Session 5

MEDICAL IMAGING PHYSICS MADE EASY

SUMMARY 1

By

Dr. Ahmad Mokhtar Abodahab

Components of Atom

Neutron

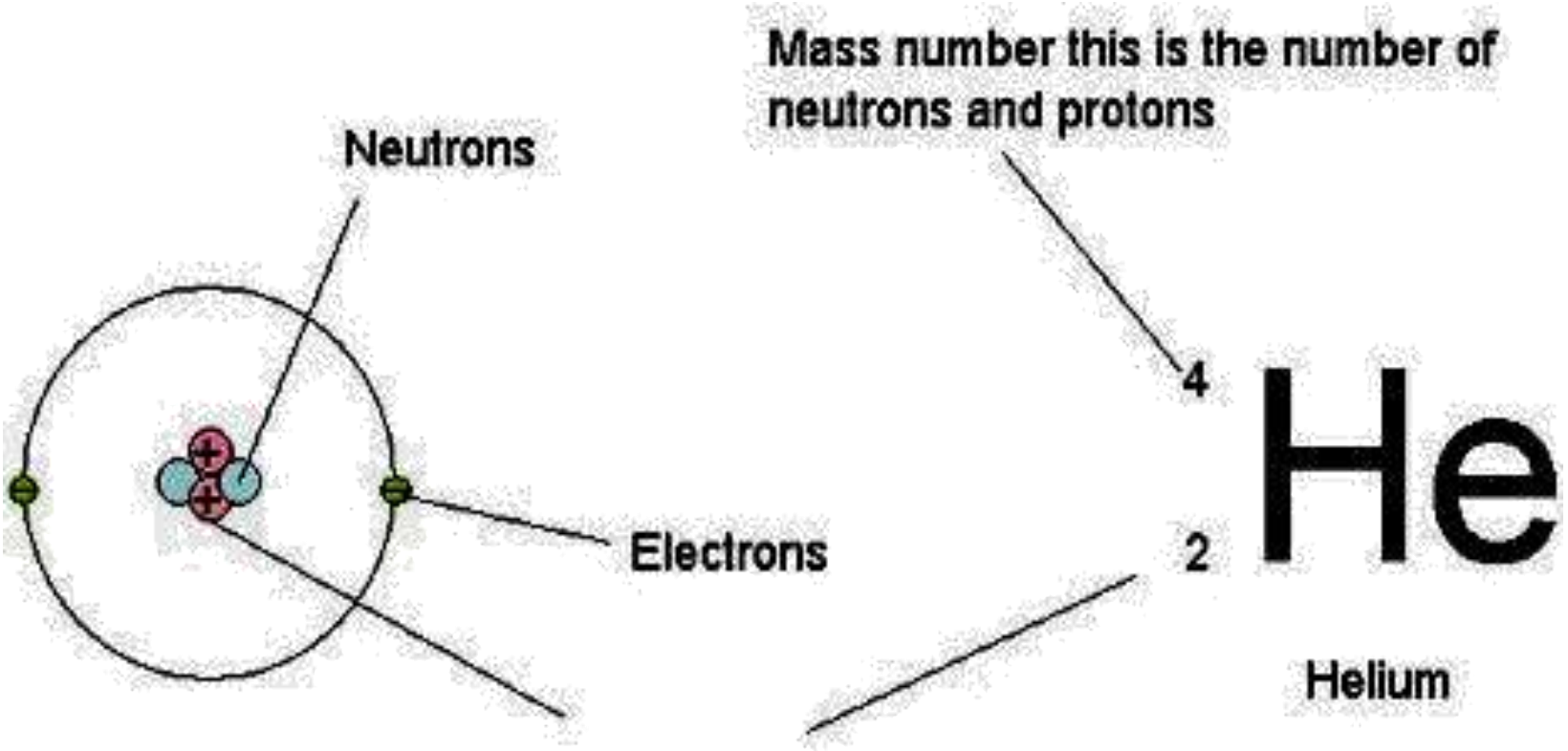
no charge

Proton

+

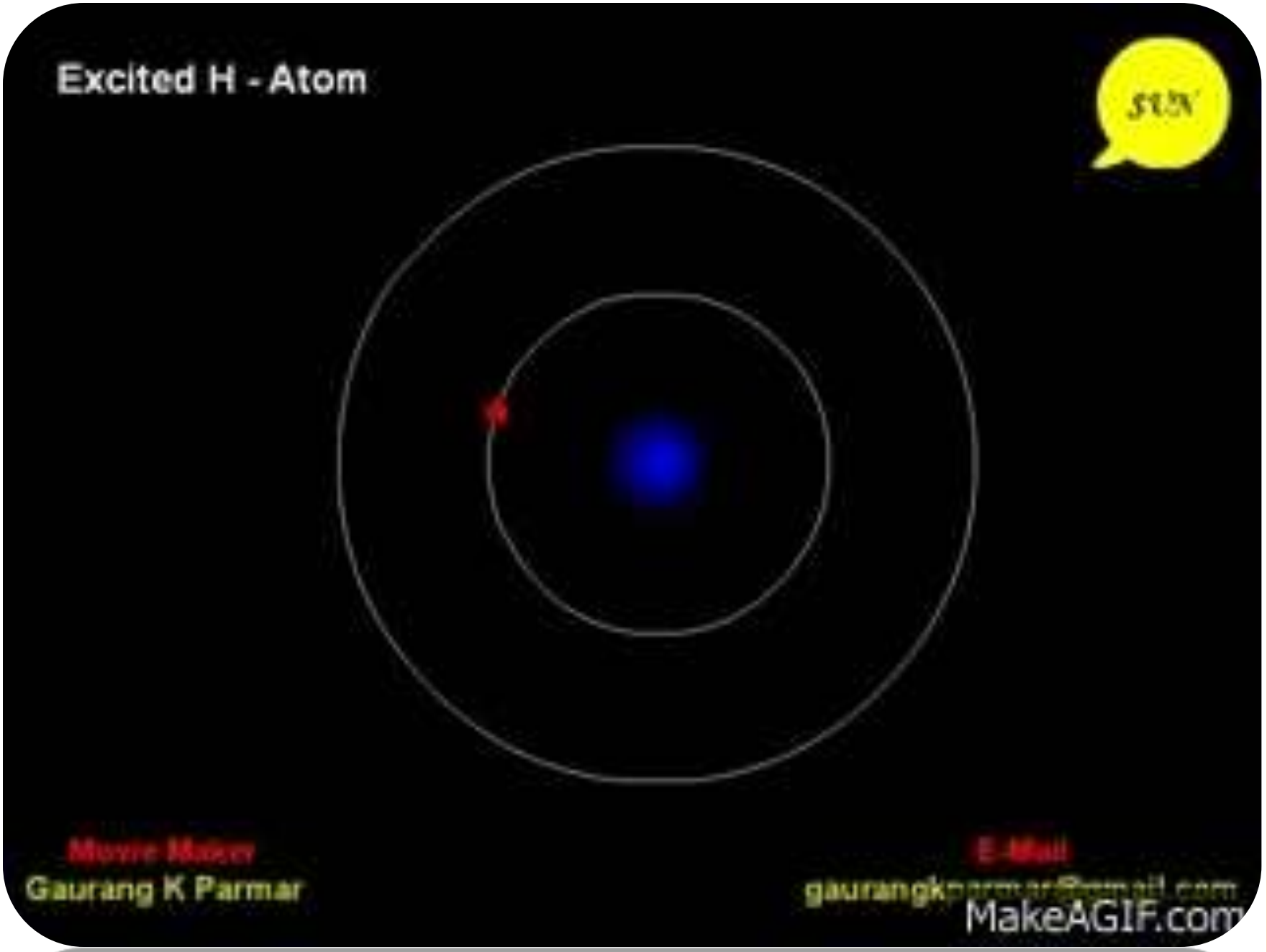
Electron

-



Protons:

This number lets us know how many protons there are. In a neutral atom this is also the same as the number of electrons.


Excited H - Atom
SUN
Movie Maker
Gaurang K Parmar
E-Mail
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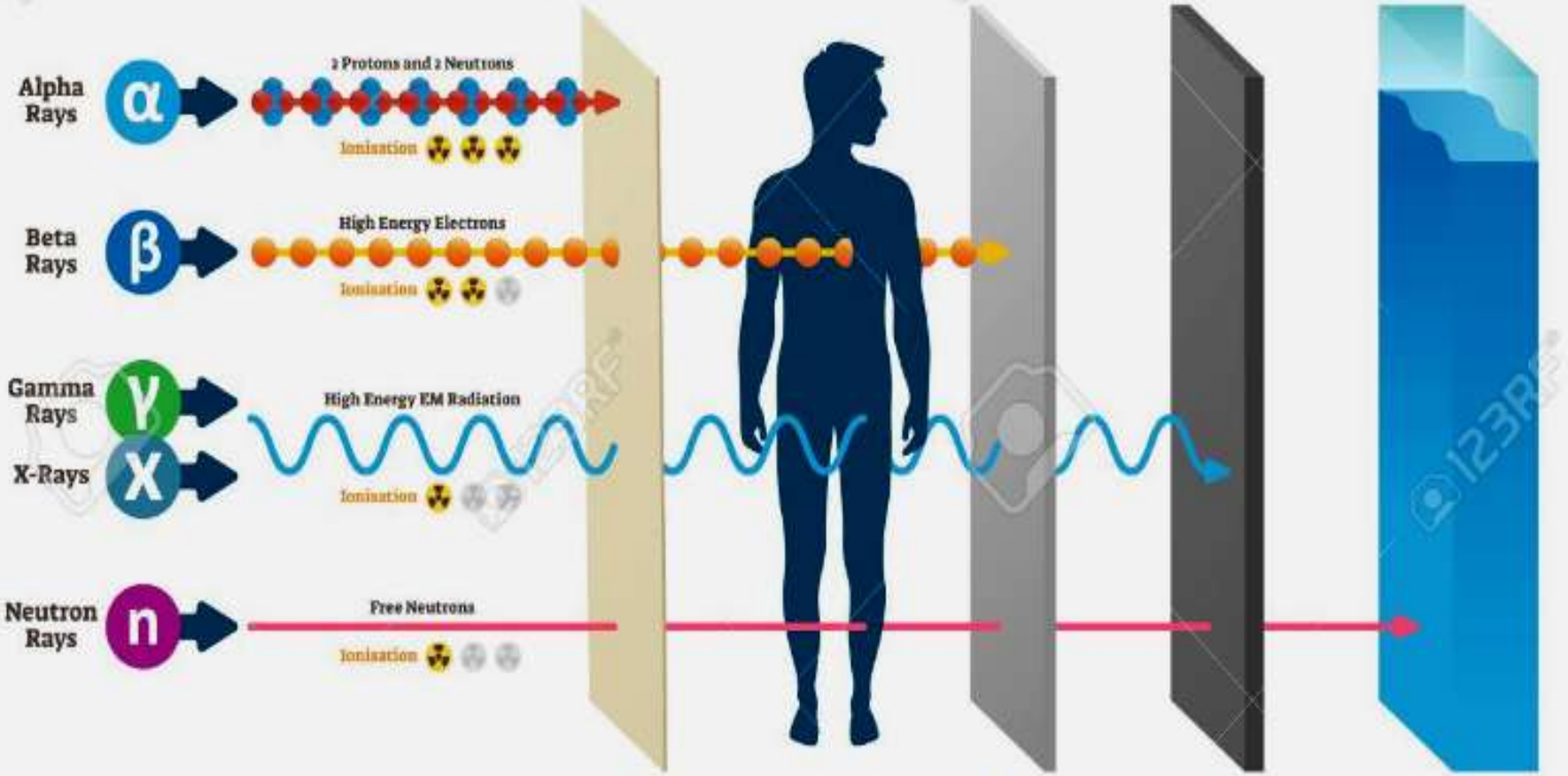
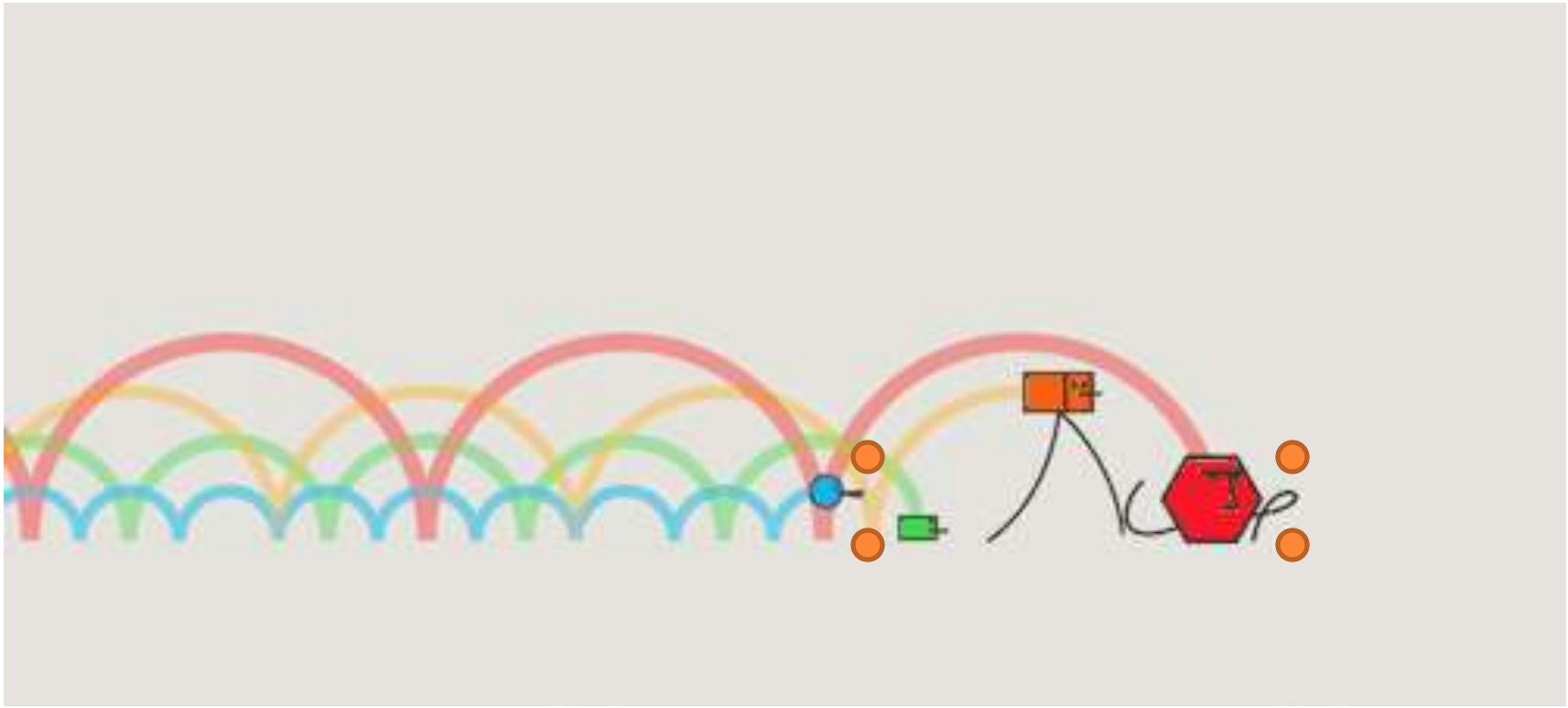
TYPES OF RADIATION



How Penetrating?

- Paper — Stops α rays
- Thin Aluminum — Stops β rays
- Thick Lead — Stops γ, X rays
- Water or Concrete — Stops neutron rays

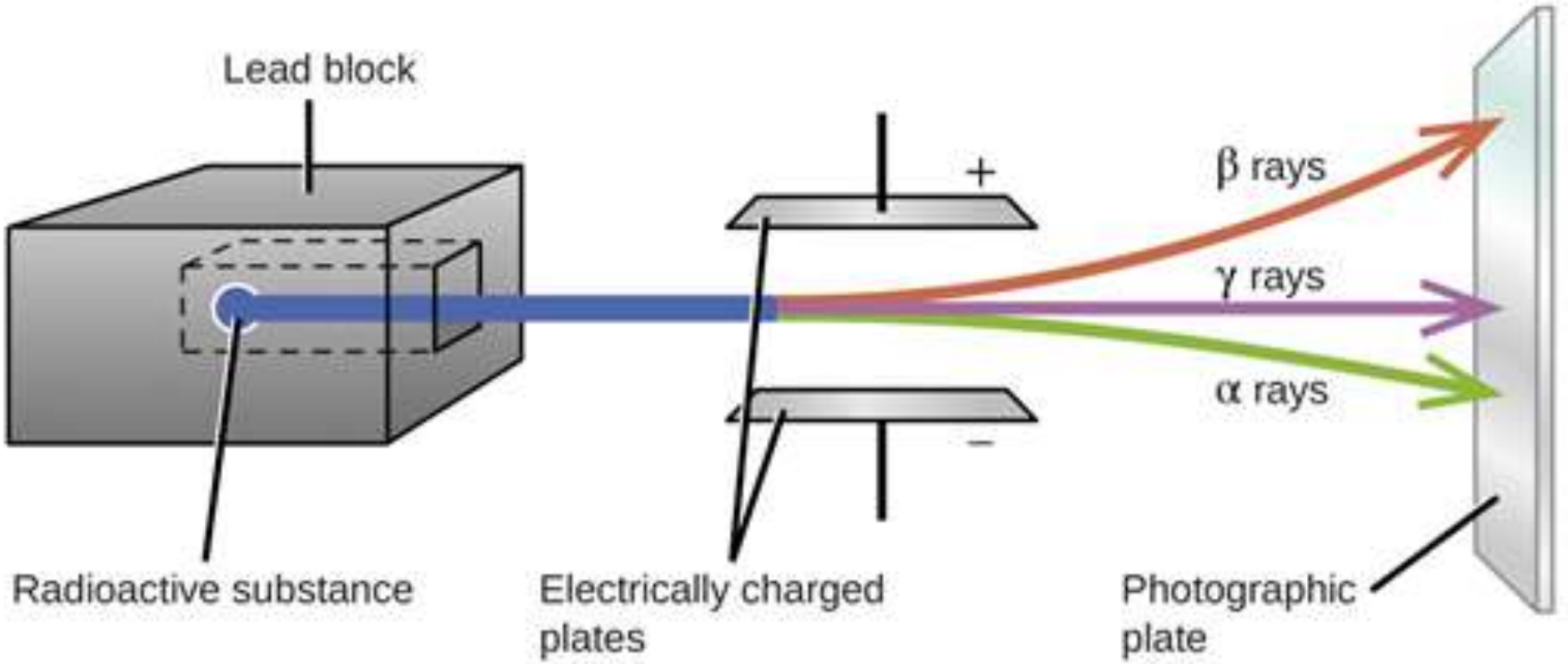


Smaller Wave length = More Penetration ability
Wave length is inversely proportional to Frequency

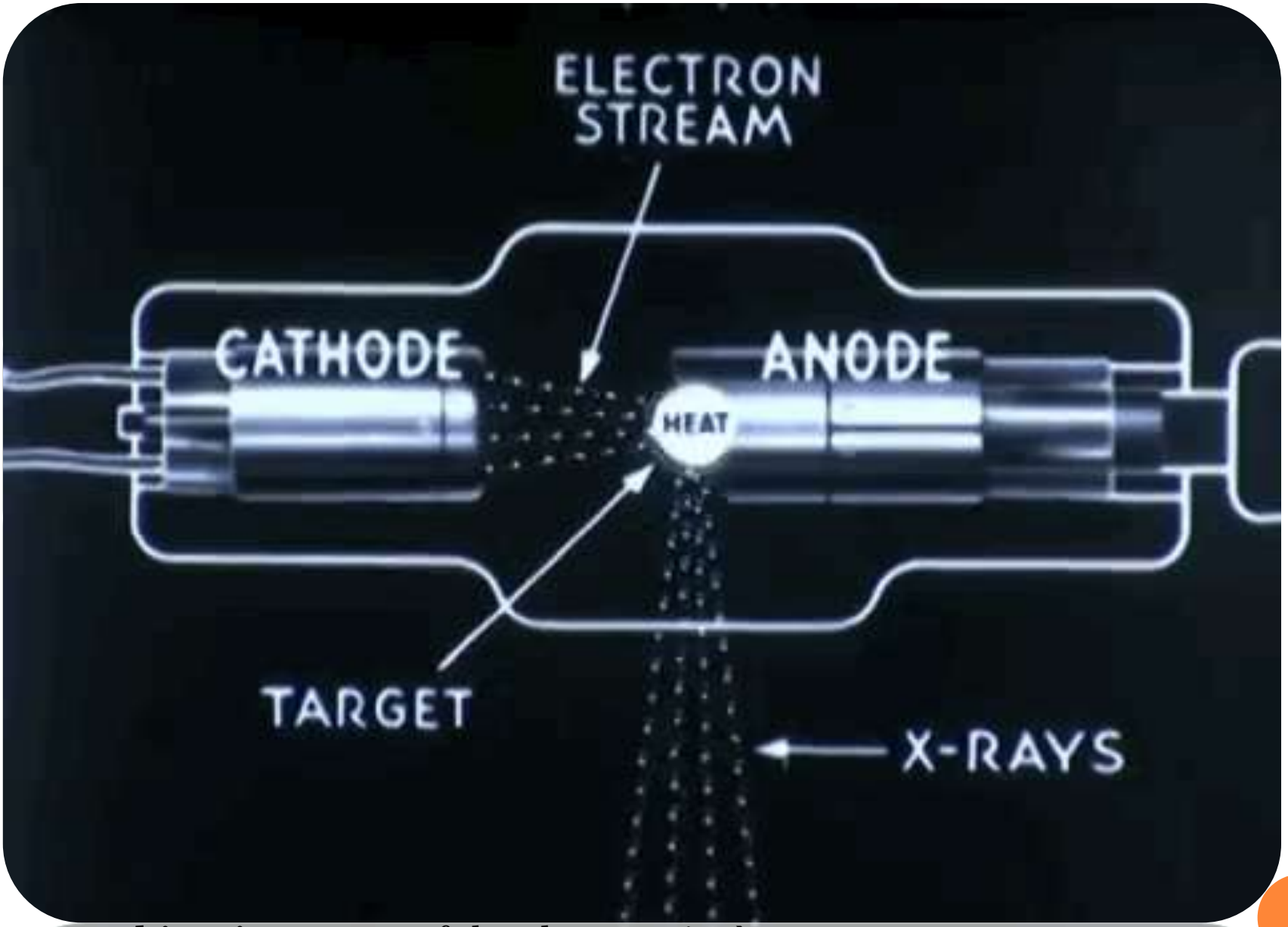
X RAY :

- **Name** : X i.e. Unknown
- **Type** : Electromagnetic wave
- **Wavelength** : 0.01 : 10 nanometer
- High penetration ability
- Radiographic characters.

1 mm = 1 Million nano



X ray & Gamma Rays Not affected by magnetic Field



kinetic energy of the electrons is →
converted into **X-rays** (no more than **1%)**
and into **heat (99%).**

- **kV** is controlling **X ray penetration**

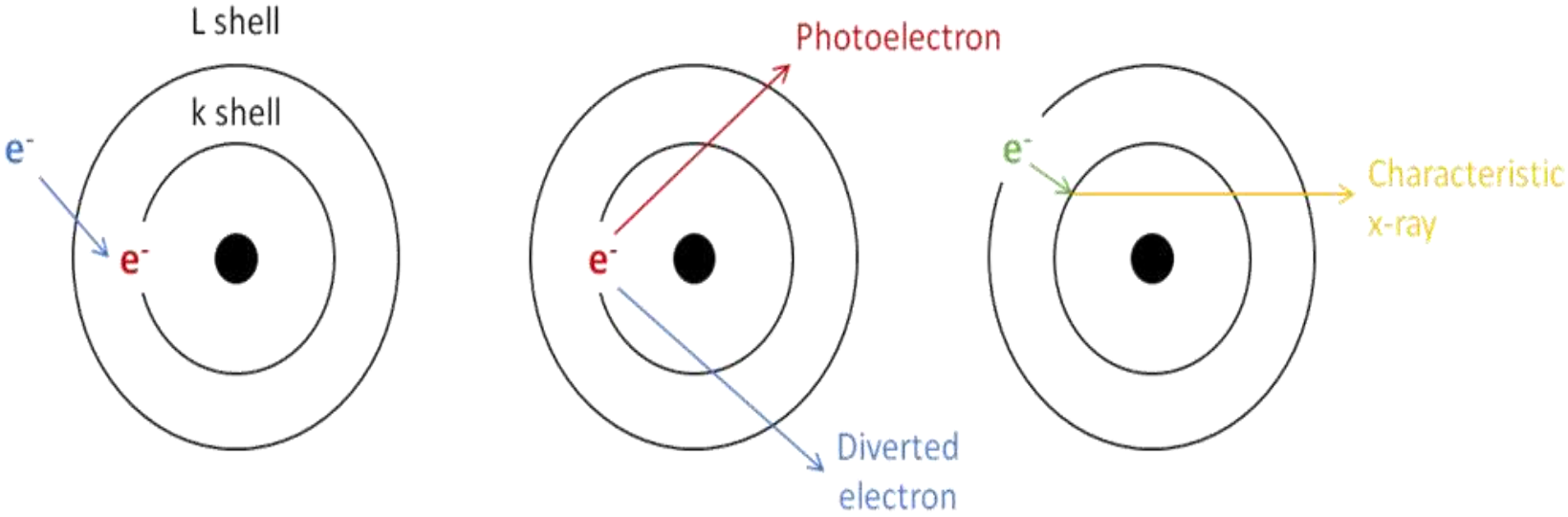
عوامل التعرض Exposure Factors:

هي العوامل التي يمكن من خلالها التحكم بالأشعة الخارجة من إنبوبة الأشعة وهي ثلاث عوامل:

1. الكيلو فولت KV: هو فرق الجهد بين الكاثود والأنود خلال إنتاج الأشعة. وهو يتحكم بطاقة الأشعة السينية فكلما زاد الكيلوفولت زادت طاقة الأشعة. وكلما زادت طاقة الأشعة السينية زادت قدرتها على إختراق الأجسام.
2. الميلي أمبير mA: كلما زاد الميلي أمبير زادت الإلكترونات المنبعثة من الكاثود إلى الأنود مما يؤدي إلى زيادة كمية الأشعة السينية.
3. مدة إنتاج الأشعة: فكلما زادت مدة إنتاج الأشعة زادت معها كمية الأشعة وهي تقاس بالثانية.

- **X ray production Interaction may be of (3 Types)**
  - interaction with K shell → **Line spectrum** characteristic X ray
  - Interaction with nucleus →**Continuous spectrum,** ***Bremsstrahlung***,
  - Electron immediately & completely stopped.

Characteristic x-ray production

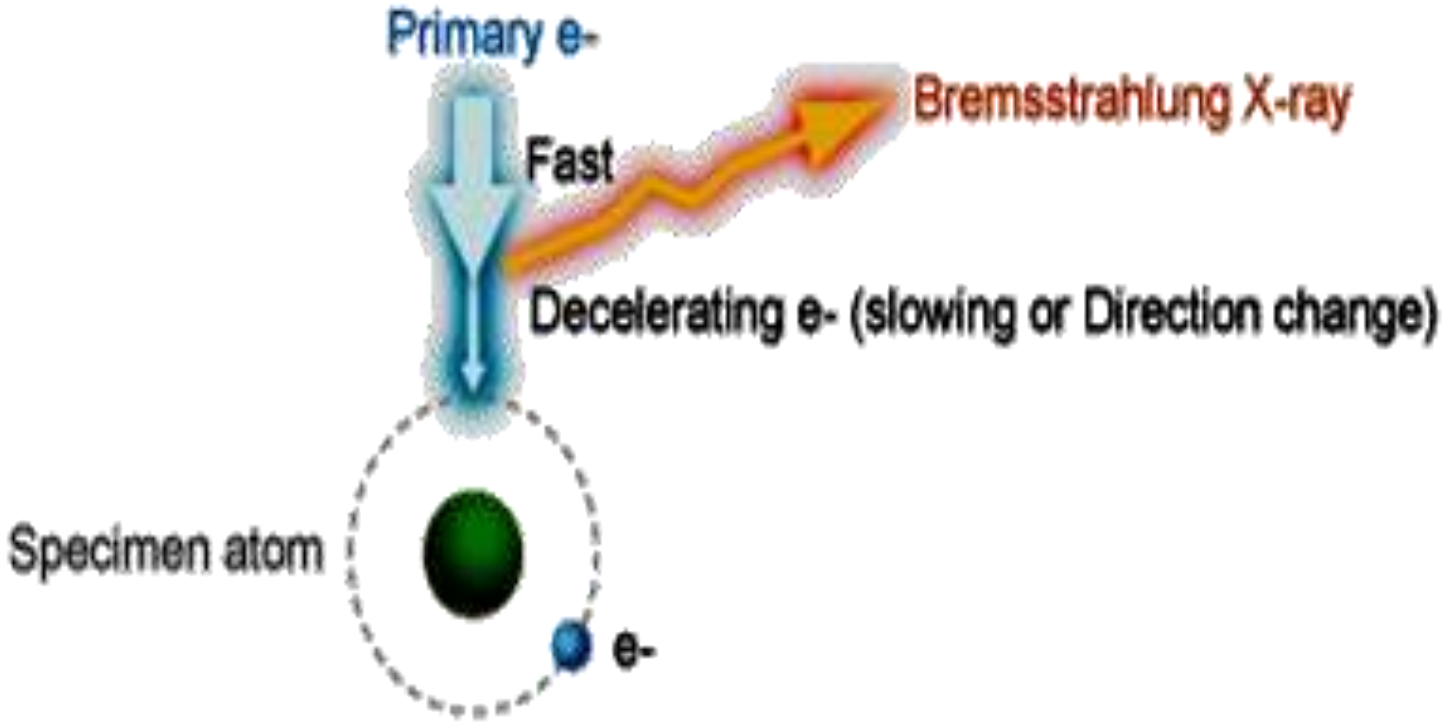


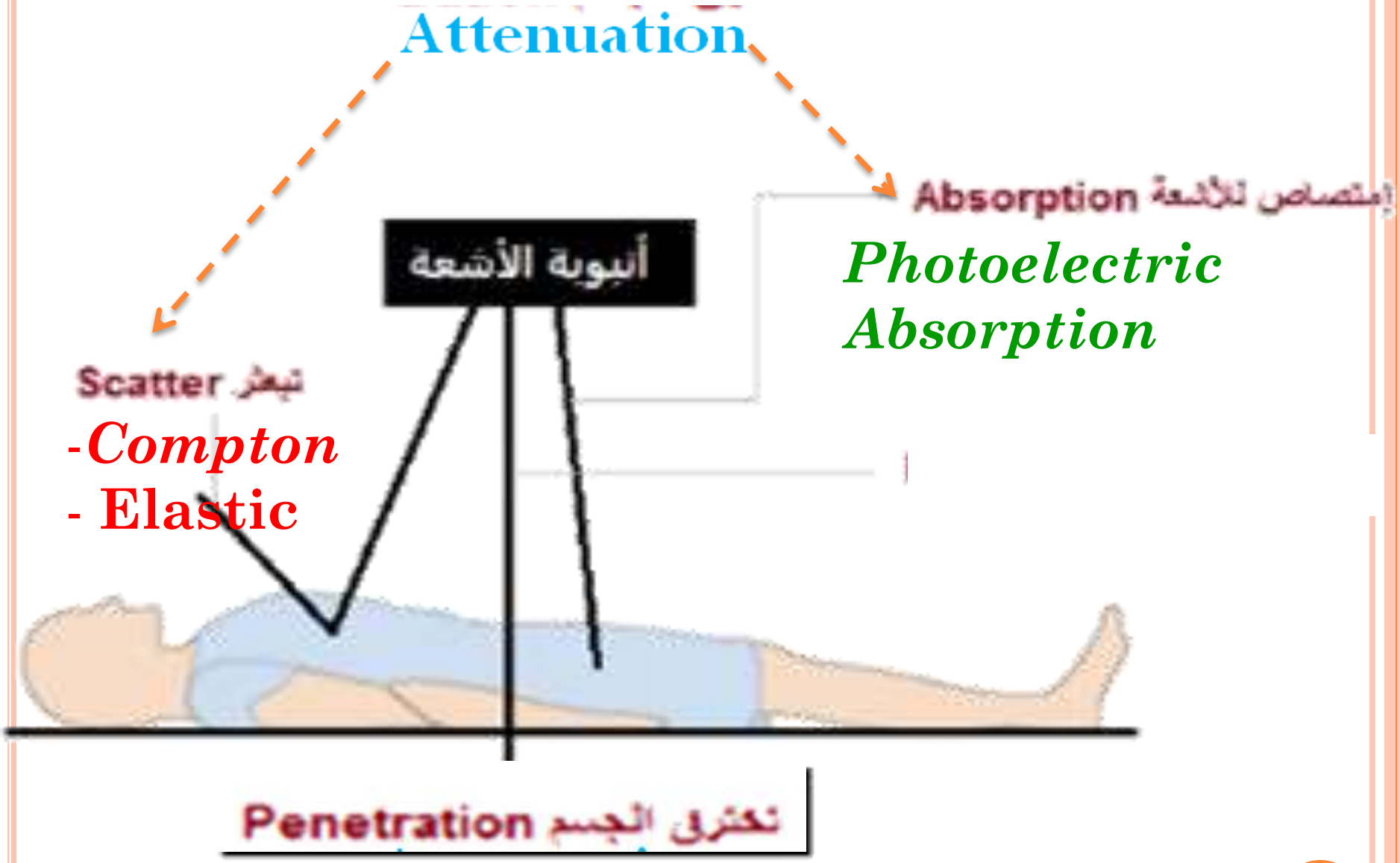
1. Bombarding electron strikes k shell (or other shell) electron

2. Bombarding electron diverted. Electron that's hit ejected as a photoelectron and absorbed

3. Outer shell electron moves down to fill the ejected electron's space. The energy from this is released as a characteristic energy photon

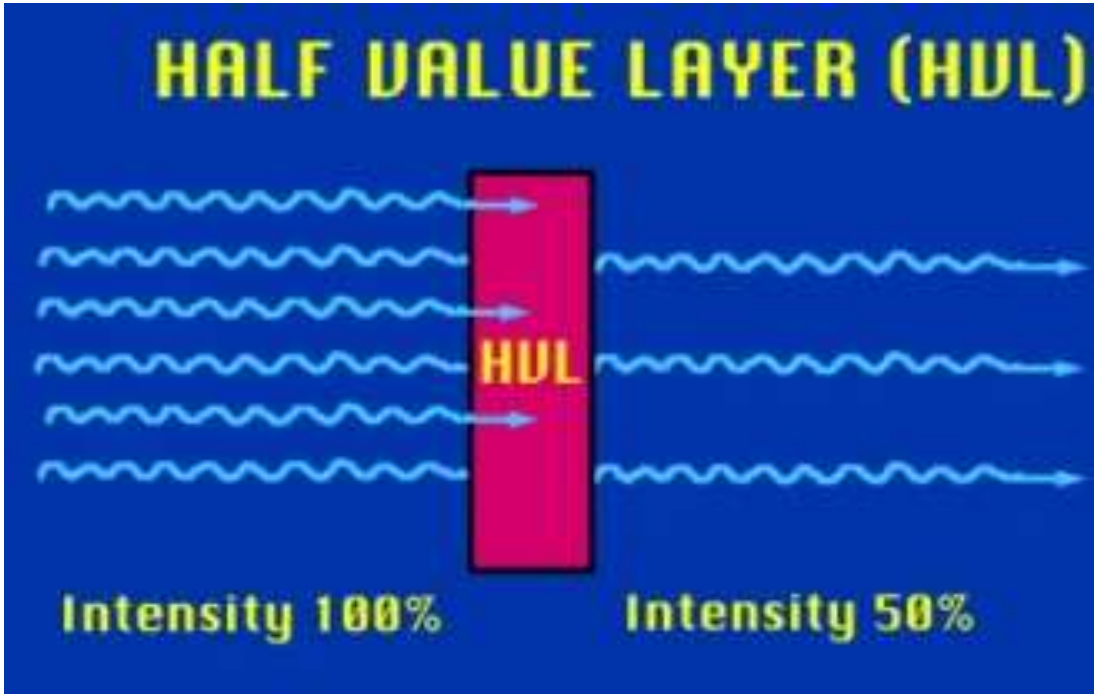
Bremsstrahlung X-ray production




Attenuation
Absorption إمتصاص للأشعة
أنبوبة الأشعة
Photoelectric
Absorption
Scatter تبعثر
-Compton
- Elastic
Penetration تخترق الجسم

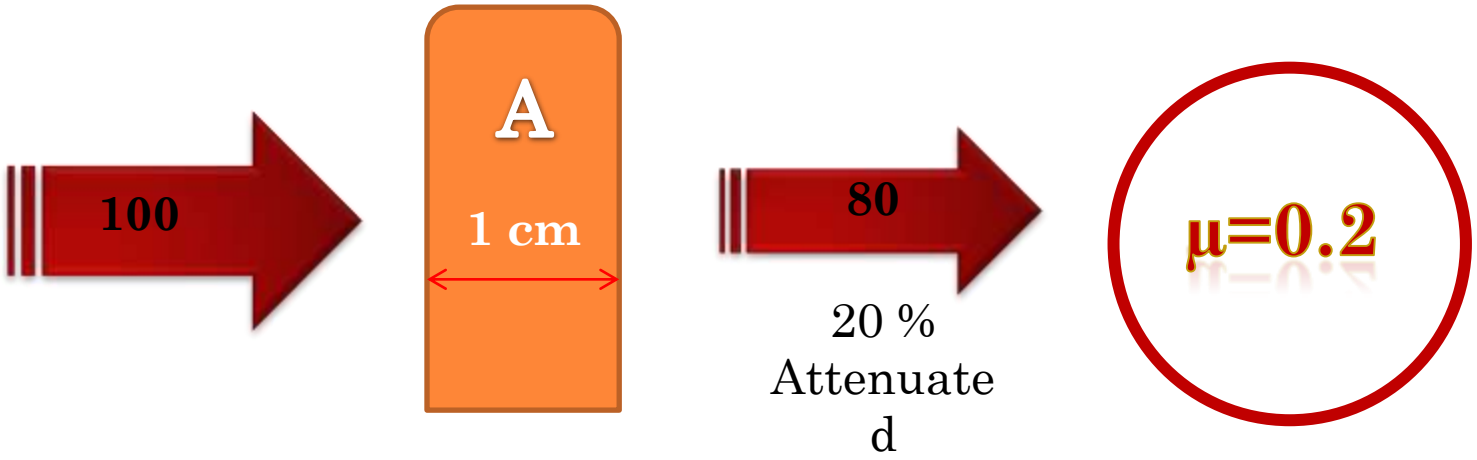
HALF-VALUE LAYER (HVL)

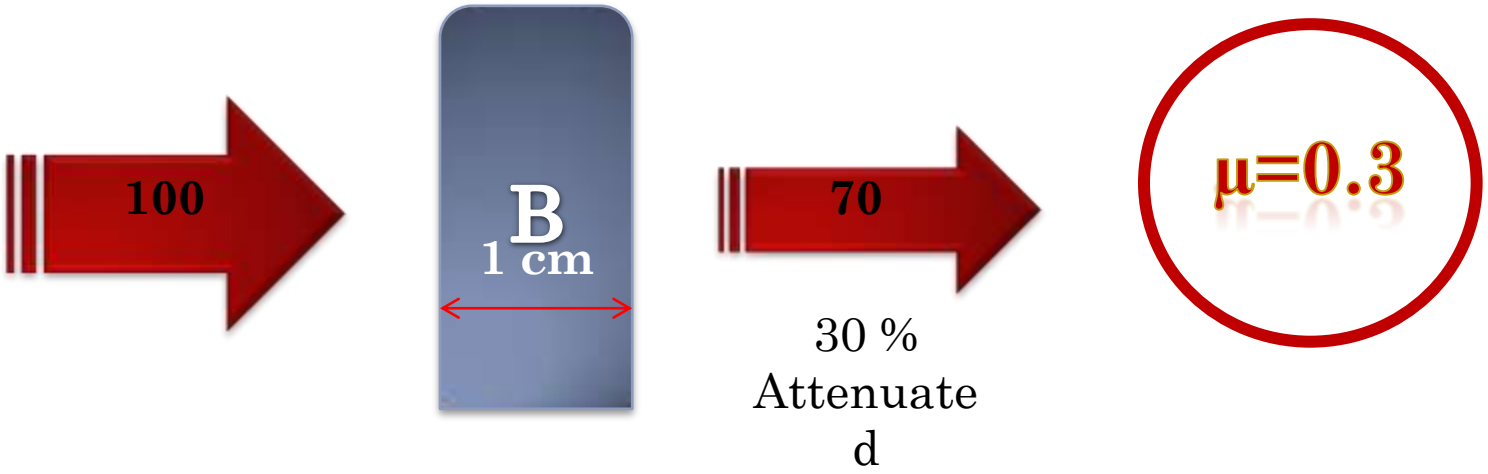
- the thickness of material that → reduce the intensity of a X ray beam → to one-half of its original value.



LINEAR ATTENUATION COEFFICIENT (μ)

Percent of attenuated photons / Thickness of matter





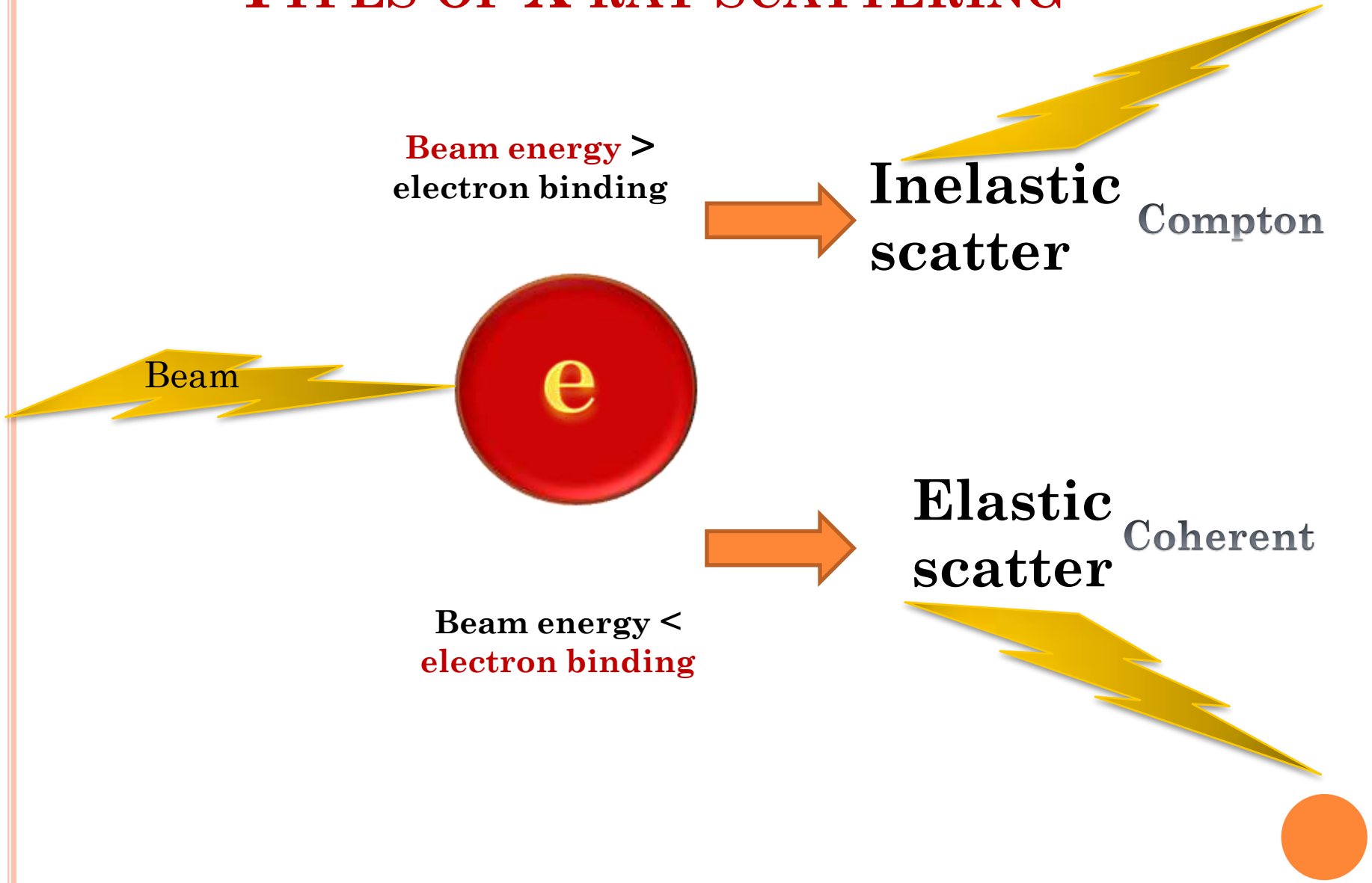
X RAY IN THE MATTER

What's occur ?

3 Process

2 Scatter & 1 Absorption

Types of X ray scattering



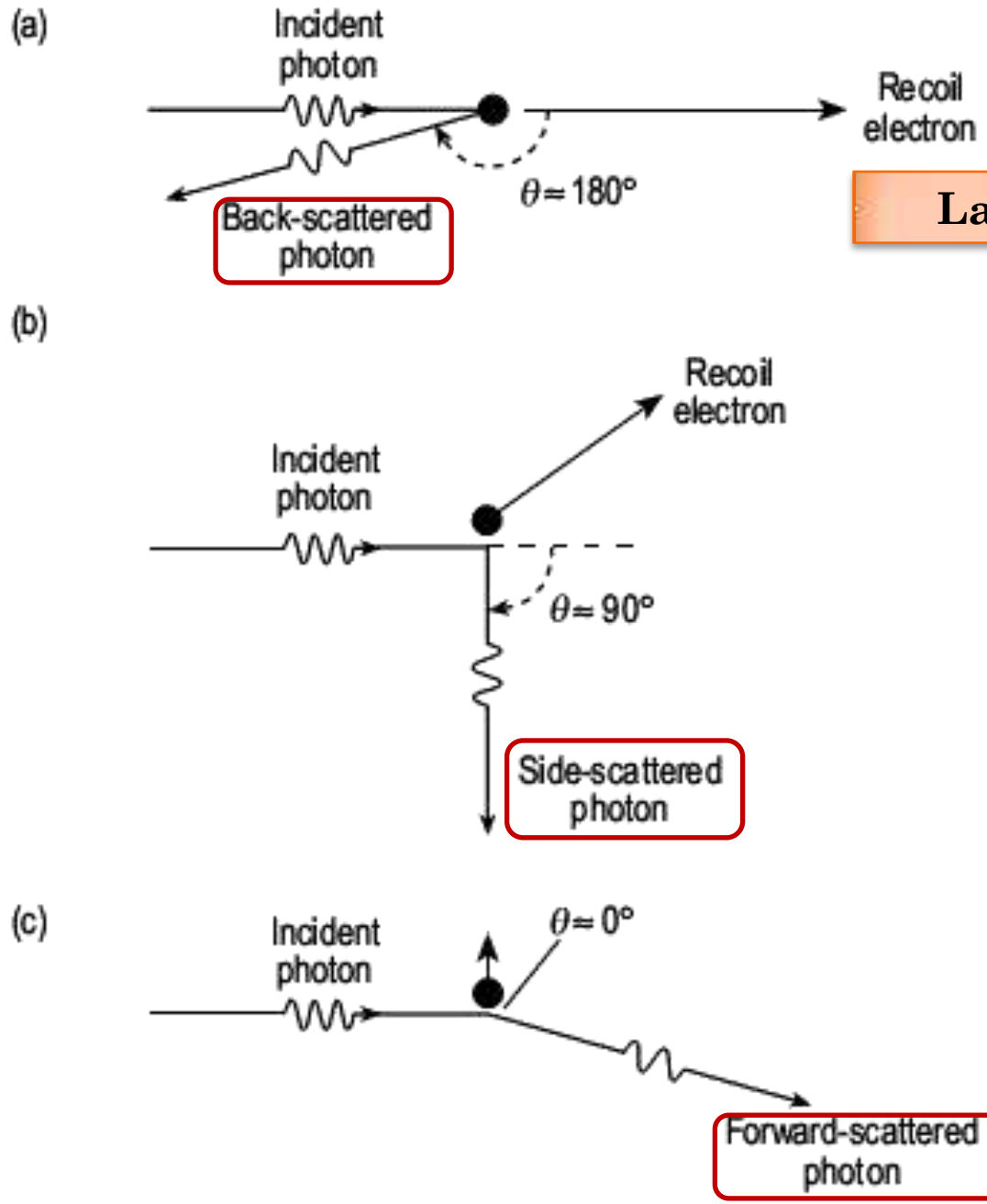


Figure 1.14 Compton scattering by a free electron.

Large angle = lower energy photon

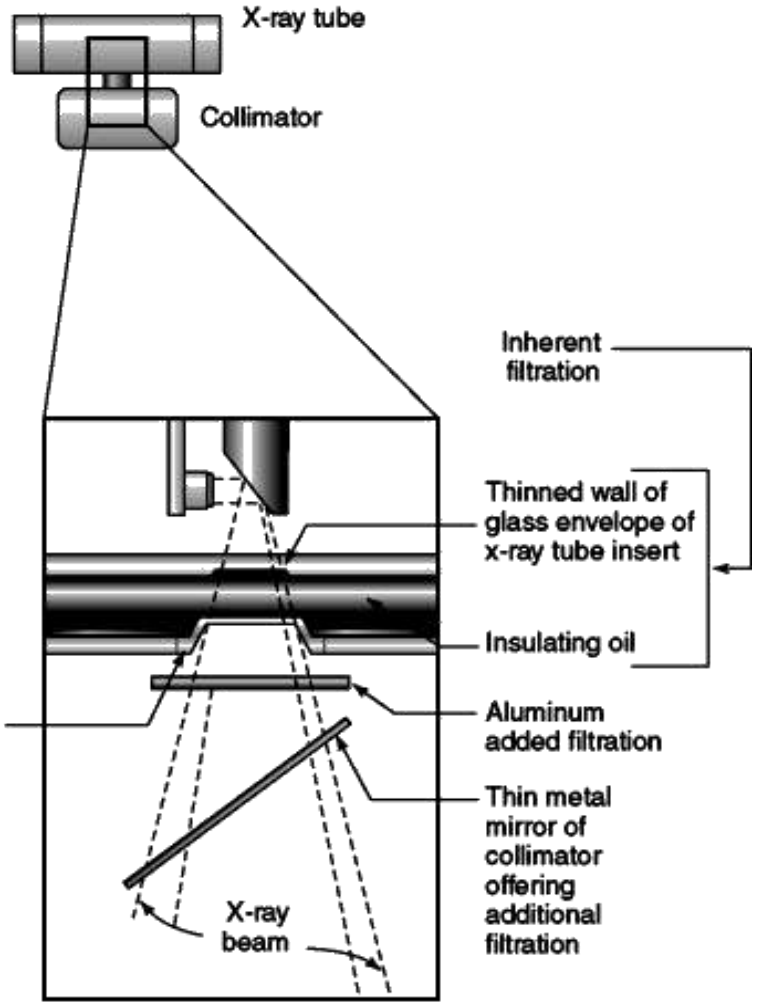
EFFECT OF THE ANGLE OF SCATTERING

Small angle = Higher energy photon

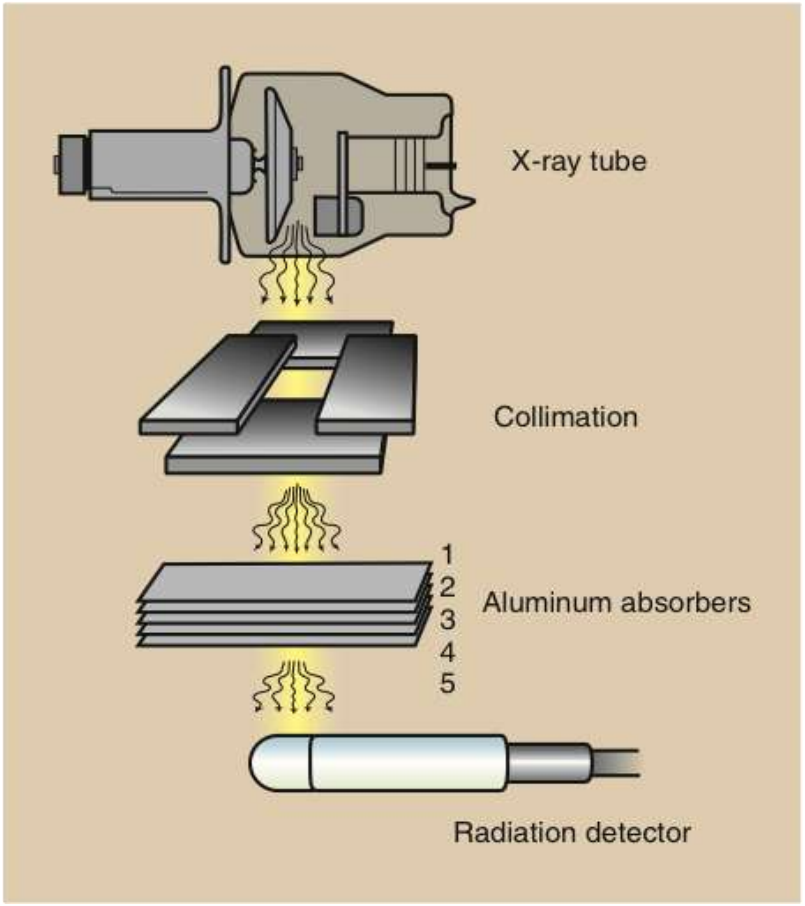
Types Of Filtration ?

Inherent & Added Filtration

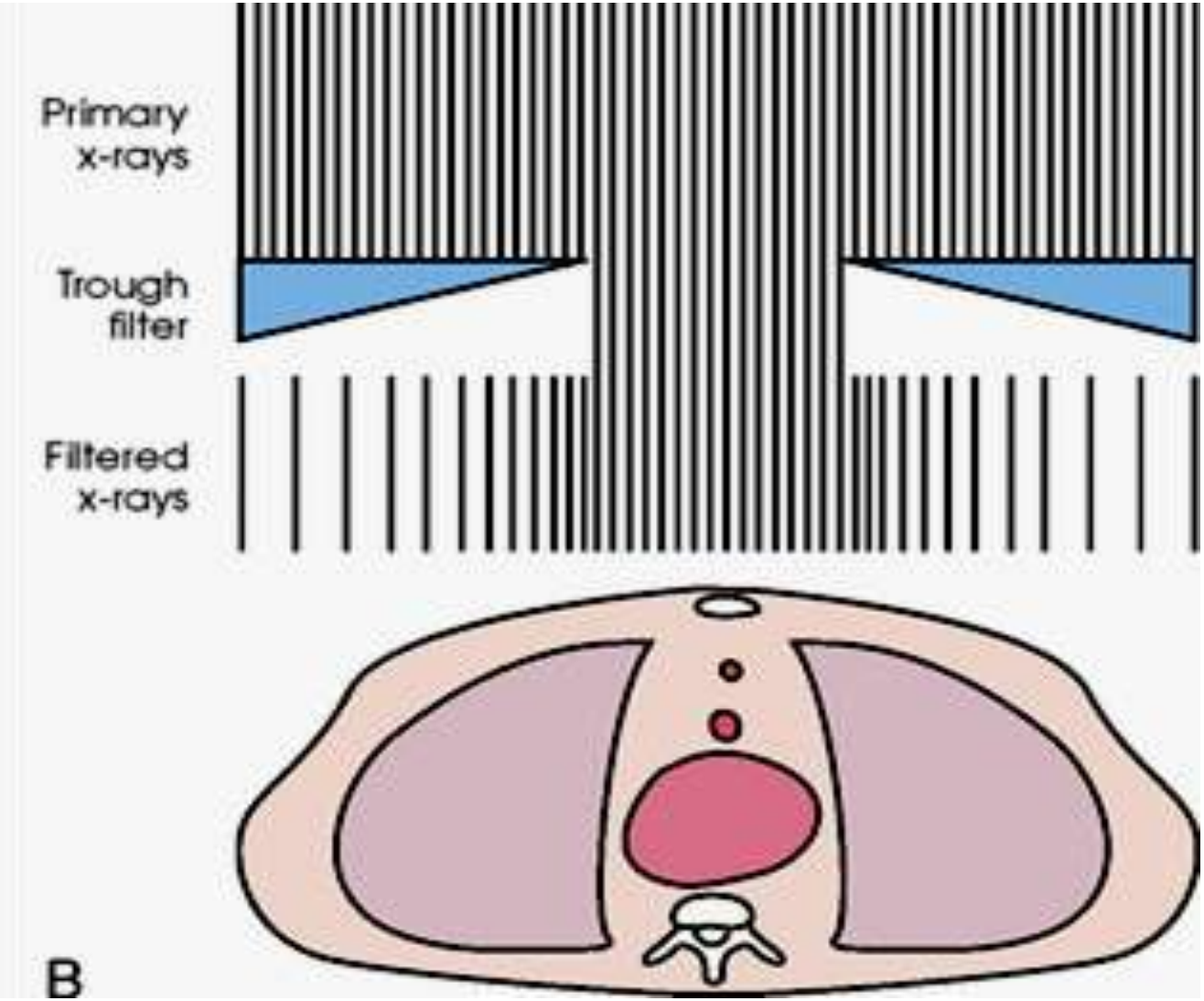
- **Inherent** :



- **Added** or **Additional filtration**:

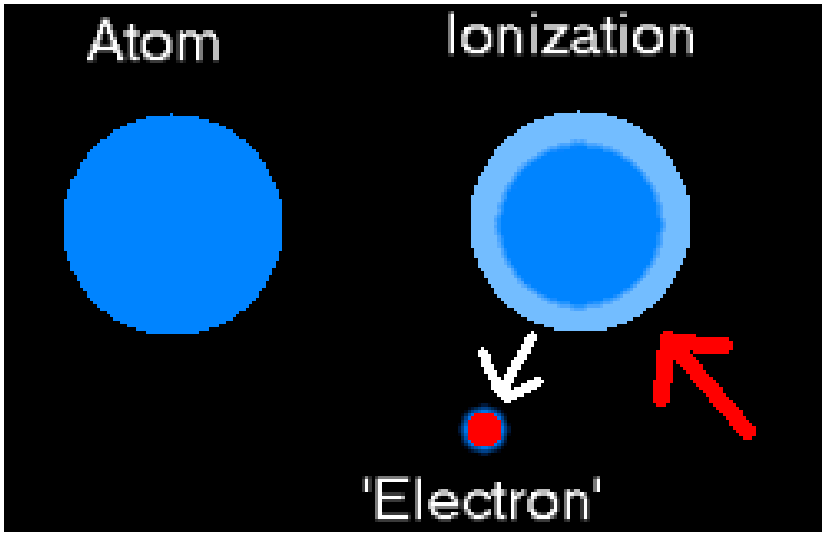


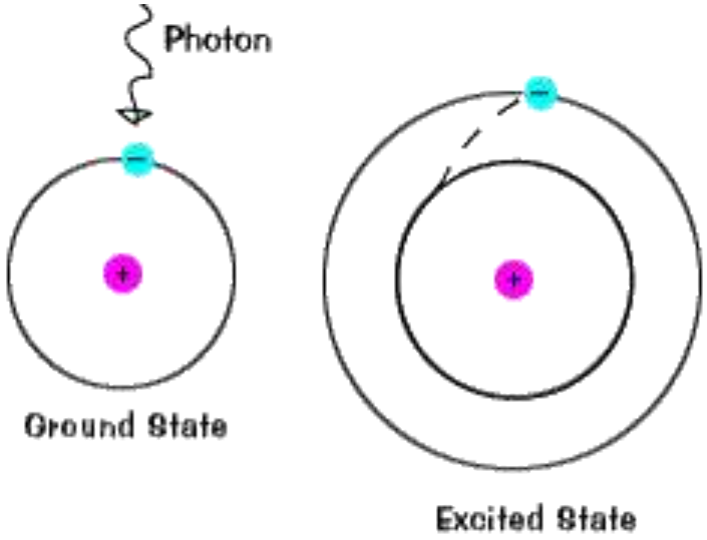
* COMPENSATING OR WEDGE FILTER



Absorbed dose

- Effects of ionizing radiations →correlated with the energy deposited as **ionization** and **excitation** of atoms of the material.





- **Absorbed dose:** energy deposited per unit mass of the material (in **joules / Kg**).

- **Absorbed dose is :**

- the energy deposited in a material from the interaction of ionizing radiations.

- expressed in the unit gray **(Gy).**

- commonly measured using ionization chambers.

-

Summary – Radiation Quantities & Units

Quantity	Equation	Medium	Type of Radiation	SI unit	Classical unit	Relation
Activity	A=dN/dt	Any medium	Any radiation	Bq (dps)	Ci	1 Ci = 3.7×10^{10} Bq
Absorbed dose	D = dE/dm	Any medium	Any radiation	Gy (J/kg)	Rad 1Rad=100 ergs/g	1 Gy=100 Rad
Equivalent dose	$H = D\times W_R$	Living tissue	Radiation dependent	Sv	rem	1 Sv = 100 rem
Effective Dose	$E = H\times W_T$	Whole body		Sv	rem	1 Sv = 100 rem
Collective effective dose	$S = E_i N_i$			man-Sv	man-rem	
Exposure	X = dQ/dm	Air	X, γ	C/kg	Roentgen, R	1 R= 2.58×10^{-4} C/kg

رسم توضيحي يشرح وحدات قياس الإشعاع والفرق بينهم

Dosimeter Principles

- **Thermal effect** → Non practical
- **Ionizing changes** in air & matter → Ionizing chamber
- Photographic changes → Photographic badges
- Luminescence

- **X-rays** and **gamma rays** cause → **luminescence** in certain materials,
- It can be used for **image formation** and also for **radiation measurement.**

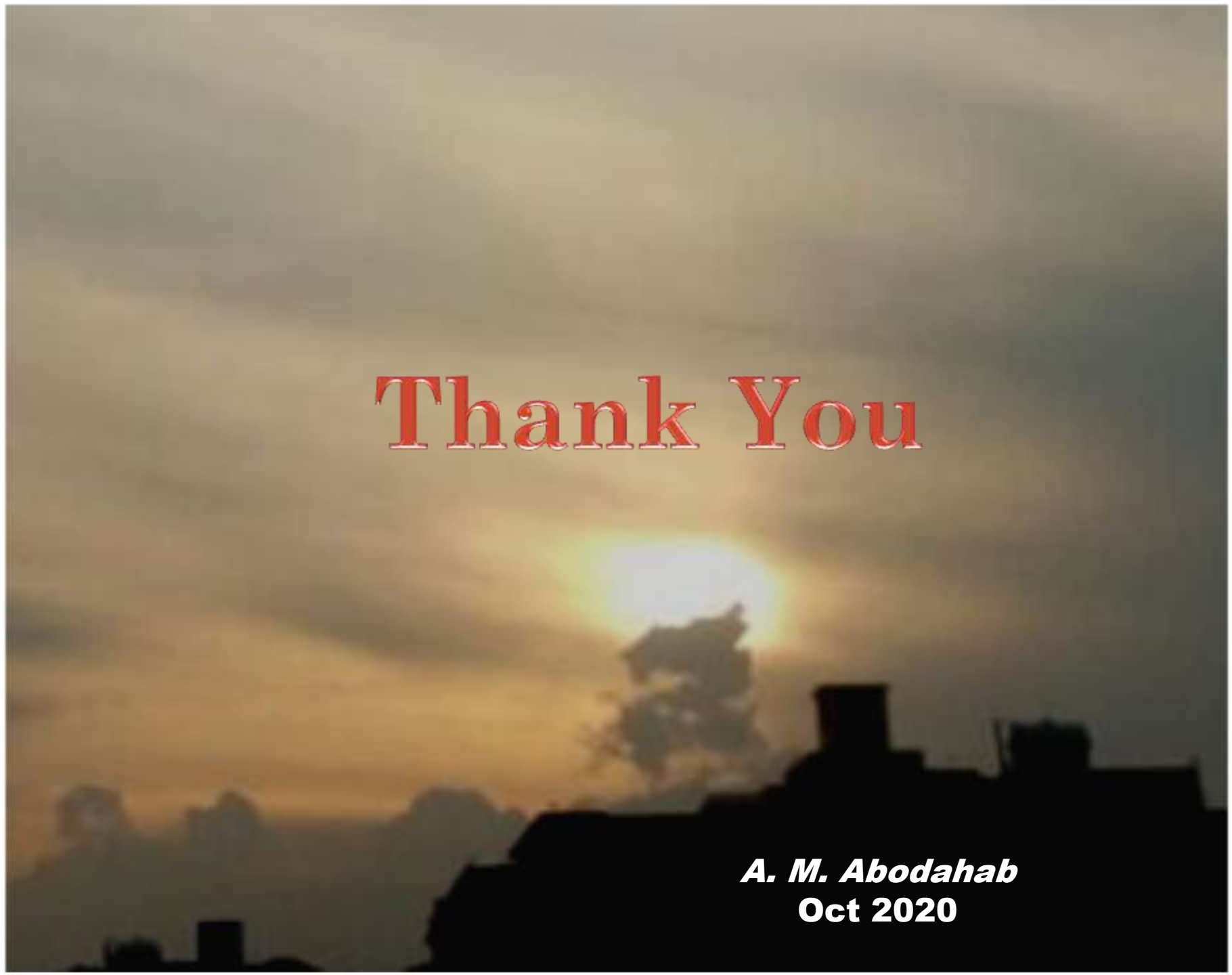
LUMINESCENCE

The process of a material absorbs energy from an external source and re-emits it in the form of visible light.

- External energy source may be : chemical, biological and physical
- in radiology we are concerned only with term **photoluminescencemay** .
- Luminescence can be divided into **two types**:
- **fluorescence,** which is (more or less) the emission of light is directly following energy input
- **phosphorescence**, which describes **delayed light emission** referred to as afterglow.

Nice websites in basics of radiology

- https://radiologykey.com/
- https://radclass.net/
- https://www.startradiology.com/
- https://www.radiologymasterclass.co.uk/
- https://www.radiologycafe.com/
- http://xrayphysics.com/
- https://radiopaedia.org/
- https://www.enec.gov.ae/


Thank You
A. M. Abodahab
Oct 2020