

# Optics

What is light?

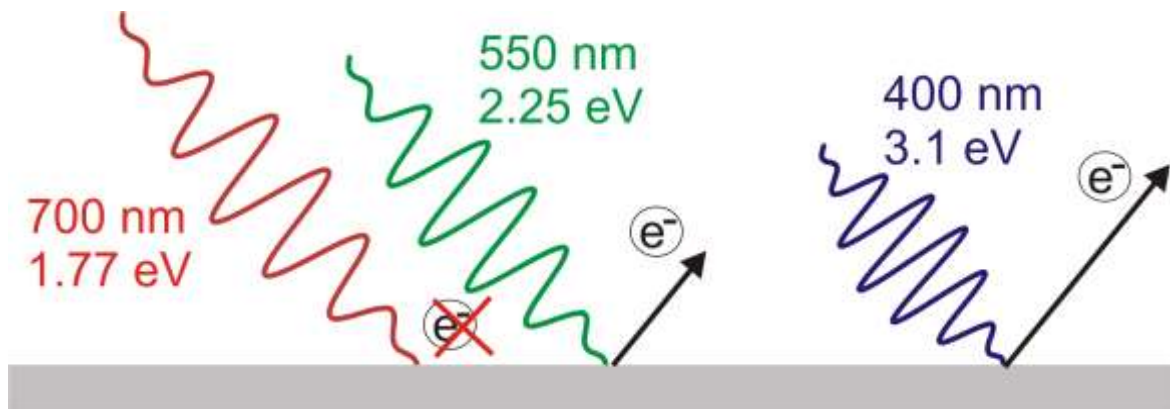
Visible electromagnetic radiation

**Wave**

## Particle Properties

The photon is the elementary particle which carries the energy of electromagnetic radiation.

Photoelectric effect: An incident photon removes an electron from the bound electrons of an atom or molecule, while the photon is absorbed.



Wave–particle duality is the concept that all matter and energy exhibits both wave-like and particlelike properties

Phenomenon

Can be explained in terms of **waves**.

Can be explained in terms of **particles**.

	waves	particles
Reflection	+	+
Refraction	+	+
Interference	+	-
Diffraction	+	-
Polarization	+	-
Photoelectric effect	-	+

## Basics of radiometry

Source, radiation, irradiated target

Emitted power ( $P$ ), intensity ( $J_E$ ), (Flux density)

$$J_E = \frac{\Delta E}{\Delta t \Delta A}$$

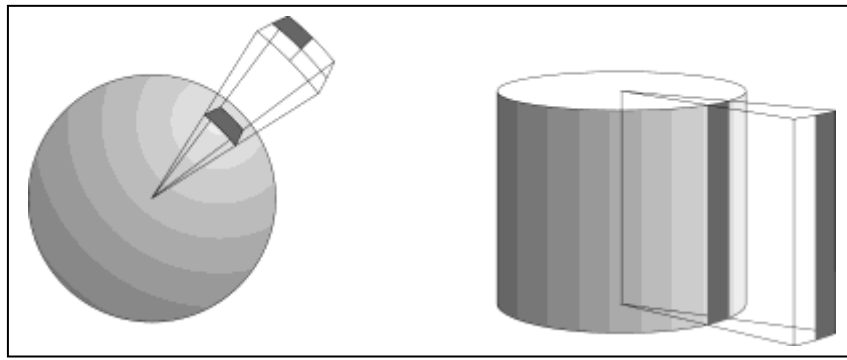
$$M = \frac{\Delta P}{\Delta A}$$

## Point-like isotropic radiator

Radiation is independent of the direction in the whole solid angle.

Total emitted power per unit surface area

## Simple laws: the roles of symmetry, distances and angles



### 1. Spherical symmetry

$$P = M_1 A_1 = M_2 A_2$$

$$\frac{M_1}{M_2} = \frac{r_2^2}{r_1^2} \quad M \sim 1/r^2$$

### 2. Cylindrical symmetry

$$M \sim 1/r$$

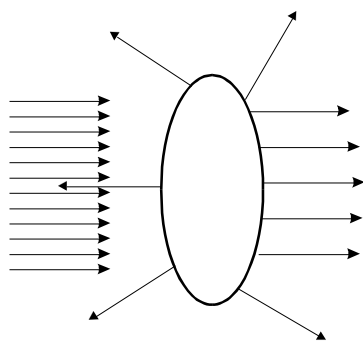
(Planar symmetry)

### 3. Out of perpendicular incidence

$$M = J \cos \alpha$$

4.)

**radiation**



**matter**

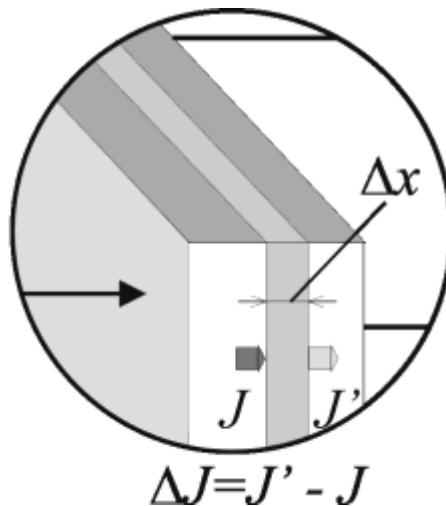
interaction:  $J$  decreases, but how? (experiment)

$\Delta J = J_{\text{out}} - J_{\text{in}}$  depends on

- |   |                                     |                 |
|---|-------------------------------------|-----------------|
| — | incident intensity                  | $J_{\text{in}}$ |
| — | layer thickness; (number of layers) | $x = k\Delta x$ |
| — | quality of matter                   | $\mu$           |

Initial assumptions:

- for „small”  $\Delta x$        $\Delta J \sim \Delta x$     and     $\Delta J \sim J$  (proportional)
- if  $\Delta x = 0$                $J_{\text{out}} = J_{\text{in}} = J_0$



$x$  characteristic for the **quantity** of matter,  
 $\mu$  for the **quality** of matter

For layers with “extreme” small  $\Delta x$        $\Delta J = J' - J = -J\mu\Delta x$

$$J(x) = J_0 e^{-\mu x}$$

Outgoing intensity ( $J$ ) depends on both the type ( $\mu$ ) and depth ( $x$ ) of the traversed medium, as well as the intensity of the incident radiation ( $J_0$ ).

