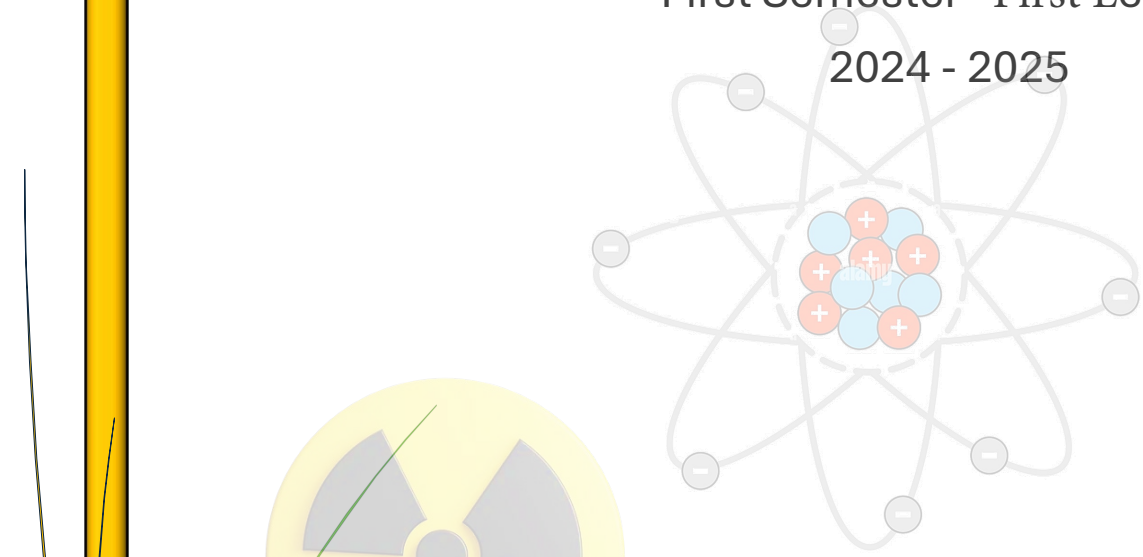
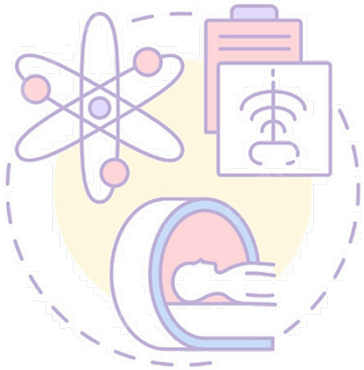
Radiation Protection

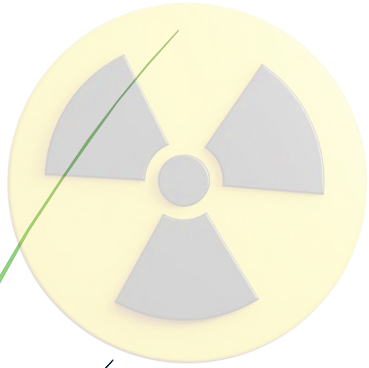
The Second Stage

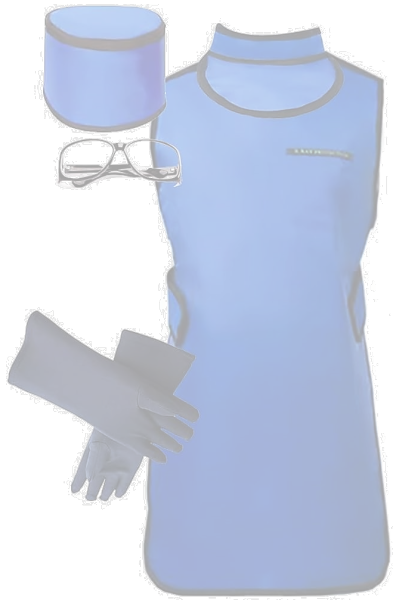
First Semester –First Lecture

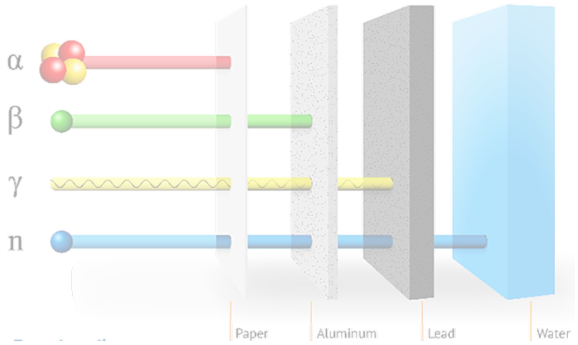
2024 - 2025











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Introduction to the Radiation

OUTLINES:

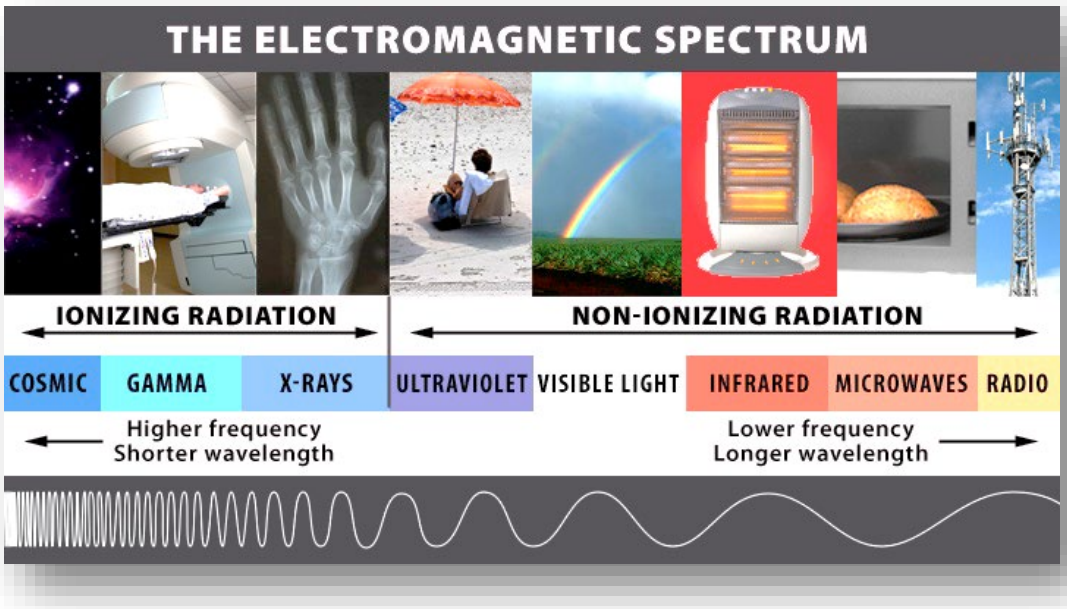
- What is Radiation?
- Sources of Radiation.
- Types of Radiation.
- How is Radiation Produced?
- We Live with Radiation?
- Do We Need Radiation Protection?
- What Can Radiation Do?

What is Radiation?

Radiation is energy that moves from one place "from the source" to another in a form that can be described as waves or particles.

Many radioisotopes naturally occurring and originated during the formation of the solar system and through the interaction of cosmic rays with molecules in the atmosphere. Tritium is an example of a radioisotope formed by this interaction.

It can come from unstable atoms that undergo radioactive decay, or it can be produced by machines "radioactive generator; X-ray tube; cyclotron".



Sources of Radiation.

Radiation sources may be natural or human productions. The difference between man-made sources of radiation and naturally occurring sources is the location from which the radiation originates.

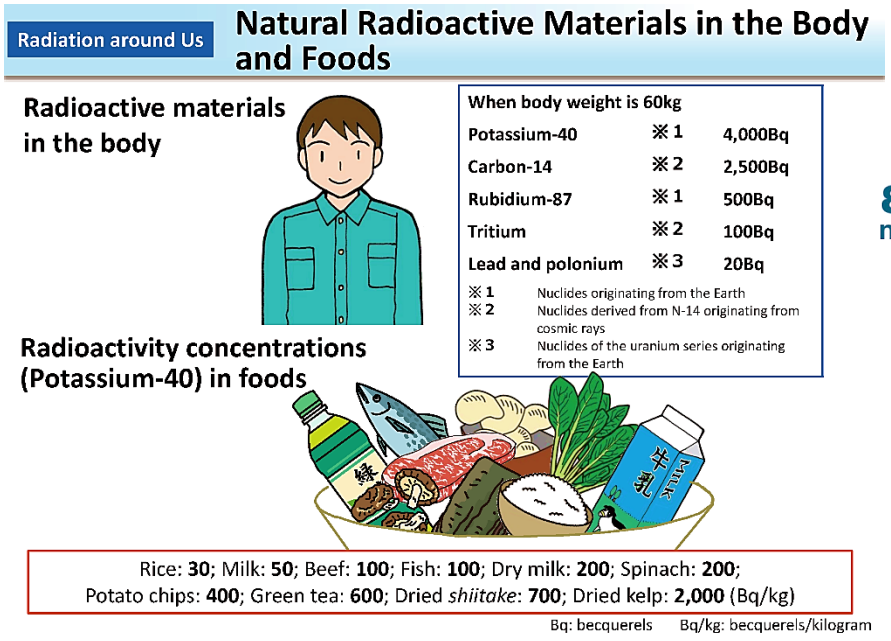
1- Natural radiation sources:

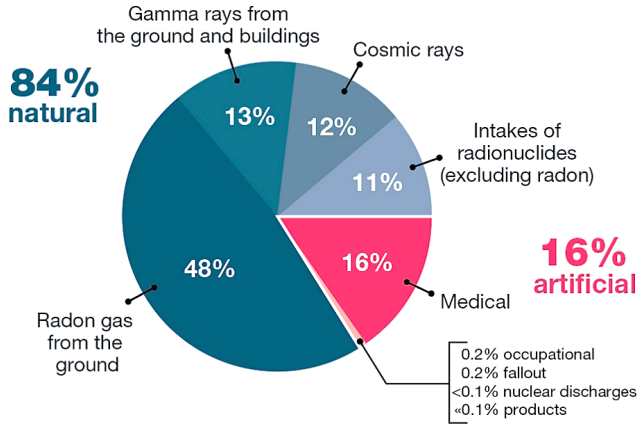
A. Cosmic rays or astro-particles are high-energy particles or clusters of particles (primarily represented by protons or atomic nuclei) that move through space at nearly the speed of light. They originate from the Sun,

from outside of the Solar System in our own galaxy and from distant galaxies.

B. Terrestrial radiation: it is due to the decay of radioactive materials in the earth itself. every day we are exposed through our skin to external radiation from the earth. (e.g. soil, rocks, soil, vegetation, groundwater, building materials).

C. Internal bodies: our bodies also contain natural radionuclides. Carbon-14, Potassium-40, crucial for life, are examples. The total average dose from natural internal sources of radiation is approximately 40 *mrem* per year.

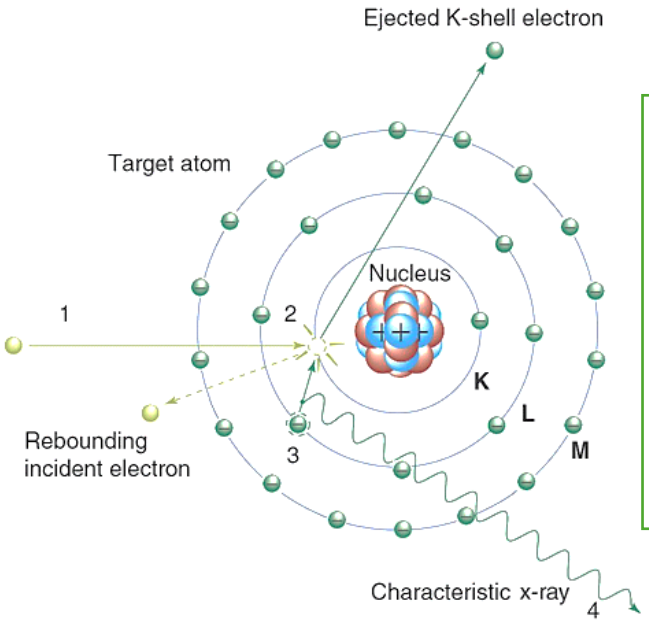




2- Human productions sources:

A. Medical radiation sources: The terms "x-ray" or "gamma ray" are sometimes used in the medical field, however they are technically different. Even though x-rays are characteristically identical to gamma rays they are produced by a different mechanism. X-rays are produced by electrons outside of the nucleus (electrons interaction); while gamma rays

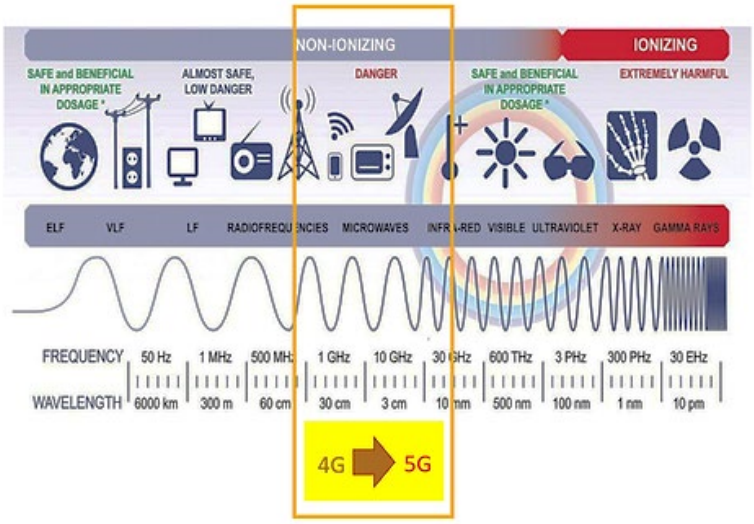
are emitted by the nucleus (nuclear interaction). They have high energetic radiation so they both have an ionizing radiation hazard.



Generation of a characteristic x-ray in a target atom occurs in the following sequence:
(1) The incident electron interacts with the K-shell electron via a repulsive electrical force.
(2) The K-shell electron is removed (only if the energy of the incident electron is greater than the K-shell binding energy), leaving a vacancy in the K-shell.
(3) An electron from the adjacent L-shell fills the vacancy.
(4) A *Kα* characteristic x-ray photon is emitted with energy equal to the difference between the binding energies of the two shells. In this case, a 59.3-keV photon is emitted.

B. Consumer products: Examples include building products (contain naturally occurring radioactive materials) such as brick, granite counter tops, or phosphate fertilizer, and antiques such as clocks and watches (may contain radium or tritium so that the dial glows in the dark).

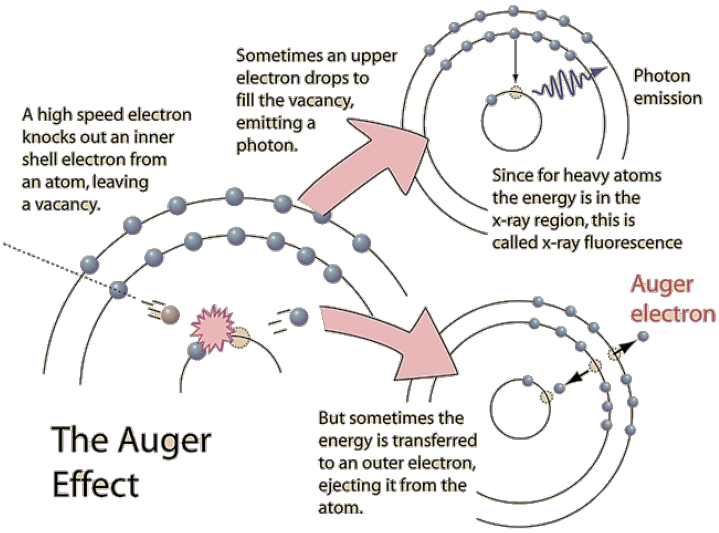
C. Atmospheric testing of nuclear weapons: Another man-made source of radiation includes residual fallout from atmospheric nuclear weapons



testing that took place in the 1950's and early 1960's. Atmospheric testing is now banned by most nations.

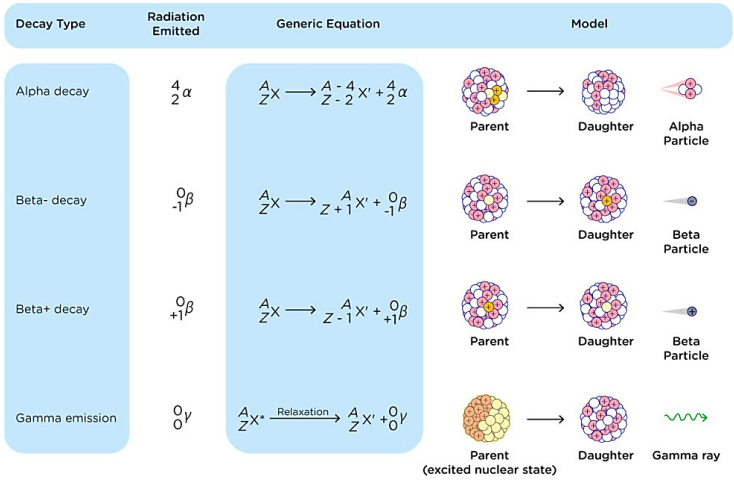
Auger Electrons

A physical phenomenon in which the filling of an inner-shell vacancy of an atom is accompanied by the emission of an electron from the same atom.



Types of Radiation

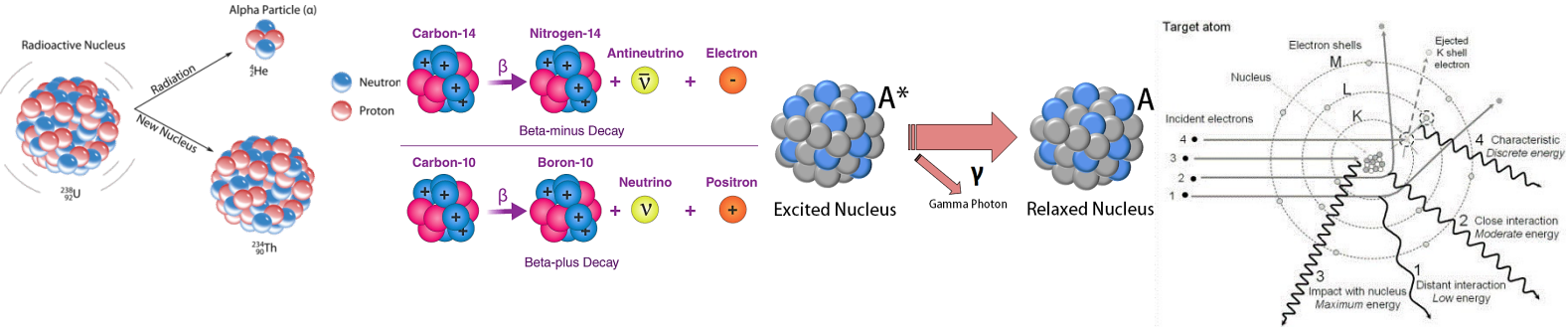
- ❖ According to source:
- ➢ Source emission
- Emitted from nucleus (alpha, beta, gamma, neutron).



- Emitted from orbitals: (x-ray photons, electrons).

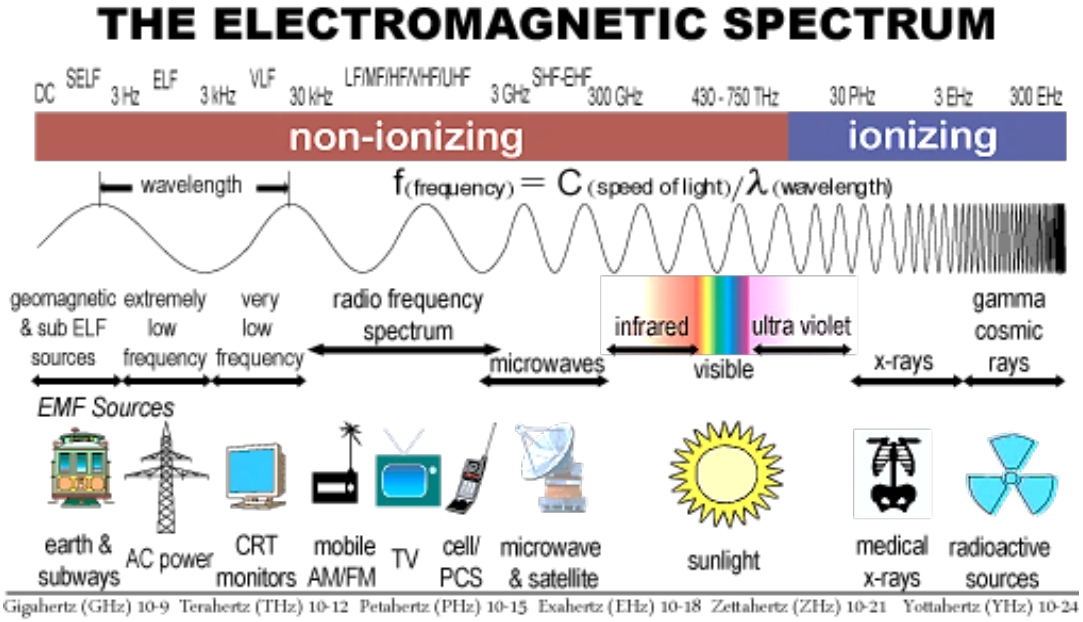
➢ Source generated:

- Man Made source (x-ray sources "x-ray machines CT, fluoroscopy, cone beam, mammography"; linear accelerator; Cyclotron; Reactors).
- Natural source (cosmic ray, sun light, gamma ray).



❖ According to ionization:

- Ionizing (alfa, beta "B^{+},B^{-}", x-ray photons, gamma photons).
- Non-ionizing (radio-waves, micro-waves, infrared, visible light, ultraviolet).



❖ According to its energy:

Low energy "low frequencies; high wavelength, unable to release an electron from an atom; unable to ionization less than 34ev, causing heating for the media" (MRI, US, RF, MW).

High energy "high frequencies; low wavelength, able to release an electron from an atom; able to ionization greater than 34ev, causing ionization the media" (x-ray photons, gamma photons).

Definition:

Radioactive material:

Is the material which unstable nucleus of atoms because of unbalance number of protons or neutrons.

It achieves stability through changes in the nucleus (spontaneous fission, emission of alpha particles, or conversion of neutrons to protons or the reverse).

Radiation Sources:

Medical and non-medical sources

- Medical sources:

Radiation has many uses in medicine. The most well-known use is X-ray machines, which use radiation to find broken bones and diagnosed disease. Another example is nuclear medicine, which uses radioactive isotopes to diagnose and treat diseases such as cancer (all the last known diagnosis sources).

Besides the diagnosis sources there are therapeutic sources such as linear accelerators that in modern machine use also X-ray sources but in MeV of the power. Other example using radioactive materials to kill the cancer cells.

- Non-medical sources:

Others which are not used in the medical field are non-medical sources of radiation and its existence doesn't mean it's for medication.