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Radiation Mechanism of Interaction with Matter

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Abstract: ***This paper contains information about radiation mechanism types, sources of radiation and its effects. It also explains about the uses of radiation in regular life: Medicine, Industry, Research etc. Radiation is a broad term that encompasses many types of energy in which some are harmful and harmless or even beneficial. Radiation refers to the energy or particles from a source which travels through space or other mediums. For instance, light, heat, microwaves and wireless communications and all its forms. Through this article, we are able to understand radiation in detail, the types, applications and more.***

Keywords: Ionized, electromagnetic wave, pyramiding dimmers, Geiger counter fluoroscope, incandescent, volcano eruption

1. Introduction

The radiation is defined as "The process of transforming emission or transmission of energy in the form of waves or particles through space".

Radiation is an energy that comes from a source and travels through space at the speed of light (speed of light =3 $x10^8$ m/sec). The energy has an electric field and magnetic field associated with it. We often categorize it into two types that depend on the energy of the radiated particles. The first is ionizing radiation, and the second non-ionized radiation.

1) Ionization Radiation

The electromagnetic wave that has sufficient energy to ionize atoms or molecules by detecting electrons from them.

The energy of ionizing radiation starts between 10 electron volts to 33 electron volts. Ionizing subatomic particles include alpha particles, beta particles, and neutrons. Ionizing radiation is also generated artificially by X-ray tubes, particle acceleration and nuclear fission. To detect/ measure ionizing radiation, an instrument called a Geiger counter can be used.

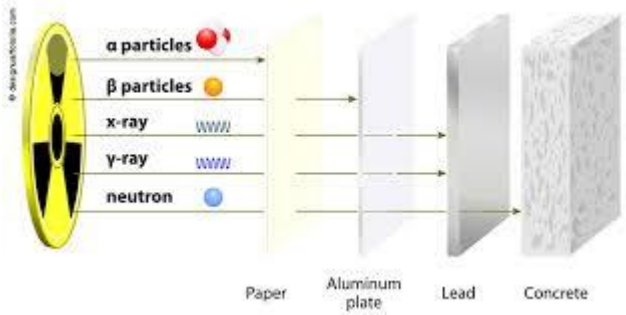

Figure: Ionization Radiation

Examples:
Alpha Particles: Relatively heavy and slow-moving particles. Easily stopped by a sheet of paper.
Beta Particles: Lighter and faster than alpha particles, able to penetrate skin but stopped by a thin layer of metal.
Gamma Rays: High- energy electromagnetic waves, highly penetrating and able to pass through most materials.
X-Rays: These X-rays are similar to gamma rays but with lower energy, used in medical imaging.

Uses of Ionization Radiation:
Ionizing radiation is used in a wide variety of fields such as medicine, nuclear power, research, and industrial manufacturing.

Medicine:
- **Diagnostic Imaging**: X-rays, CT scans, PET scans, and Fluoroscopy are used to diagnose diseases and injuries.
- **Radiotherapy:** It is used to treat cancer and other diseases.
- **Disinfecting:** It is used to disinfect medical instruments and blood.

Industry:
- **Smoke Detector:** It is used in smoke detectors.
- **Nuclear Power Generation:** It is a byproduct of nuclear power generation

Agriculture:
Improving Natural Compounds: Ionizing radiation can be used to improve the properties of natural compounds, such as those found in food.

Research:
Preserving Cultural Heritage: It can be used to disinfect and preserve cultural heritage artifacts.

Causes of Ionization Radiation:
Cell Damage: Ionizing radiation can damage cells by altering their molecules, which can lead to cell death or mutations.
Sickness: In high acute doses, it will result in radiation burns and radiation sickness.
Cancer: In Ionization Radiation the lower levels doses over a protected time can cause cancer.
DNA: DNA is always susceptible to damage by ionizing radiation, also by radiation with enough energy to excite certain molecule bonds to form pyramiding dimers. A good example is ultra violet spectrum energy which begins at about 3.1ev (400 nm) at close to the same energy level which can cause sun bum to unprotected skin.

2) Sources of Ionization Radiation Exposure

Natural sources of ionizing radiation include radiation in the environment from rocks and soil as well as cosmic radiation from space is called background radiation.

Artificial Source of ionization radiation include:

a) Nuclear Energy
   Medical devices such as:
   - X-ray machines
   - CT scanners
   - Mammography
b) Baggage X-ray screening devices
c) Industrial devices used for scientific research and measurement

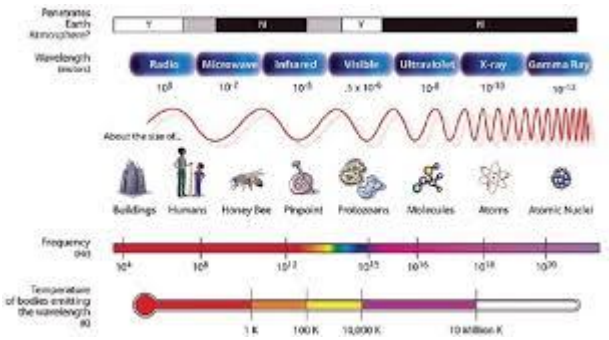

Figure: Sources of Ionization Radiation

3) Non-Ionization Radiation

The Non-Ionization Radiation which comprises of alpha particles, beta particles, and gamma particles. Non-ionizing radiation is a type of electromagnetic radiation that doesn't have enough energy to remove electrons from atoms or molecules.

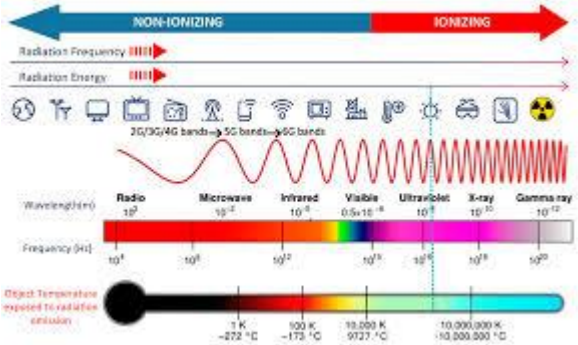

Figure: Non - Ionized Radiation

Examples:

- **Radio Waves**: Used in cell phones and radio emitters
- **Microwaves**: Used in microwave ovens to heat food and water
- **Infrared Radiation**: Absorbed by the skin and eyes as heat
- **Visible Light**: A part of the non-ionizing radiation spectrum
- **Ultraviolet Light**: A part of the non-ionizing radiation spectrum, and is also released by tanning beds, black lights, and electric arc lighting
- **Lasers**: Operate in the UV, visible, and IR frequencies

Health effects

- Exposure to high levels of non-ionizing radiation can damage tissue by heating it.
- Normal levels of UV radiation can be helpful, and produce vitamin D.

Uses of Non-Ionization Radiation:

Non-ionizing radiation (NIR) has many uses, including in healthcare, sterilization, and industrial equipment.

Healthcare

- **Ultrasound Imaging**: Used to create images of the body
- **Laser Surgery**: Used to perform surgical procedures
- **MRI**: Used to create images of the body using radio waves and a large magnet
- **Tran cranial Magnetic Stimulation**: Used to treat depression
- **UV Light Therapies**: Used to treat skin conditions

Sterilization

- **Germicidal Lamps**: Used to sterilize surfaces and some transparent objects

Industrial equipment

- **Specialized Industrial Equipment**: Used at higher levels for industrial purposes

Everyday life

- **Tanning Beds**: Used to tan the skin
- **Microwave Ovens**: Used to cook food
- **Wireless Devices**: Used for cell phones, cell phone towers, and Wi-Fi
- **Lighting Products**: Used for LED lights and incandescent light bulbs
- **Power lines and Household Wiring**: Used to supply electricity
- **Handheld Lasers and Laser Pointers**: Used for various purposes

Most exposures to non-ionizing radiation are not considered hazardous

Causes of Non-Ionization Radiation:

Non-ionizing radiation can cause a variety of health effects, including tissue heating, skin damage, and vision loss.

Tissue Heating:

- **Microwaves**: Heat water and food in microwave ovens
- **Infrared Light**: Can cause tissue heating
- **Radiofrequency Electromagnetic Fields (EMF)**: Can cause tissue heating at higher frequencies

Skin damage

- **Ultraviolet (UV) Light**: Can cause skin burns, premature aging, and skin cancer
- **Visible Light**: Can cause skin reddening
- **Photochemical Reactions**: Can damage the skin and retina

Vision loss

- **Visible Light**: Can cause vision loss
- **Photokeratitis**: Can cause a milky white cornea
- **Cataracts**: Can be caused by UV light.
- **Corneal Burns**: Can be caused by arc eye other effects .
- **Peripheral Nerve Stimulation**: Can cause tingling sensation
- **Central Nervous System Stimulation**: Can stimulate muscles and nerves

- **Changes in Melatonin Levels**: Can be caused by visible light.

4) Sources of Non-Ionizing Radiation

Non -Ionizing radiation can come from Natural and Artificial sources.

Natural sources of Non- Ionizing radiation include:

- Lighting
- Light and heat from the sun
- The Earth's natural electric and magnetic fields

Artificial sources of Non-Ionizing radiation include everyday things such as:

a) Tanning Beds
b) Microwave ovens
c) Wireless devices such as:
   - Cell phones
   - Cell phone towers
   - Wi-Fi Equipments
   - Radio and TV broadcast antennas
d) Lighting products such as:
   - LED lights
   - Incandescent light bulbs
   - Compact Fluorescent bulbs
   - Power Lines and Household Wiring
   - Handheld lasers and laser pointers

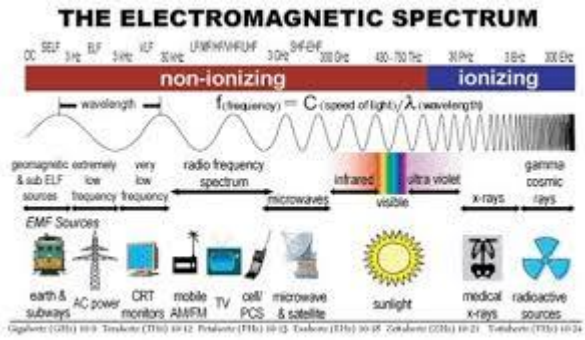

Figure: Sources of Non-Ionized Radiation

Electromagnetic Radiation:

Electromagnetic radiation is a form of electrical and magnetic wave energy. The electromagnetic radiation spectrum contains variable wavelengths and frequencies. **Examples**: X-Rays, Visible light, Infra red light, and radio waves.

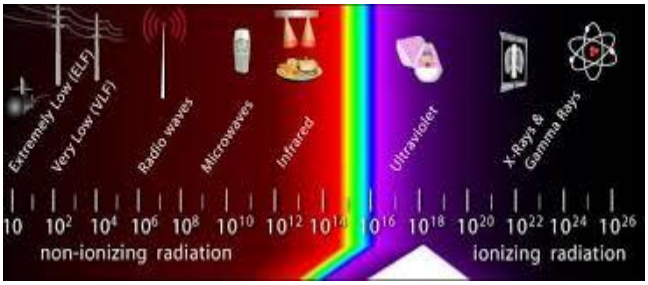

Figure: Electromagnetic Radiation Spectrum.

Depending on the process of electromagnetic spectrum this radiation can be categorized in ranges to measure it. An instrument used to measure the radiation is the Geiger counter.

Table 1: Wavelength ranges of electromagnetic radiation spectrum

Region	Wavelength (Angstroms)	Wavelength (centimeter)	Frequency (Hertz)	Energy (ev)
Radio	$>10^9$	>10	$<3x10^9$	$<10^{-3}$
Microwaves	10^9-10^6	10-0.01	$3x10^9$-$3x10^{12}$	10^{-3}-0.01
Infrared	10^6-7000	0.01-$7x10^{-5}$	$3x10^{12}$-$4.3x10^{14}$	0.01-2
Visible	7000-4000	$7x10^{-5}$-$4x10^{-5}$	4.3x 1014-7.5x 1014	2-3
Ultraviolet	4000-10	$4x10^{-5}$-10^{-7}	7.5x 1014-3x1017	3-10^3
X-rays	10-0.1	10^{-7}-10^{-9}	$3x10^{17}$-$3x10^{15}$	10^3-10^5
Gamma Rays	<0.1	$<10^{-9}$	$>3x10^{15}$	$>10^5$

5) Noise and sound (Acoustical Radiation)

Acoustical radiation is energy that is produced by a vibrating source and travels through air, water and solid materials in the form of waves. These vibrations produce sound.

Sound can be separated into 3 categories:

- Infrasound is the range of low frequency sound waves that humans do not typically hear. Scientists measure infrasound levels to detect earthquakes and to forecast volcano eruptions.
- Audible sound is the range of medium frequency sound waves that most humans can hear. Listening to a sound that is too loud can damage your hearing.
- Ultrasound is the range of high frequency sound waves that humans typically do not hear. Medical professionals use ultrasound to create an image of tissues inside of the body.

6) Irradiate Food

Irradiation is used in food processing to:

- Reduce microbial load on spices and dehydrated seasoning preparations, meaning it destroys bacteria, molds and yeast which cause food to spoil
- Control Insects in Wheat, Flour and whole wheat flour
- Increase shelf life by preventing sprouting or germination in potatoes and onions
- Reduce the bacterial count in fresh and frozen raw ground beef, and improving its safety
- Extensive research and testing resulted in irradiation becoming widely recognized as a safe and effective method of reducing harmful bacteria in food products. Foods treated with irradiation are safe to eat and retain their nutritional value, taste, texture and appearance.

2. Conclusion

Ionizing radiation generates free radicals. Free radicals interact with biological tissues, most importantly DNA. The severity of radiation-induced damage depends on the cell's sensitivity and the type and dose of radiation. There may be a DNA damage repair, but there are deterministic effects visible over a short-term period and a long-term period. The late somatic effects may manifest as malignancy and other genetic mutations.

In this generation people are addicted to social media and others. Try to interact less with the internet as much as possible, as it is good for our life in the same bad way too.

References

[1] "Monte Carlo Methods for Radiation Transport: Fundamentals and Advanced Topics (Biological and Medical Physics, Biomedical Engineering)" by Oleg N Vassiliev
[2] "Tutorials in Radiotherapy Physics: Advanced Topics with Problems and Solutions" by Patrick N McDermott
[3] "Image Processing in Radiation Therapy (Imaging in Medical Diagnosis and Therapy)" by Kristy K Brock
[4] "Step By Step Radiation Therapy Treatment and Planning" by Rathi Arun Kumar
[5] "Delineating Organs at Risk in Radiation Therapy" by Giampiero Ausili Cèfaro and Domenici Genovese
[6] "Khan's The Physics Of Radiation Therapy" by Faiz M Khan and John P Gibbons
[7] "Radiation Therapy Physics (Medical Radiology)" by W L Brady and H P Heilmann.