Radi-N2 & You

Radiation & Human Space Exploration

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Radiation is a type of energy that can travel through space in the form of a wave or as fast-moving particles. You have lived all of your life surrounded by many forms of radiation and probably never knew it!

Types of Radiation

Most of the radiation you are exposed to on a daily basis is **electromagnetic radiation** (EMR), which is made up of electrical and magnetic energy. EMR can have a wide range of energy (or **frequency**), from very low energy, such as radio waves, to very high energy, such as gamma rays. This range of energy is called the **electromagnetic spectrum** (EMS). EMR is characterised by its frequency (number of waves per second) (see bottom of Figure 1) and **wavelength** (distance between two adjacent wave peaks – see middle of Figure 1). The higher the wave's frequency (such as at the gamma ray end), the shorter its wavelength.

Visible light, ultraviolet radiation, infrared radiation, radio waves, microwave radiation, x-rays, and gamma rays are all natural forms of EMR (see Figure 1). The only parts of the electromagnetic spectrum that are directly detectable by our senses are infrared radiation (felt as heat) and visible light. Radio waves, x-rays and gamma rays, although they cannot be seen or felt, can pass through your body. Electromagnetic radiation travels as little packets (**quanta**) of energy called **photons** (chargeless bundles of energy that travel in a vacuum at the speed of light - 3.00 x 10^8 m/s).

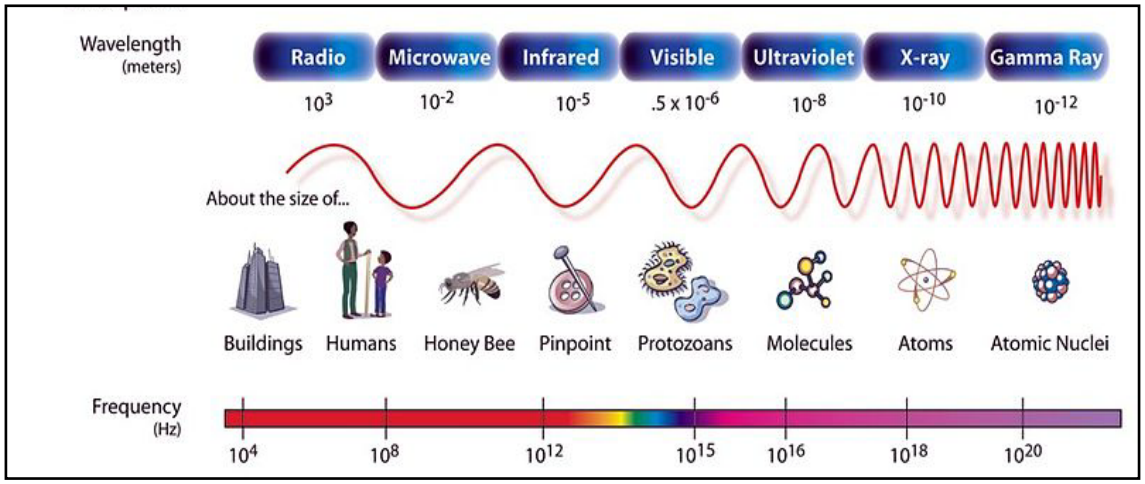

Figure 1: Characteristics of the electromagnetic spectrum. (Public domain image from Wikimedia Commons at: http://commons.wikimedia.org/wiki/File:EM_Spectrum3-new.jpg)

Radiation can be classified as either non-ionizing or ionizing. **Non-ionizing radiation** is radiation which does not have enough energy to **ionize** atoms or molecules (cause them to gain or lose **electrons**). Non-ionizing radiation includes radio waves, microwaves, and visible light. Although they cannot ionize atoms, non-ionizing radiation is not completely harmless. Microwaves are energetic enough to cook your food and ultraviolet radiation can give you a sunburn. **Ionizing radiation** does carry enough energy to knock electrons out of their parent atoms, causing ions to be formed. X-rays and gamma rays are examples of ionizing radiation. This type of high-energy radiation can quickly produce cancers or even kill cells outright. This is why you wear a lead smock when getting a dental x-ray and why x-ray technicians are in a different room when they are using x-ray equipment.

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Particle Radiation

Another type of radiation is **particle radiation**. This type of radiation consists of atomic or subatomic particles, such as protons, neutrons and electrons, which have **kinetic energy** (energy of a mass in motion). **Alpha particles** (large, slow, positively charged particles made up of two protons and two neutrons, like the nuclei of helium) and **beta particles** (small, fast, positively charged particles - **positrons** - and negatively charged particles - **electrons**) are **directly ionizing** because they carry a charge and can interact directly with atomic electrons through **coulombic forces** (i.e., like charges repel each other; opposite charges attract each other). N**eutrons** are particles found in the nucleus of atoms and, unlike protons and electrons, are not charged. Neutron radiation is a type of **indirectly ionizing** radiation made up of free neutrons that occurs when neutrons are released from atoms. These free neutrons can react with the nuclei of other atoms to form new **isotopes** (variants of an element with the same number of protons but different numbers of neutrons), which in turn may emit radiation such as gamma rays. Neutron radiation is called indirectly ionizing because it does not ionize atoms in the same way as charged particles.

Cosmic Radiation

Radiation is present throughout the environment here on Earth - in the air, water, food, soil and in all living organisms. Radiation also comes from our Sun and outer space. This space radiation, also called **cosmic radiation**, includes both electromagnetic radiation such as gamma rays as well as particles such as the nuclei of atoms. Fortunately, Earth's atmosphere and **magnetosphere** (magnetic field) help absorb and filter them out, which protect us from high doses of cosmic radiation. However, some radiation is able to pass through. The dose of cosmic radiation that people receive varies depending on altitude. Since the atmosphere is thinner at higher altitudes, less cosmic radiation is filtered out than it is at lower altitudes.

Hazards of Radiation for Human Space Travel

Cosmic radiation is one of greatest dangers for space travellers. Cosmic ray particles, having both high energy and speed, are dangerous to both people and their machines. This is because when these particles collide with particles of other things, such as a spacecraft, the International Space Station, or human tissue, they can split molecules, which results in the formation of secondary particles such as protons, neutrons and other subatomic particles. The main danger from neutrons is their ability to penetrate matter. Since neutrons are large and uncharged, they are more penetrating than alpha particles, beta particles and even gamma rays (see Figure 2). In the case of human cells and tissue, neutron radiation can cause cells to mutate, become cancerous, or die. We still have a lot to learn about cosmic radiation, which is why research into this area is important for future space missions. The International Space Station is one place where this research is happening right now!

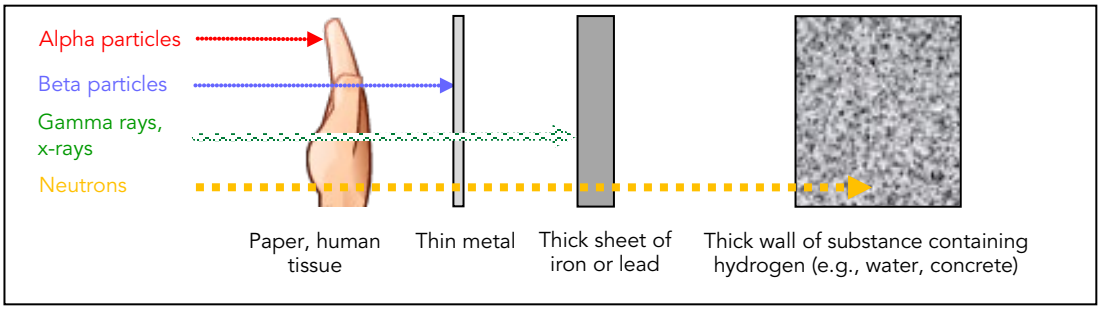

Figure 2: Penetration ability of various forms of radiation.