

Biothermal physics

Sixth lecture

Non-ionizing Radiation

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Third Stage

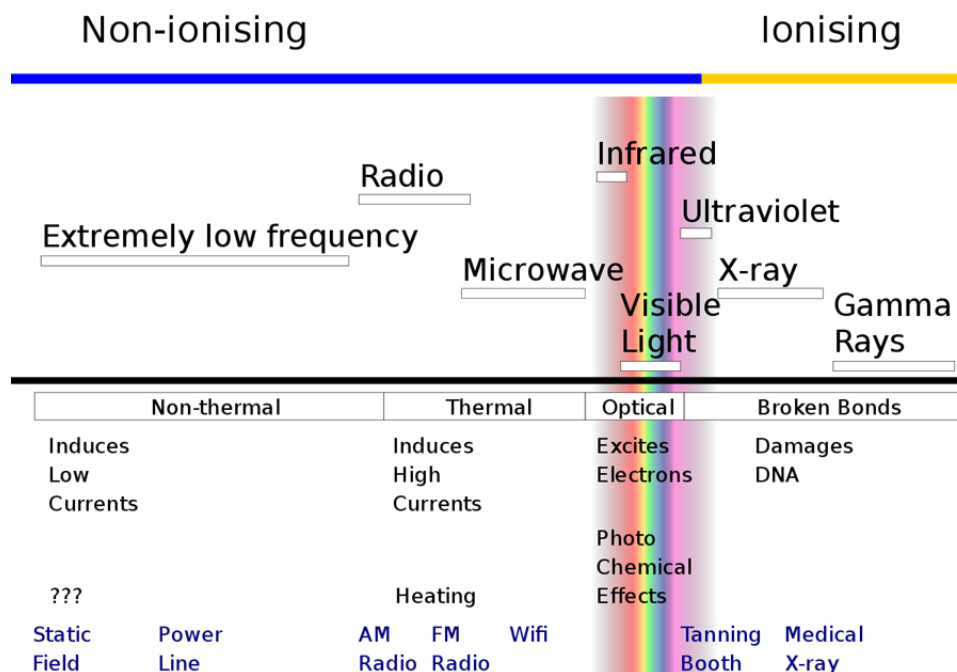
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introduction

- **Radiation:** Energy emitted from a body or source that is transmitted through an intervening medium or space and absorbed by another body.
- Radiation is classified as being either **non-ionizing** or **ionizing**.
- **Non-ionizing** radiation is **longer wavelength**, **lower frequency** and **lower energy**.
- **Ionizing** radiation is **short wavelength**, **high frequency** and **higher energy**.
- Ionizing radiation **has sufficient energy to produce ions in matter at the molecular level**.
- If that matter is a human significant damage can result including **damage to DNA and denaturation of proteins**.
- Non-ionizing radiation *is any kind of radiation in the electromagnetic spectrum that does not have enough energy to remove an electron from an atom and turn it into an ion.*
- This is not to say that non-ionizing radiation can't cause injury to humans but the injury is generally limited to **thermal damage i.e. burns**.



- **The visible spectrum** is essentially the divide between ionizing and non-ionizing radiation.

Types of Non-Ionizing Radiation

- ✚ Non-ionizing radiation can be divided from *lowest to highest frequency* into:

1. ELF (Extremely Low Frequency)
2. Radio Frequencies
3. Microwave Frequencies
4. Lasers
5. Infrared
6. Visible Spectrum
7. Ultraviolet

1. Extremely Low Frequencies (ELF)

- ✓ **Waves are on the far end of the electromagnetic spectrum**
- ✓ **Come from**: power lines, electrical equipment and wiring, and electrical appliances such as electric blankets, refrigerators, razors and hair dryers.
- ✓ Normal levels of ELF radiation are *no dangerous to humans*.

2. Radio Frequencies (RF)

- ✓ **Come from**: AM and FM radio broadcasts, Wi-Fi signals, cell phones, amateur radio, television and airport security scanners use radio frequency (RF) waves.
- ✓ **The effects of RF waves on the body** in terms of heat generation. For example, using a cell phone causes the ear and/or head to get warm.
- ✓ RF waves are divided into categories: **high frequency (HF), medium frequency (MF), low frequency (LF) and very low frequency (VLF)**.
- ✓ There is no scientific proof that RF non-ionizing radiation increases the risk of cancer or causes any harmful effects on the body.

3. Microwaves (MW)

- ✓ **comes from** microwave ovens, radar, transmission towers, satellite transmissions.
- ✓ **A microwave oven works** because microwaves excite the water molecules in food and cause them to vibrate, generating heat and cooking the food. Atoms and molecules can also emit and absorb MW radiation.
- ✓ Overexposure to MW radiation can cause **cataracts** and **skin burns**.
- ✓ **There are three subcategories of MW radiation.**
 - i) Extremely high frequency (EHF) waves* are used in remote sensors and radio astronomy.
 - ii) Super high frequency (SHF) waves* are commonly used in microwave ovens, radar transmitters, cell phones and satellite communications.
 - iii) The ultra-high frequency (UHF)* is used in television broadcasts, walkie-talkies and cordless phones.
- ✓ Microwaves are sometimes grouped with radio waves *because these two types of non-ionizing radiation have some overlap on the electromagnetic spectrum.*

4. Lasers (Light Amplification by Stimulated Emission of Radiation)

- ✓ **Lasers** stimulate atoms and molecules and cause them to produce light and concentrate it into a beam of radiation.
- ✓ Lasers can be made from **visible light, UV and IR waves**.
- ✓ Store checkout scanners, CD and DVD players, remote controls, dental drills, laser pointers and laser printers all use lasers.
- ✓ **Maser** work in the same way, except **they amplify MW and RF waves** (the “M” stands for microwave).
- ✓ Lasers are also made from the elements argon, helium and neon, ruby crystals, chemicals and liquid dyes.

- ✓ **Risk**: when not used properly, lasers burn and cause severe damage to tissues, especially in the eye. The narrow beam of light concentrates the effects on the retina, causing blind spots.

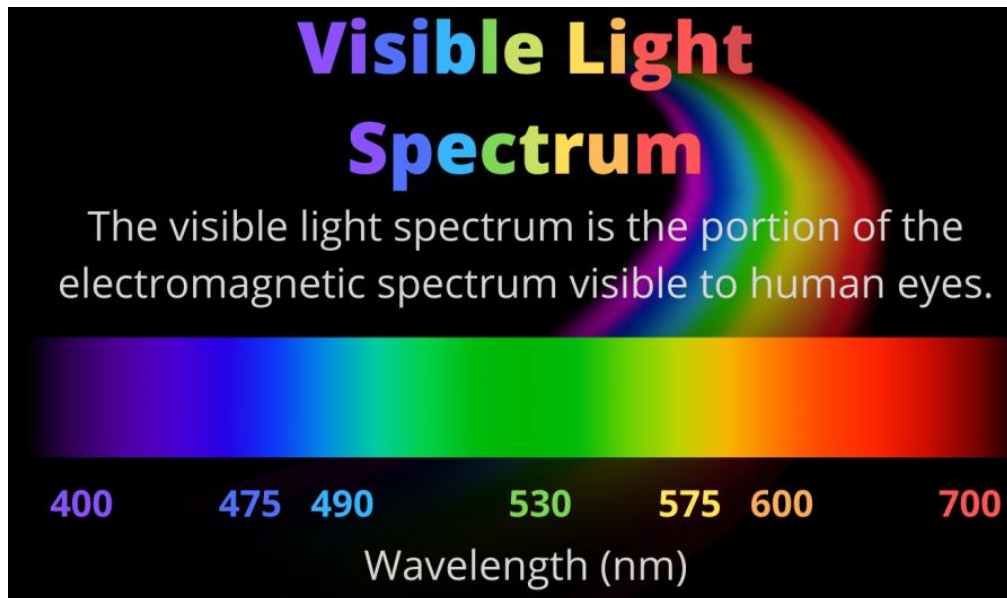
5. Infrared (IR)

- ✓ Everything on Earth gives off some amount of infrared (IR) radiation.
- ✓ The human eye can't see most of the IR spectrum, but we can feel it as heat.
- ✓ **IR radiation is used** in furnaces, heat lamps, toasters, night-vision goggles and the lasers seen on TV remote controls.
- ✓ About half of the total energy the sun gives off is in the form of IR radiation, which we feel as heat.
- ✓ **In large amounts**, this type of radiation can *damage the eyes and even cause blindness*.
- ✓ IR radiation from the sun is normally absorbed by the Earth's surface and the clouds, then released as heat into the atmosphere.
- ✓ When the atmosphere has a lot of water vapor, along with nitrogen, sulfur and fluorocarbons, the IR radiation gets trapped and causes the atmospheric temperature to rise. This is called the **greenhouse effect**.
- ✓ Temperature increases like this cause changes in the weather patterns on Earth and lead to climate change.

6. Visible Light

- ✓ 400 to 700nm wavelengths.
- ✓ The visible light portion of the electromagnetic spectrum can be seen by humans, animals and other organisms.
- ✓ This type of light consists of seven colors: red, orange, yellow, green, blue, indigo and violet.
- ✓ When all the colors are present at one time, the light is white. Rainbows are created when visible light passes through raindrops.

- ✓ The raindrops act like a prism and break the light down into its individual colors.
- ✓ Overexposure to visible light can damage both the eyes and skin. Possibility of retinal injury from 400-500 nm blue frequencies.



7. Ultraviolet (UV)

- ✓ **Ultraviolet (UV) radiation comes from** the sun, welding, black lights and UV lasers.
- ✓ The sun emits UVA, UVB and UVC rays.
- ✓ UVC rays are absorbed by the ozone layer and never actually reach the Earth. Both UVA and UVB light are important for humans in the production of Vitamin D.
- ✓ However, the effects of overexposure to UV rays can be negative and can be immediate or delayed.
- ✓ Sunburn, skin cancer and cataracts develop over time with excessive exposure.