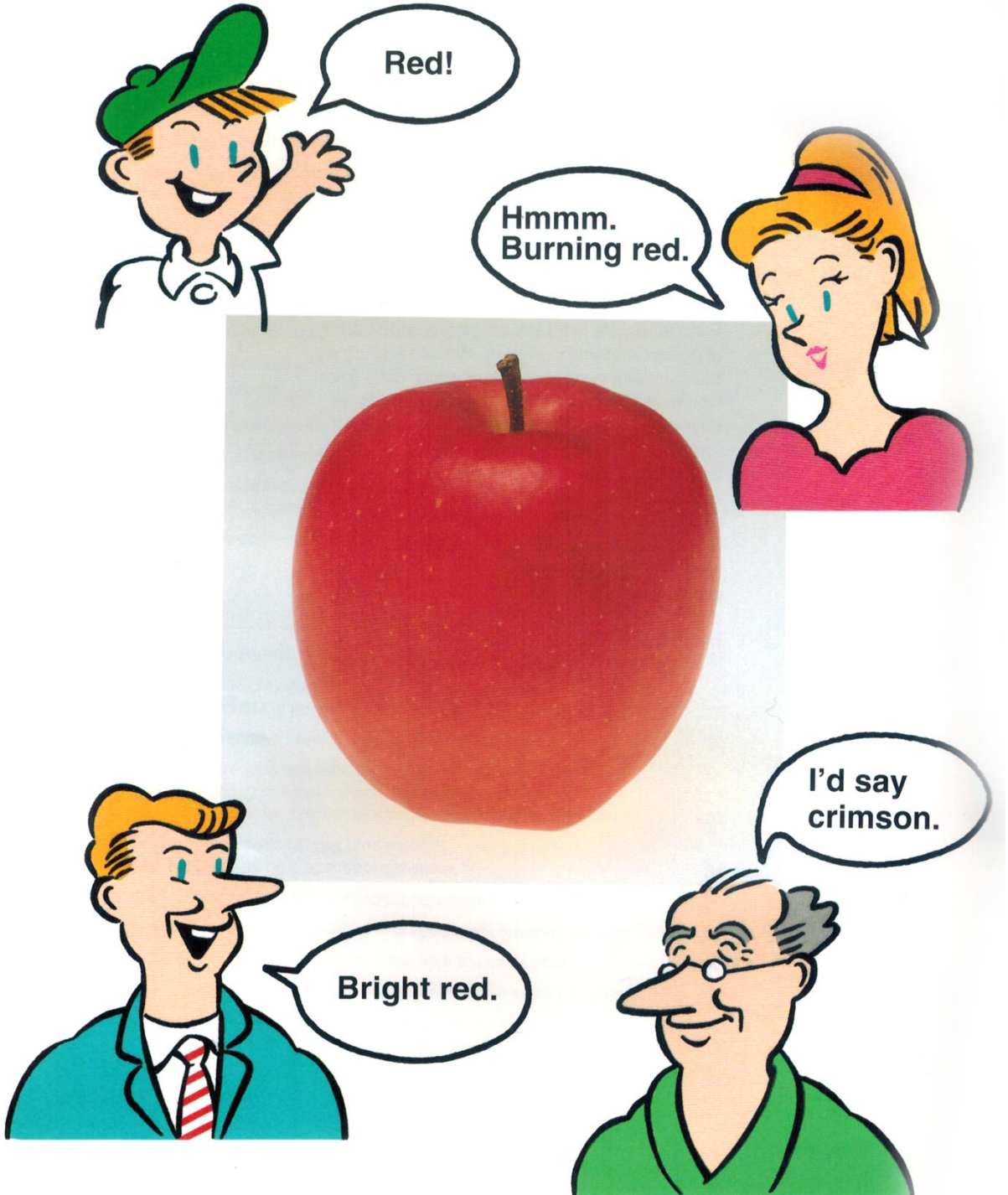
Color and light measurements

Dr. Nebojša Fišeković



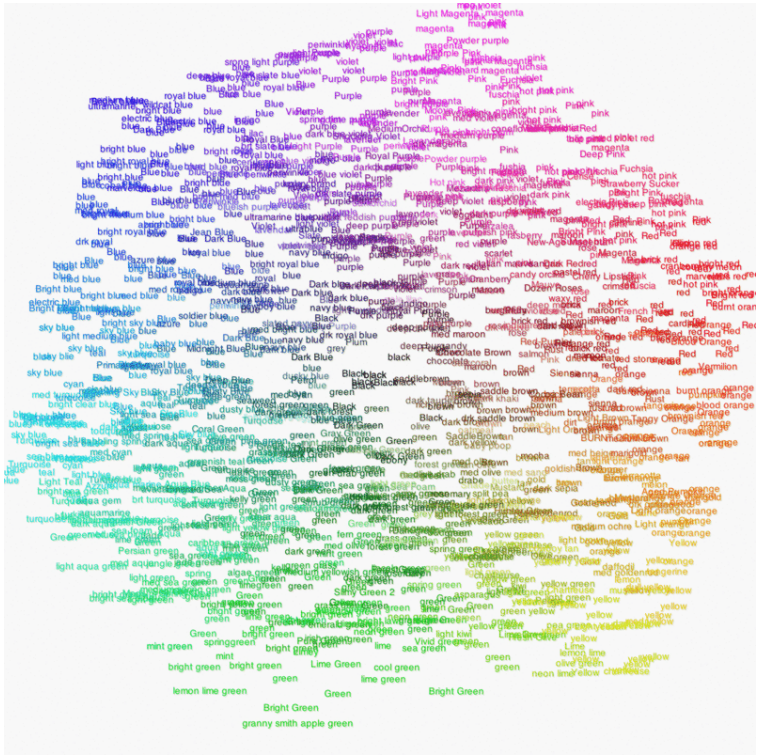
What color is this apple?

- Red
- Burning red
- Bright red
- Crimson
- Vermilion
- Cinnabar
- Rose
- Scarlet

Some “creative” solutions

How about making a list of color names???

aliceblue	antiquewhite	aqua	aquamarine	azure	beige	bisque
black	blanchedalmond	blue	blueviolet	brown	burlywood	cadetblue
chartreuse	chocolate	coral	cornflowerblue	cornsilk	crimson	cyan
darkblue	darkcyan	darkgoldenrod	darkgray	darkgreen	darkkhaki	darkmagenta
darkolivegreen	darkorange	darkorchid	darkred	darksalmon	darkseagreen	darkslateblue
darkslategray	darkturquoise	darkviolet	deeppink	deepskyblue	dimgray	dodgerblue
firebrick	floralwhite	forestgreen	fuchsia	gainsboro	ghostwhite	gold
goldenrod	gray	green	greenyellow	honeydew	hotpink	indianred
indigo	ivory	khaki	lavender	lavenderblush	lawngreen	lemonchiffon
lightblue	lightcoral	lightcyan	lightgoldenrodyellow	lightgreen	lightgray	lightmagenta
lightpink	lightsalmon	lightseagreen	lightskyblue	lightslategray	lightsteelblue	lightyellow
lime	limegreen	linen	magenta	maroon	mediumaquamarine	mediumblue
mediumorchid	mediumpurple	mediumseagreen	mediumslateblue	mediumspringgreen	mediumturquoise	mediumvioletred
midnightblue	mintcream	mistyrose	moccasin	navajowhite	navy	oldlace
olive	olivedrab	orange	orangered	orchid	palegoldenrod	palegreen
paleturquoise	palevioletred	papayawhip	peachpuff	peru	pink	plum
powderblue	purple	red	rosybrown	royalblue	saddlebrown	salmon
sandybrown	seagreen	seashell	sienna	silver	skyblue	slateblue
slategray	snow	springgreen	steelblue	tan	teal	thistle
tomato	turquoise	violet	wheat	white	whitesmoke	yellow
yellowgreen						



Dolores Labs Color Names Cloud

…or even a map???

Just 1300 color names should be enough

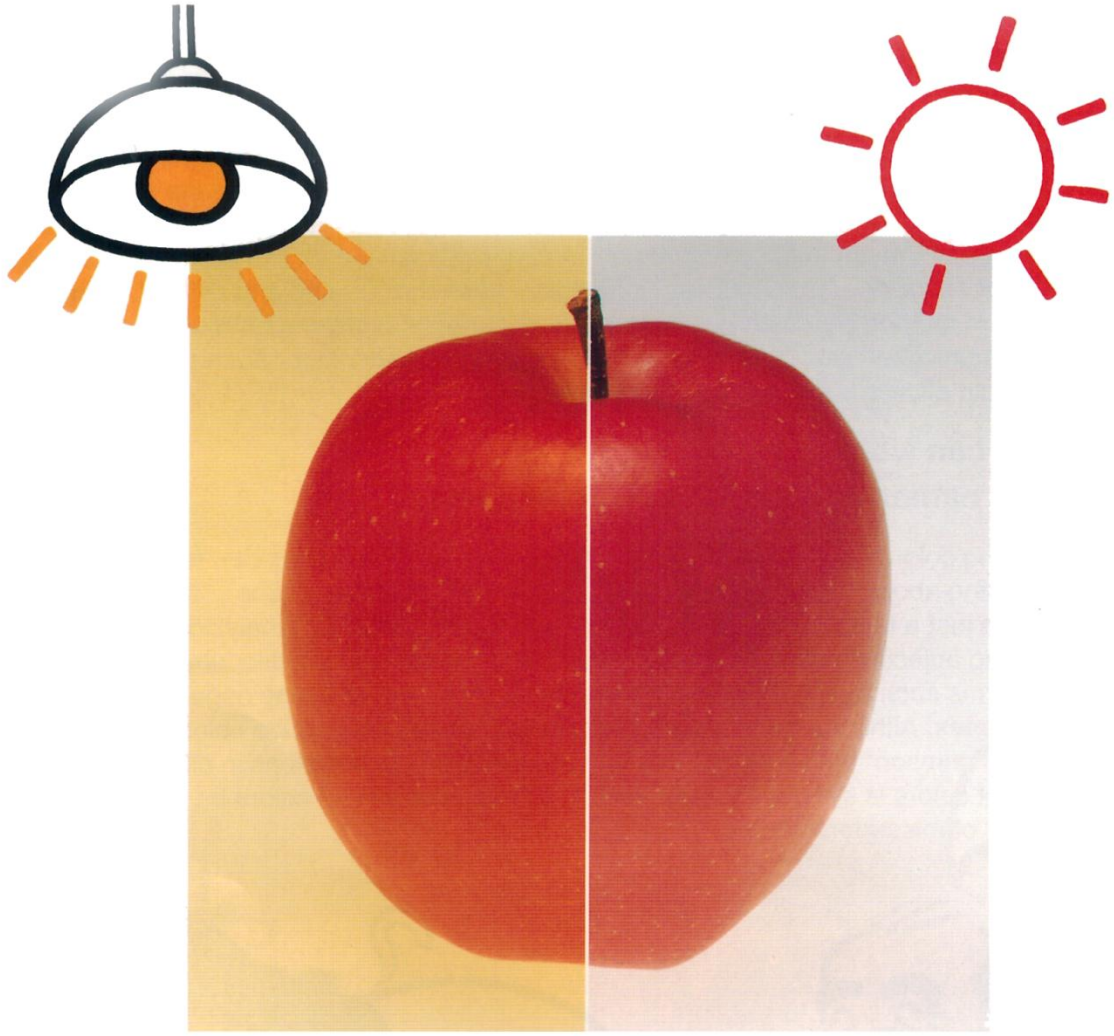
Dozen roses

Cranbery melon

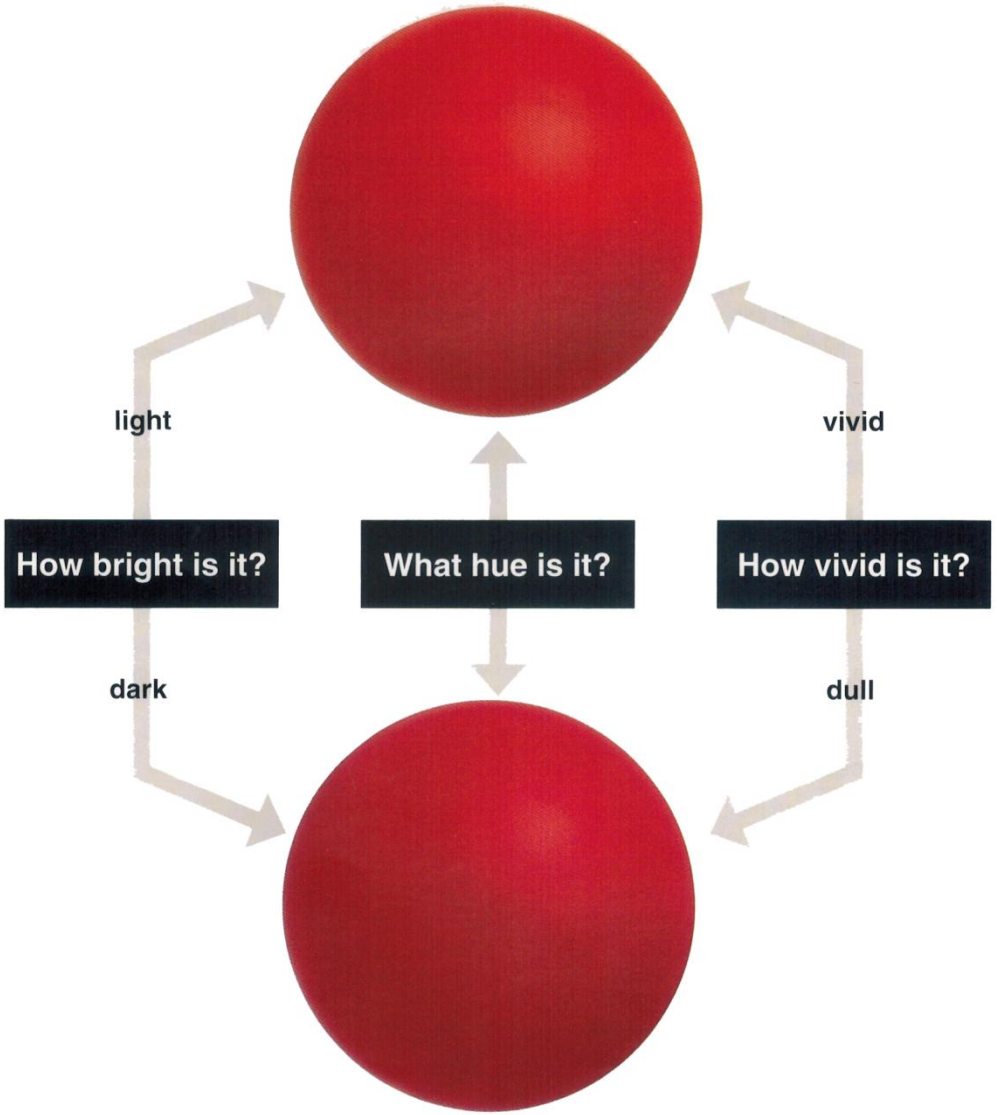
Cherry lipstik

And even worse… the same color, but it looks different

- Light source differences
- Observer differences
- Size differences
- Background differences
- Directional differences



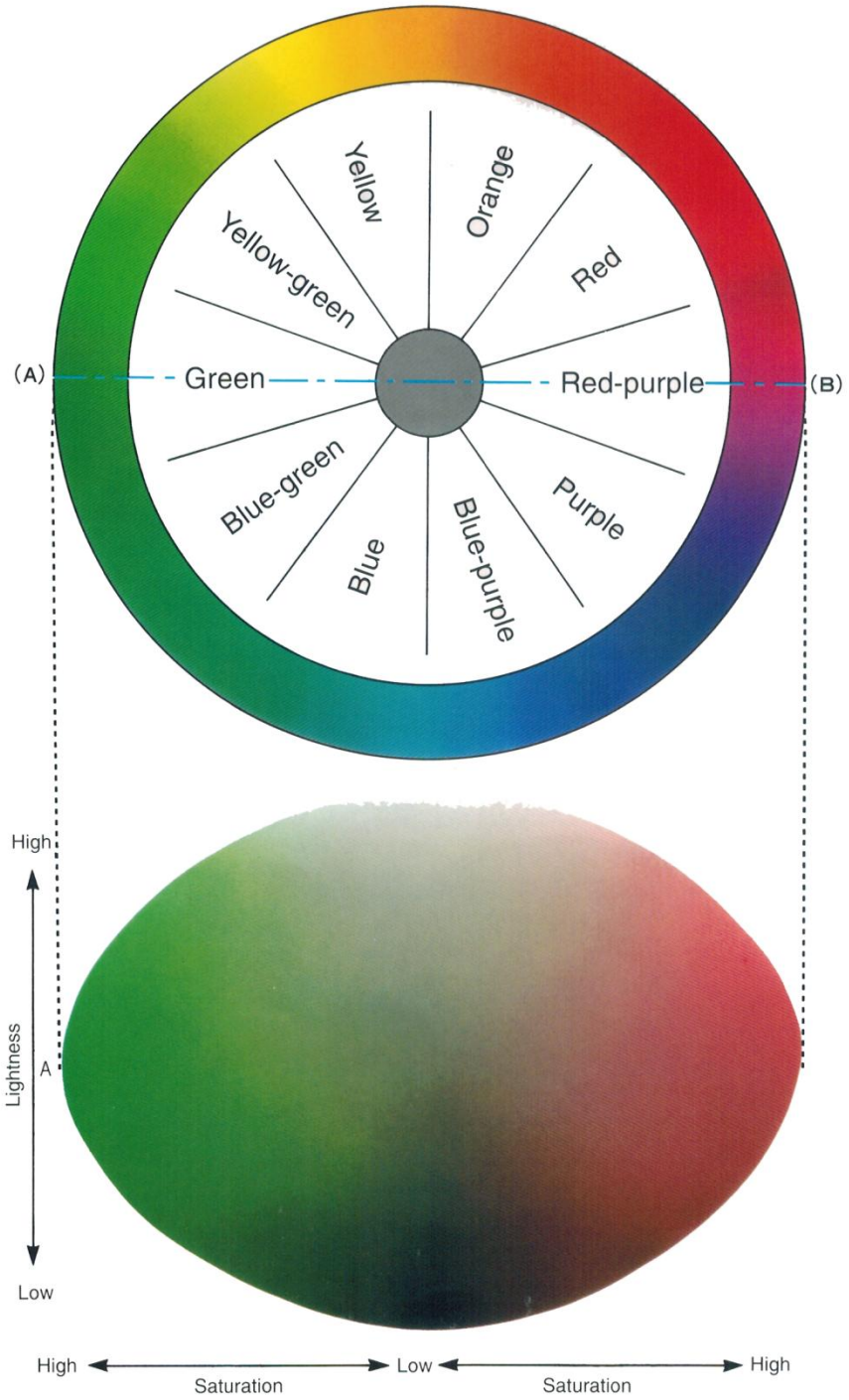
Color parameters



- Hue (color)

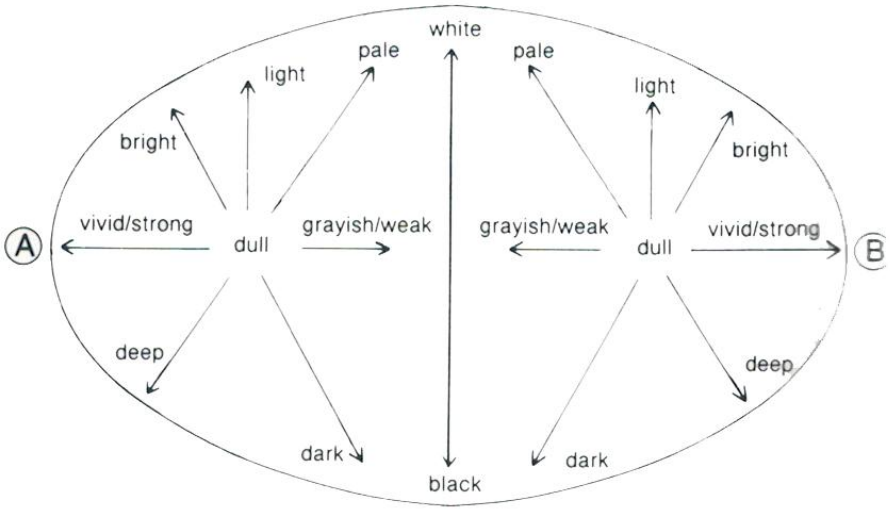
- Lightness (brightness)

- Saturation (vividness)

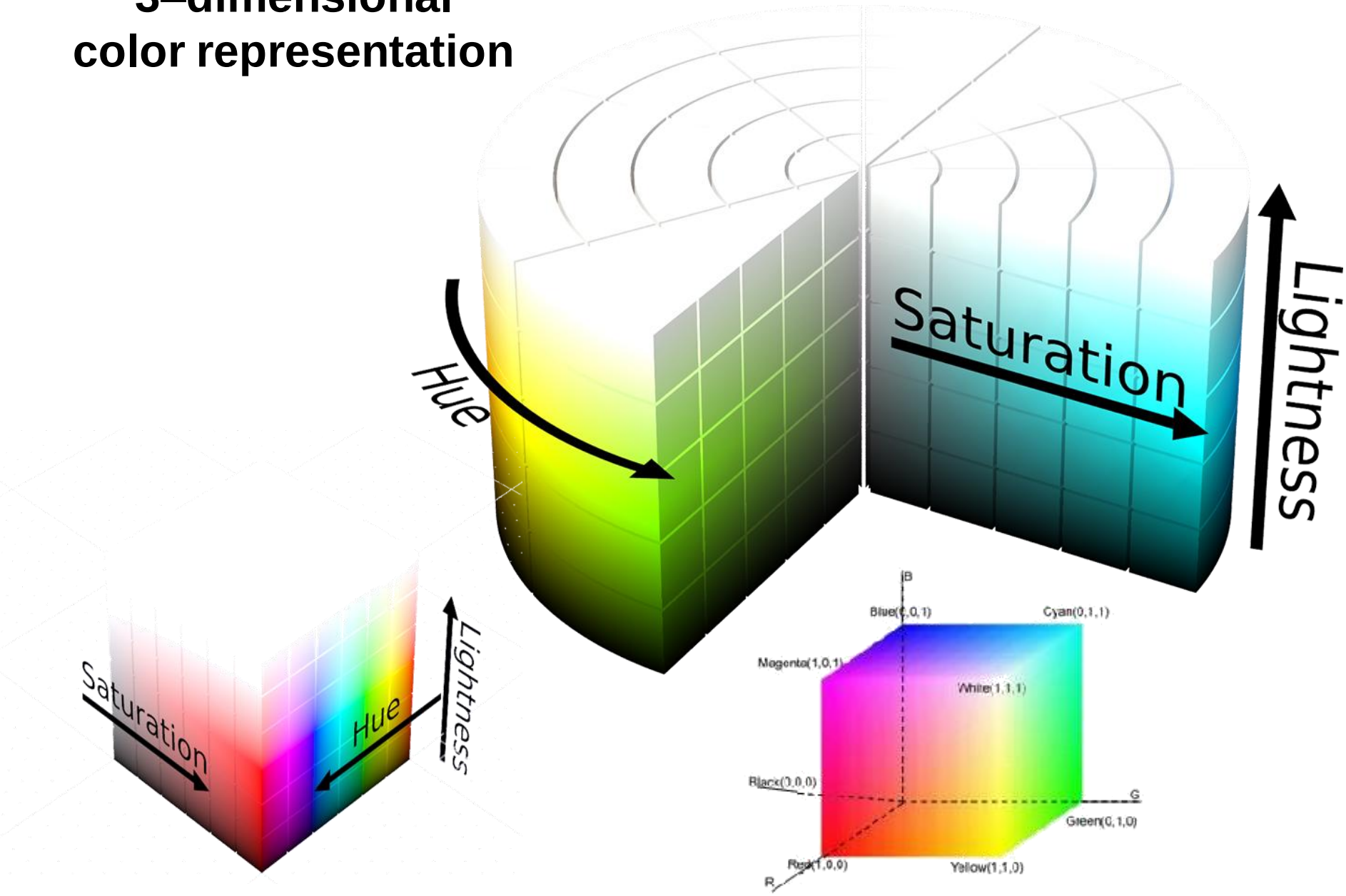


Hue. Lightness. Saturation.

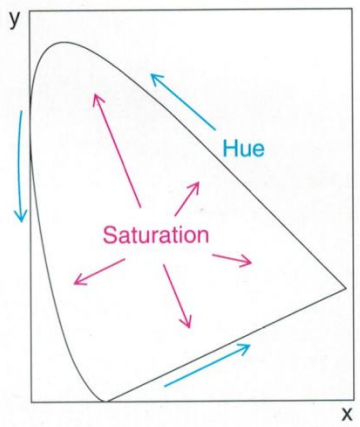
The world of color is a mixture of these three attributes

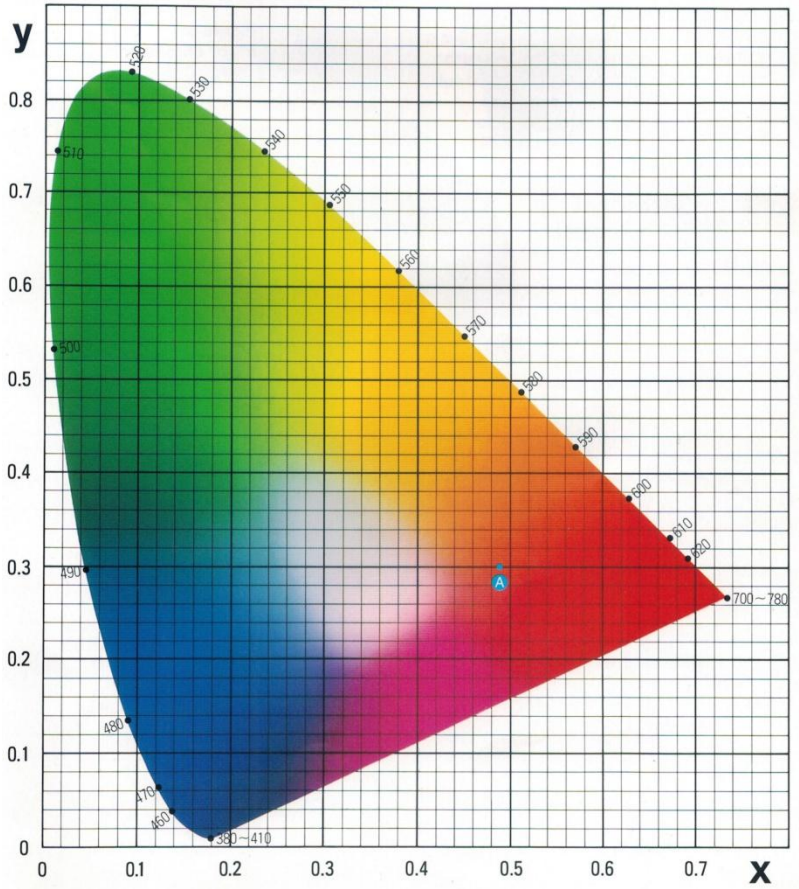


3–dimensional color representation

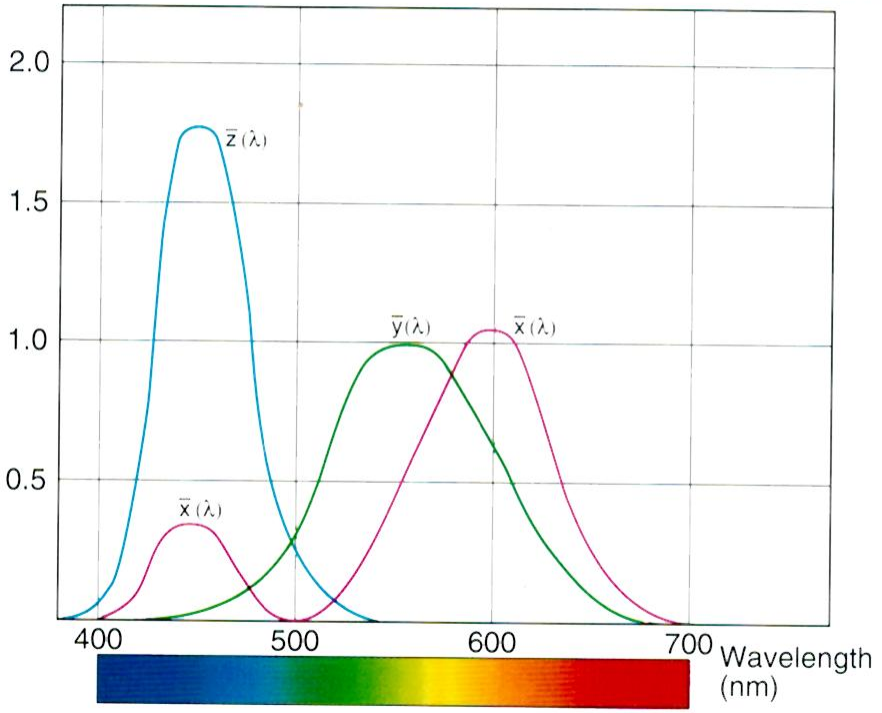


XYZ tristimulus value and the Yxy color space

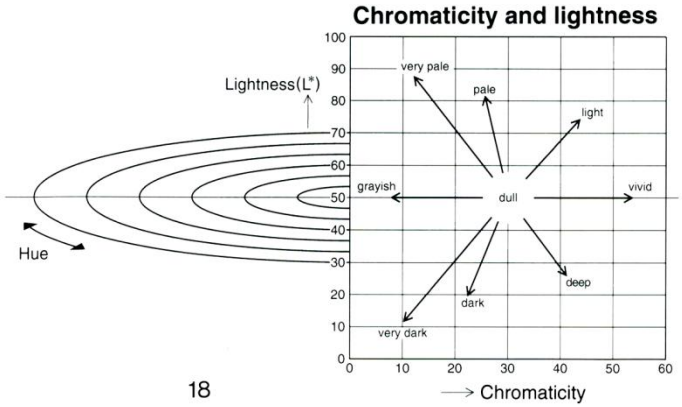


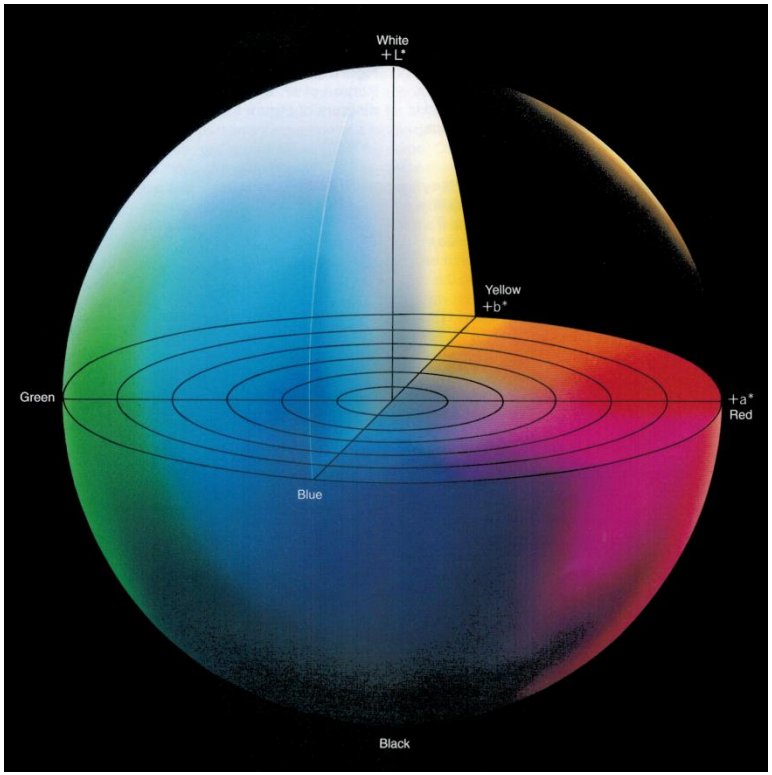


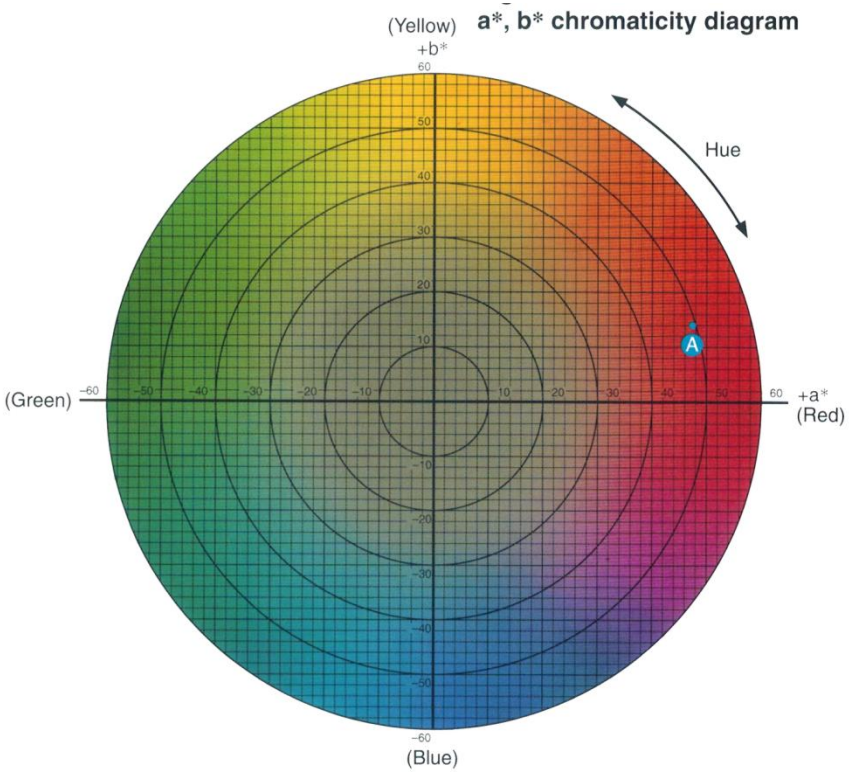
Spectral sensitivity corresponding to the human eye
(Color-matching functions of the 1931 Standard Observer)

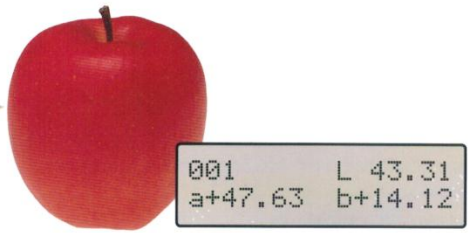


L*a*b color space

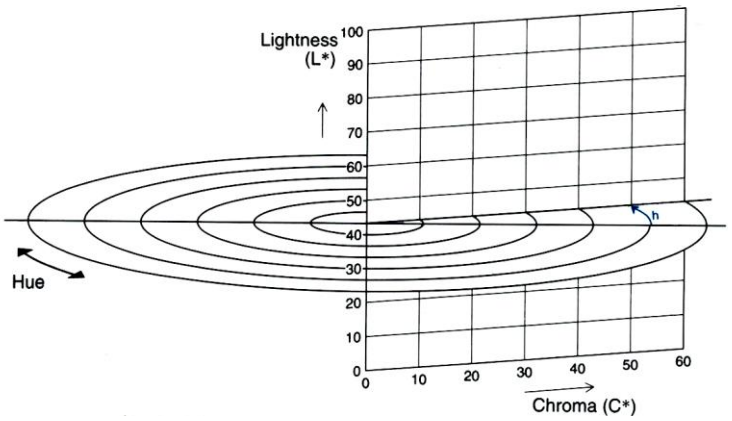


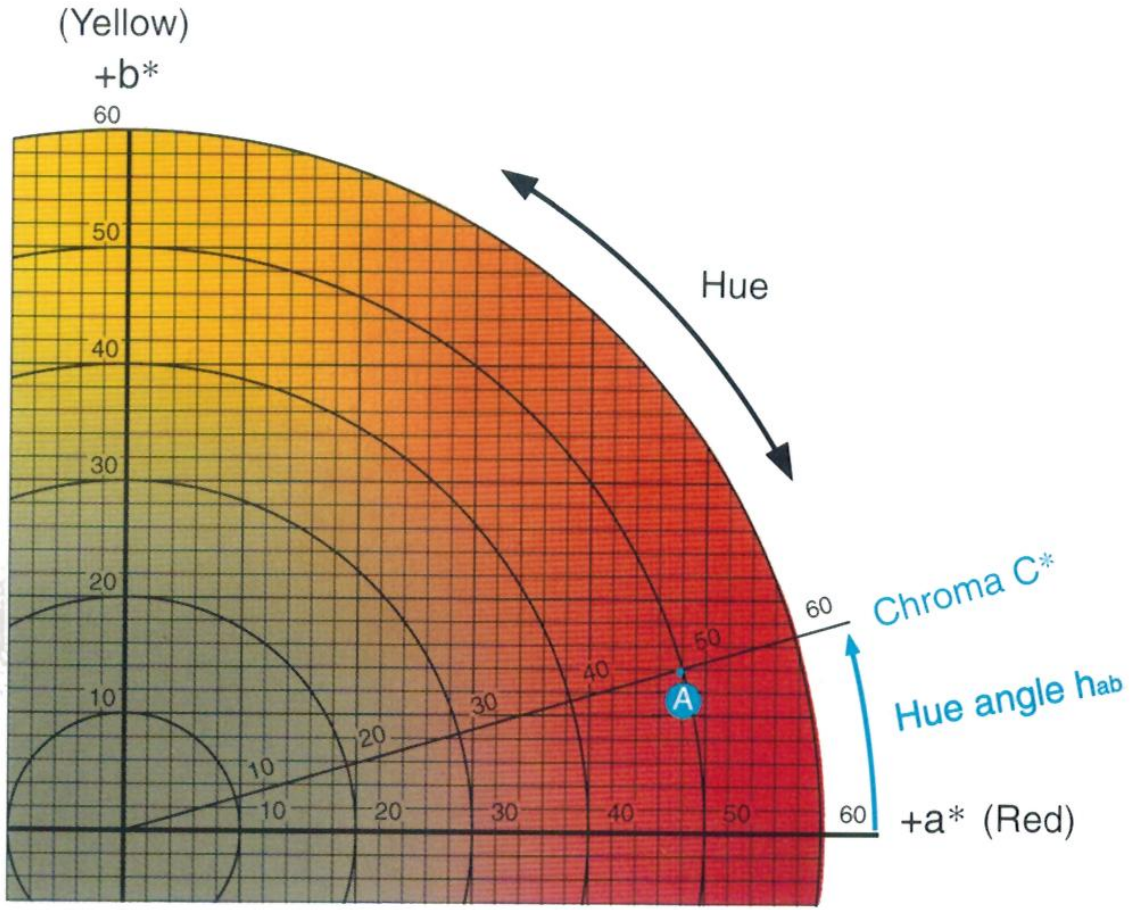


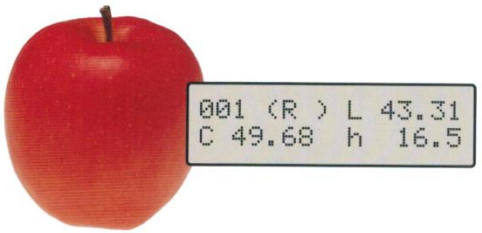




L*C*h color space







$$\text{Chroma } C^* = \sqrt{(a^*)^2 + (b^*)^2}$$

$$\text{Hue angle } h_{ab} = \tan^{-1}\left\{\frac{b^*}{a^*}\right\}$$

Colorimeter

XYZ tristimulus values

```
001       X 21.21
Y 13.37   Z  9.32
```

Yxy color space

```
001       Y 13.37
x .4832   y .3045
```

L*a*b* color space

```
001       L 43.31
a+47.63   b+14.12
```

L*C*h color space

```
001 (R )  L 43.31
C 49.68   h  16.5
```

Hunter Lab color space

```
001       HL 36.56
a+42.18   b +8.84
```

By using a colorimeter the color value is instantly measured in each color space

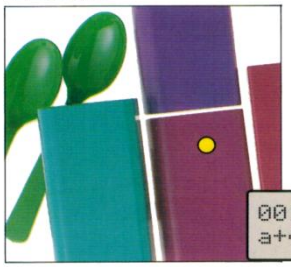
Applications of colorimeter

Printing

XYZ(Yxy) color space

001 Y 10.82
x .1554 y .1794

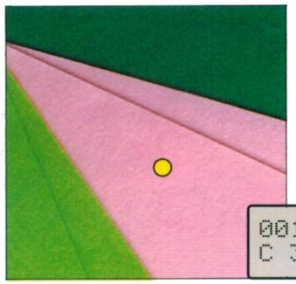
Plastic



L*a*b* color space

001 L 34.27
a+44.53 b-21.92

Textiles



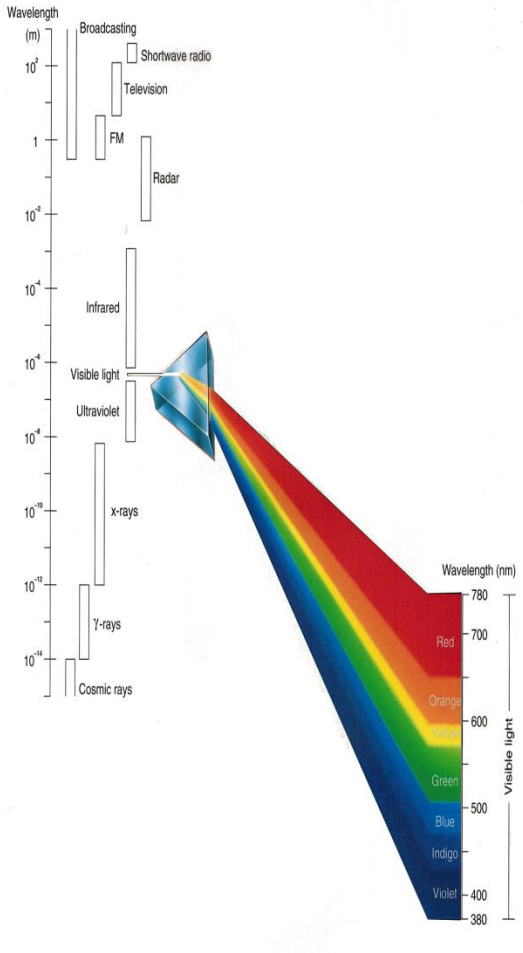
L*C*h color space

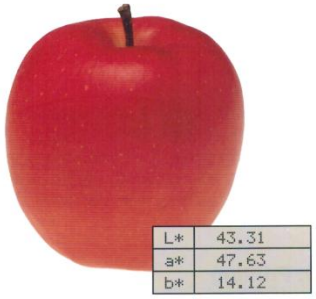
001 (R) L 76.47
C 37.34 h 359.7

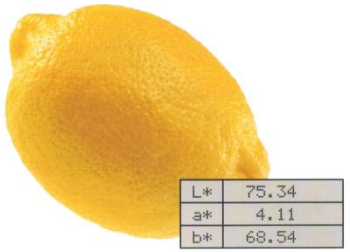
Features of colorimeter

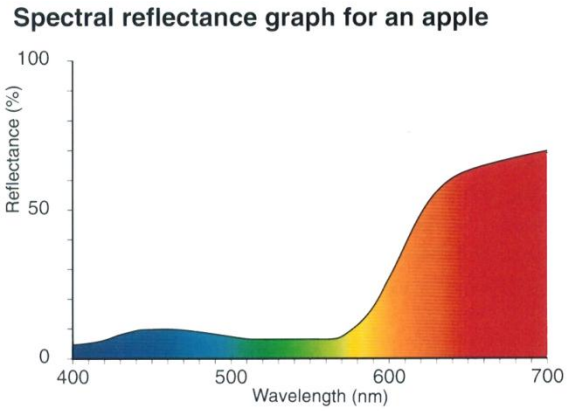
- Data display
- Measurement in each color space
- Color difference measurement
- Data memory
- Data communication
- Built-in light source
- Constant illumination
- Constant viewing angle
- Standard observer sensitivity
- Elimination of area/contrast effect

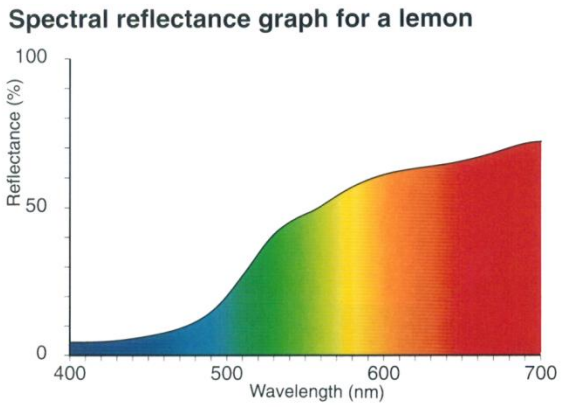
What about the components of light (and color)?

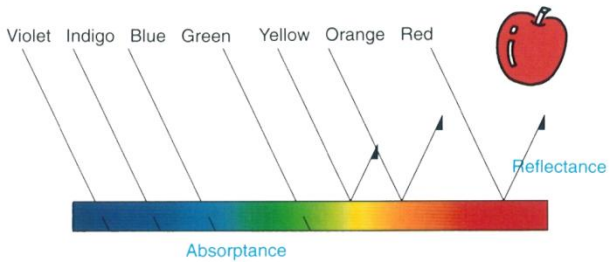


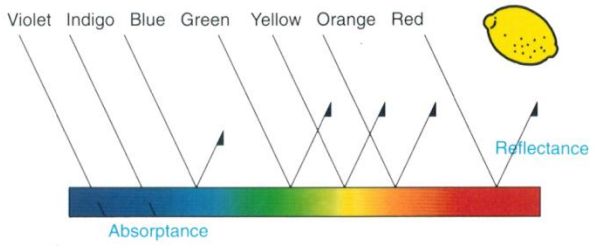








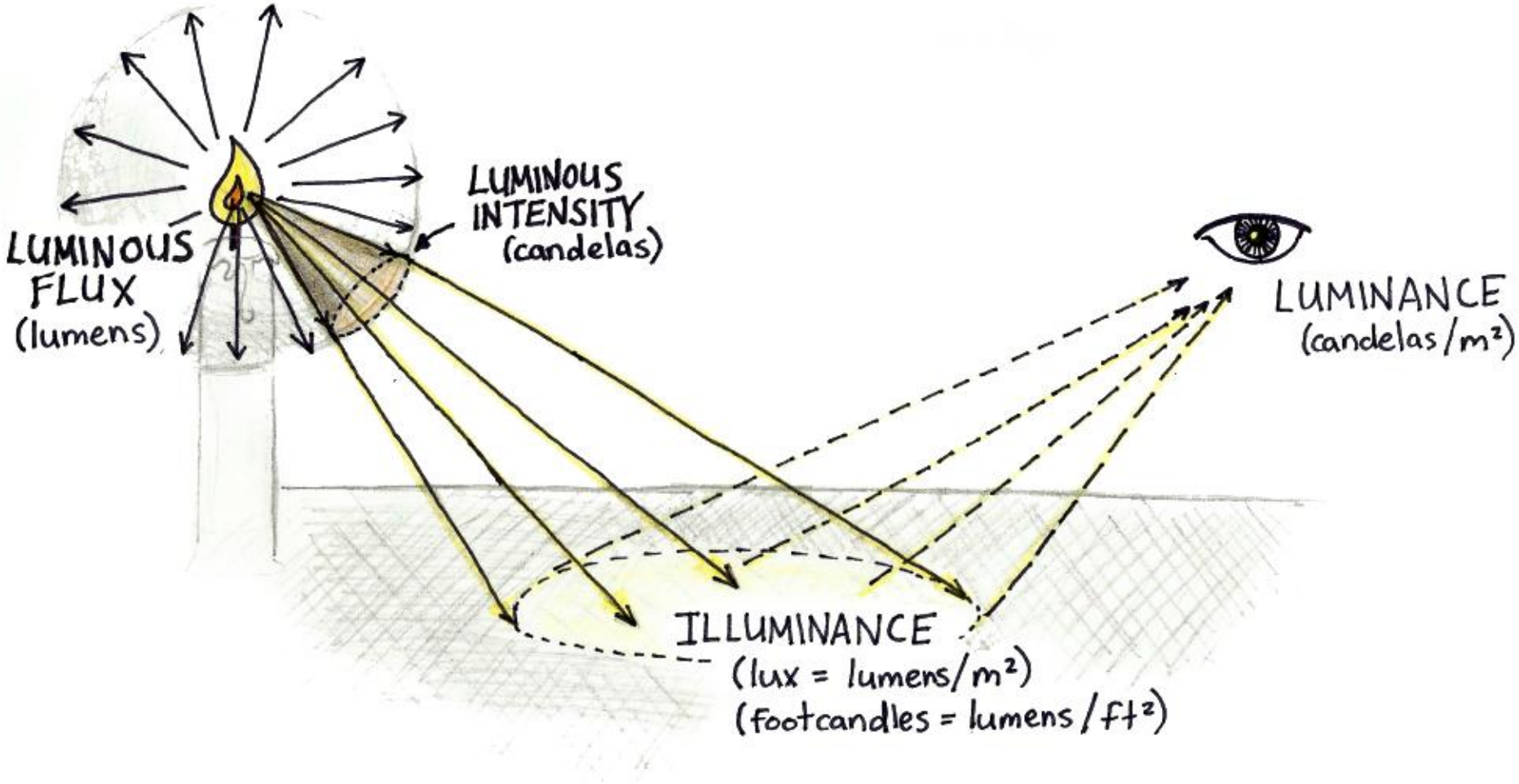




Features of spectrophotometer

- Spectral graph display
- Measuring parameters of white light as CCT and CRI
- Measuring luminous flux
- Color spaces
- Color difference measurement
- Data memory
- Data communication
- Spectral sensor
- Fixed illumination/viewing angle
- Illuminant conditions

And how about measuring light?
It's another long story…



Laboratory for light measurement

Luxmeter
(illuminance)

Luminance
meter
(luminance)

Goniophotometer
(luminous intensity)

Spectrophotometer
(spectrum)

Power suppliers
and power analyzers

Integration sphere
(luminous flux)

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