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Lec: 1

Classification of Radiation

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Types of Radiation

There are four major types of radiation: alpha, beta, neutrons, and electromagnetic waves such as gamma rays. They differ in mass, energy and how deeply they penetrate people and objects.

1. Alpha Radiation

Alpha radiation is a heavy, very short-range particle and is actually an ejected helium nucleus.

Some characteristics of alpha radiation are:

- Most alpha radiation is not able to penetrate human skin.
- Alpha-emitting materials can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds.
- A variety of instruments has been designed to measure alpha radiation. Special training in the use of these instruments is essential for making accurate measurements.
- A thin-window Geiger-Mueller (GM) probe can detect the presence of alpha radiation.
- Instruments cannot detect alpha radiation through even a thin layer of water, dust, paper, or other material, because alpha radiation is not penetrating.
- Alpha radiation travels only a short distance (a few inches) in air, but is not an external hazard.
- Alpha radiation is not able to penetrate clothing.

Examples of some alpha emitters: radium, radon, uranium, thorium.

2. Beta Radiation

Beta radiation is a light, short-range particle and is actually an ejected electron. Some characteristics of beta radiation are:

- Beta radiation may travel several feet in air and is moderately penetrating.
- Beta radiation can penetrate human skin to the "germinal layer," where new skin cells are produced. If high levels of beta-emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin injury.
- Beta-emitting contaminants may be harmful if deposited internally.
- Most beta emitters can be detected with a survey instrument and a thin-window GM probe (e.g., "pancake" type). Some beta emitters, however, produce very low-energy, poorly penetrating radiation that may be difficult or impossible to detect. Examples of these difficult-to-detect beta emitters are hydrogen-3 (tritium), carbon-14, and sulfur-35.

Examples of some pure beta emitters: strontium-90, carbon-14, tritium, and sulfur-

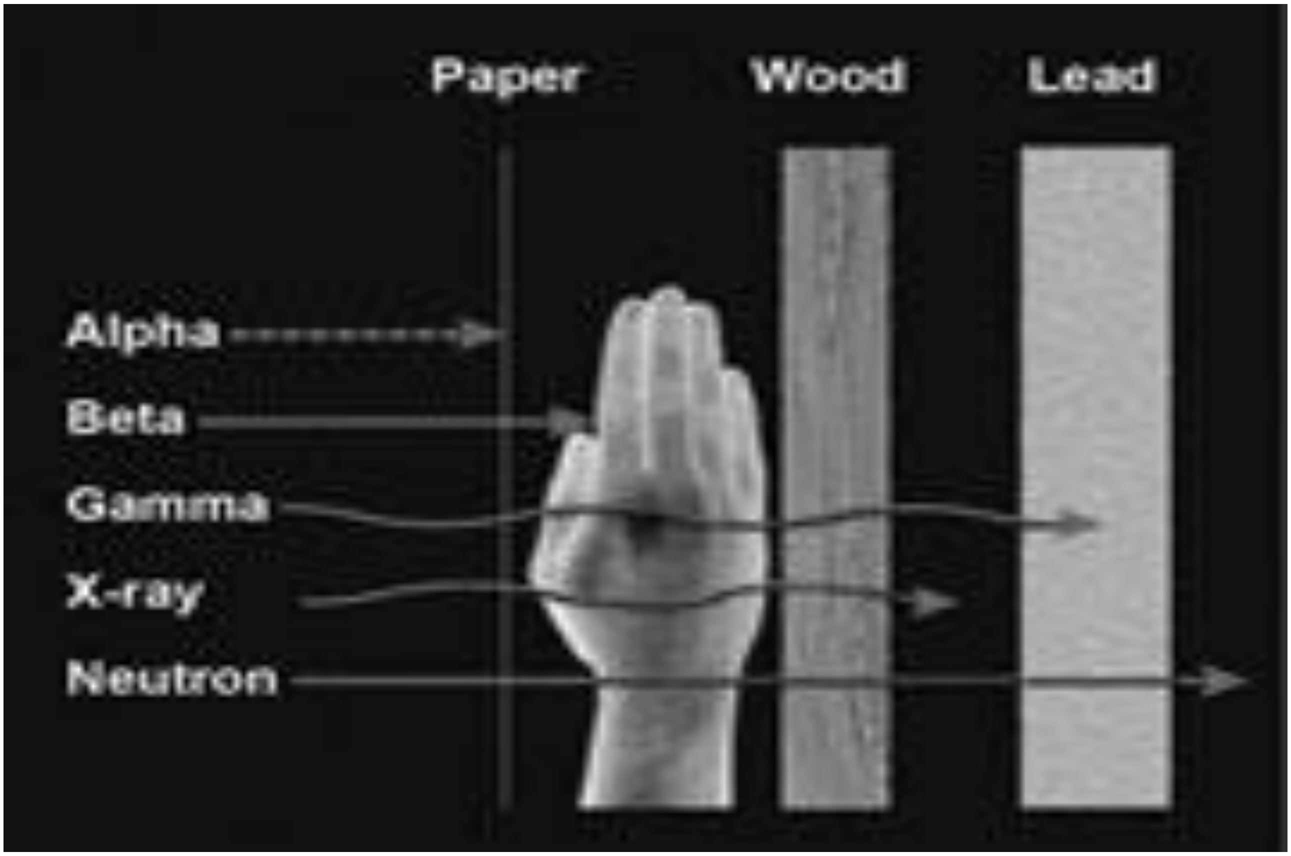
3. Neutron

This is a particle that doesn't have any charge and is present in the nucleus of an atom. Neutrons are commonly seen when uranium atoms split, or fission, in a nuclear reactor. If it wasn't for the neutrons, you wouldn't be able to sustain the nuclear reaction used to generate power.

4. Gamma and X Radiation

Gamma radiation and x rays are highly penetrating electromagnetic radiation. Some characteristics of these radiations are:

- Gamma radiation or x rays are able to travel many feet in air and many inches in human tissue. They readily penetrate most materials and are sometimes called "penetrating" radiation.
- X rays are like gamma rays. X rays, too, are penetrating radiation. Sealed radioactive sources and machines that emit gamma radiation and x rays respectively constitute mainly an external hazard to humans.
- Gamma radiation and x rays are electromagnetic radiation like visible light, radiowaves, and ultraviolet light. These electromagnetic radiations differ only in the amount of energy they have. Gamma rays and x rays are the most energetic of these.
- Dense materials are needed for shielding from gamma radiation. Clothing provides little shielding from penetrating radiation, but will prevent contamination of the skin by gamma-emitting radioactive materials.
- Gamma radiation is easily detected by survey meters with a sodium iodide detector probe.
- Gamma radiation and/or characteristic x rays frequently accompany the emission of alpha and beta radiation during radioactive decay.



Above image showing how different kinds of radiation travel different distances and have different abilities to penetrate, depending on their mass and their energy

- Alpha particle, because it's very heavy and has a very large charge, doesn't go very far at all. This means an alpha particle can't even get through a sheet of paper. An alpha particle outside body won't even penetrate the surface of skin. But, if you inhale or ingest material that emits alpha particles, sensitive tissue like the lungs can be exposed. This is why high levels of radon are considered a problem in your home.

- Beta particles go a little farther than alpha particles. **You could use a relatively small amount of shielding to stop them**. They can get into your body but can't go all the way through. To be useful in medical imaging, beta particles must be released by a material that is injected into the body. They can also be very useful in cancer therapy when put the radioactive material in a tumor.
- Gamma rays and x-rays can penetrate through the body. This is why they are useful in medicine—to show whether bones are broken or where there is tooth decay, or to locate a tumor. **Shielding with dense materials like concrete and lead** is used to avoid exposing sensitive internal organs or the people who may be working with this type of radiation. For example, the technician who does my dental x-rays puts a lead apron over me before taking the picture. That apron stops the x-rays from getting to the rest of my body. The technician stands behind the wall, which usually has some lead in it, to protect himself.
- Neutrons, because they don't have any charge, don't interact with materials very well and will go a very long way. The only way to stop them is with large quantities of water or other materials made of very light atoms.

Note: Radiation is all around us (called background radiation).