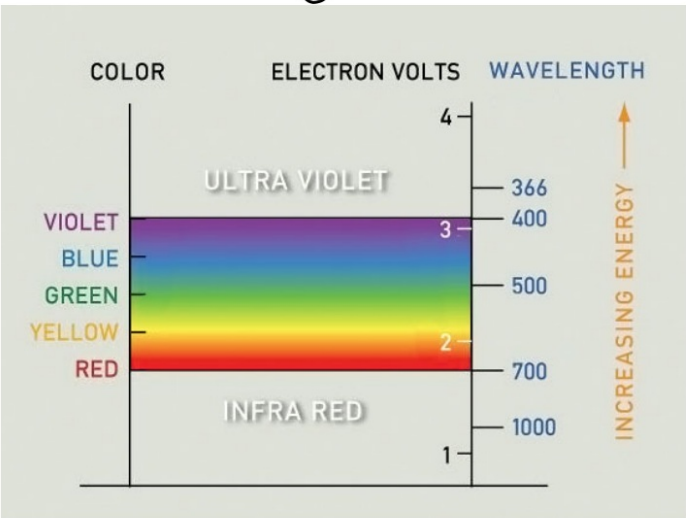
# Solid State Physics P13

## Optical properties

## Emission and absorption of visible light

visible light $380\,nm < \lambda < 700\,nm$ $1.6\,eV < E < 3.2\,eV$

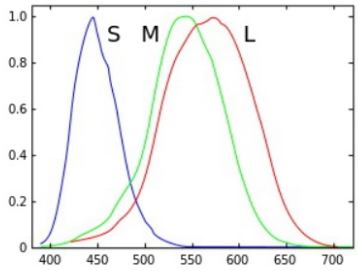



human eye: in the retina

3 types of cones → color

(some women: 4 types)

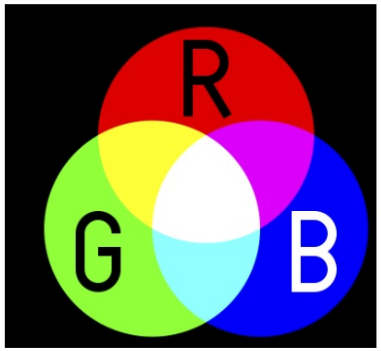
1 type of rods → intensity in dim light only



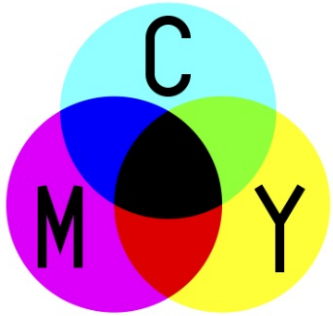
Color perception: 1) physical → frequencies (superposition)
(no such colors as brown or purple)
2) psychological — may see colors when there are none, or see brown or purple

same color: reflects that color
reflects the complementary colors

Color mixing



additive (display)



subtractive (print)

## Absorption of visible light

Pure insulator crystals when $E_g > 3.2$ eV are colorless and transparent

impurities and lattice defects → colored & possibly opaque.

$E$ levels in $E_g$

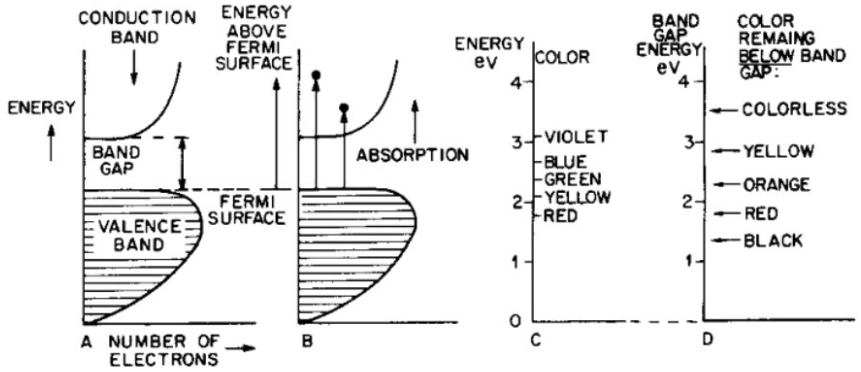
example: $Al_2O_3$ (corundum) – transparent, colorless

substitutional $Cr$ → when transparent => gems

color red = ruby

pink - orange = padparascha

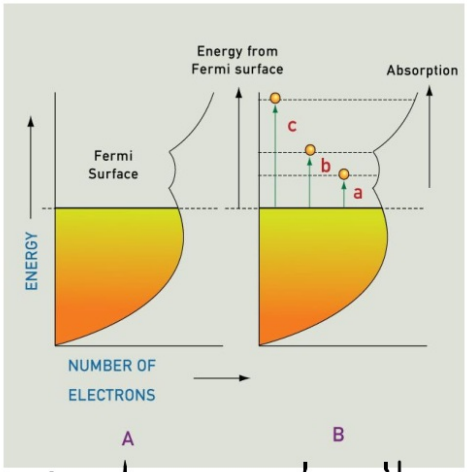
any other = sapphire (e.g. green sapphire)



metals — no $E_g$

semiconductors — $E_g < 1.6\,eV$ → usually silvery copper —

gold – relativisti effects decrees $r_{Bohr}$ s state moves nearer to d state ⇒ instead of UV absorption → blue absorption




band diagram

transition for all visual frequencies

**Emission of visible light**

**Luminescence** – not from heat

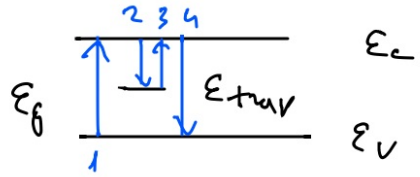
a) perfect lattice → direct transition to ground state

b) through impurity levels

c) between —||— 

**phosphorescence** – not from heat through traps

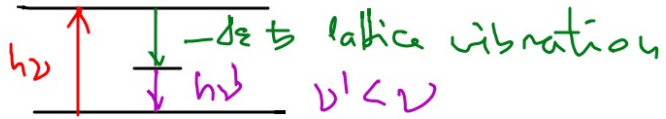
through metastable states in $\mathcal{E}_g$




time delay

cathode ray tubes

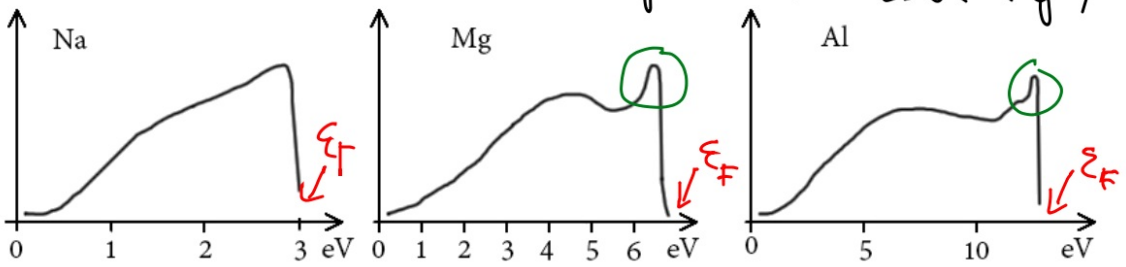
fluorescence




## X-ray emission

atomic levels → single frequency

Solids → band spectrum (above $\mathcal{E}_g$)

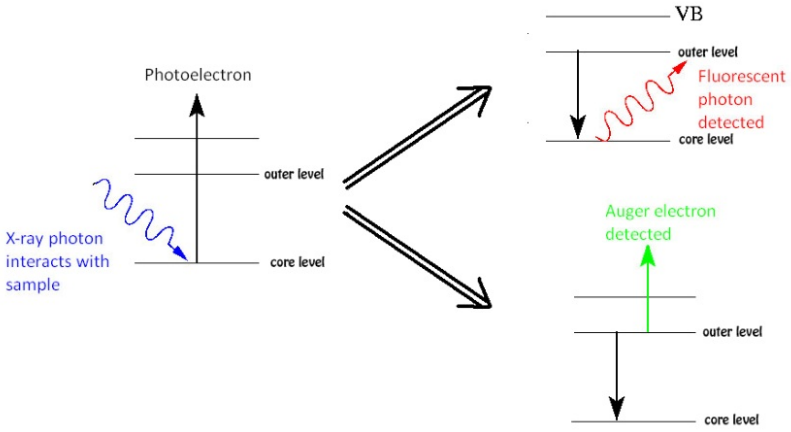


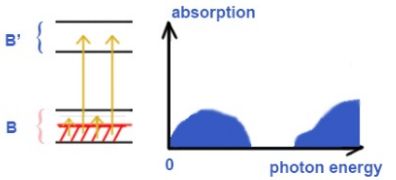

$$I(\mathcal{E}) \propto g(\mathcal{E})$$

$$g(\mathcal{E}) = \frac{8\pi\sqrt{2m_e^3}}{h^3}\sqrt{\mathcal{E}}$$

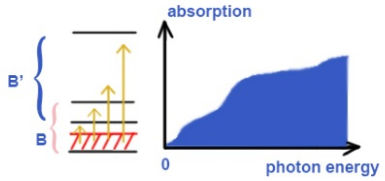
$3p$ - $3s$ overlap

# X-ray absorption.

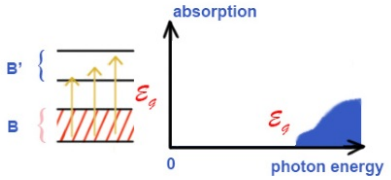


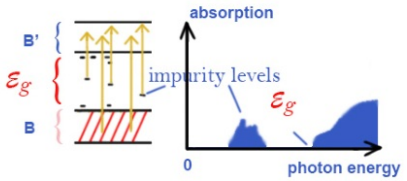

conductor
no band overlap




conductor
band overlap




insulator




semiconductors