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TO STUDY THE EFFECTS OF ELECTROMAGNETIC SPECTRUM AND RADIATION ON HEALTH AND ITS EFFECTS

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ABSTRACT

Since 1888, electromagnetic fields (EMFs) have been a common occurrence among humans worldwide. And in a variety of ways, these electromagnetic fields are all around us. Even the human body has the ability to generate its own electromagnetic waves. Accelerating charged particles that are moving through the vacuum at the speed of light C create electromagnetic waves. Although electromagnetic waves have been a gift to humanity, they can also cause acute health impacts (such as burning of human tissues) and occasionally pose serious health hazards (including cancer, cataracts, etc.) to the human body. This is known as electromagnetic pollution. Electromagnetic fields, or EMFs, are typically used to describe EM waves with lower frequencies, whereas electromagnetic radiation is used to describe EMW with higher frequencies. The generation of electromagnetic radiation is likewise rising dramatically day by day along with technological improvement. The dangers of electromagnetic waves have been the subject of numerous researches since the 19th century.

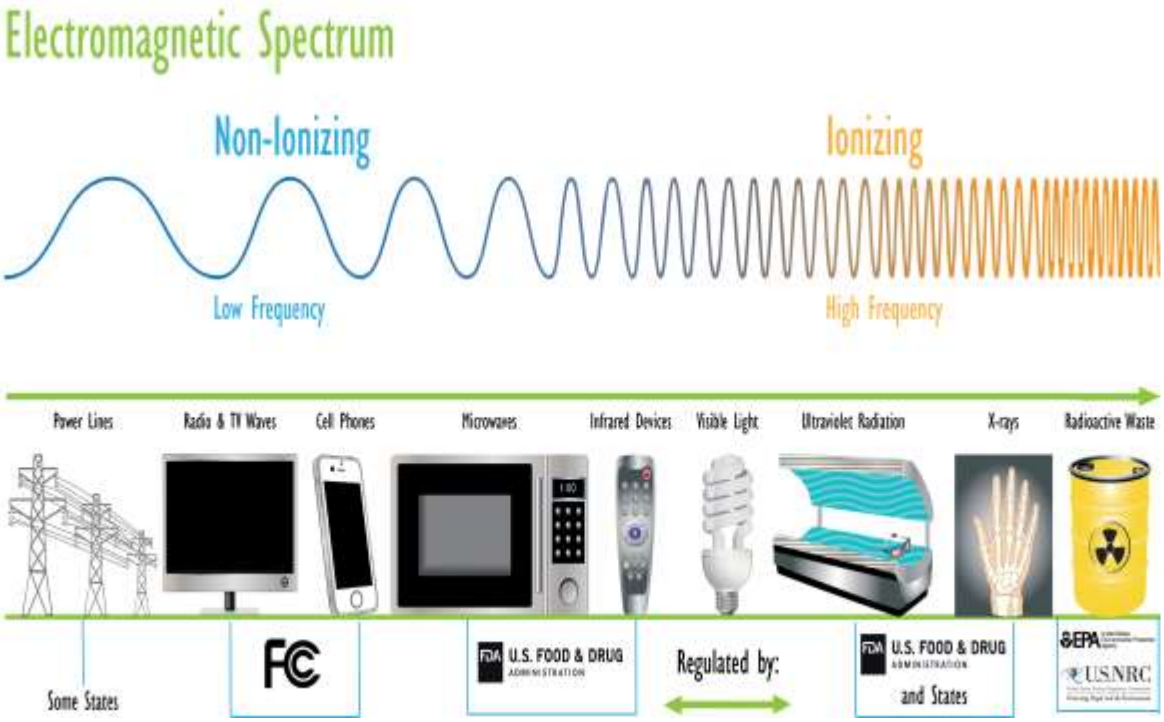
KEY WORDS: Electromagnetic, Spectrum, Alpha, Beta, Gamma, Particles, Radiation.

1. INTRODUCTION

1.1 ELECTROMAGNETIC SPECTRUM

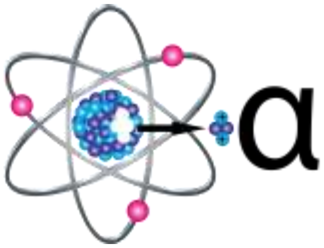
As the frequency rises, the energy of the radiation depicted on the spectrum below climbs from left to right

The goal of EPA's radiation protection efforts is to shield the environment and people from the ionising radiation that results from using radioactive materials for human purposes. Other organisations control the non-ionizing radiation that electrical gadgets like radio transmitters and cell phones release.



1.2 TYPES OF IONIZING RADIATION

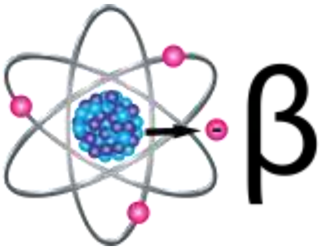
- **ALPHA PARTICLES**



Two protons and two neutrons from the atom's nucleus combine to form the positively charged alpha particles (). The most toxic radioactive materials, such as uranium, radium, and polonium, decay to produce alpha particles. Although alpha particles are extremely energetic, their weight prevents them from travelling very far from the atom since they expend their energy over short distances.

Depending on how a person is exposed, alpha particle exposure can have a significant impact on their health. Exposure to the exterior of the body is not a serious problem because alpha particles lack the energy to penetrate even the outermost layer of skin. But once inside the body, they can be highly dangerous. Alpha-emitters can harm delicate live tissue if they are eaten, breathed, or enter the body through a cut. These big, heavy particles are more hazardous than other radiation because of the way they affect things. They can release all of their energy in a few cells because to the close proximity of the ionisations they create. Cells and DNA suffer more serious damage as a result.

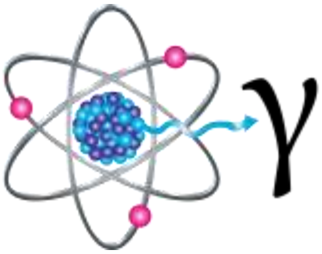
- **BETA PARTICLES**



When an atom undergoes radioactive decay, beta particles () are tiny, swiftly moving particles having a negative electrical charge. These particles are released by some unstable elements, including strontium-90, carbon-14, and hydrogen-3 (tritium).

Because the ionisations that beta particles produce are more widely spaced, they penetrate more deeply than alpha particles but cause less damage to DNA and live tissue. Although they move through the air more slowly than alpha particles, they can still be blocked by a layer of clothes or a thin covering of an element like aluminium. Some beta particles have the potential to penetrate the skin and harm, including skin burns. Beta-emitters, like alpha-emitters, are most dangerous when they are eaten or inhaled, though.

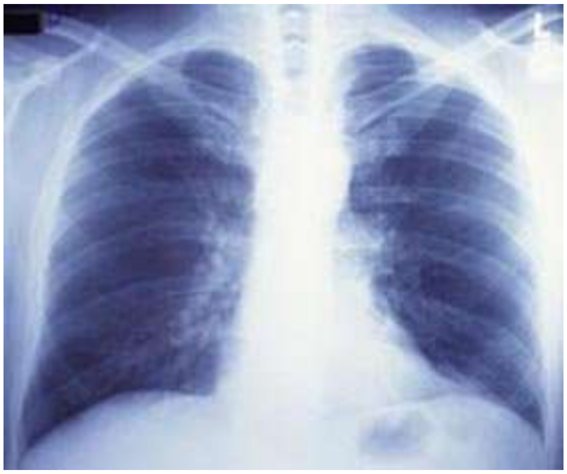
- **GAMMA RAYS**



Photons, or weightless packets of energy, are what gamma rays () are. Gamma rays are pure energy as opposed to alpha and beta particles, which have both energy and mass. Although considerably more energetic than visible light, gamma rays resemble it. During radioactive decay, gamma rays are frequently released alongside alpha or beta particles.

The entire body is exposed to radiation risks from gamma rays. They can quickly pass through defences like skin and clothing that can stop alpha and beta particles. Gamma rays have such a strong penetrating force that stopping them may need several inches of a thick substance, like lead, or perhaps a few feet of concrete. The human body can be totally penetrated by gamma rays, which can then generate ionisations that harm DNA and tissue.

- **X-RAYS**

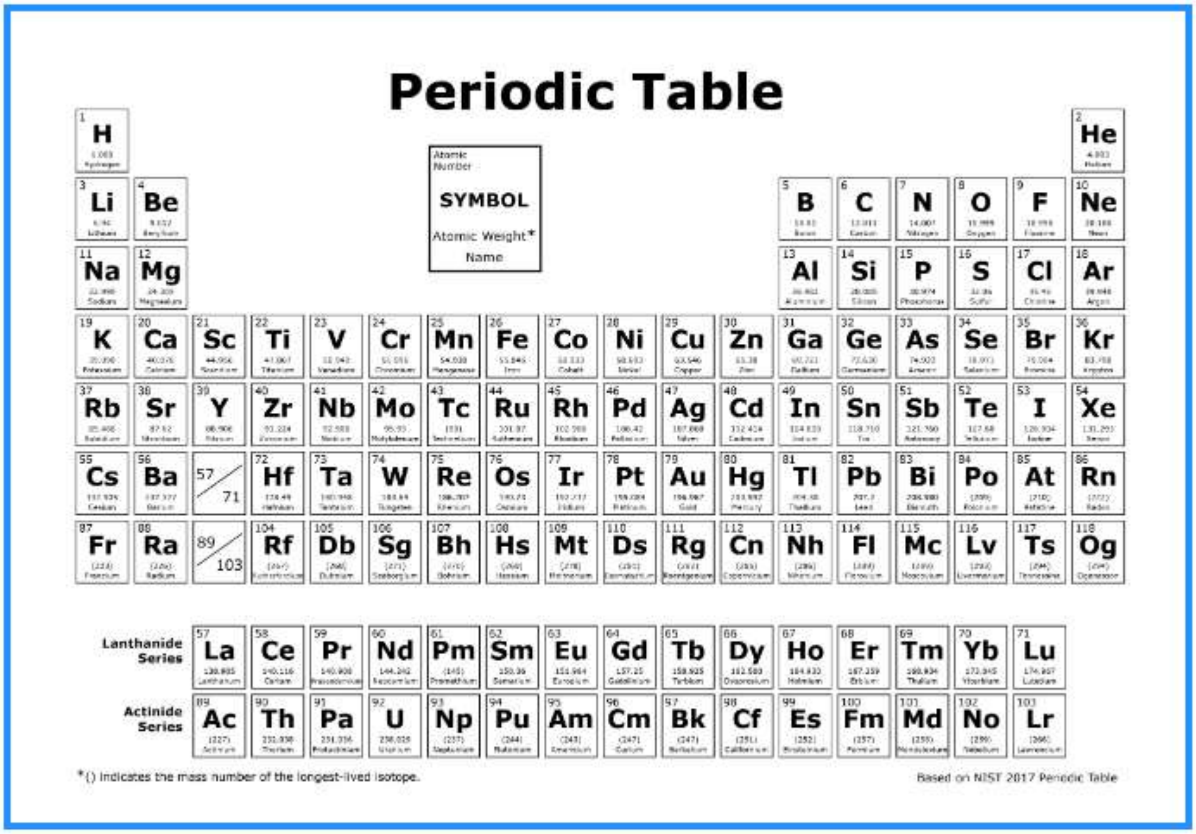


Almost everyone has heard about x-rays because of its application in medicine. As pure energy photons, X-rays and gamma rays share this property. Gamma and X-rays originate from various regions of the atom, although they share many fundamental characteristics. Gamma rays are produced inside the nucleus, whereas X-rays are produced by activities outside the nucleus. Additionally, they often have lesser energies than gamma rays, which makes them less piercing. X-rays can be created by electricity-powered machinery or spontaneously.

Every day, thousands of x-ray machines are employed in medical procedures. Known as a CT or CAT scan, computerised tomography creates precise images of the body's bones and soft tissues using specialised x-ray equipment. The main source of man-made radiation exposure is medical x-rays. Find out more about the sources and doses of radiation. X-rays are also employed in industry for process monitoring and inspection.

1.3 PERIODIC CHART

The periodic table's elements can appear in a variety of ways. These formations come in both stable and unstable varieties. The most prevalent form of an element in nature is typically the one that is most stable. All substances, though, have an unstable form. Unstable forms are radioactive and emit ionising radiation. Some substances, like uranium, have no stable forms and are therefore always radioactive. Radiation-emitting substances are referred to as radionuclides.



Periodic Table

Atomic Number
SYMBOL
Atomic Weight*
Name

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
Lanthanide Series		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
Actinide Series		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

*() indicates the mass number of the longest-lived isotope.

Based on NIST 2017 Periodic Table

1.4 RADIATION HEALTH EFFECTS

Ionizing radiation has enough energy to disrupt the atoms in live cells, causing their genetic material to be damaged (DNA). Fortunately, our bodies' cells are very effective at fixing this damage. However, if the damage is not properly repaired, a cell could eventually perish or develop cancer.

Acute health impacts like skin burns and acute radiation syndrome (also known as "radiation sickness") can occur after exposure to extremely high doses of radiation, such as from being close to an atomic explosion. Long-term health consequences like cancer and cardiovascular disease are another possibility. Low doses of radiation in the environment do not immediately harm us, but they do slightly increase our risk of developing cancer.

1.5 ACUTE RADIATION SYNDROME FROM LARGE EXPOSURES

A very high dose of radiation administered over a brief period of time can sometimes result in mortality during the following days or weeks in addition to symptoms like nausea and vomiting within hours after exposure. Acute radiation syndrome, also referred to as "radiation sickness," is what this is.

Acute radiation syndrome can only be brought on by very high radiation exposure—more than 0.75 grey (75 rad) in a short period of time (minutes to hours). This amount of radiation is equivalent to having your entire body exposed to the radiation from 18,000 chest x-rays during the course of this brief time. A nuclear explosion, unintentional handling of a highly radioactive source, or source rupture are examples of extreme occurrences that might cause acute radiation sickness, which is an uncommon condition.

1.6 RADIATION EXPOSURE AND CANCER RISK

Low-level radiation exposure has no immediate negative impact on health, but it can slightly raise your lifelong risk of developing cancer. Studies that monitor groups of radiation-exposed individuals, such as atomic bomb survivors and personnel in the radiation industry, are available. These studies demonstrate that exposure to radiation increases the risk of developing cancer, and that this risk rises with radiation dose. On the other hand, when the radiation dose decreases, the risk of developing cancer also decreases.

In international units called millisieverts or rem, radiation doses are often expressed (U.S. units). One radiation exposure or a series of exposures over time can be used to calculate a dose. A single 100 millisievert (10 rem) or lower uniform whole-body exposure would not cause cancer in about 99% of people. 1 When considering that approximately 40% of men and women in the United States will be diagnosed with cancer at some point in their lifetime, it would be incredibly challenging to detect an excess of malignancies brought on by radiation at this dose.

Even low individual risks may eventually cause an unacceptable number of extra cancer cases in a big population. For instance, in a population of one million people, an average 1% increase in a person's lifetime chance of developing cancer could lead to 10,000 more cancer cases. To safeguard the American population, including vulnerable populations like children, from elevated cancer risks brought on by cumulative radiation exposure over a lifetime, the EPA establishes regulatory limits and suggests emergency response standards well below 100 millisieverts (10 rem).

1.7 LIMITING CANCER RISK FROM RADIATION IN THE ENVIRONMENT

The linear no-threshold (LNT) model serves as the foundation for the EPA's regulatory caps and nonregulatory guidance for public exposure to low level ionising radiation. According to the LNT model, there is no threshold and the risk of cancer from low-dose exposure is proportionate to dose. To put it another way, halving the dose also halved the risk.

- **EXPOSURE PATHWAYS**

Estimating health impacts requires knowledge of the radiation type received, how a person is exposed (external vs. internal), and the duration of exposure.

The energy of the radiation that a specific radionuclide produces determines the risk associated with exposure to it.

- The radiation's nature (alpha, beta, gamma, x-rays).
- Its actions (how often it emits radiation).
- External versus interior exposure

When the radioactive source is external to your body, this is known as external exposure. Your body can be exposed to X-rays and gamma rays, which can deposit energy as they move through.

When radioactive material enters the body by food, drink, inhalation, or injection, it is referred to as internal exposure (from certain medical procedures). If considerable amounts are swallowed or inhaled, radionuclides may constitute a serious health risk.

• Where the radionuclide concentrations in the body and how long it stays there; How quickly the body breaks down and removes the radionuclide after ingestion or inhalation.

- **SENSITIVE POPULATIONS**

Radiation exposure is particularly harmful to children and unborn children. Children and foetuses have rapidly dividing cells, which increases the chance that radiation will interrupt the process and harm the cells. When updating radiation protection regulations, EPA takes into account changes in sensitivity caused by age and sex.

1.8 HEALTH EFFECTS BY SECONDARY RADIATION

The majority of harmful health effects from ionising radiation exposure can be divided into two categories:

- Deterministic effects (damaging tissue reactions), largely as a result of cell death or dysfunction after high doses from radiation burns.
- Stochastic consequences, such as cancer, and heritable effects, such as heritable disease in a person's offspring due to mutations in reproductive (germ) cells or cancer development in exposed persons as a result of somatic cell mutations.

The most frequent effect is stochastic cancer induction, which has a latent period of years or decades following exposure. For instance, even though the majority of persons with CML have not been exposed to radiation, ionising radiation is one of the causes of chronic myelogenous leukaemia. Although the process by which this happens is clear, quantitative approaches for estimating the degree of risk are still debatable.

The linear no-threshold model (LNT), which is the most frequently accepted model, states that the incidence of malignancies brought on by ionising radiation rises linearly with effective radiation exposure at a rate of 5.5% per sievert. If this is the case, medical imaging would come in second place as the source of radiation that poses the greatest risk to the general public's health. Teratogenesis, cognitive decline, and heart disease are further stochastic effects of ionising radiation.

1.9 CONCLUSION

The experiment's findings contradict classical electromagnetism, which assumes that energy is continuously transferred from light waves to electrons, who eventually emit energy when they have accumulated enough. The kinetic energy of the expelled electrons might theoretically shift in response to changes in light intensity, with sufficiently weak light leading to a delayed emission. However, independent of the light's intensity or exposure time, the experimental results reveal that electrons are only moved when the light surpasses a specific frequency. Albert Einstein proposed that a beam of light is not a wave propagating through space, but a swarm of discrete energy packets, known as photons, because a low-frequency beam at a high intensity does not build up the energy required to produce photoelectrons, as would be the case if light's energy accumulated over time from a continuous wave.

The DNA molecule can be damaged by radiation with enough energy to excite specific molecular bonds and cause them to create pyrimidine dimers, even though DNA is always susceptible to damage from ionising radiation. Even while it may not be ionising, this energy is close to it. A notable example is the ultraviolet spectrum, which starts at about 3.1 eV (400 nm) and is near to the energy level that can burn unprotected skin due to photoreactions in collagen and DNA damage in the UV-B region (for example, pyrimidine dimers). Thus, the electronic stimulation of molecules that occurs in the mid- and low-ultraviolet electromagnetic spectrum—which is short of ionisation but results in similar non-thermal effects—damages biological tissues. Reactive oxygen species (ROS) are electrically excited molecules that can cause reactive damage, even though visible light and ultraviolet A (UVA), which is closest to visible energy, have been shown to result in the generation of ROS in skin to some extent (erythema). [26] All of these skin impacts, including ionisation damage, go beyond what is caused by basic thermal reactions.

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