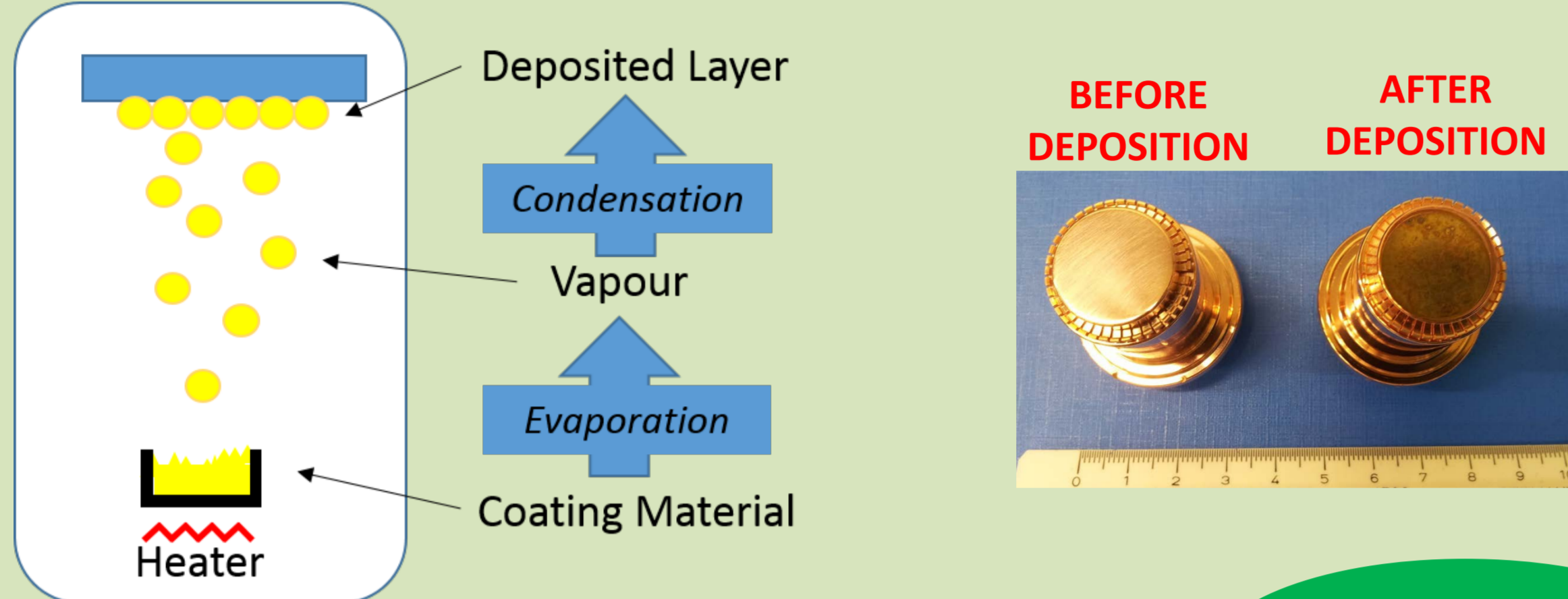


## Production

- Photocathodes are made of special **photoemissive materials**.
- The photoemissive layer is produced by **thin film deposition**:



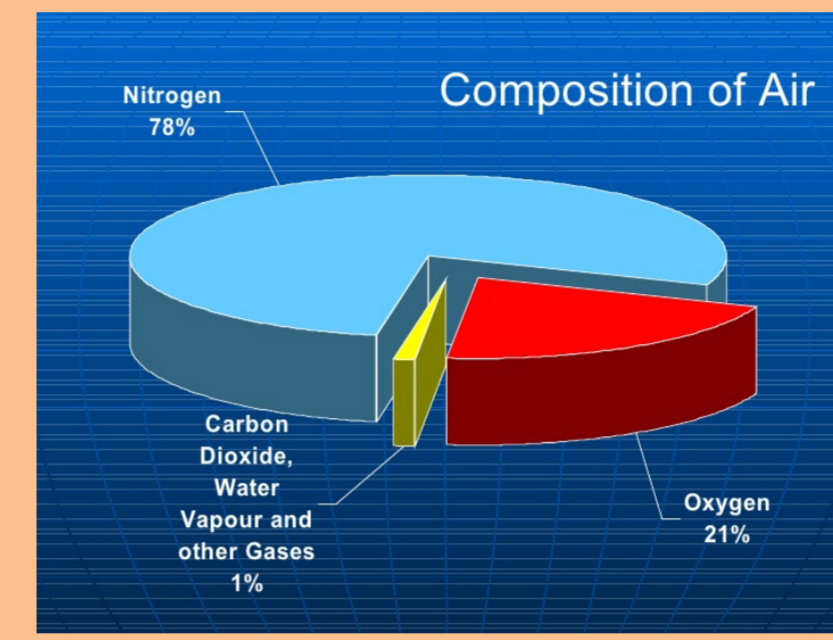
- The deposited **film thickness** is around 0.1  $\mu\text{m}$ . **Average human hair thickness: 15  $\mu\text{m}$ !**

## Vacuum Environment

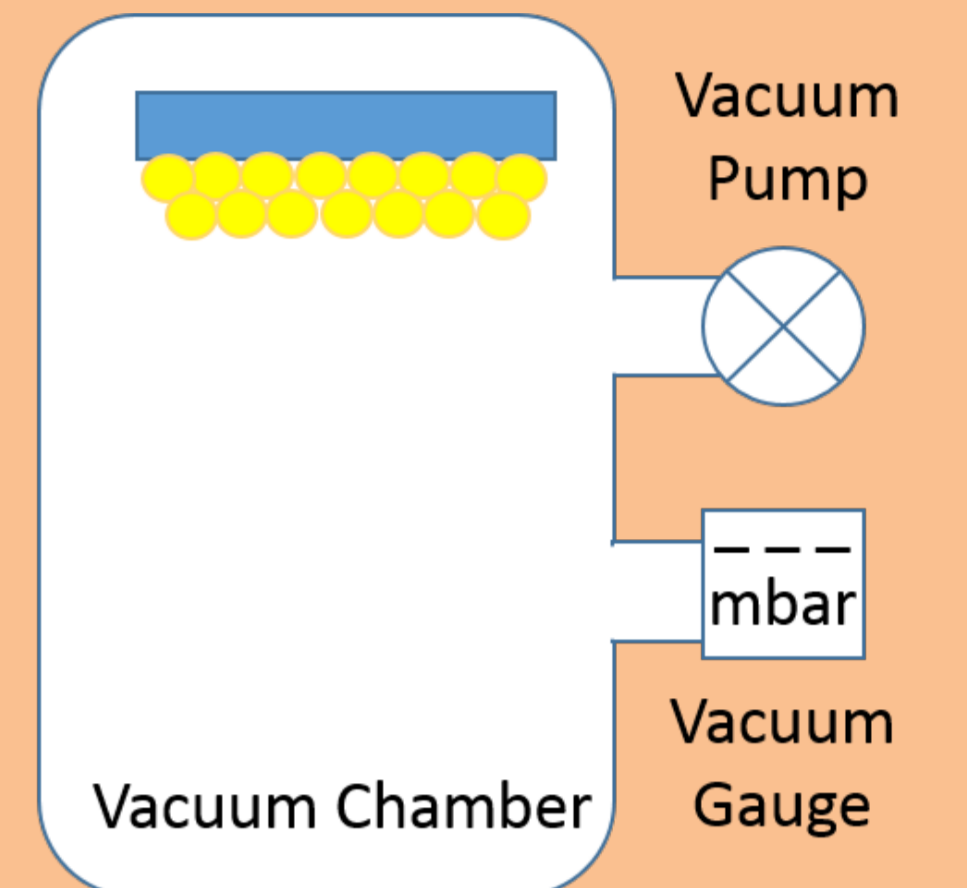
- Photocathodes material can easily react with oxygen: the **oxidation** deteriorates the cathode performance.



- The air is made of:



Atmospheric Pressure: 1000 mbar!

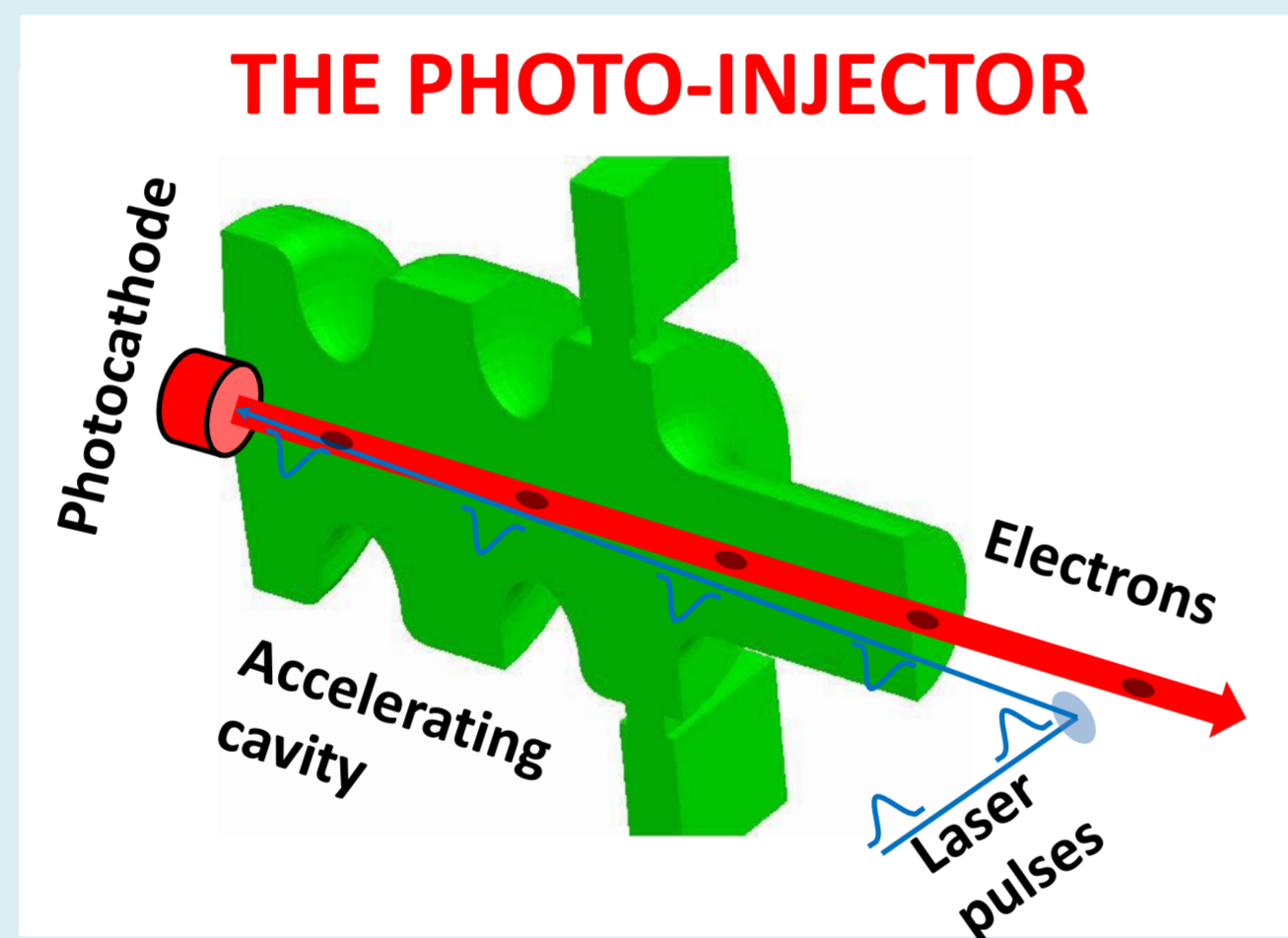


- Photocathodes must be kept under **Ultra High Vacuum: 10<sup>-10</sup> mbar**.

## PHOTOCATHODES

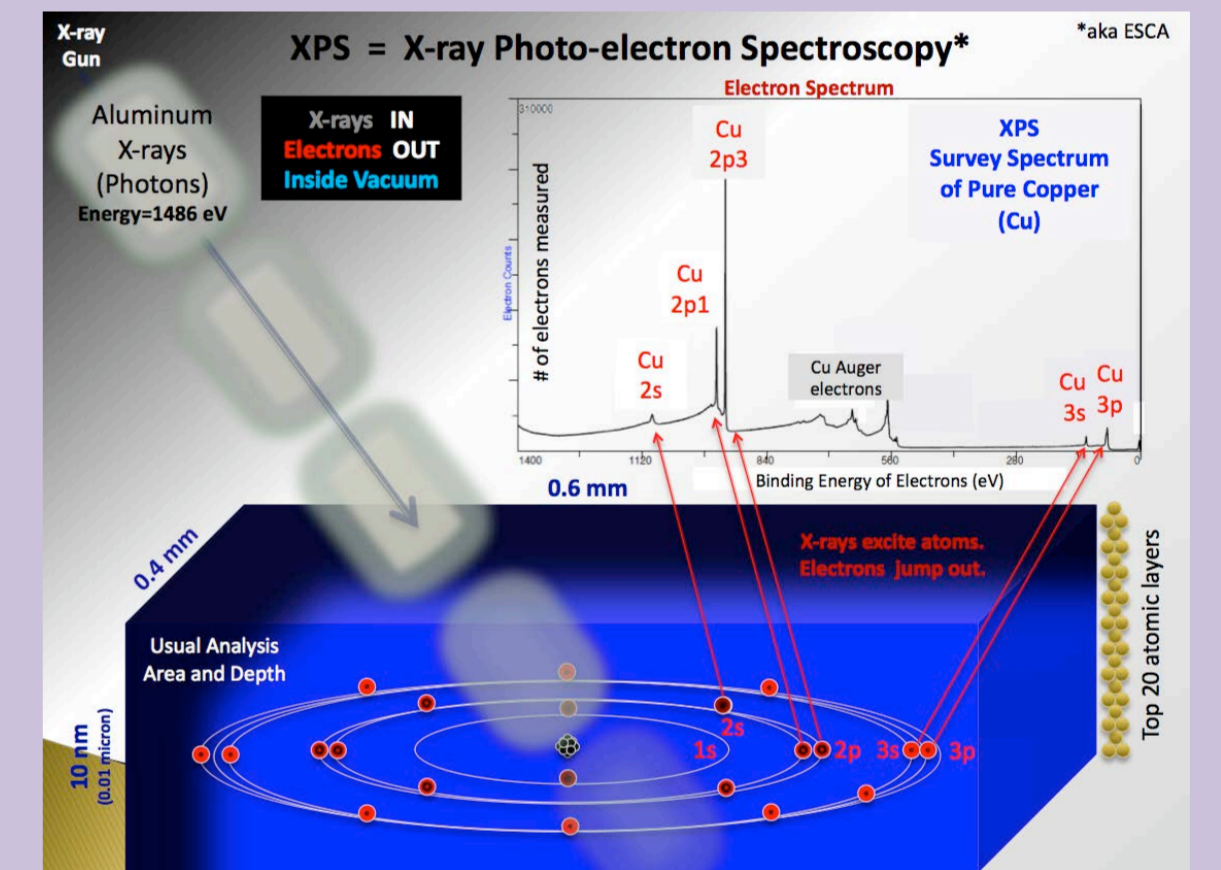
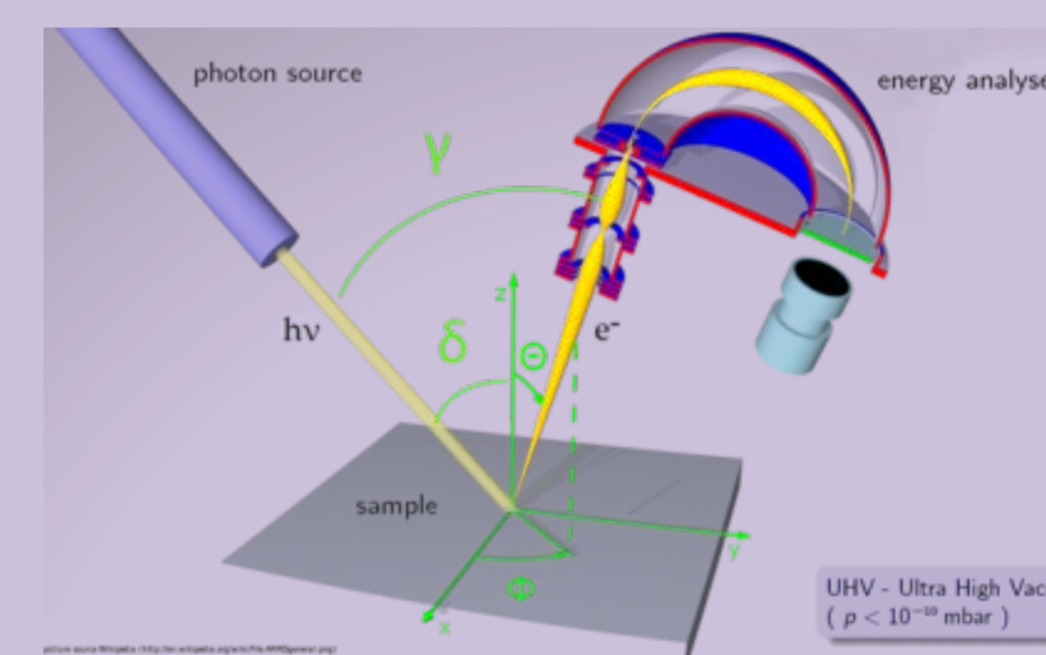
## Application

- Particle accelerators** need a particle (ions or electrons) **source**.
- The pulsed **laser** shoots on the photocathode and electrons are emitted thanks to the **photoelectric effect**.
- The electro-magnetic field produced inside the accelerating cavity "speeds up" the electrons.
- The electrons are then **injected** in the accelerator.



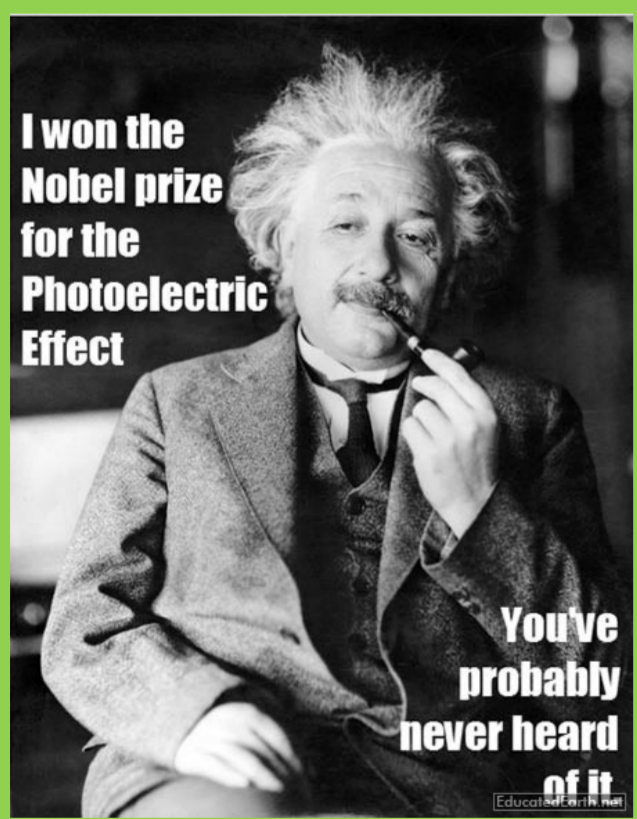
## Material Studies

- X-Ray Photoemission Spectroscopy** is used to analyse the cathode chemical composition.
- The x-rays are sent to the analysed sample and electrons are emitted.



- The measured electron energy is a direct indication of the atomic levels energy, therefore of a given **chemical element**.

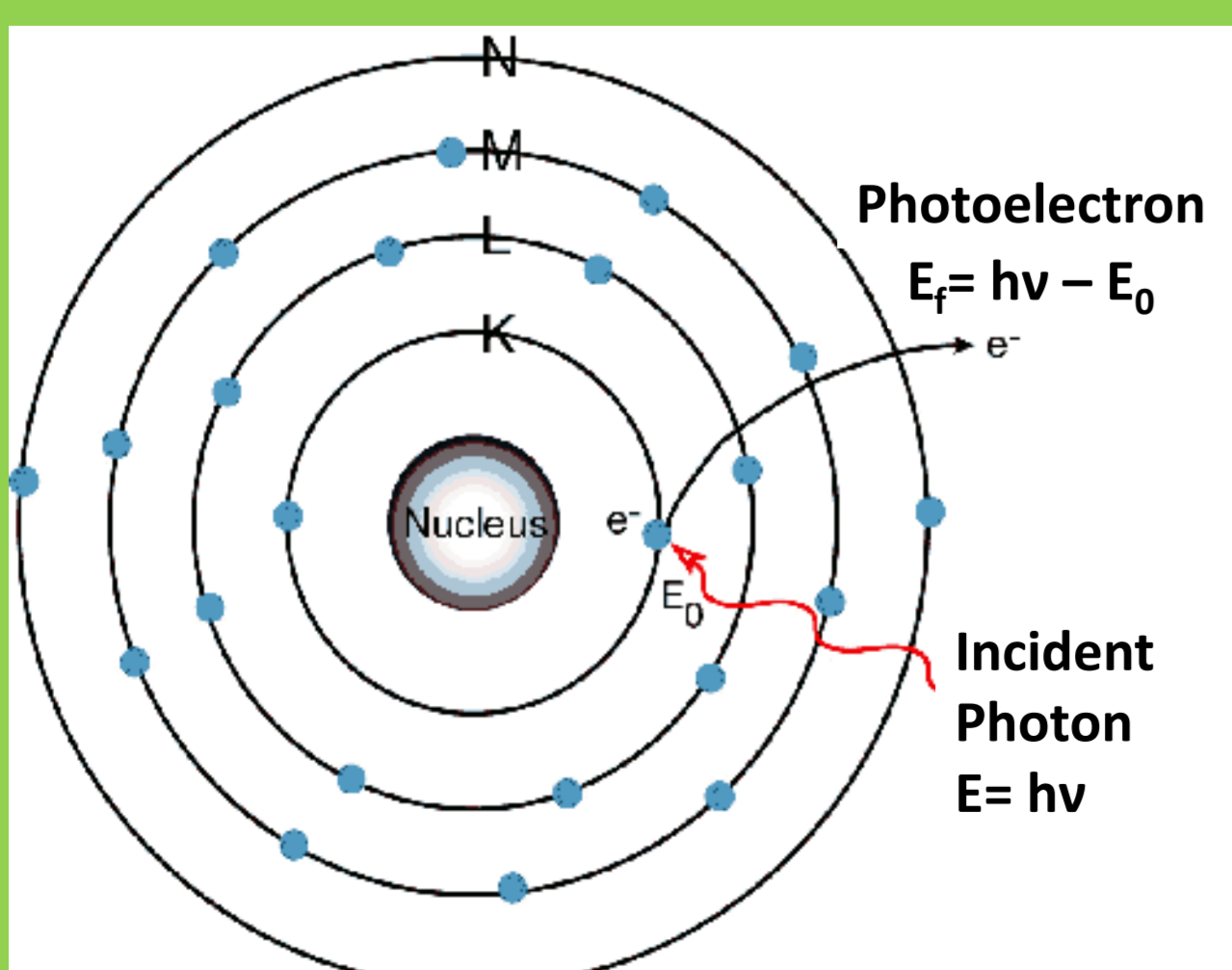
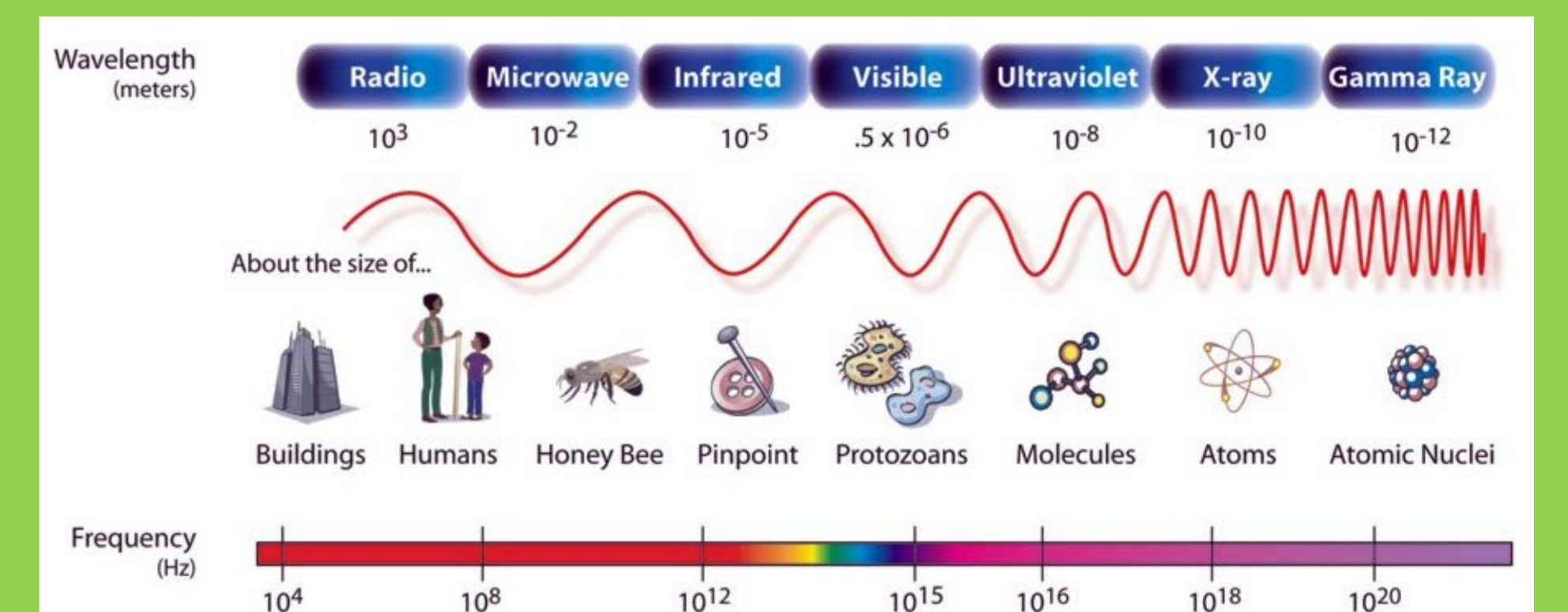
## The Photoelectric Effect



Albert Einstein, 1905

- The electromagnetic radiation (light, laser beam, x-rays) is made of **photons**: elementary particle, light bundle.
- The **photon energy** (E) is proportional to the frequency:

$$E_1 = h\nu_1 \quad E_2 = h\nu_2 \quad E_1 > E_2 \quad \nu: \text{Frequency [Hz]} \quad h: \text{Planck Constant [J*s]}$$



- In quantum physics the energy of an atom displays discontinuous levels.
- If the atom is excited (e.g. by a photon), an electron can jump to the next energy level.
- If the **photon energy** matches the **atomic level energy** (+ the material work function) electrons are emitted.

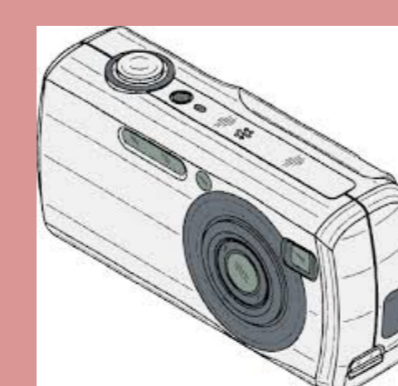
## Many Applications

Particle Accelerators

CTR TV

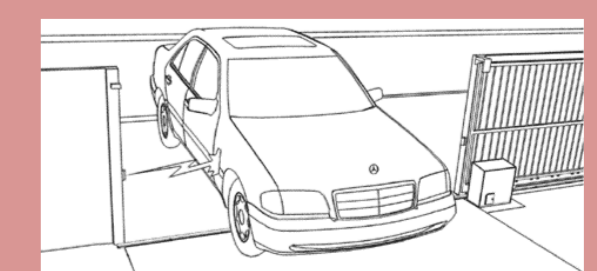
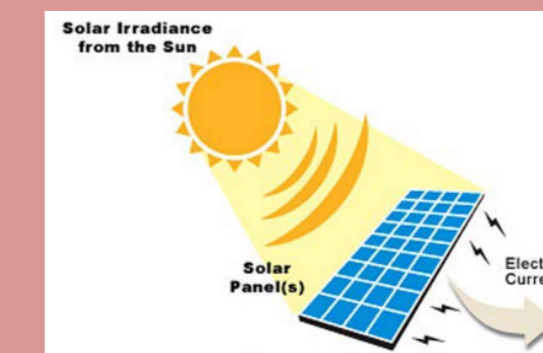


Material Science



Digital Camera

Photovoltaic cells



Safety Photocells