



# Color Measurement Through Instrumentation

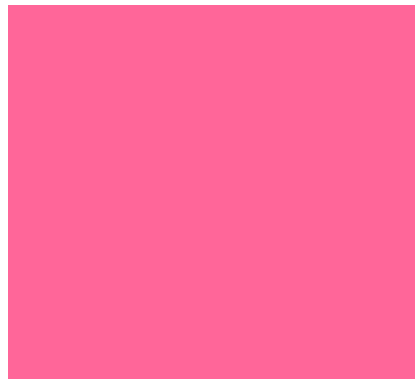
**GAA – March 20, 2009 – Bob Binder**

# What is color

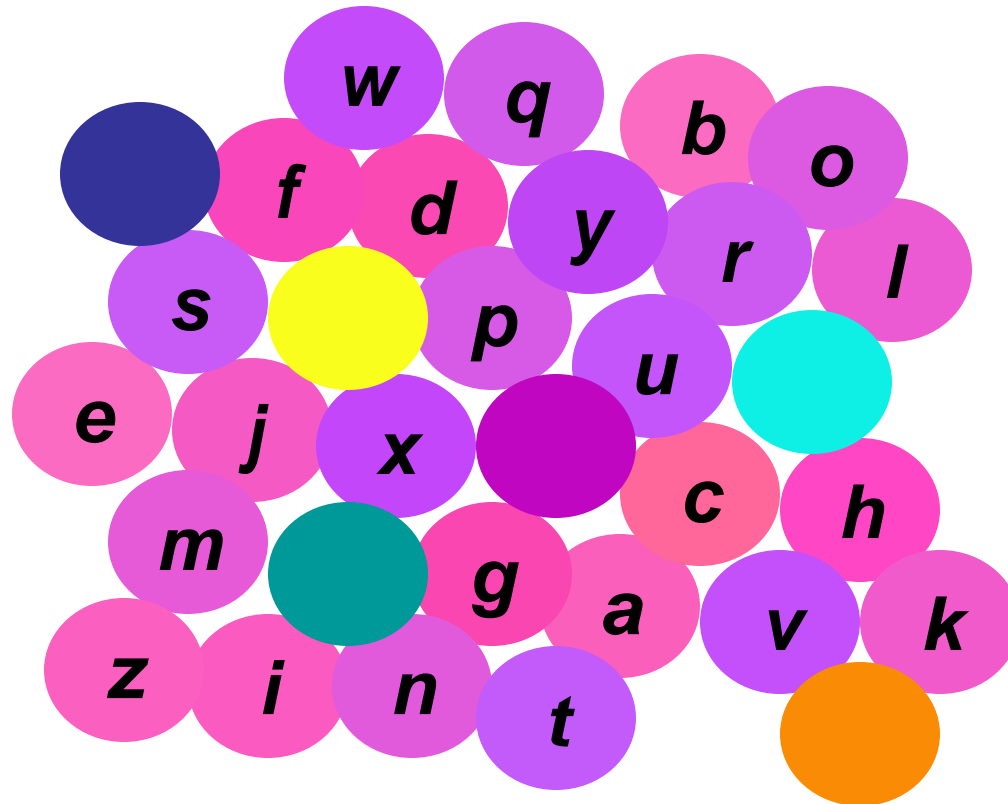
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- ▶ Color is a sensation in our minds

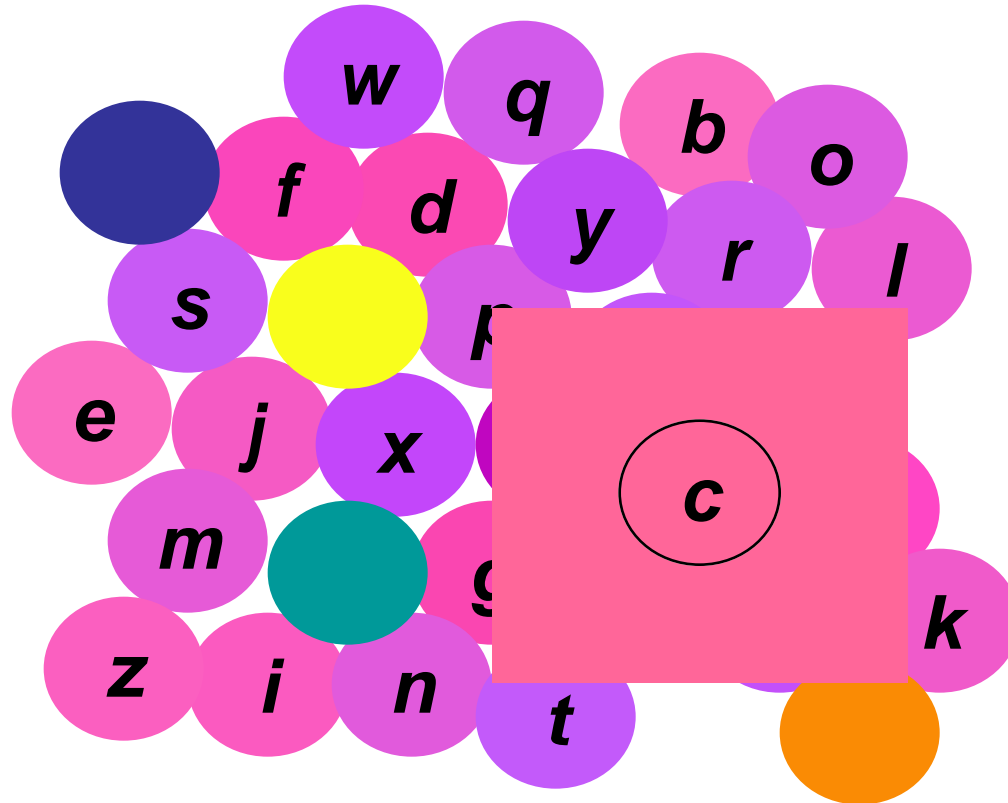
# Identify this color



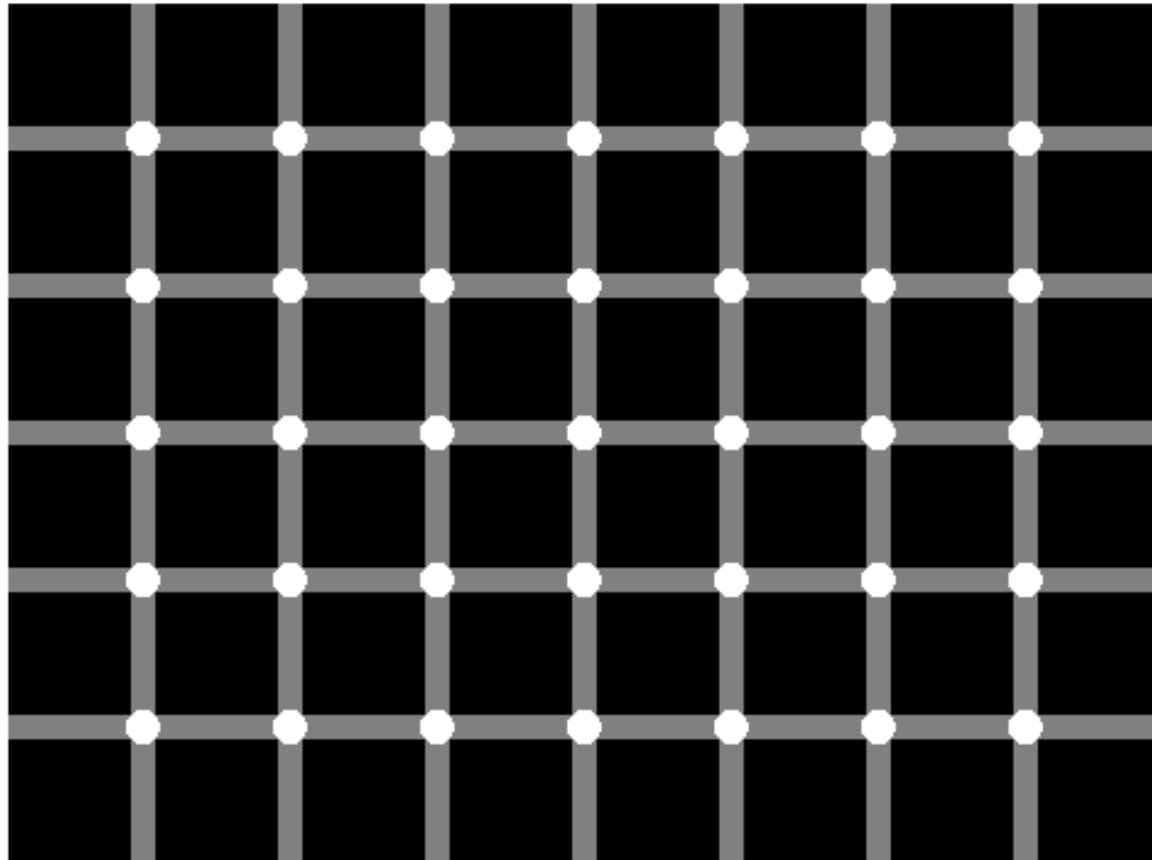
# Which color is it?

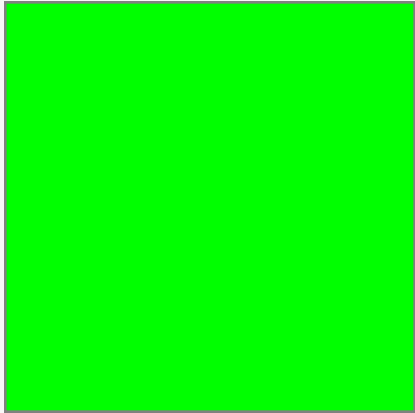


# Which color is it?

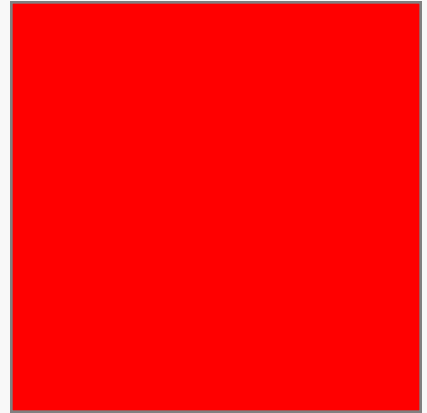


# The eye factor



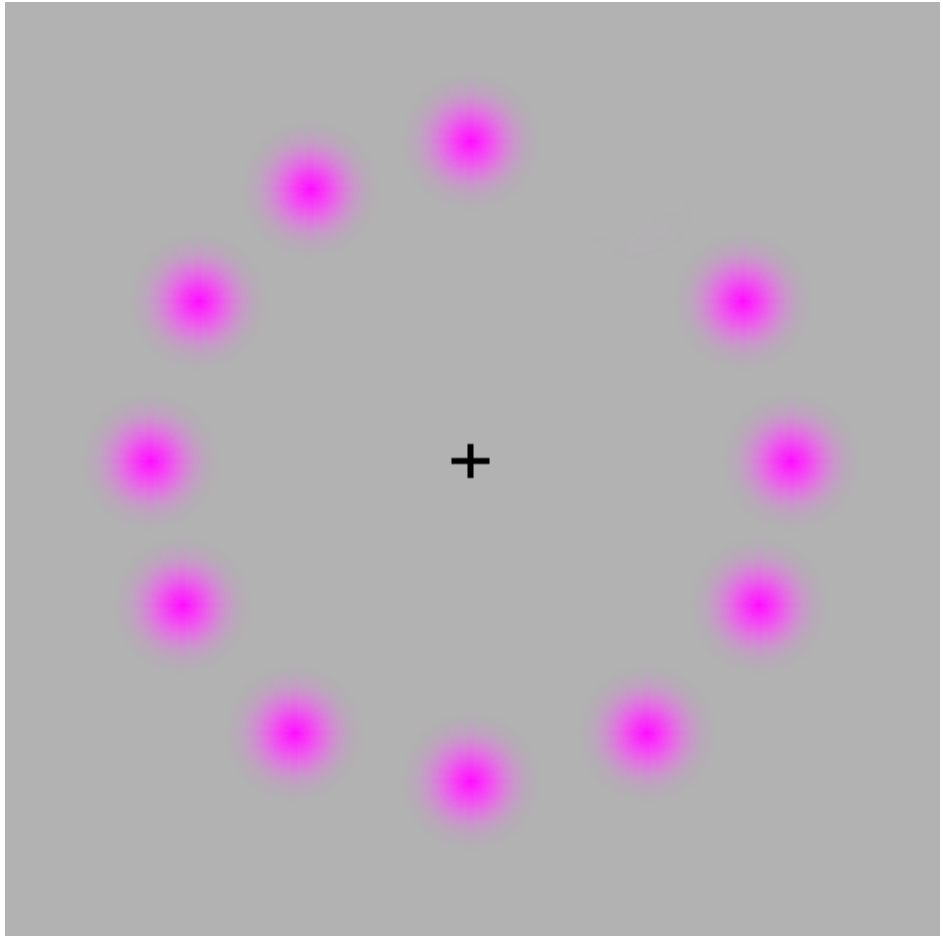


**X**



**X**

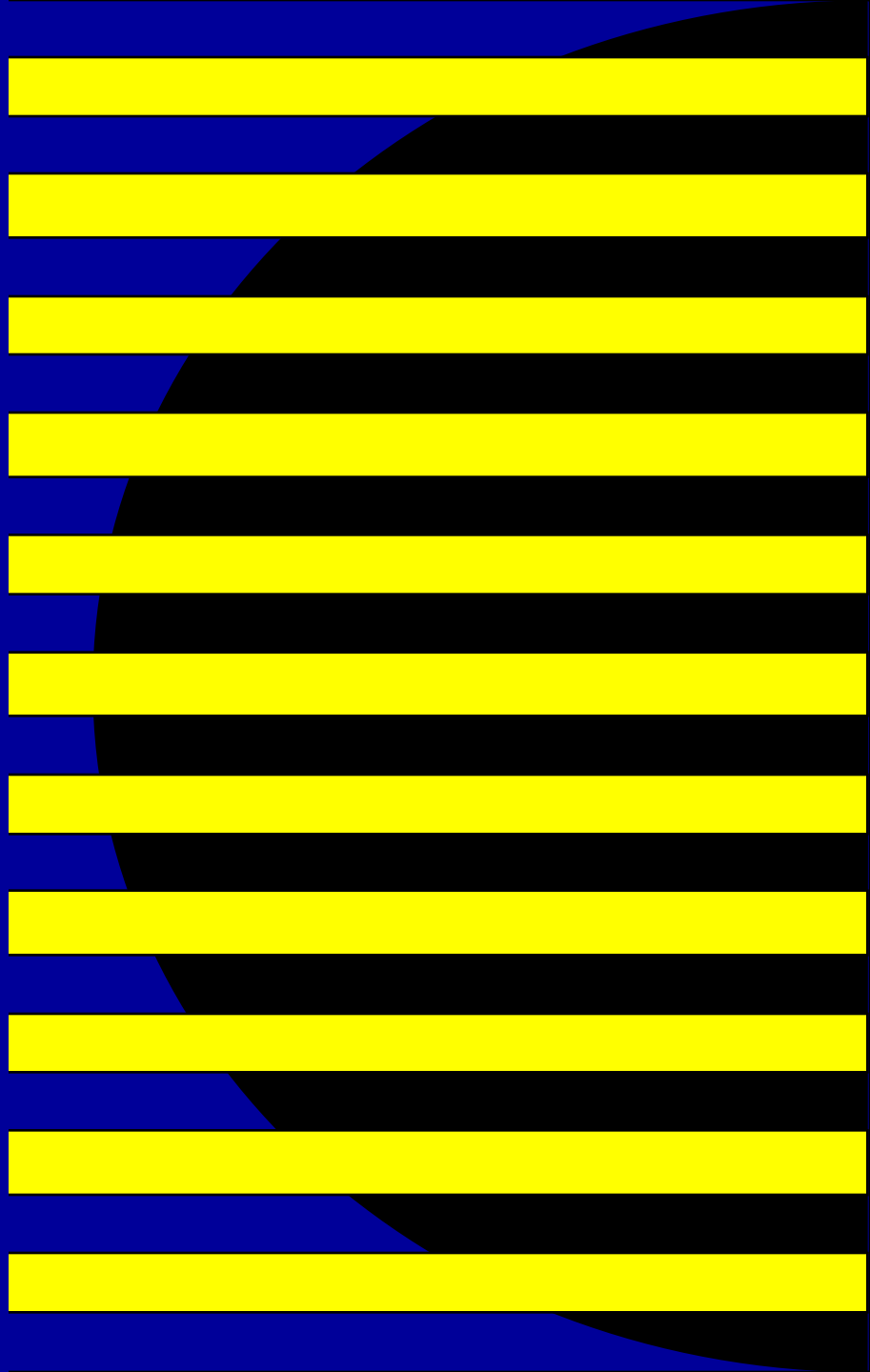
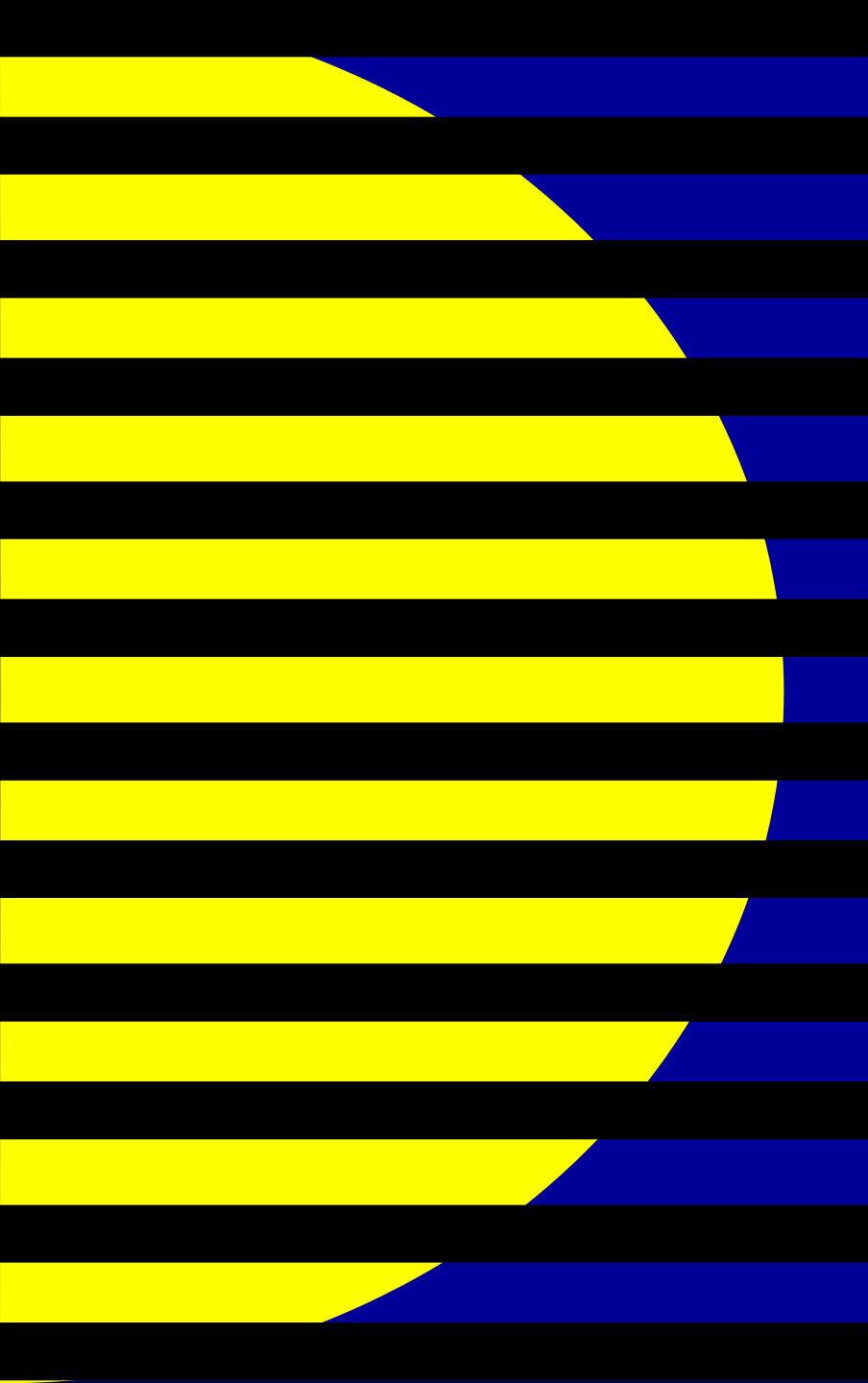




## ▶ Retinal fatigue

- Brief exposure to strong colors leaves an after image
- Considerable rest may be needed to let the eye recover





## ▶ Retinal fatigue

### Background effects

- The fovea sees the greatest detail, but is still affected by the rest of the eye
- Always be aware of your field of view





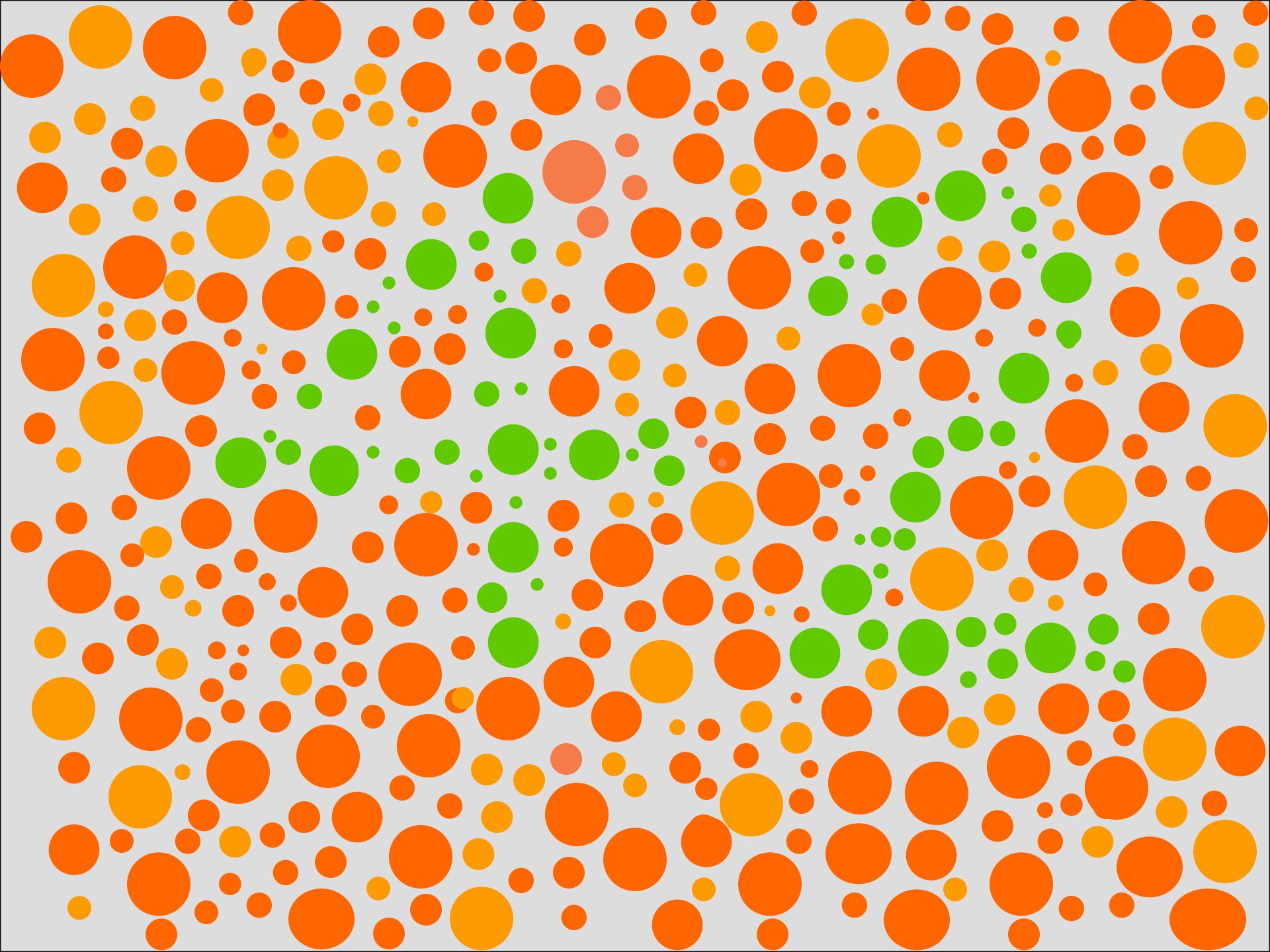
## ▶ Retinal Fatigue

Background effects

Poor Color Memory

- Two objects must be viewed simultaneously in order to fully judge their differences





- ▶ Retinal Fatigue
- Background effects
- Poor Color Memory
- Colorblindness

- 1 in every 13 males suffers from red-green colorblindness. 1 in every 300 females

# Light is color

The image displays three overlapping screenshots of the 'Lighting Tool' software interface, illustrating different lighting and color analysis scenarios.

**Top Window:** Shows a 3D scene with a blue and green surface. The interface includes a menu bar (File, Edit, Device, Help), a 3D view area, and control panels for illuminant (D75) and viewing angle (10 Degree).

**Middle Window:** Shows a 2D color comparison with a pink and orange surface. The interface includes a menu bar (File, Edit, Device, Help), a 2D view area, and control panels for illuminant (D75) and viewing angle (10 Degree). Below the view area is a table with columns 'Sample' and 'Illuminant':

Sample	Illuminant
[Green]	A
[Green]	A
[Blue]	C
[Blue]	C
[Blue]	D50
[Blue]	D50
[Blue]	D55
[Blue]	D55
[Blue]	D65
[Blue]	D65
[Blue]	D75
[Blue]	D75

**Bottom Window:** Shows a 2D color comparison with a light green and yellow surface. The interface includes a menu bar (File, Edit, Device, Help), a 2D view area, and control panels for illuminant (D75) and viewing angle (10 Degree). Below the view area is a table with columns 'Sample', 'Illuminant', and 'Observer':

Sample	Illuminant	Observer
[Yellow]	A	2 Degrees
[Yellow]	A	10 Degrees
[Light Green]	C	2 Degrees
[Light Green]	C	10 Degrees
[Light Green]	D50	2 Degrees
[Light Green]	D50	10 Degrees
[Light Green]	D55	2 Degrees
[Light Green]	D55	10 Degrees
[Light Green]	D65	2 Degrees
[Light Green]	D65	10 Degrees
[Light Green]	D75	2 Degrees
[Light Green]	D75	10 Degrees

- ▶ Retinal Fatigue
- Background effects
- Poor Color Memory
- Colorblindness

## Lighting conditions

- Failure to adopt standardized viewing conditions often results in poor color decisions

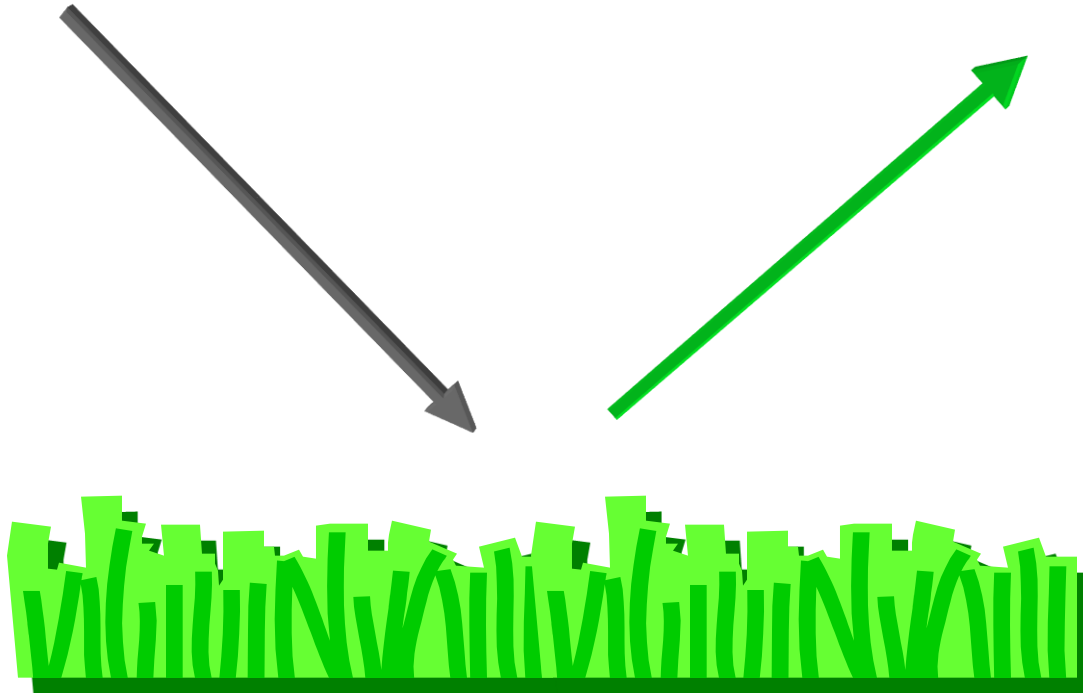
- ▶ Retinal Fatigue
- Background effects
- Poor Color Memory
- Colorblindness
- Lighting conditions

## Age

- As we age our color perceptions change. The corneal lens yellows and becomes less flexible

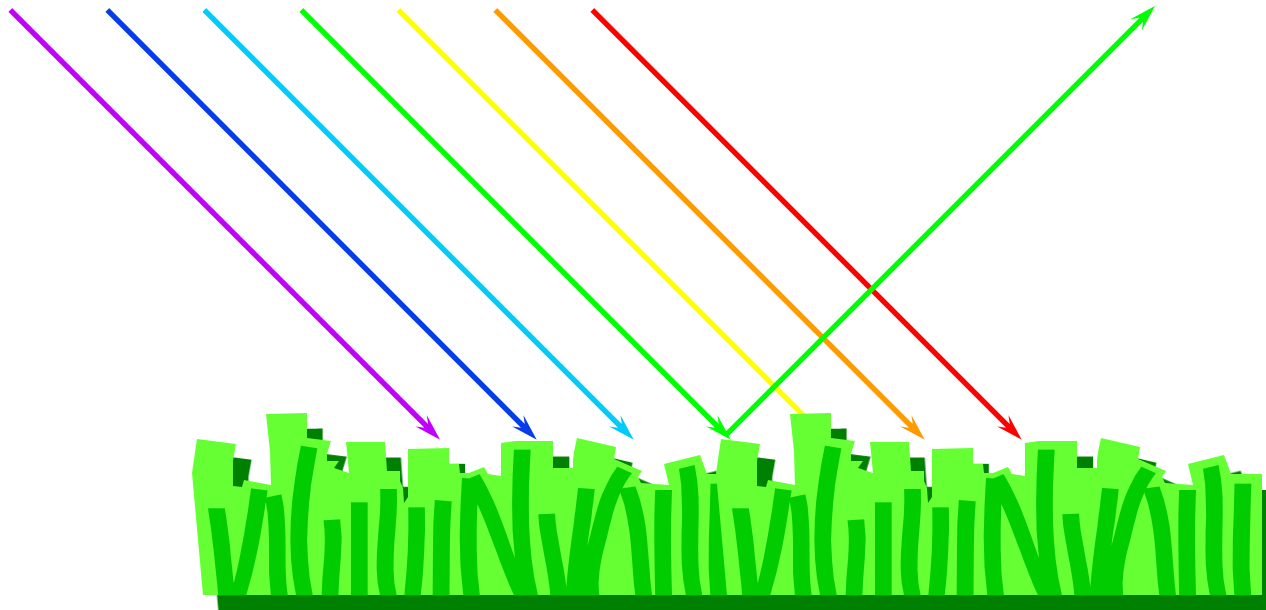
# What is color?

▶ Is the grass green?

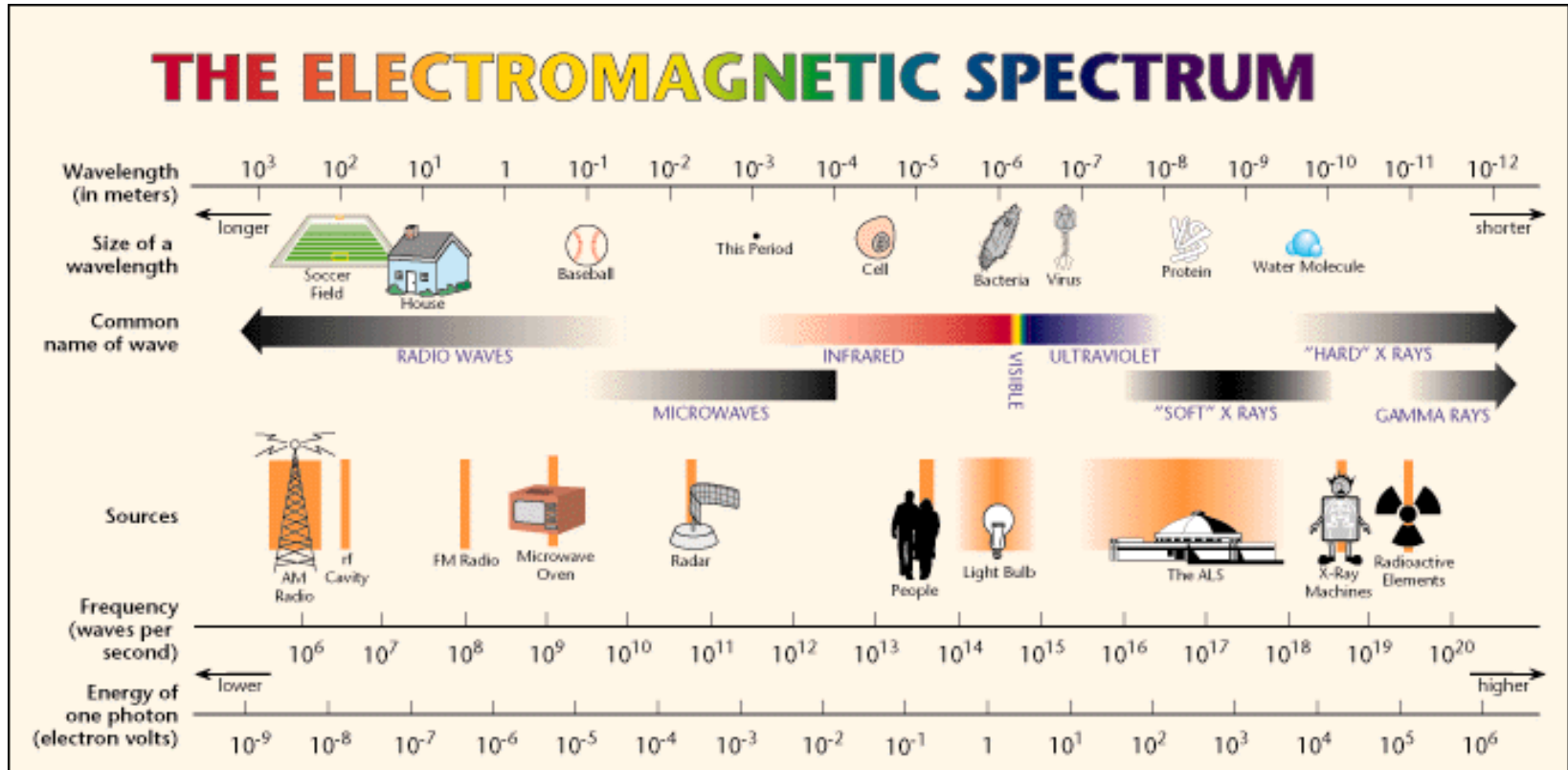


# Green looks green because . . .

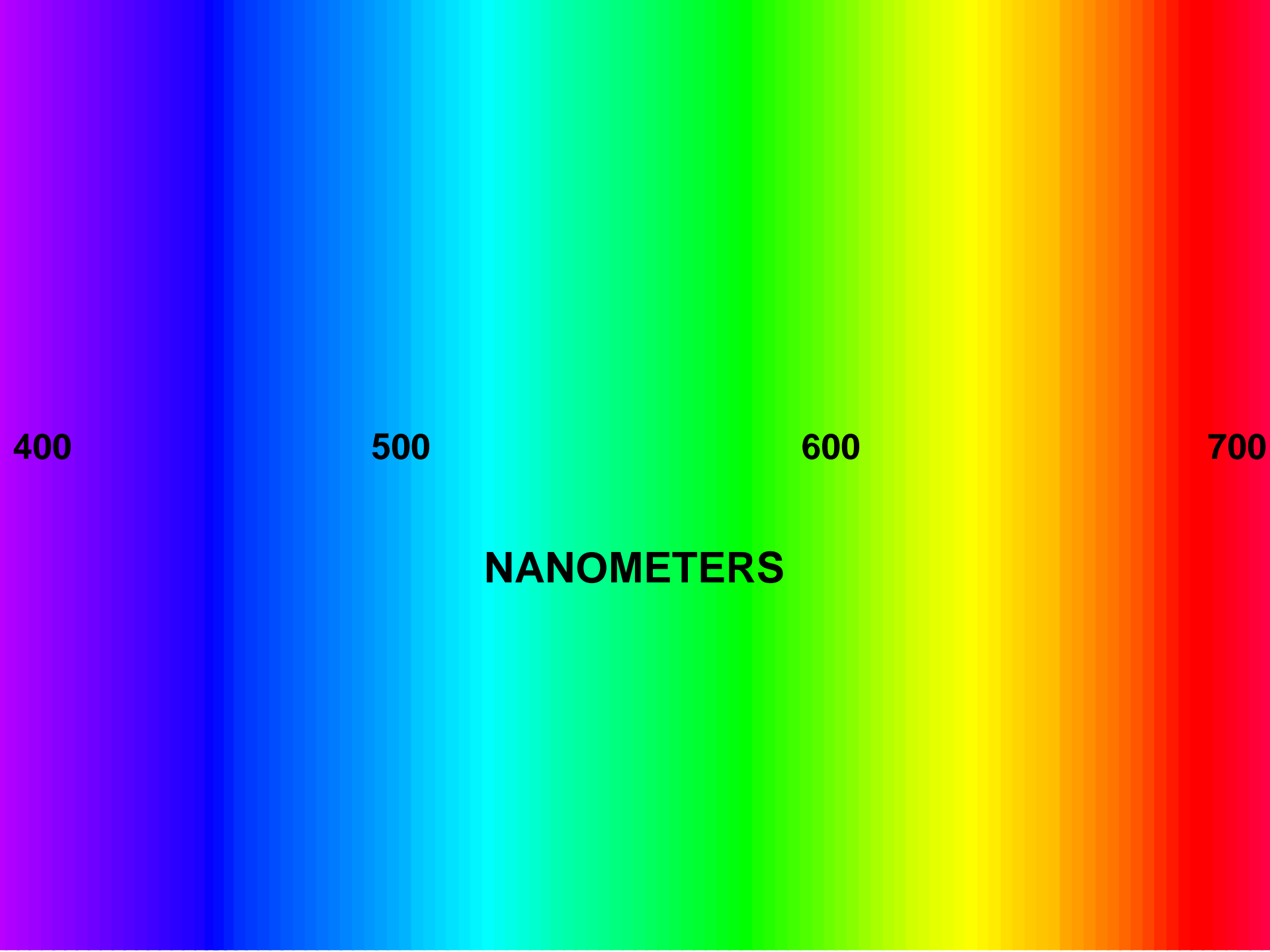
▶ Is the grass green?



# The electromagnetic spectrum







400

500

600

700

**NANOMETERS**

# Color control - density

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## ▶ Ink (pigment) amount

- Density

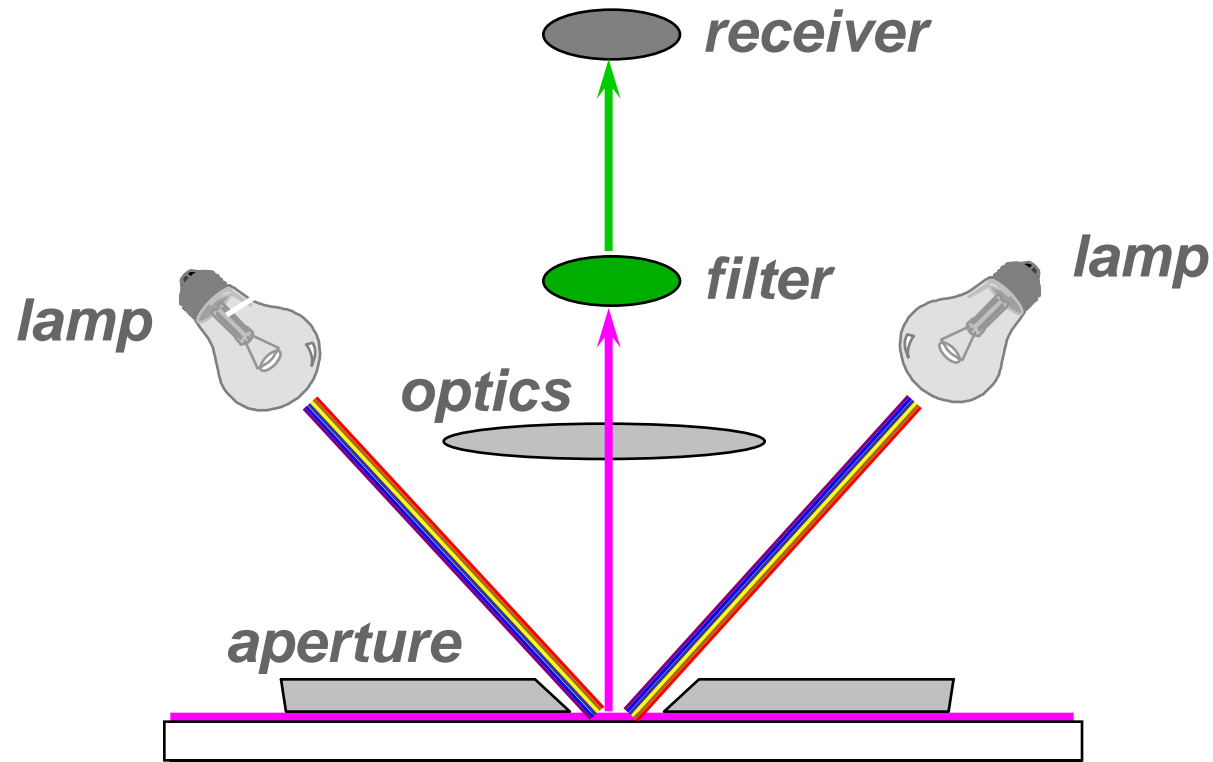
## Printability

- Dot area
- Trap
- Print contrast
- Hue error / grayness

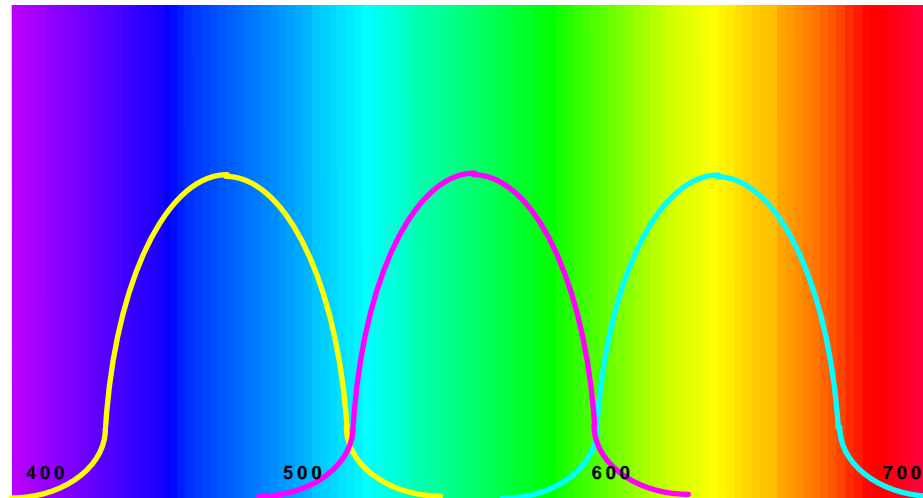
## Process control

# Densitometer

- ▶ Uses one filters at a time



- ▶ How it views the spectrum
  - Status defines the view
    - Status T the ANSI standard
    - Status E the DIN standard

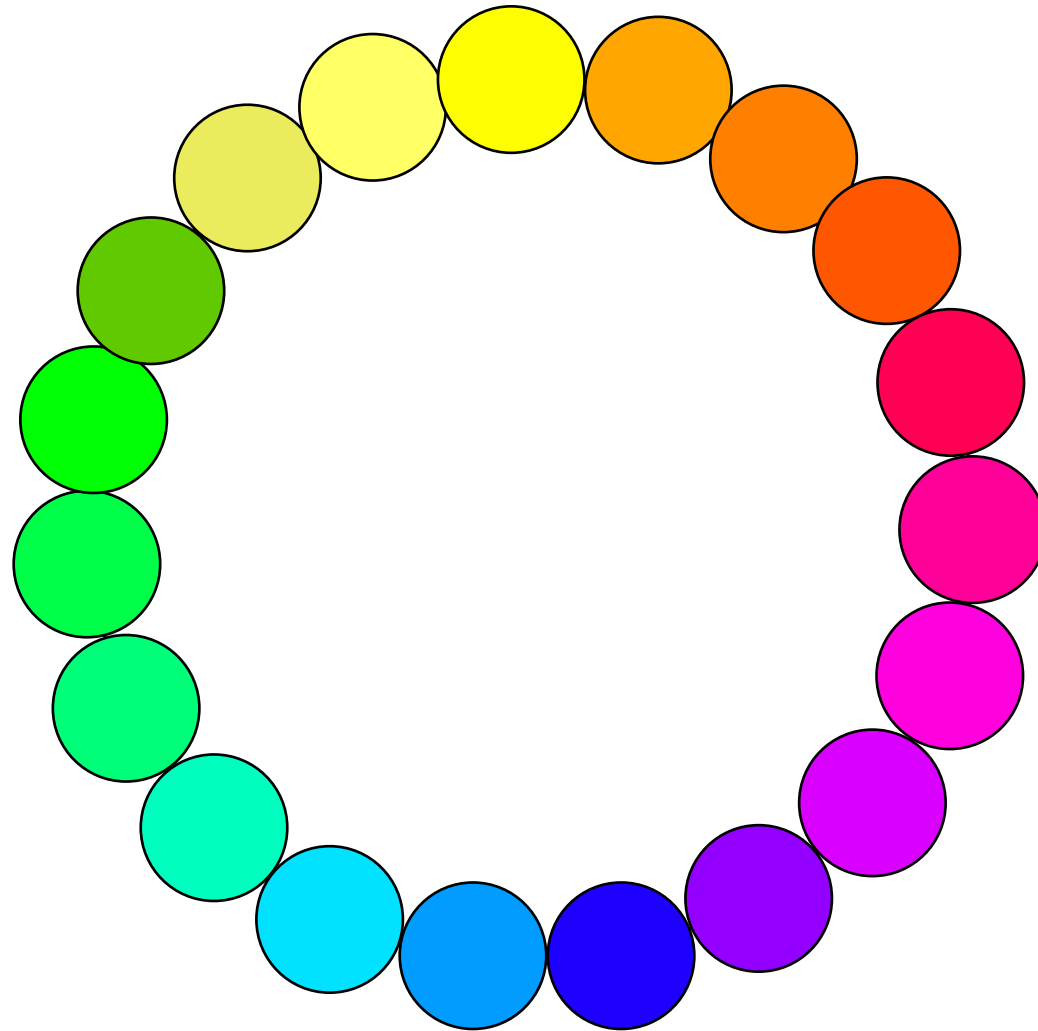


# Munsell's hue



Red, Green, Blue, Orange, etc...

# Munsell's hue circle



# Munsell's value (lightness)

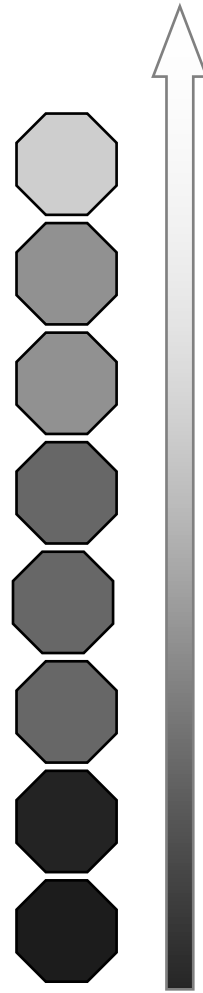
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## ▶ The lightness of a color

- Light Green, Dark Green
- Black, Gray

The quality by which we distinguish lighter shades from darker ones.

# Munsell's value (lightness)





# Munsell's chroma

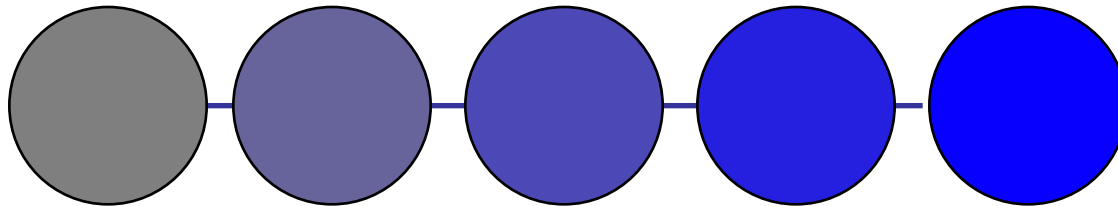
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- ▶ The strength of a color (distance from gray)
  - Candy Apple Red, Chrome Yellow

The quality by which we distinguish strong saturated colors from weak, achromatic ones.

# Munsell's chroma

- ▶ The strength of the color

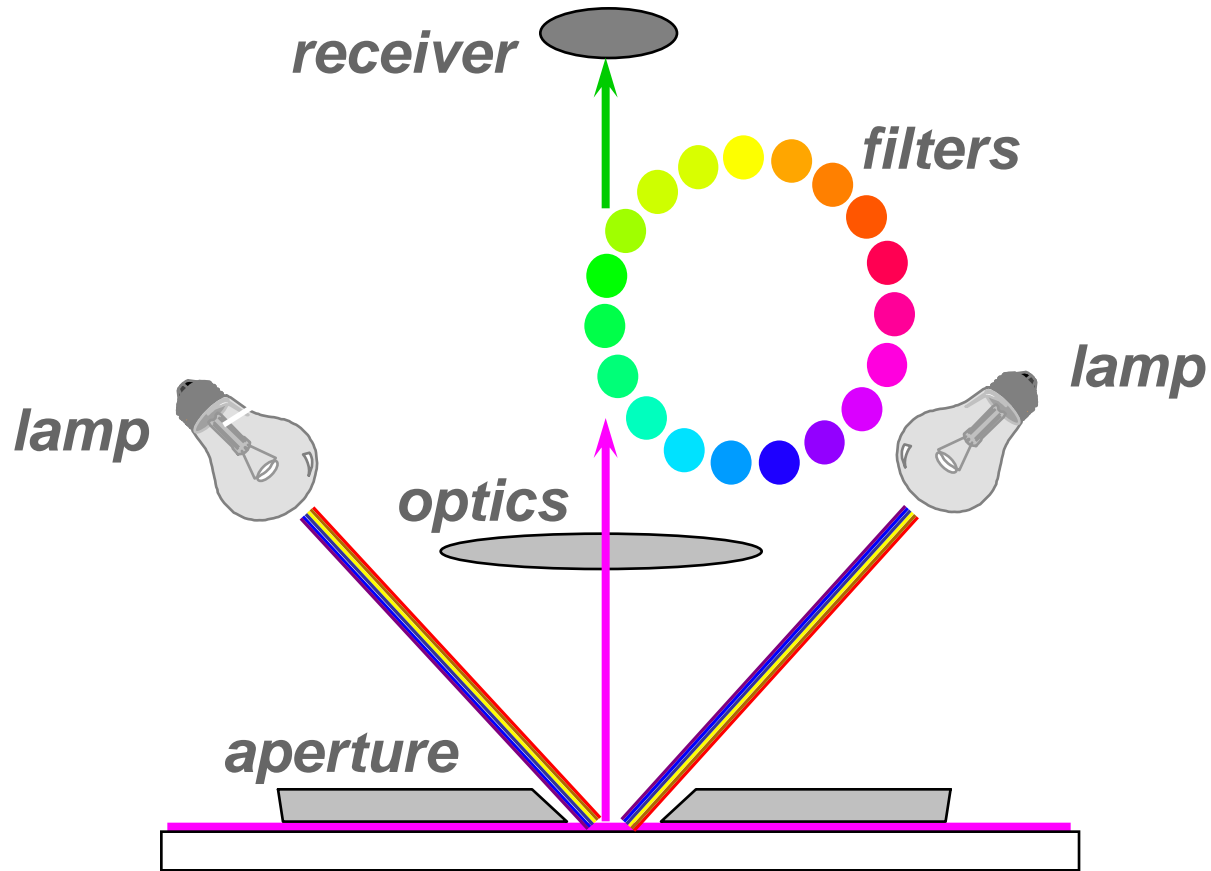


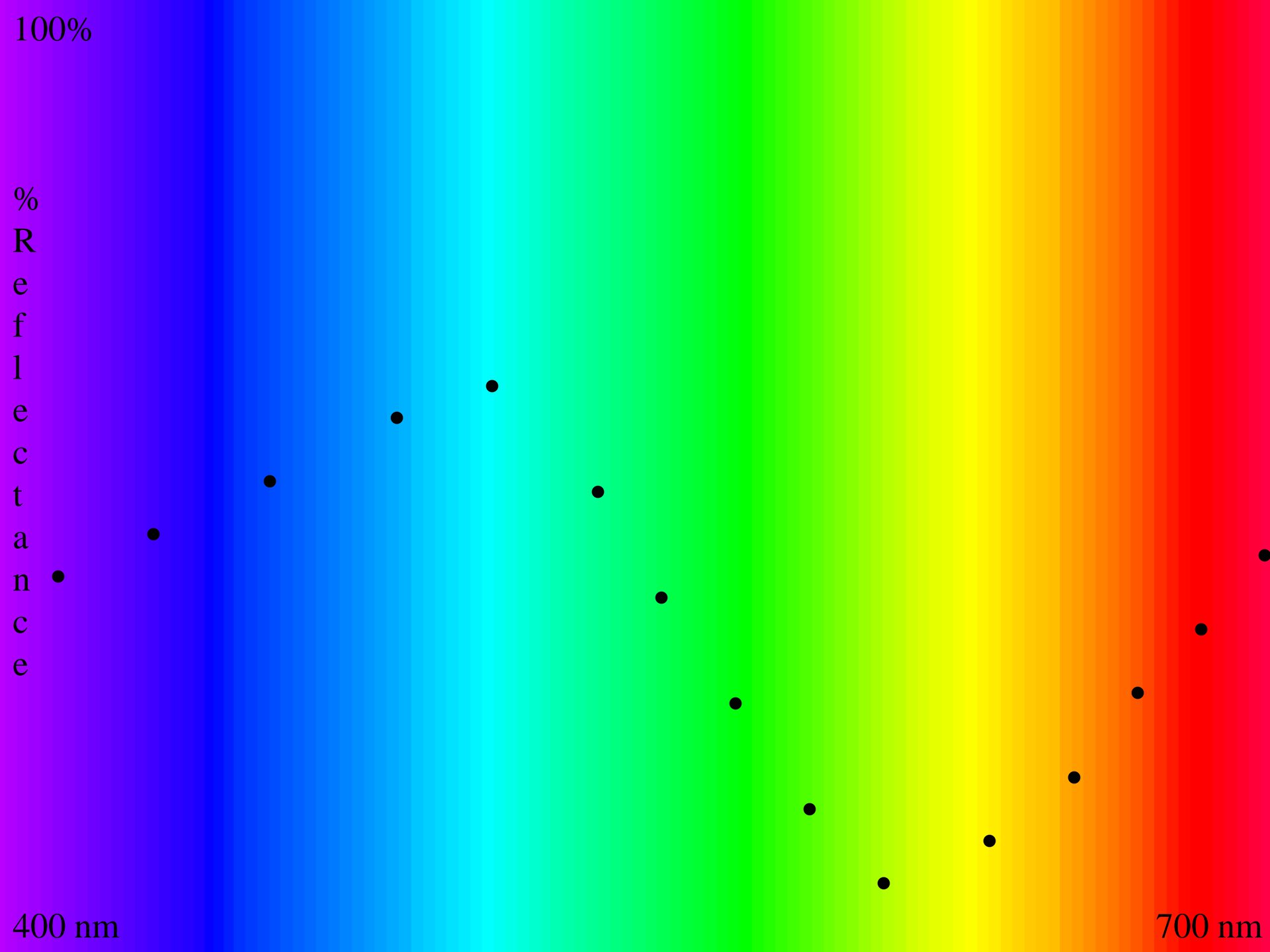
# The Munsell system

- ▶ Hue
- Value
- Chroma



# Spectrophotometer



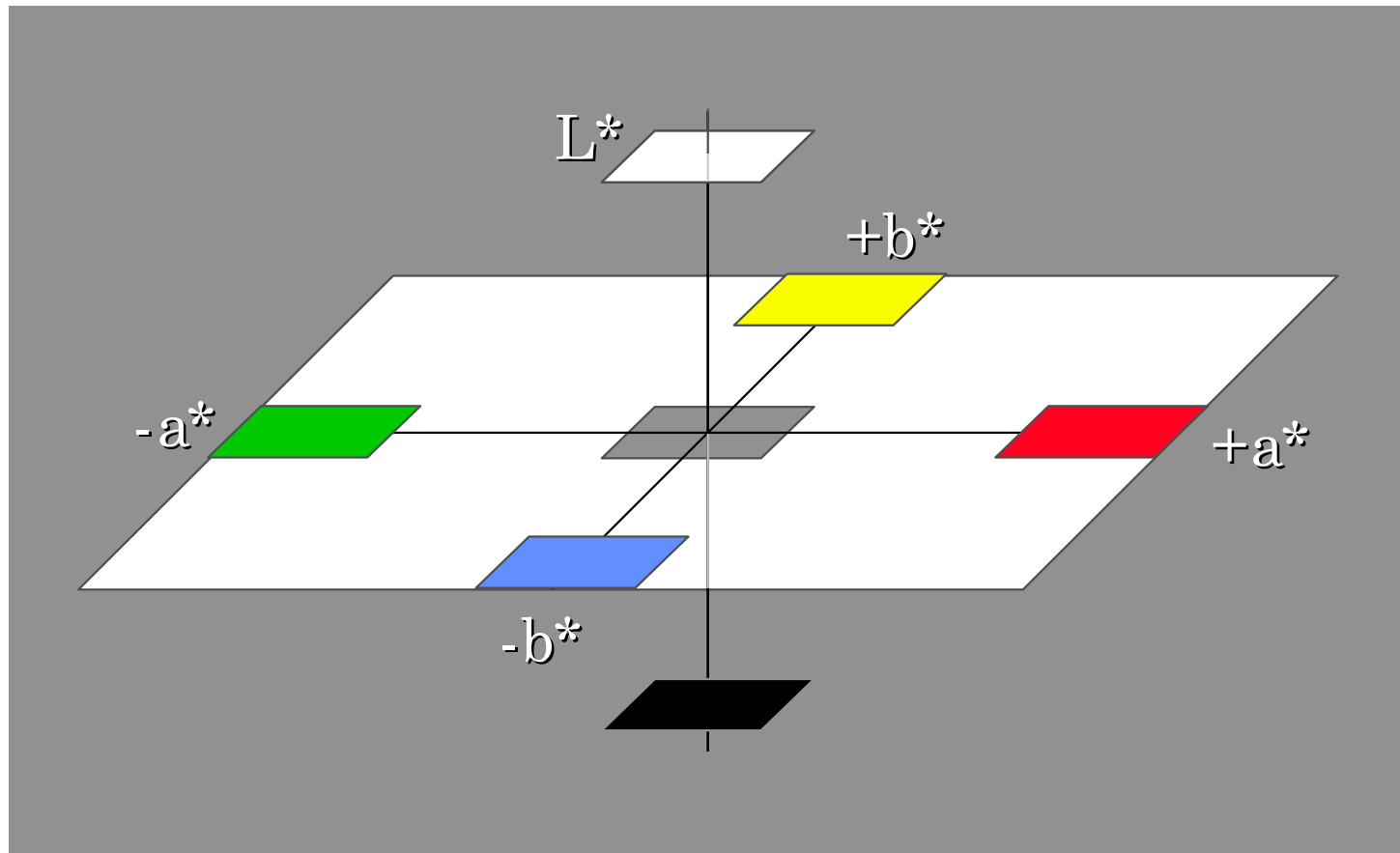


100%

%  
R  
e  
f  
l  
e  
c  
t  
a  
n  
c  
e

400 nm

700 nm



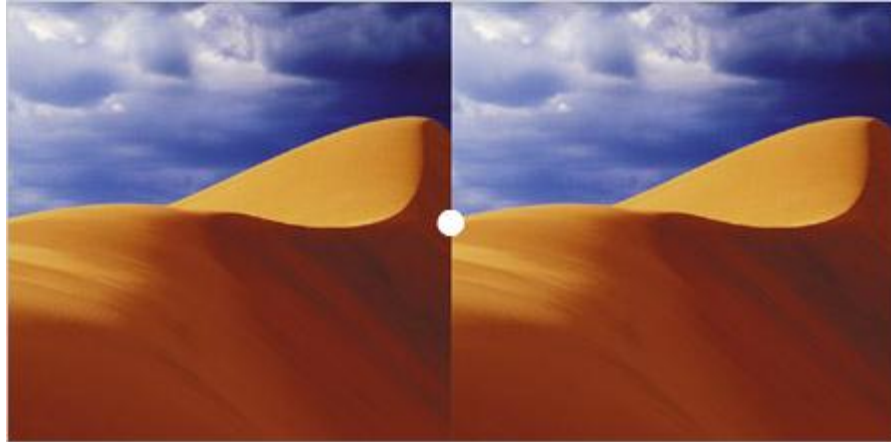
# Color control - Spectrophotometry

## ▶ Gives the “fingerprint” of the color

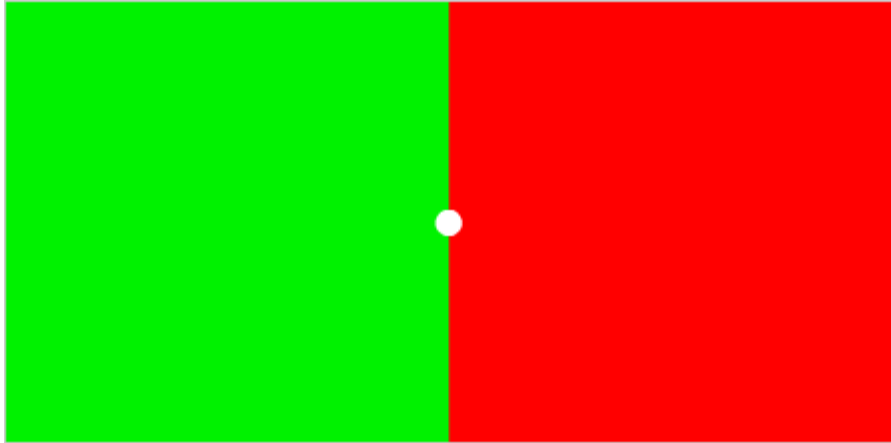
It can give all of the information of a densitometer or colorimeter and more

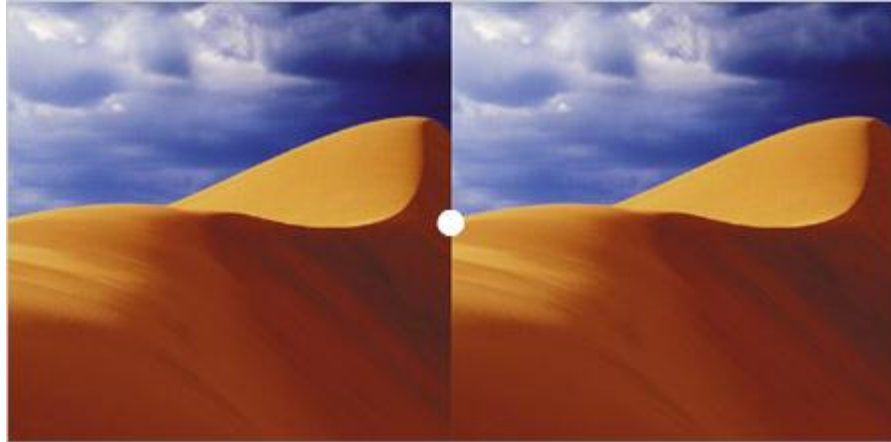
- Required for profiling applications
- Required for ink formulation
- Best QA tool

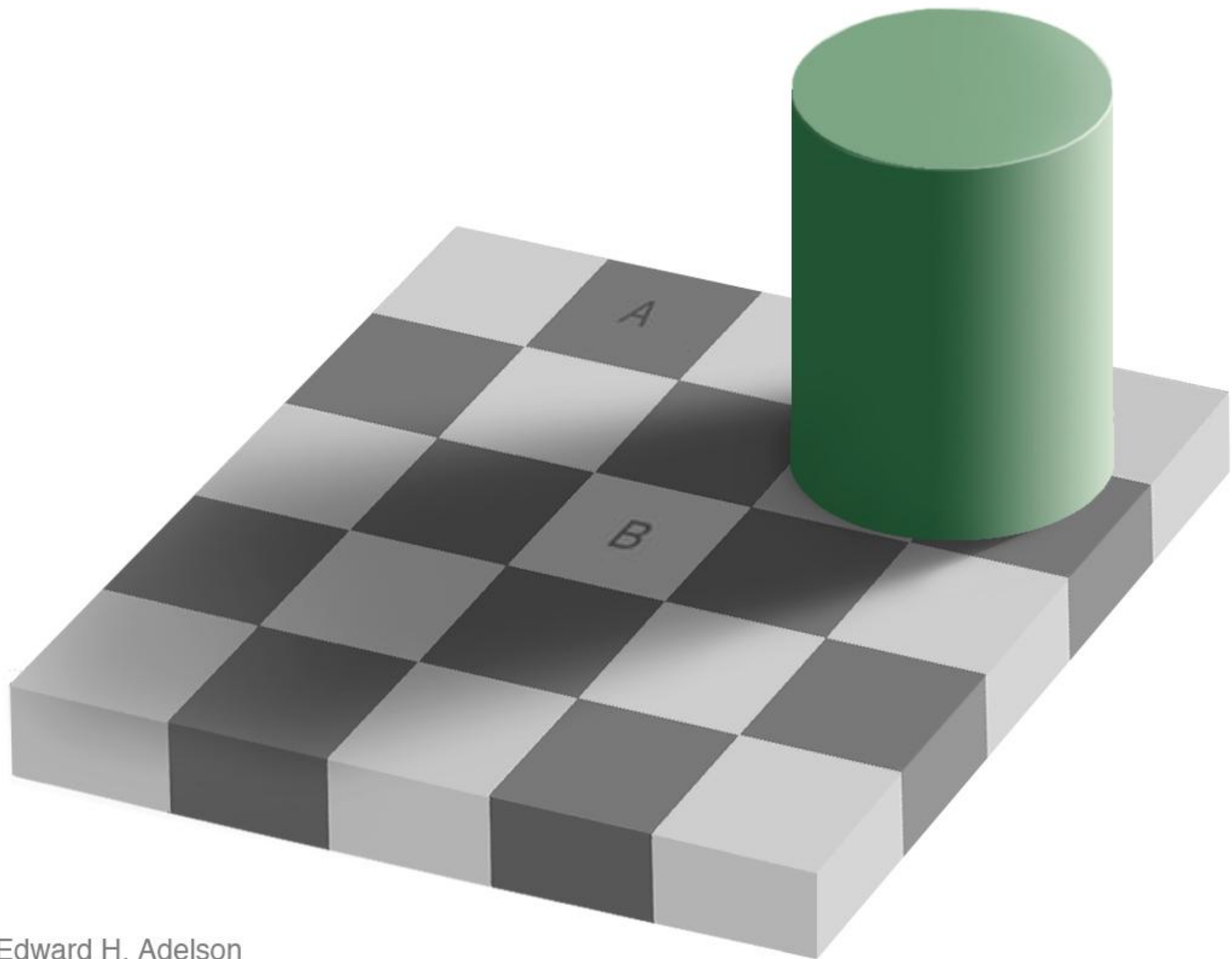




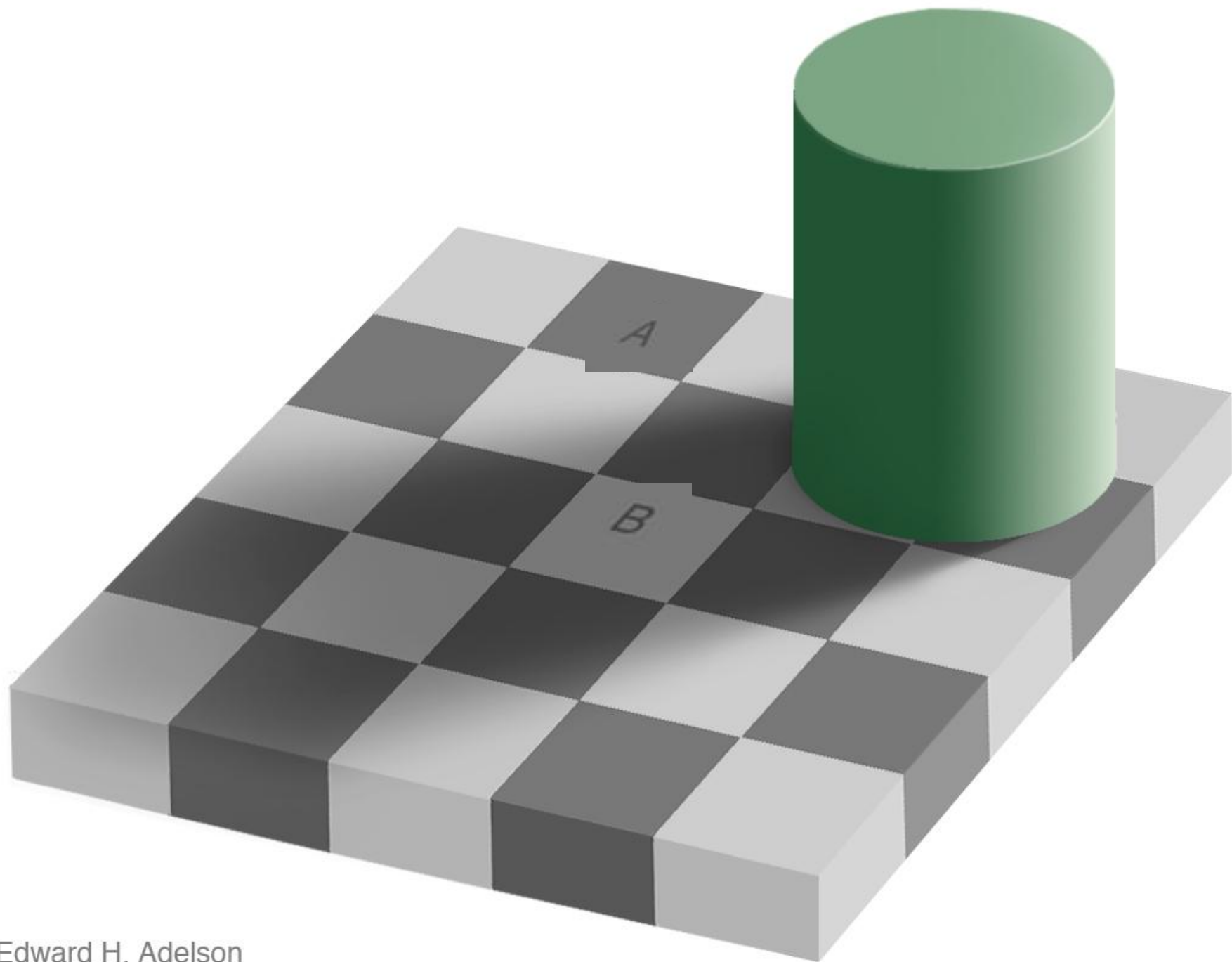




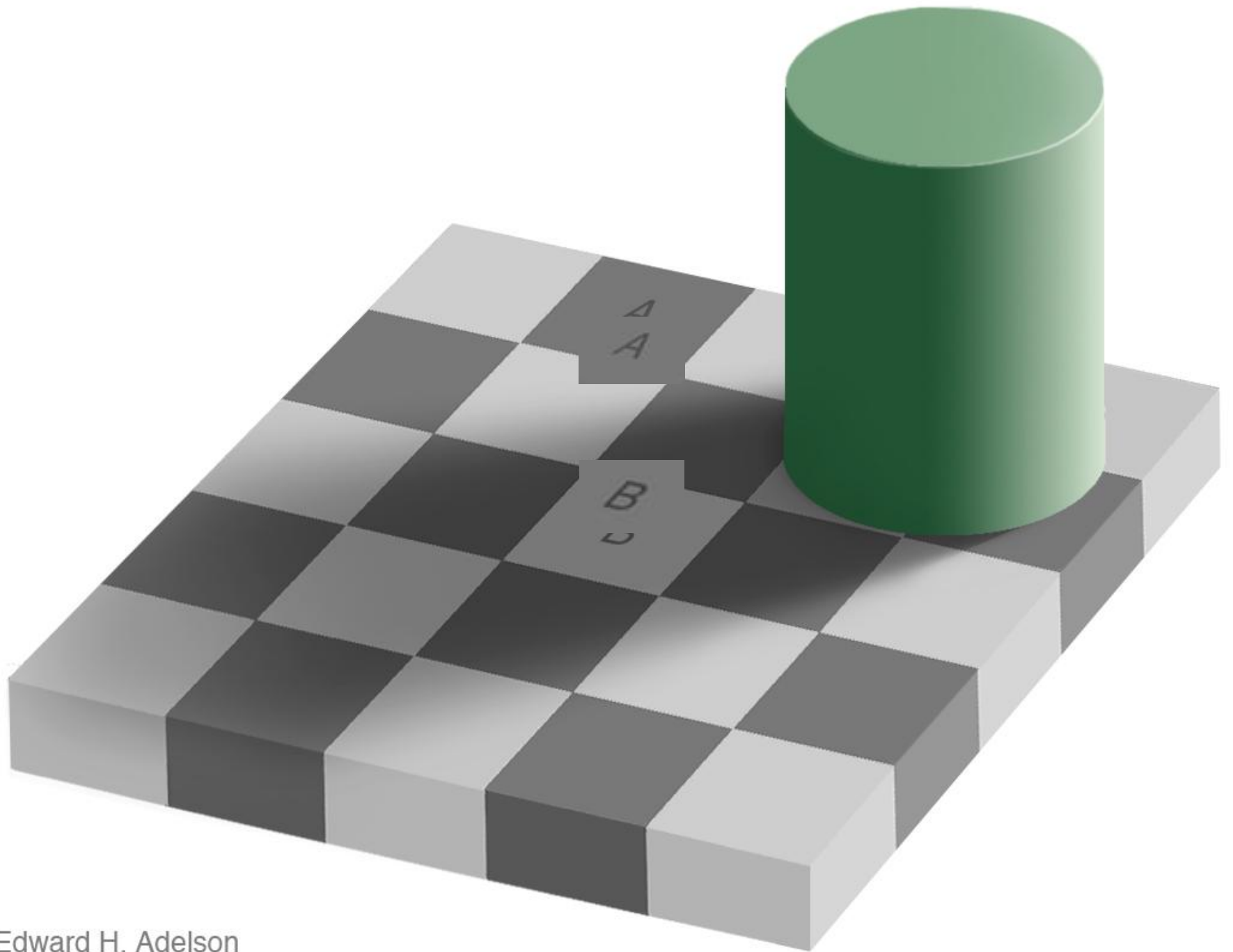




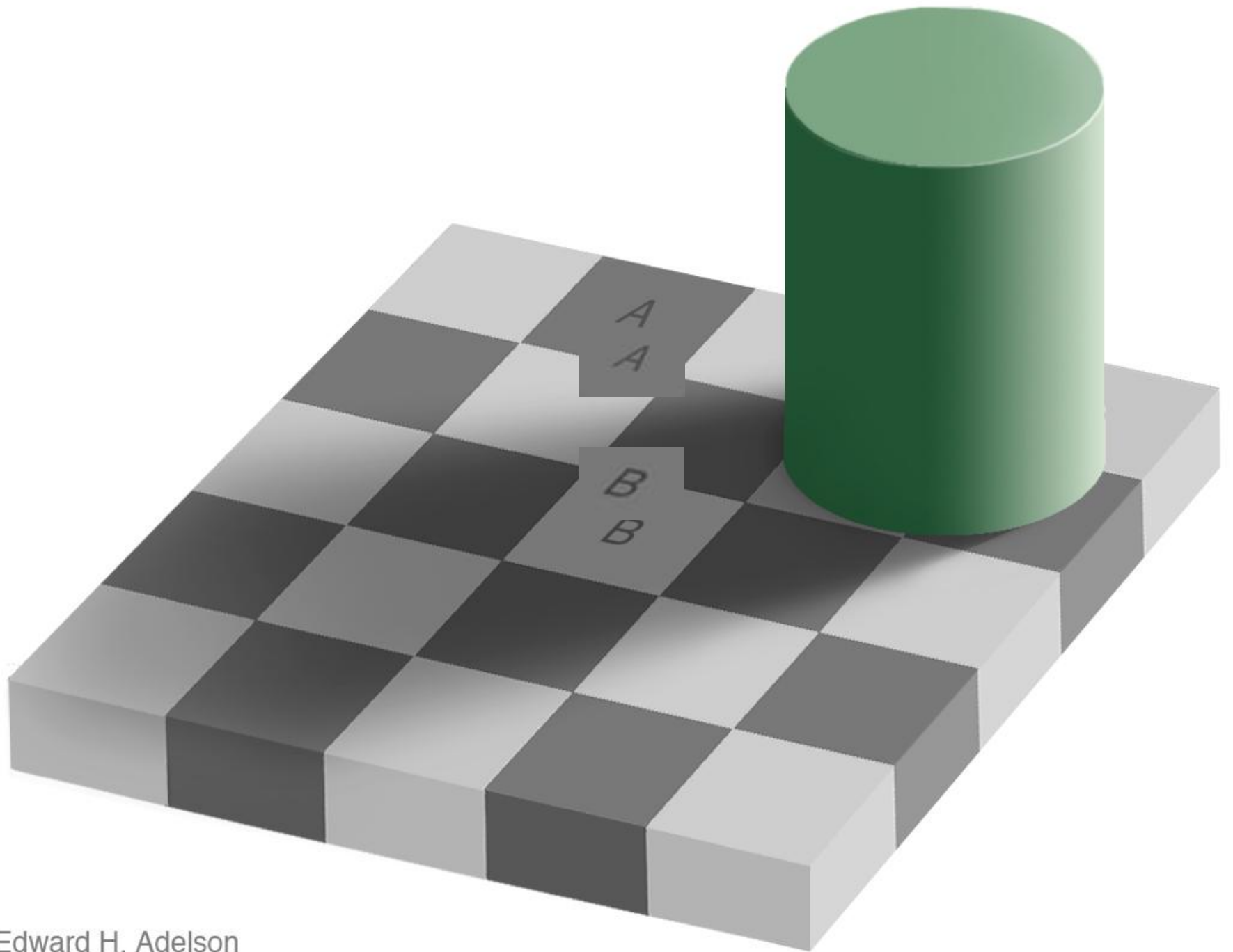
Edward H. Adelson



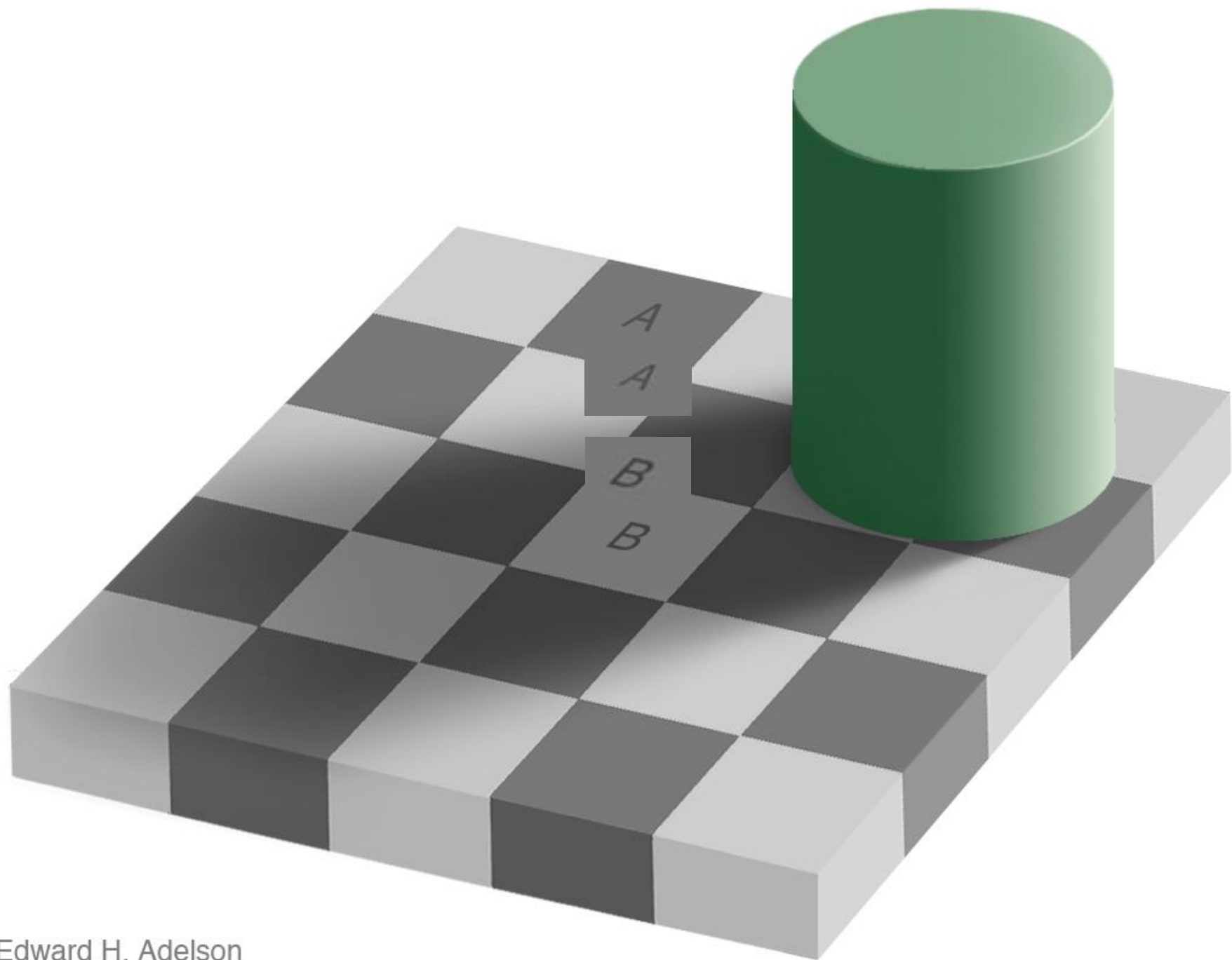
Edward H. Adelson



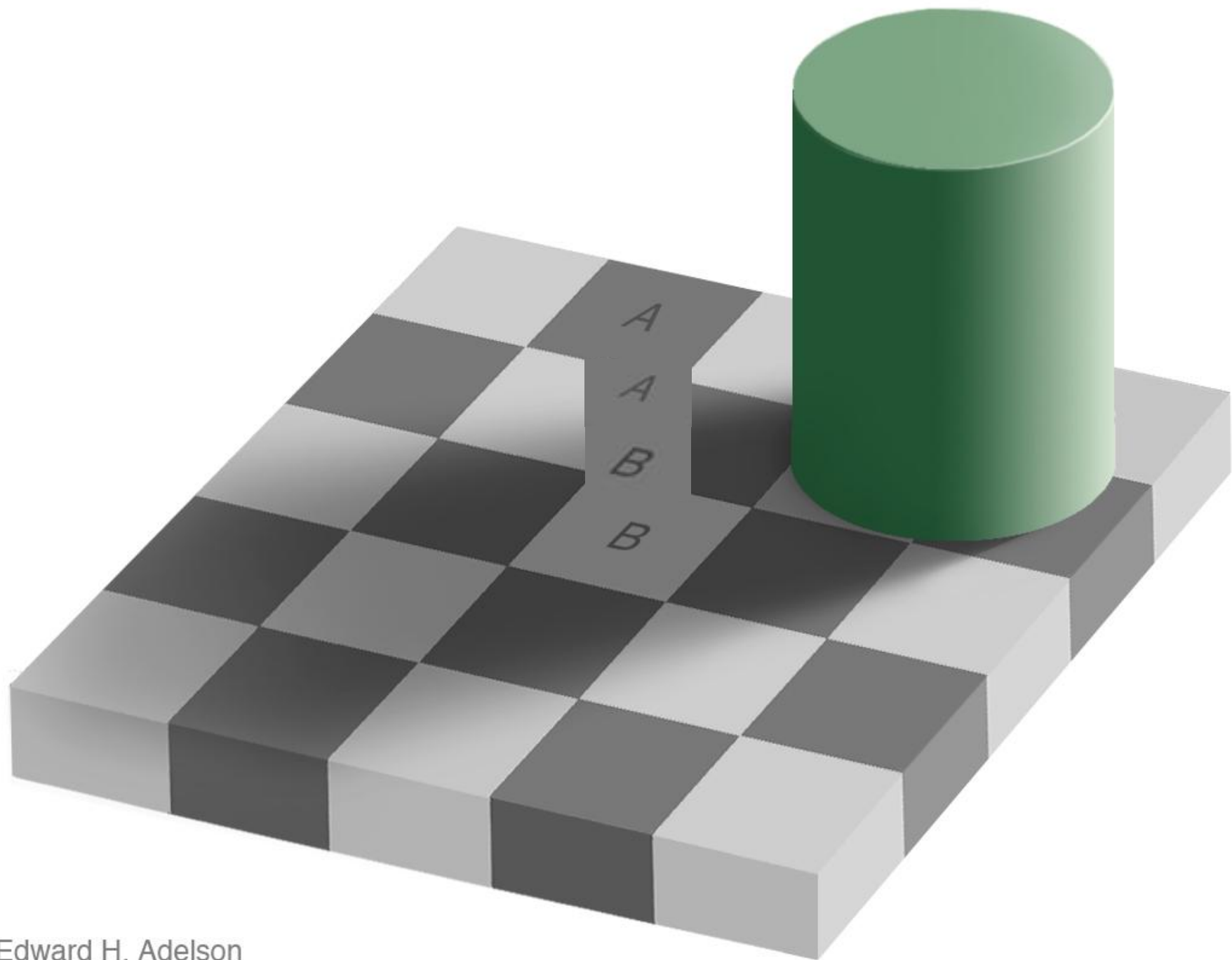
Edward H. Adelson



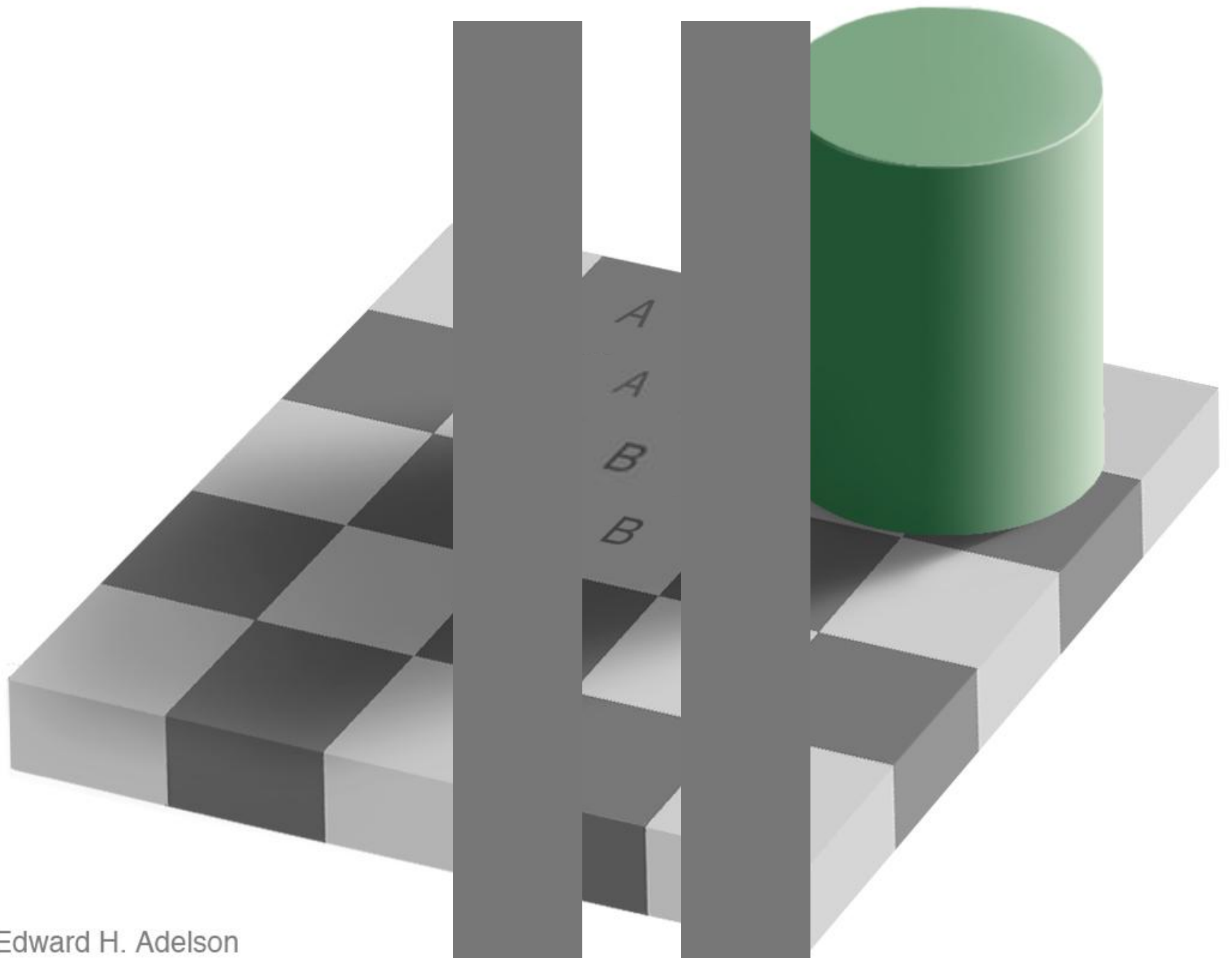
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## Questions & Answers