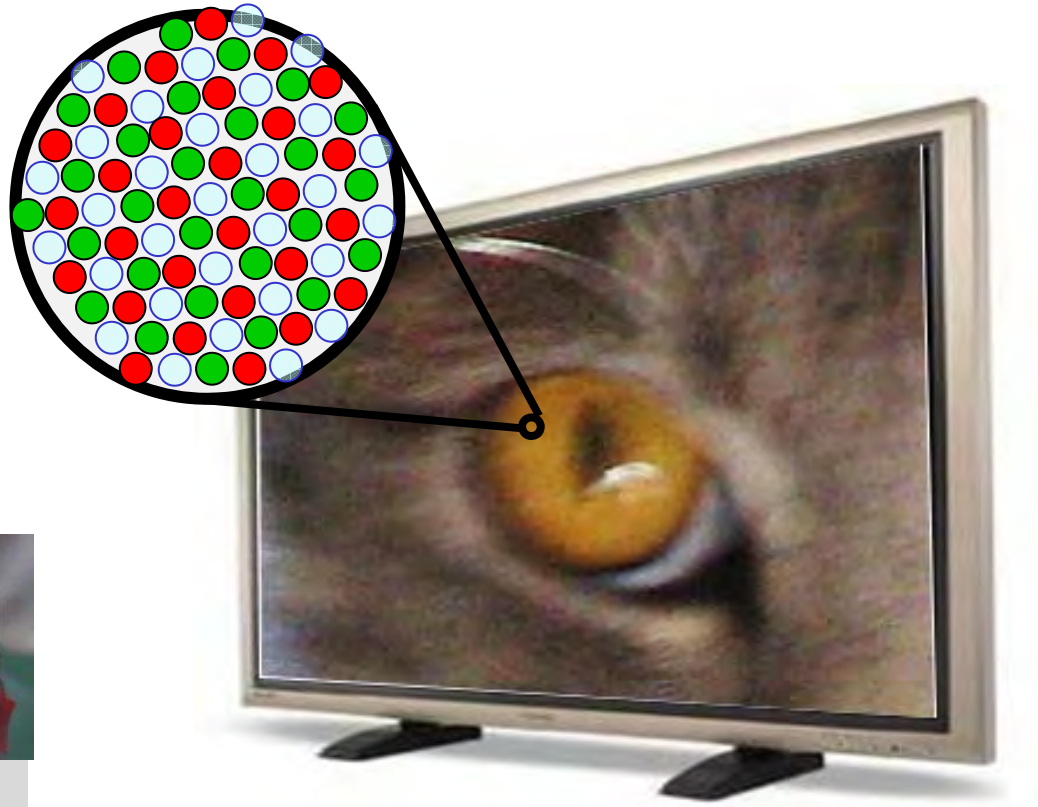
Yellow seen when Ron and Greg are excited, either by yellow photons *or* red & green photons.

“True” Yellow & Mixed Yellow

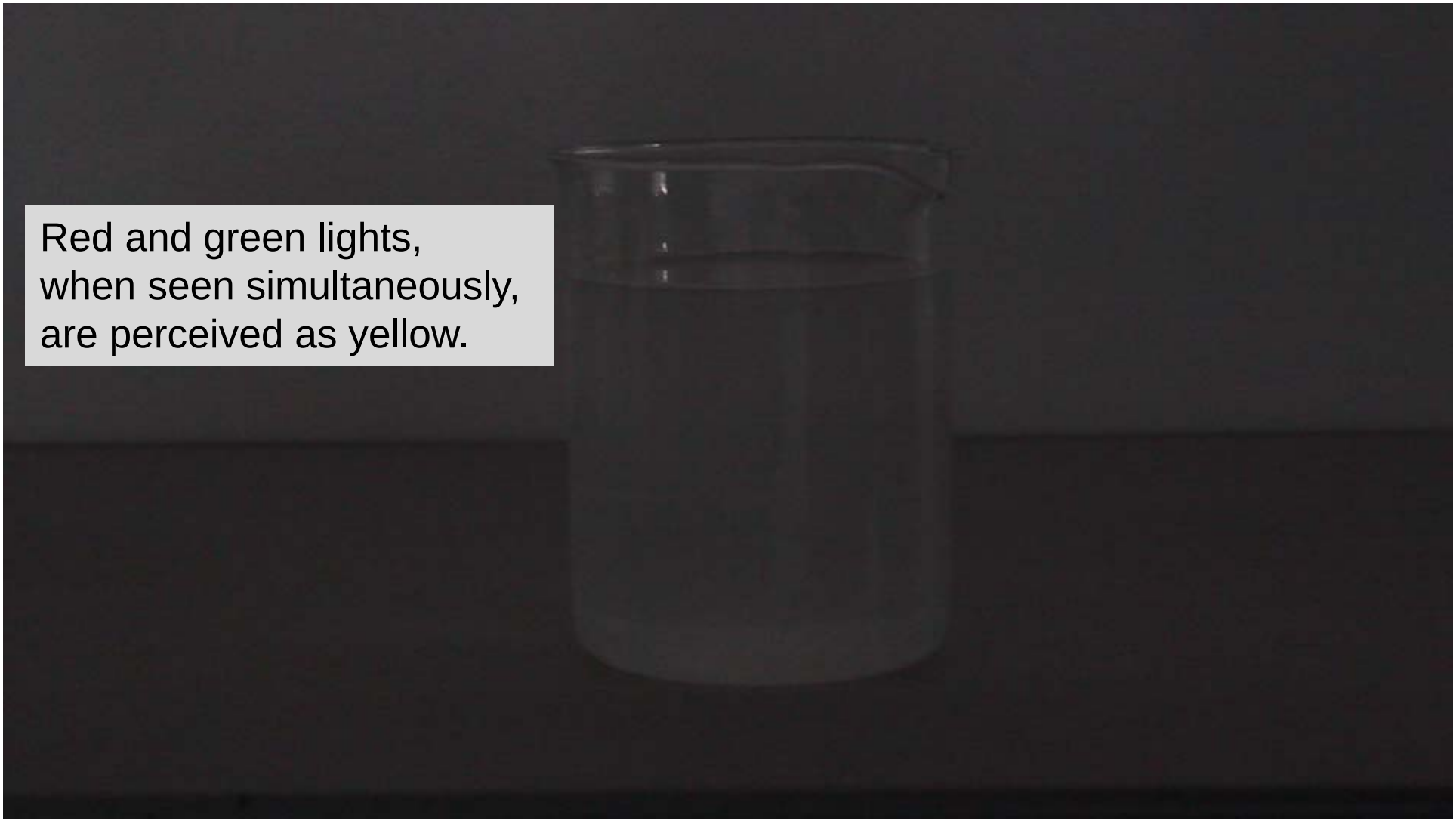
Sodium lamps emit near pure yellow photons

“Electric pickle” is a sodium light

Color monitor produces yellow by turning on the red and green pixels.

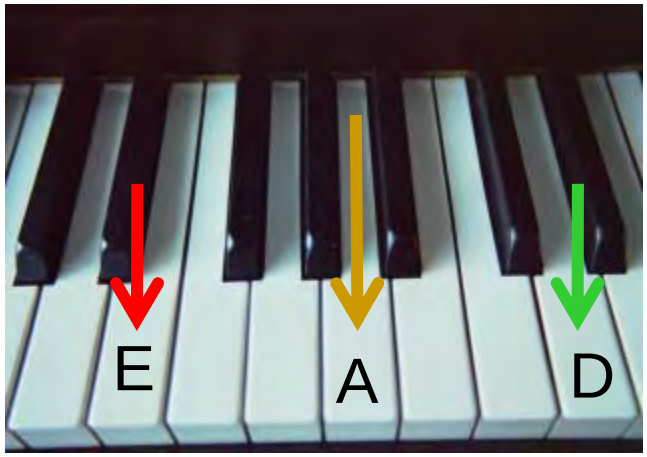


Red & Green Lights

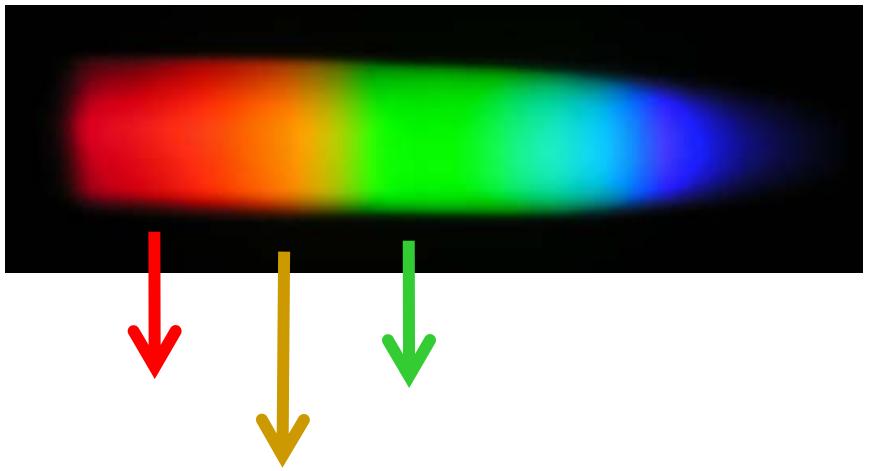


The Ear vs. The Eye

How the ear senses sound waves is distinct from how the eye senses light waves.

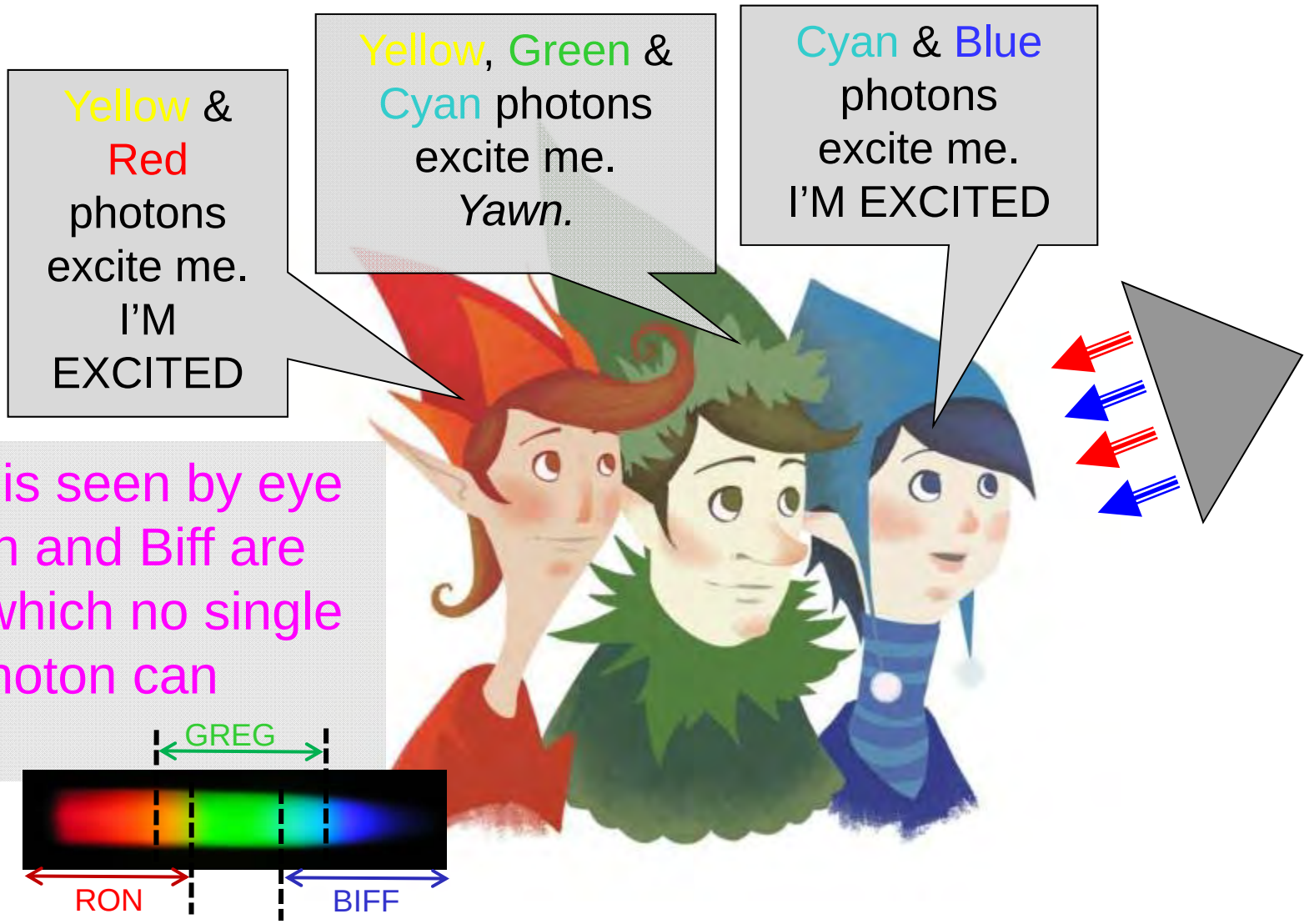


Hearing an E and a D together does not sound like an A.



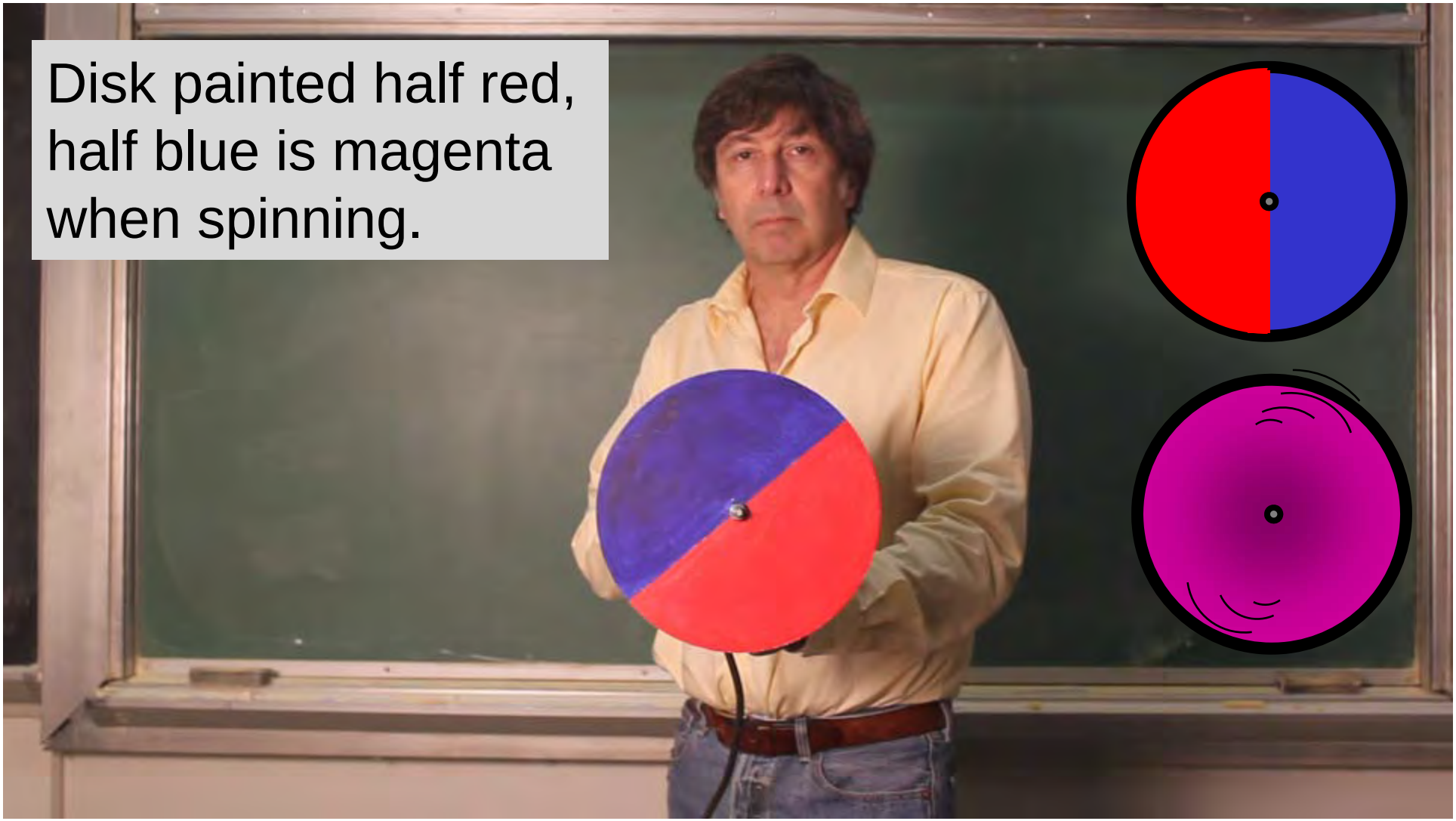
Seeing green and red together does look like yellow light.

Trichromatic: Seeing Magenta



Magenta is seen by eye when Ron and Biff are excited, which no single type of photon can achieve.

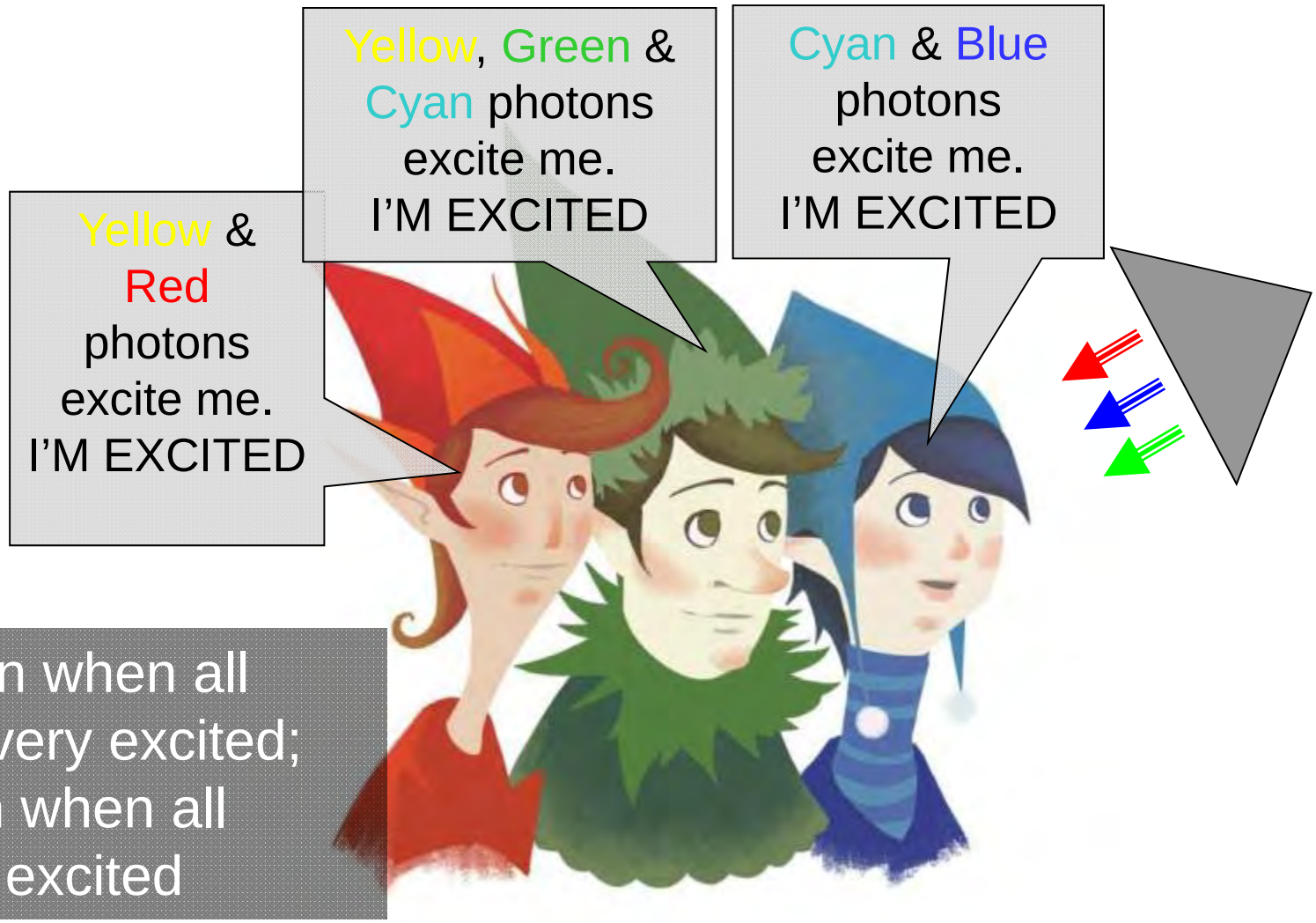
Maxwell Color Disk



Trichromatic: Two is Not Enough

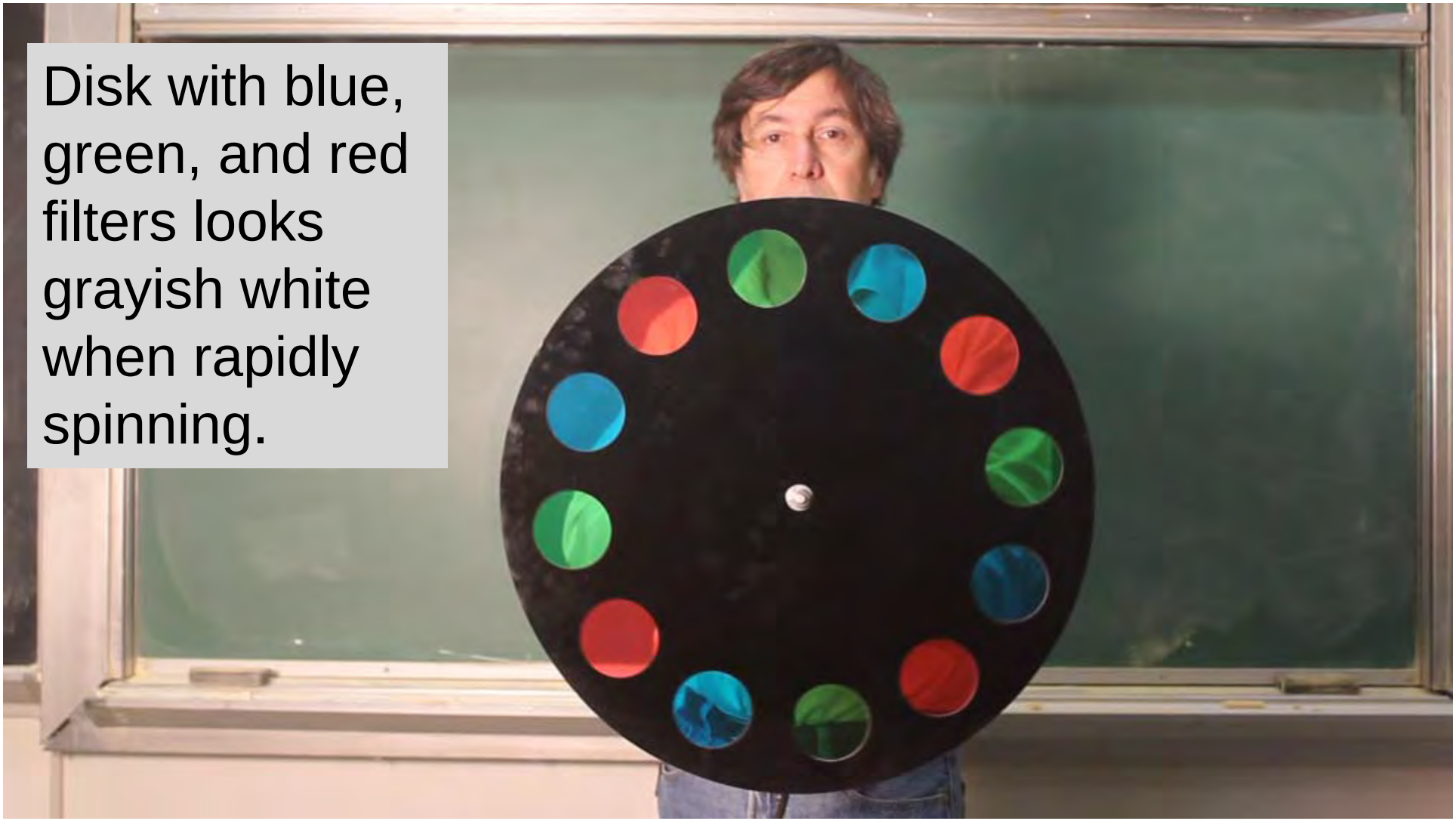
With only two receptors
Green and Magenta
appear as the same color.

Trichromatic: Seeing White



White seen when all three are very excited; Gray seen when all three less excited

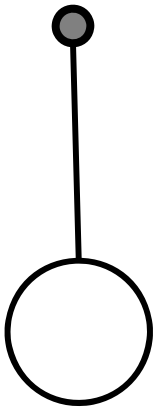
Maxwell Color Wheel - White



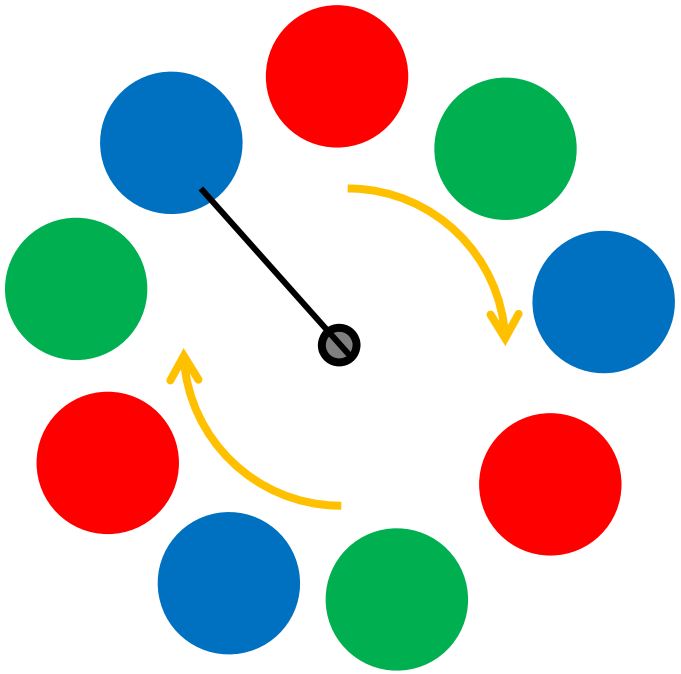
Disk with blue, green, and red filters looks grayish white when rapidly spinning.

White Mixing Ball

This color ball rapidly flashes red, green, and blue. Your eye can only see the separate colors when the ball is moving.



Not moving



Spinning

White Mixing Ball

Summary

- Visible light is composed of photons of with wavelengths between 400 to 700 nanometers.
- Trichromatic theory explains the connection between the spectrum and the color we see.
- Yellow is seen with yellow photons or a mix of red and green photons (or both).
- Magenta is seen only with a mix of red and blue photons (there are no magenta photons).
- White is seen with a mix of red, green, and blue photons.