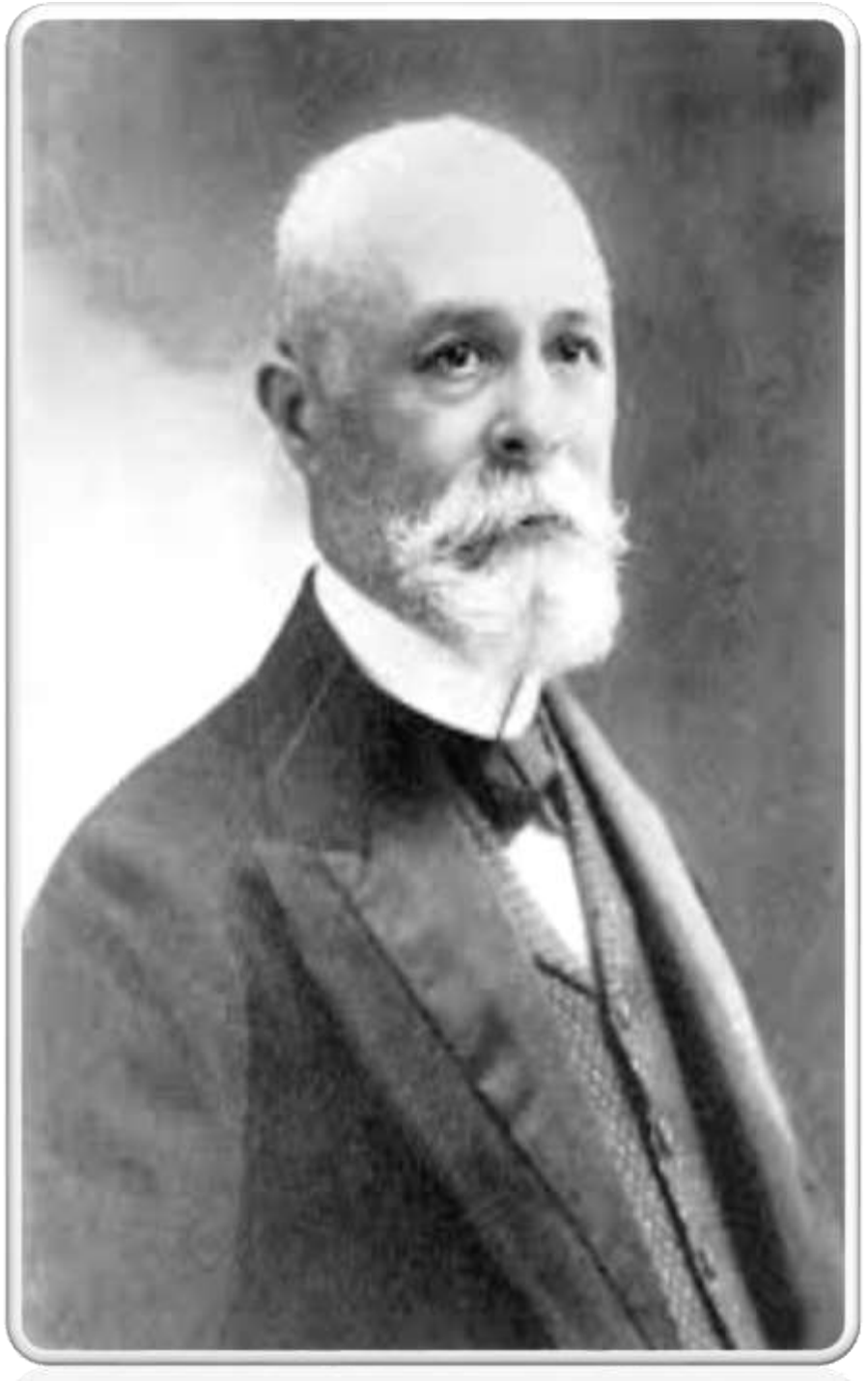

RADIOACTIVITY

Discovery of Radioactivity

- In 1896, the French physicist Antoine Henri Becquerel (1852–1908) accidentally found that a uranium-rich mineral called pitchblende emits invisible, penetrating rays
- there are two experimental evidence that shows Becquerel's rays is originated inside the nucleolus of an atom.

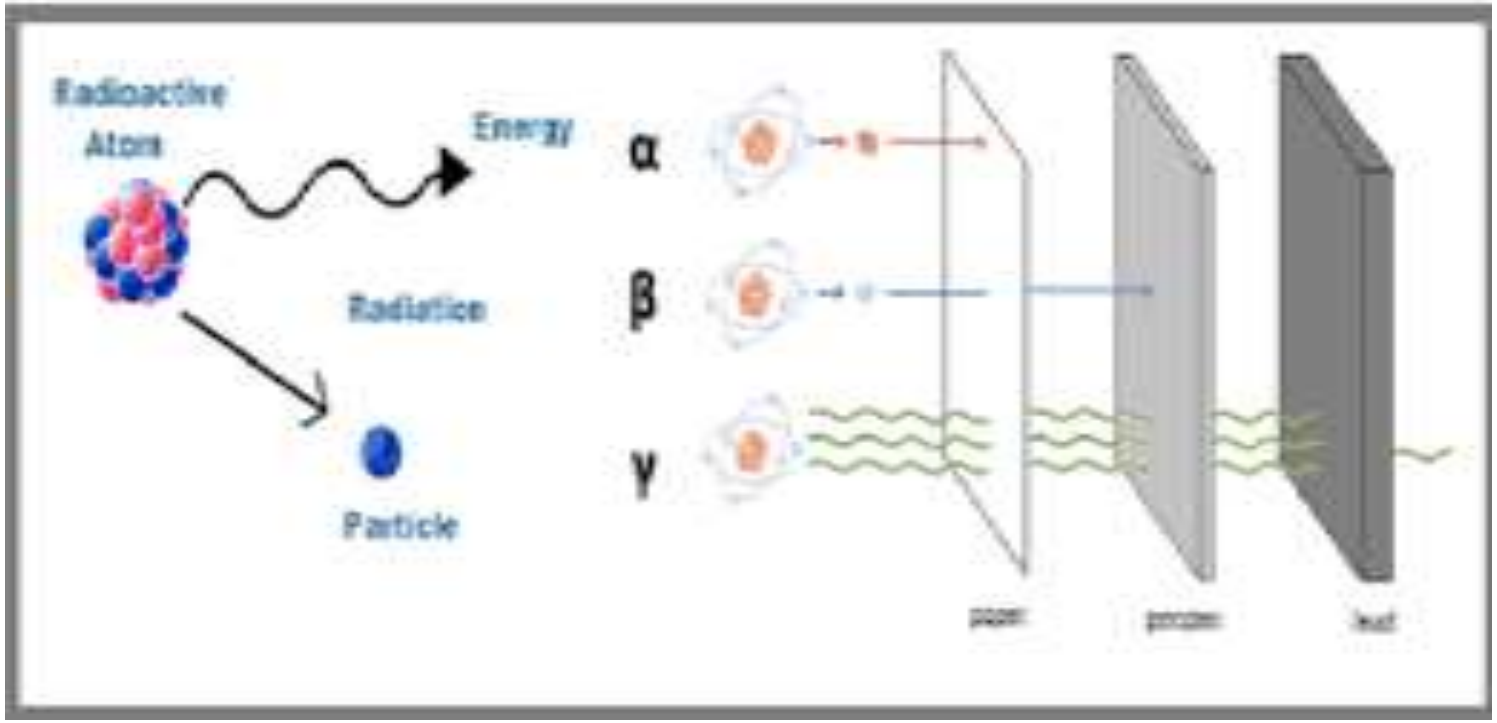
1. the first one is ,the radiation was found with a certain element called uranium
2. The huge energy emitted during each event



- In 1898, Marie Curie began her doctoral study of Becquerel's rays.
- She and her husband soon discovered two new radioactive elements, which she named polonium (after her native land) and radium (because it radiates).

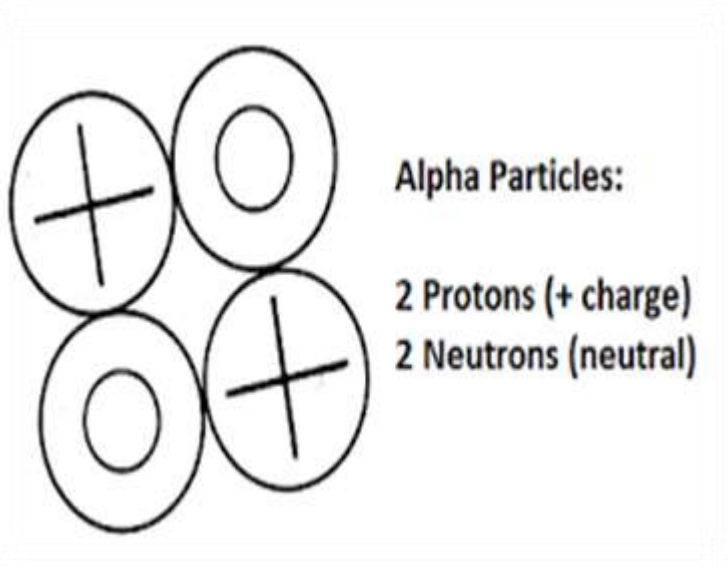
- uranium. Over a period of four years, working under poor conditions and spending their own funds, the Curies processed more than a ton of uranium ore to isolate a gram of radium salt.
- Curie's radium salt glowed visibly from the radiation that took its toll on them and other unaware researchers. Shortly after completing her Ph.D.,

Types of Nuclear Radiation

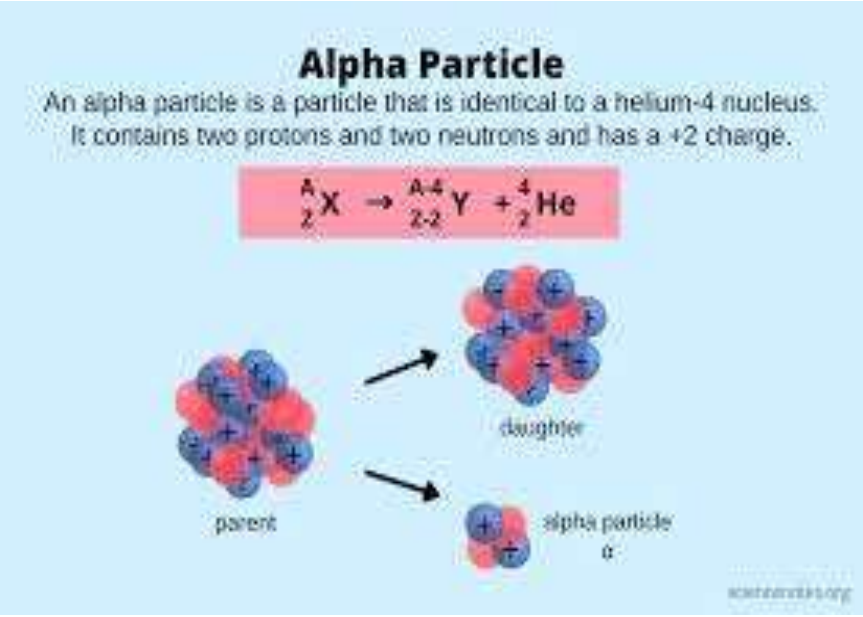


- soon after the discovery of nuclear radiation indicated that different types of rays are emitted. Eventually, three types were distinguished and named alpha , beta , and gamma .

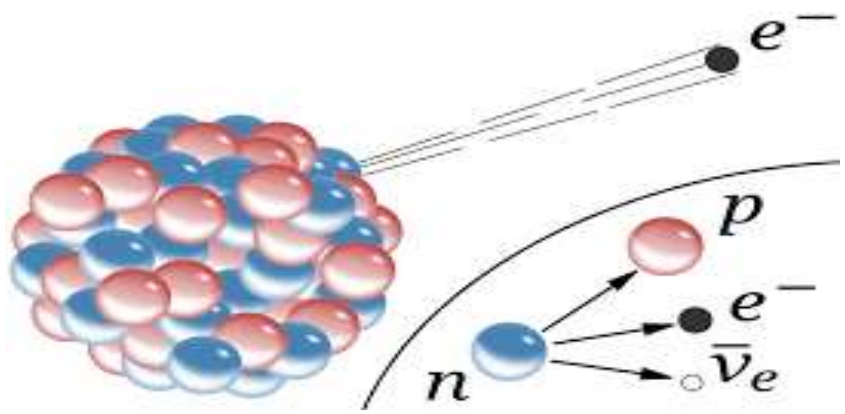
Alpha particles radiation



- ✓It consist two neutrons and two protons.
- ✓It occur with in high atomic numbers
- ✓Alpha particles are relatively slow and heavy compared with other forms of nuclear radiation.
- ✓It's a positive charge particles.
- ✓It reflected by electric and magnetic field.
- ✓They have less penetration power.
- ✓ the daughter nucleus of atomic number decreased by 2 and its atomic mass by 4 from its parental nucleus.



Beta particle radiation

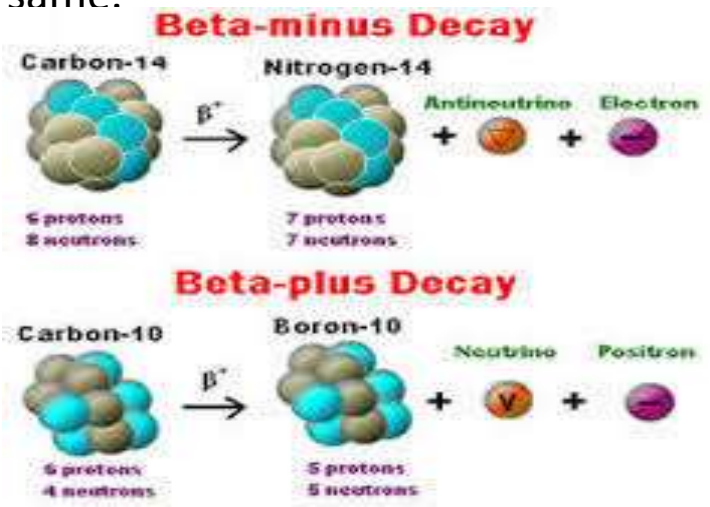


positron or beta plus emission

- It occur when the nucleus contain few number of neutron.
- a proton will turn into a neutron and emit a fast-moving positron.
- A positron is the antimatter version of an electron. It has the same relative mass of zero, so its mass number is zero, but a +1 relative charge. It can be written as $^{0}_{+1}e$, however sometimes it is also written as $^{0}_{+1}\beta$.

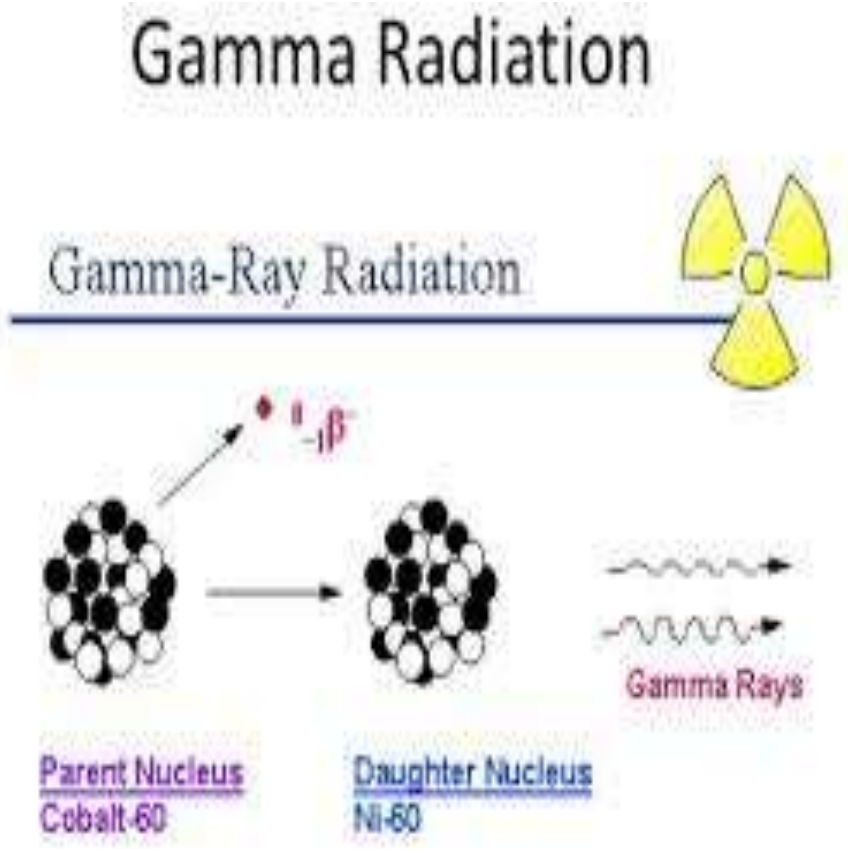
beta minus emission

- they are energetic electron which emitted from the nucleus of an atom
- .it occur when the ratio of neutron to proton is high in the nucleus
- a neutron is transformed to yield a proton, causing an increase in the atom's atomic number
- The beta particle is an electron but it has come from the nucleus, not the outside of the atom.
- Beta decay causes the atomic number of the nucleus to increase by one and the mass number remains the same.

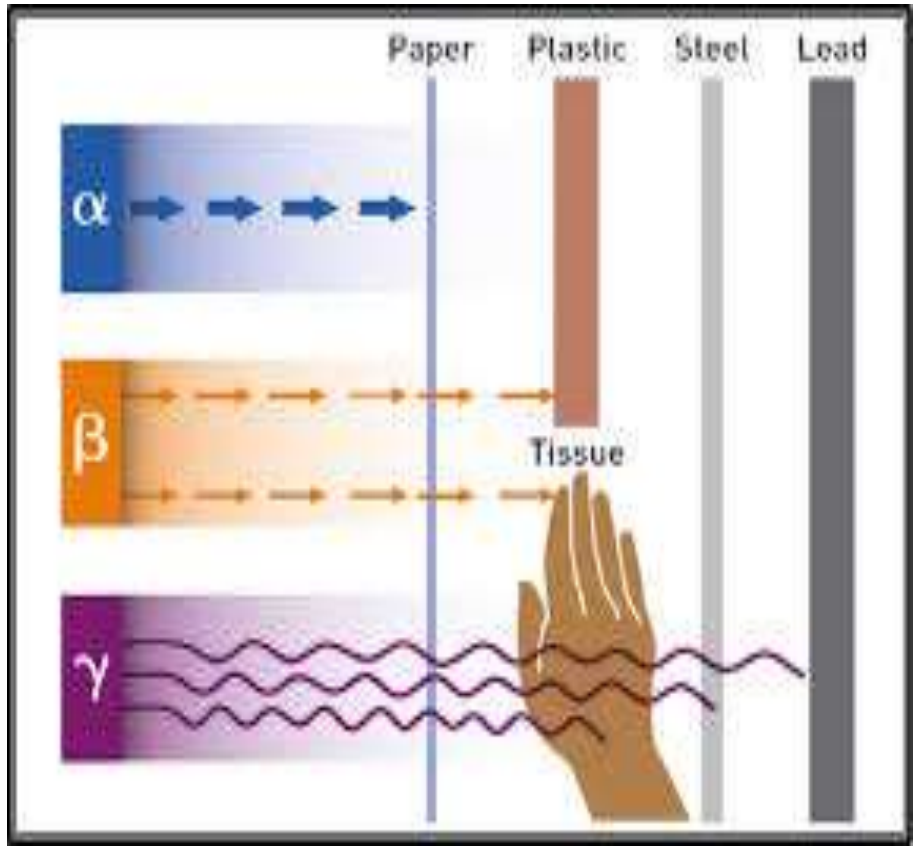


Gamma particle radiation

- Gama rays are high energetic, high frequency and high electromagnetic radiations,
- they have no charges and mass so the y almost not interact with in particles in there path.
- They hold the highest power of penetration.
- They are the most penetrating but least ionizing and very difficult to resist them from entering the body.
- The Gamma rays carry a large amount of energy and can also travel via thick concrete and thin lead.



Ionization and penetration power

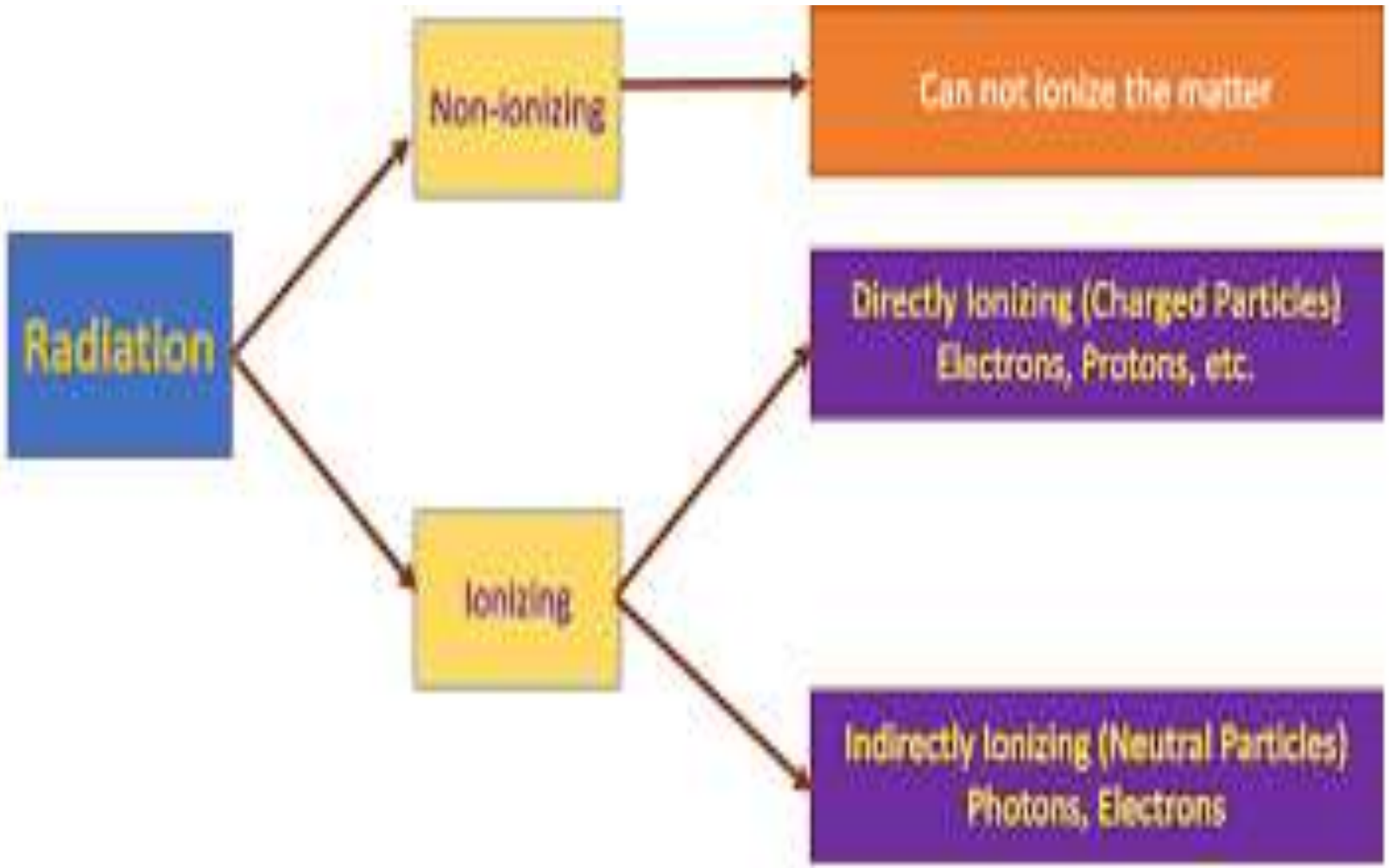


- Ionizing power refers to how well can it knock out electrons from target nuclei.
- Penetration power is how far can the ray travel before losing all energy.
- alpha s, beta s, and gammas has enough energy per event to ionize atoms and molecules in any material.
- They produce ion and molecule fragments knocking electrons from them
- the greater mass present the greater ionizing power
- And also the greater mass are the more penetrate through material

The difference between ionizing and non ionizing radiation

- Ionizing radiation is a powerful form of energy with medical applications such as diagnostic testing.
- At high enough doses, it can alter your body's cells and DNA.
- Unlike some non-ionizing radiation, it can cause serious harm or cancer with enough exposure.

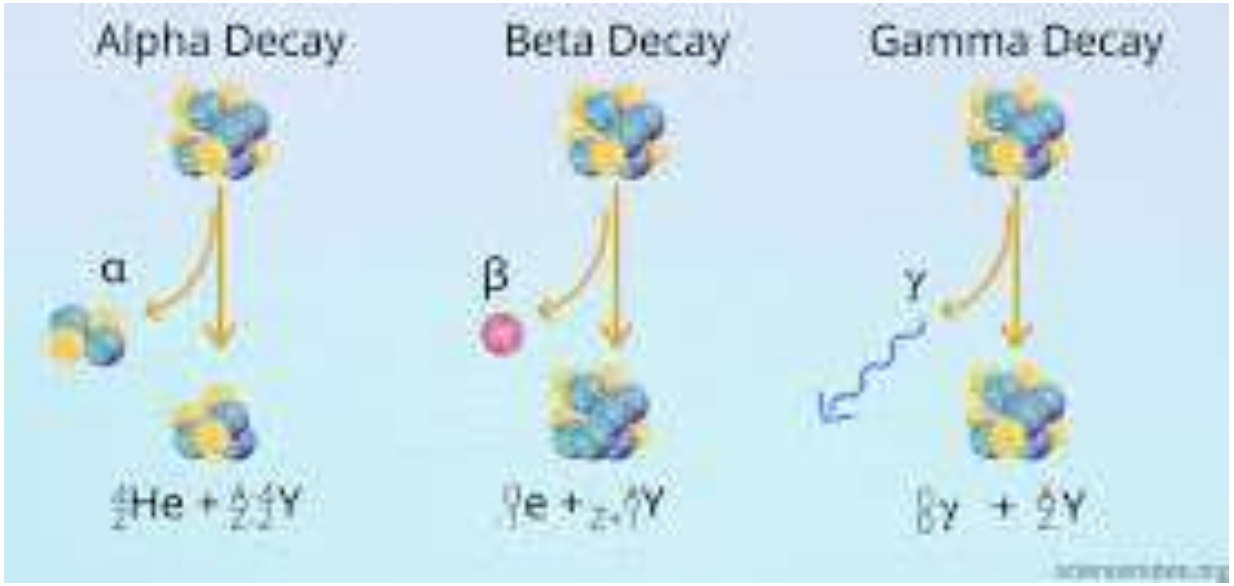
- **Non-ionizing radiation** is a form of radiation with less energy than ionizing radiation.
- It does not remove electrons from atoms or molecules of materials that include air, water, and living tissue.


Radiation
Non-ionizing
Can not ionize the matter
Ionizing
Directly Ionizing (Charged Particles)
Electrons, Protons, etc.
Indirectly Ionizing (Neutral Particles)
Photons, Electrons

Effective Dose

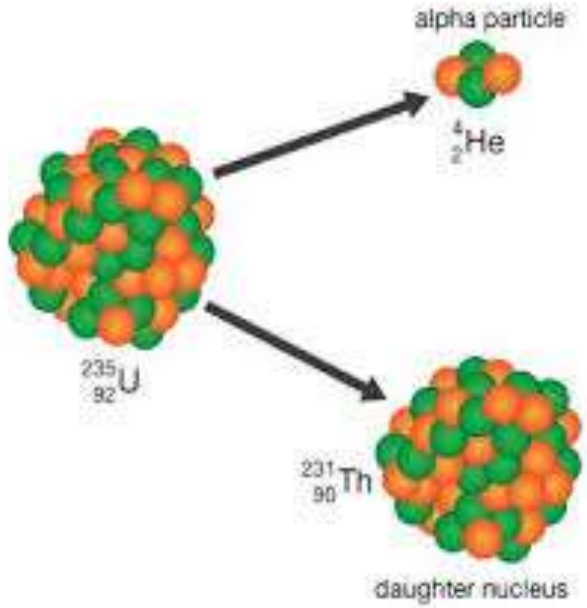
- The risk of developing adverse health effects depends on the radiation dose.
- The higher the dose the higher is the risk of adverse effects.
- Absorbed dose describes the amount of energy deposited per unit mass in an object or person

Nuclear Decay and Conservation Laws



- Nuclear decay occurs when the nucleus of an atom is unstable and spontaneously emits energy in the form of radiation.

Alpha decay



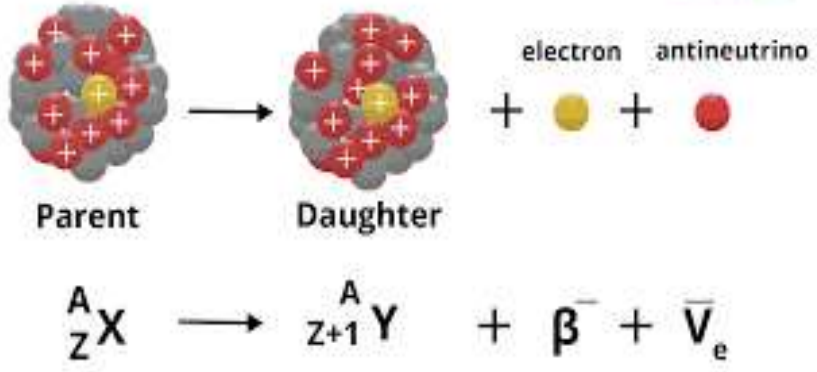
- Alpha decay is a nuclear decay process where an unstable nucleus changes to another element by shooting out a particle composed of two protons and two neutrons.
- In alpha decay, a 4He nucleus simply breaks away from the parent nucleus
- In alpha decay the charge and the momentums are conserved

Beta decay

- It is a radioactive decay in which an electron is emitted
- The are actually two types of beta decay beta-minus decay and beta-plus decay

Beta-minus decay(β^-)

- In beta-minus decay, an energetic negative electron is emitted, producing a daughter nucleus of one higher atomic number and the same mass number.
- a neutron is converted to a proton, and the process creates an electron and an electron antineutrino.



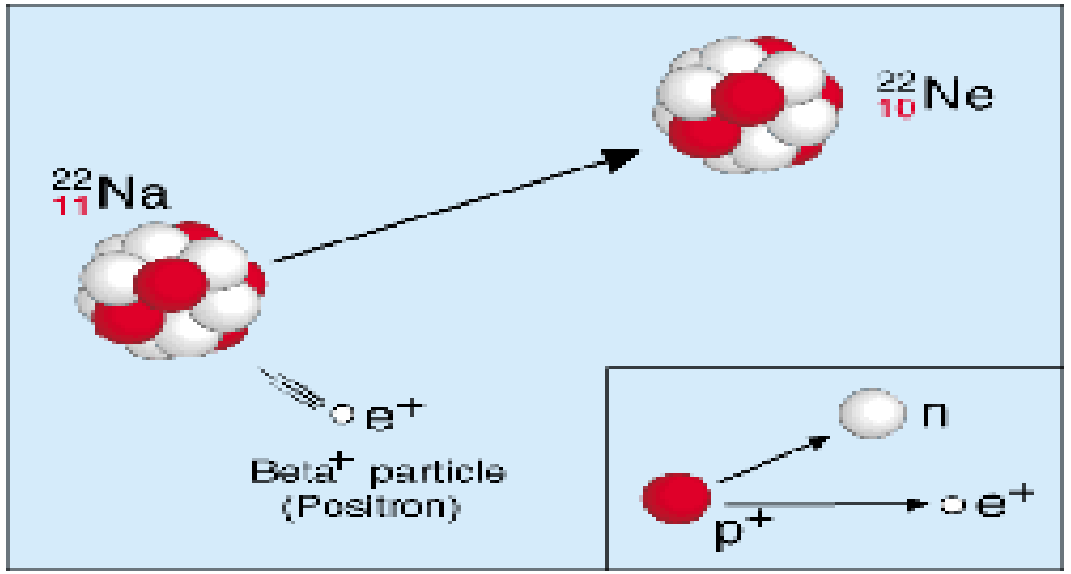
Neutrino

- It is a particle emitted in beta decay
- the neutrino was discovered after beta decay was known.

Cont’d

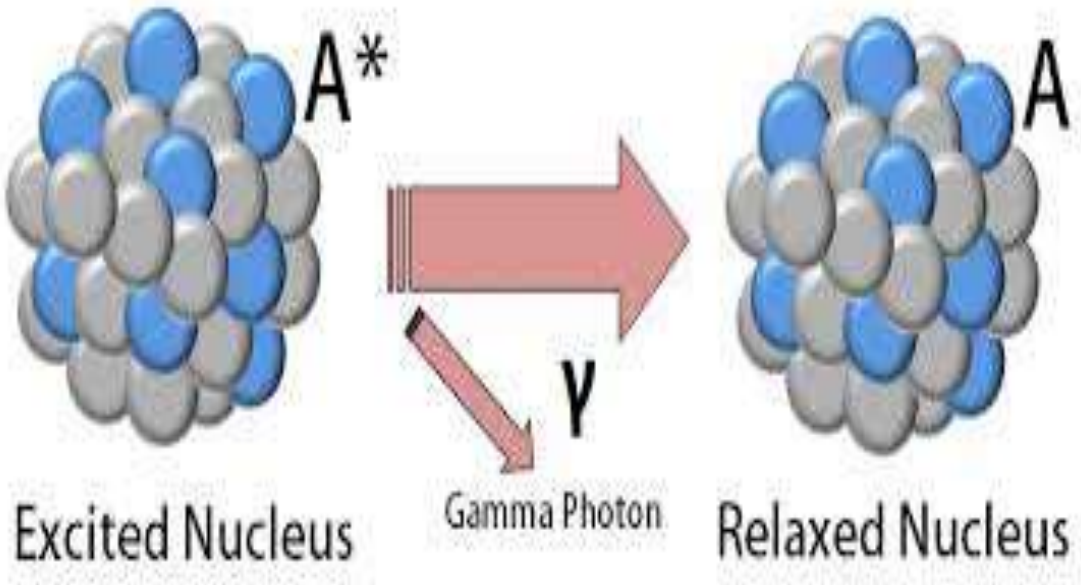
- They are nearly mass less, have no charge, and do not interact with nucleons via the strong nuclear force.
- They travel at the speed of light and doesn’t affected by EM waves.
- They carry charge linear momentum and angular momentum.
- It reveals a new conservation law, which state that obeyed in all circumstances, states that the total electron family number is constant.

Beta-plus decay



- the nucleus emits a neutrino and a positron (the antimatter form of an electron)
- Certain nuclides decay by the emission of a positive electron
- This is anti electron or positron decay

Gamma decay



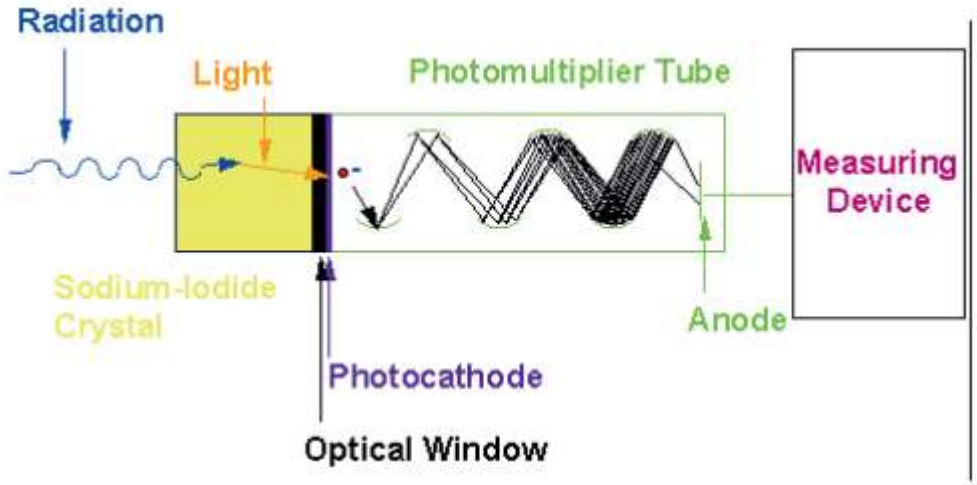
- it is the simplest form of nuclear decay it is the emission of energetic photons by nuclei left in an excited state by some earlier process.
- when an electron jumps from a level of high energy to a level of low energy, there is an emission of a photon.

Radiation Detectors

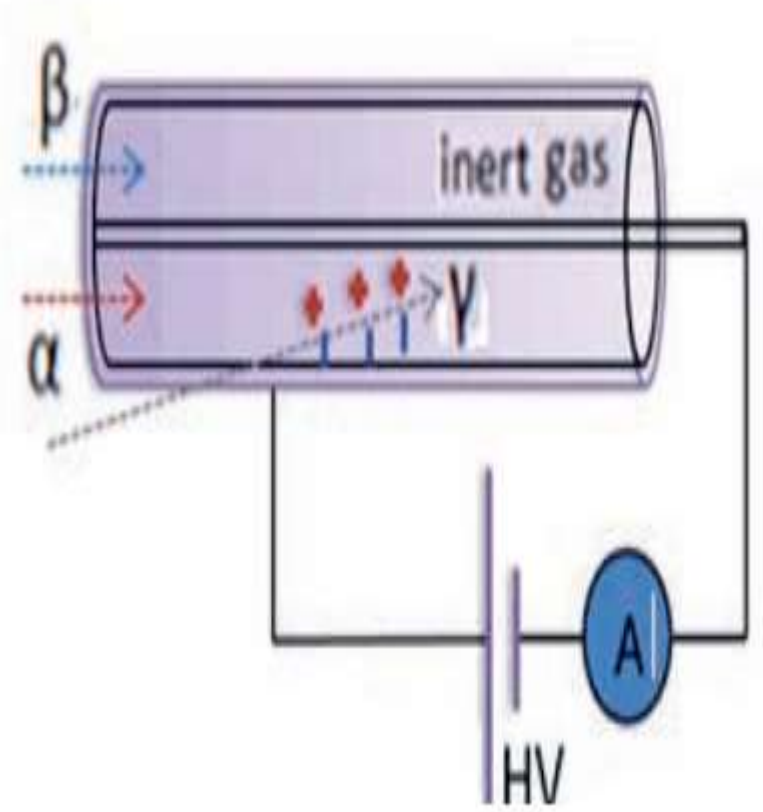
(a)

A radiation detector is a device that measures the ionization of radiations such as beta radiation, gamma radiation, and alpha radiation with the matter.

scintillators:



- A scintillator is a general term for substances that emit fluororescence when exposed to radiations of high energy it is a type of phosphor.
- materials that absorb energetic radiation such as gamma rays, X-rays, or neutrons and convert that energy into short bursts of visible photons.
- The incident radiation can be measured quantitatively by photo-electrically converting/amplifying the emitted fluorescence with a photo multiplier tube (PMT)
- They have the ability to distinguish between alpha, beta, and gamma radiation,



Geiger counter

- It used to quickly detect and measure radiation.
- It exploits the natural process of ionization to detect and measure radiation
- Geiger counters can detect alpha, beta, and gamma radiation. However, they cannot differentiate which one is beta, or gamma or alpha radiation.
- It is widely used in applications like radiological protection, radiation dosimetry, and experimental physics.

Half-Time

- Half-life (symbol t½) is the time required for a quantity (of substance) to reduce to half of its initial value.
- A half-life is the time taken for something to halve its quantity
- The term is commonly used in nuclear physics to describe how quickly unstable atoms undergo radioactive decay or how long stable atoms survive
- The number of any radiouctive parent nuclei decreases with time since it emits radiation in the form of αand β emissions.

Quantum Tunneling

- It is a phenomenon in which particles penetrate a potential energy barrier with a height greater than the total energy of the particles.
- It defined as a quantum mechanical process where wave functions can penetrate through a potential barrier.
- Quantum tunneling is forecasted to create physical limits to the dimensions of the transistors employed in microelectronics.
- .Tunneling can be understood through the concepts of Heisenberg’s uncertainty principle.
- Both tunneling and uncertainty principle are mutually compatible.
- Quantum tunneling falls under the domain of quantum mechanics.