

Imaging Modalities

The electromagnetic spectrum is the range of frequencies of electromagnetic radiation and their respective wavelengths and photon energies.

Electromagnetic Spectrum

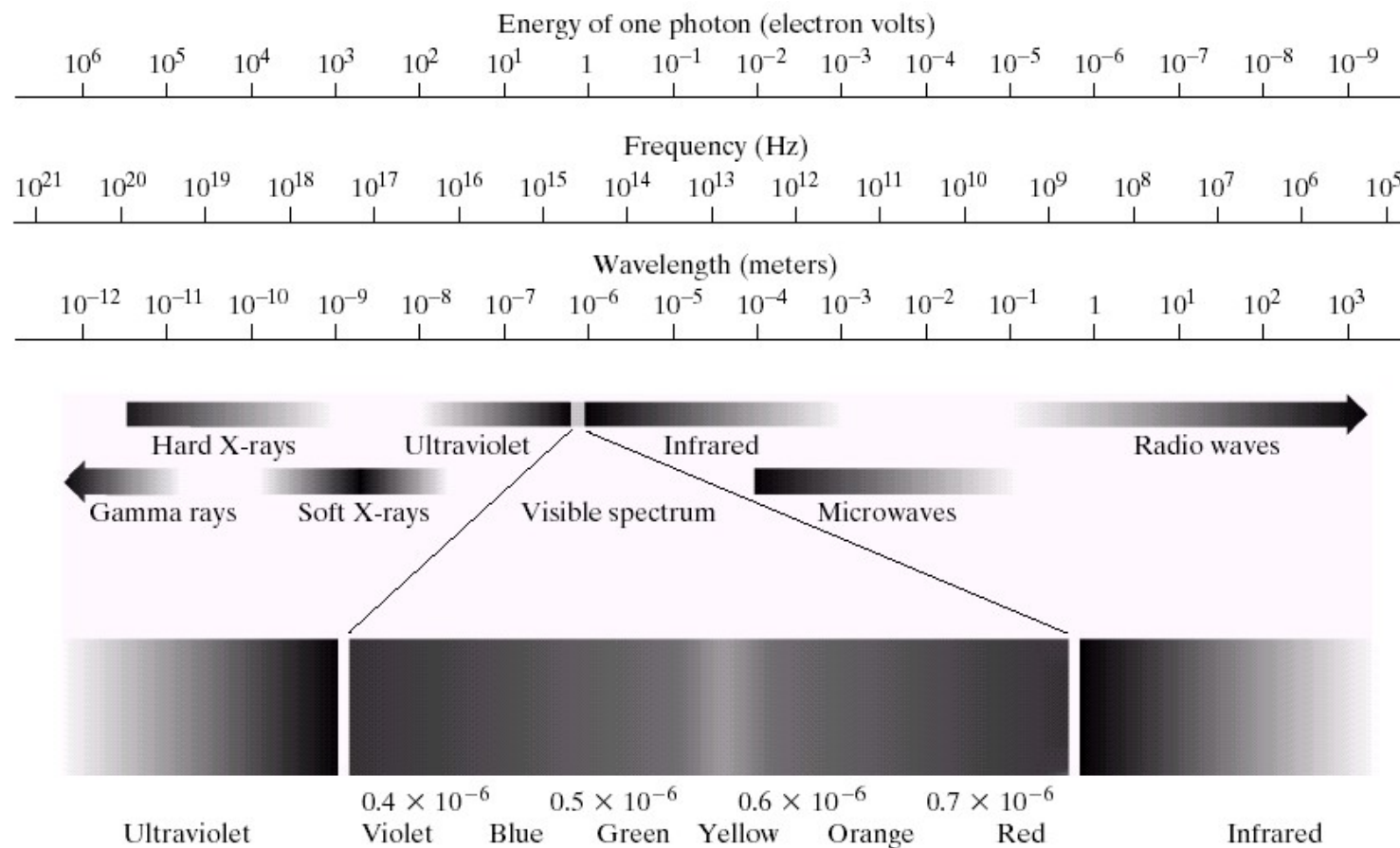


FIGURE 2.10 The electromagnetic spectrum. The visible spectrum is shown zoomed to facilitate explanation, but note that the visible spectrum is a rather narrow portion of the EM spectrum.

1) Visible Light

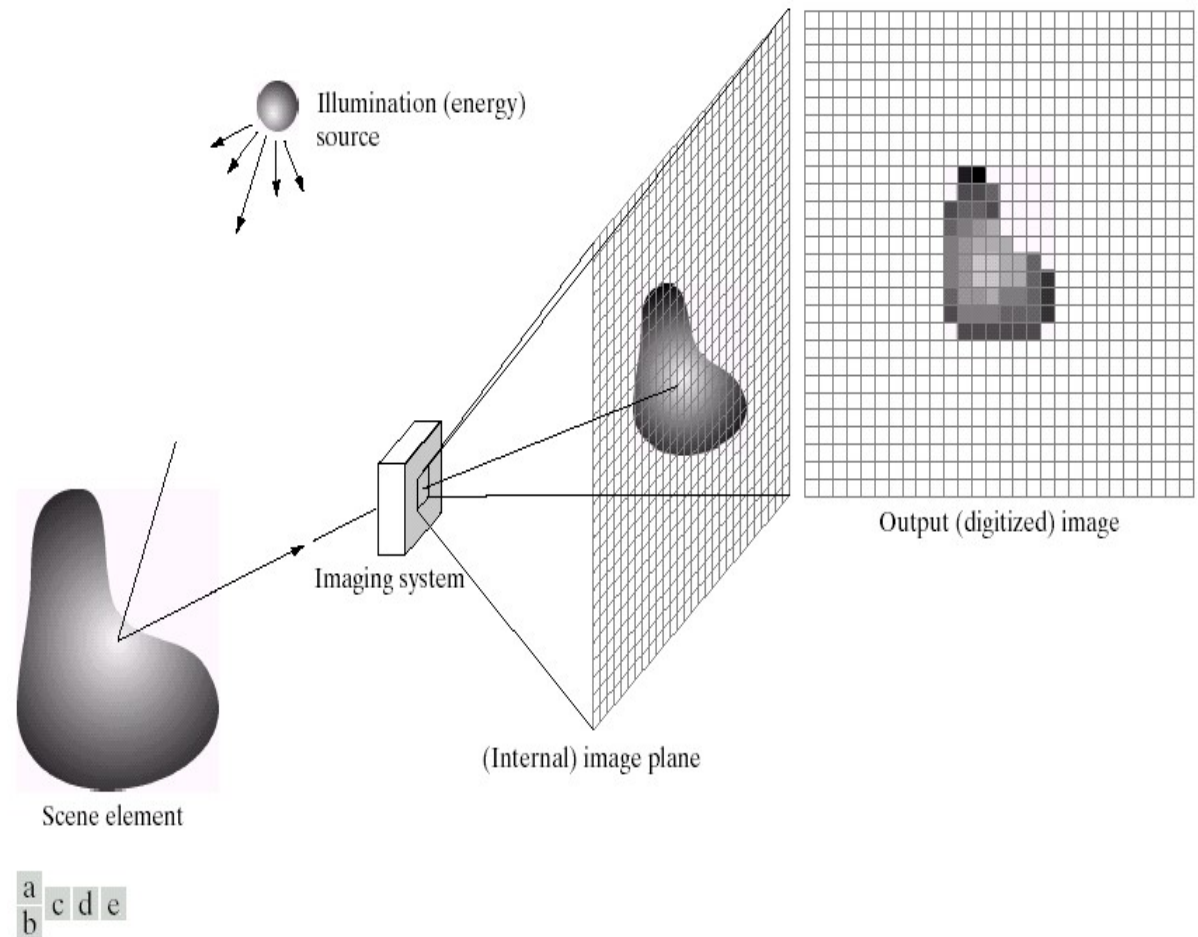


FIGURE 2.15 An example of the digital image acquisition process. (a) Energy (“illumination”) source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Visible light is the portion of the electromagnetic spectrum that can be seen with the naked eye. The electromagnetic spectrum consists of different forms of electromagnetic radiation, but only those falling within wavelengths of 390-700 nm can be detected by the human eye.

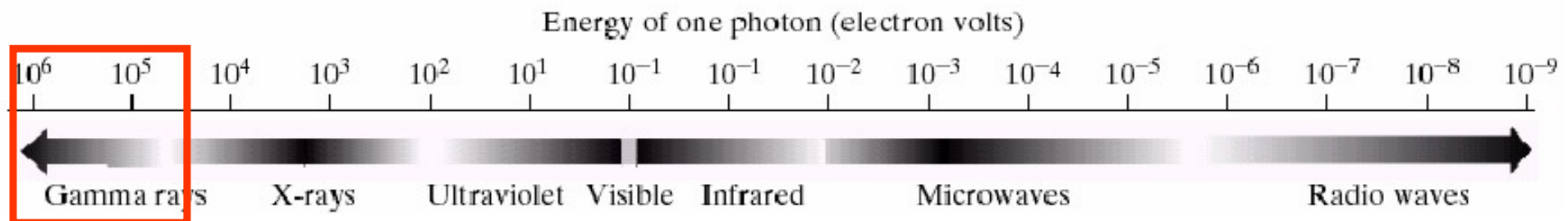
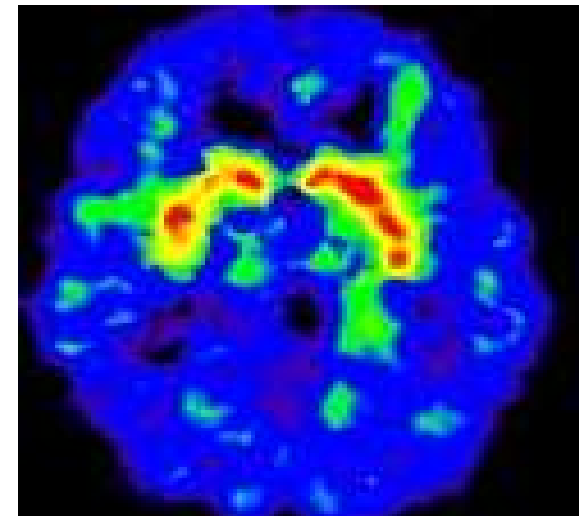
Beyond Visible

- Gamma Ray
- X-ray
- Ultraviolet
- Microwave
- Infrared
- Radio waves

A gamma ray, also known as gamma radiation, is a penetrating form of electromagnetic radiation arising from the radioactive decay of atomic nuclei. It consists of the shortest wavelength electromagnetic waves, typically shorter than those of X-rays.

2) Gamma Rays

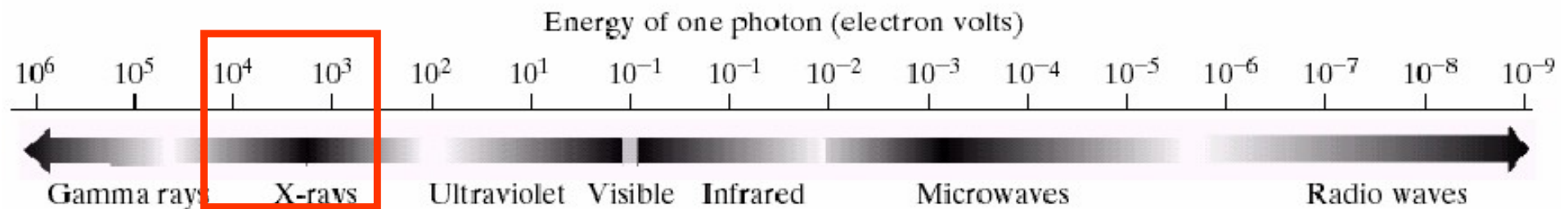
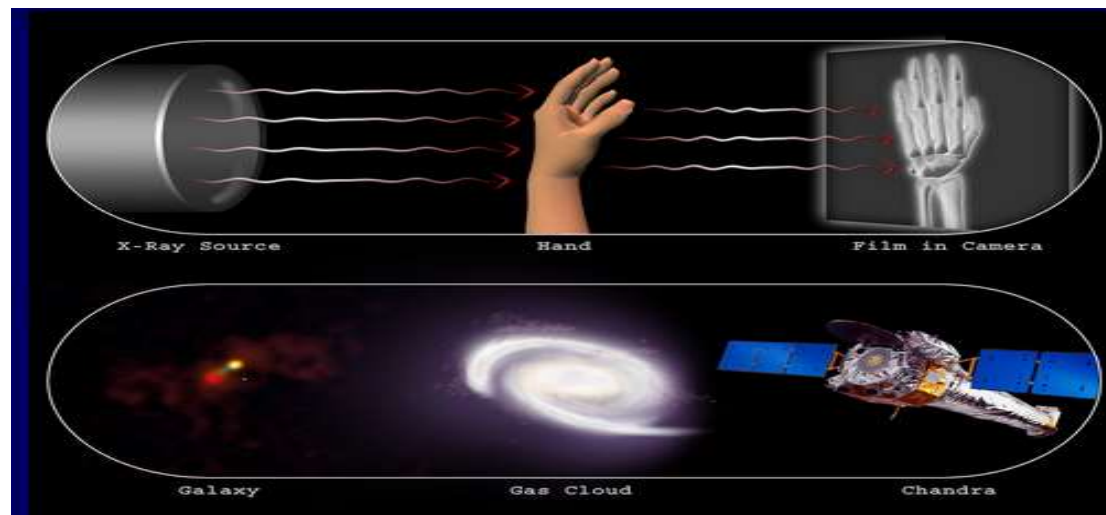
- Gamma Rays: Carry the most energy and have the shortest wavelengths.
- Used in *Nuclear medicine* (PET scan)



X-rays are a form of electromagnetic radiation, similar to visible light. Unlike light, however, x-rays have higher energy and can pass through most objects, including the body. Medical x-rays are used to generate images of tissues and structures inside the body.

3) X-ray

- These rays have enough energy to penetrate deep into tissues and cause damage to cells; are stopped by dense materials, such as bone.
- Used in Medical, astronomy and industrial applications



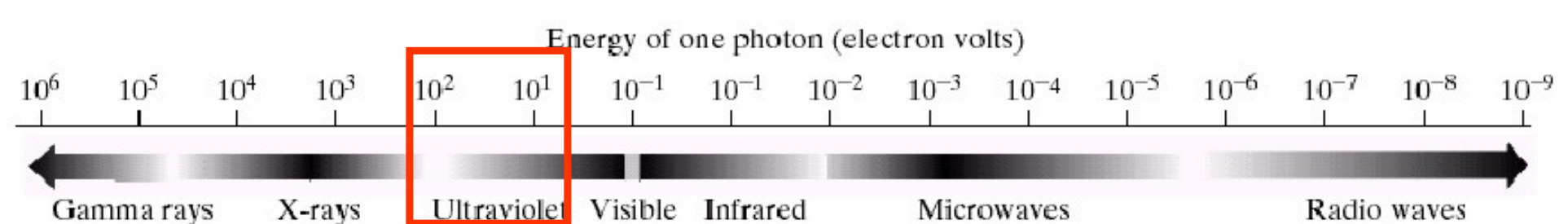
Ultraviolet is a form of electromagnetic radiation with wavelength from 10 nm to 400 nm, shorter than that of visible light, but longer than X-rays. UV radiation is present in sunlight, and constitutes about 10% of the total electromagnetic radiation output from the Sun.

4) Ultraviolet

- Energy is high enough with UV rays to penetrate living cells and cause them damage.
- Used in Industry, microscopy and lasers(sterilization).



Infected corn(microscope)

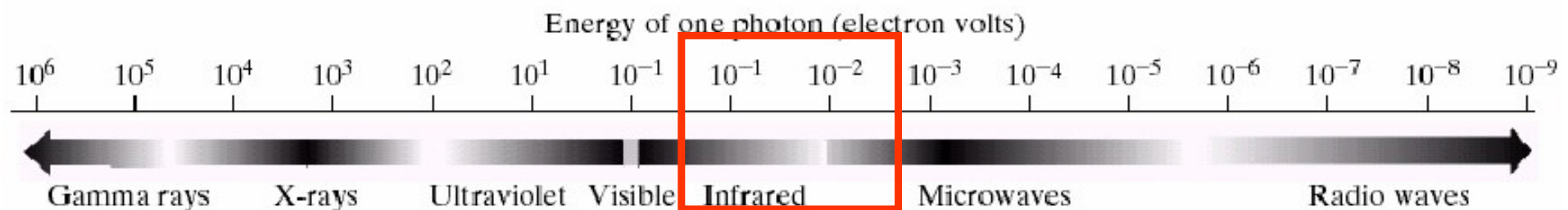


Infrared radiation (IR), or infrared light, is a type of radiant energy that's invisible to human eyes but that we can feel as heat. All objects in the universe emit some level of IR radiation, but two of the most obvious sources are the sun and fire. IR is a type of electromagnetic radiation, a continuum of frequencies produced when atoms absorb and then release energy.

5) Infrared

--A **infrared camera** is a device that forms an image using infrared radiation. The higher an object's temperature, the more infrared radiation is emitted .

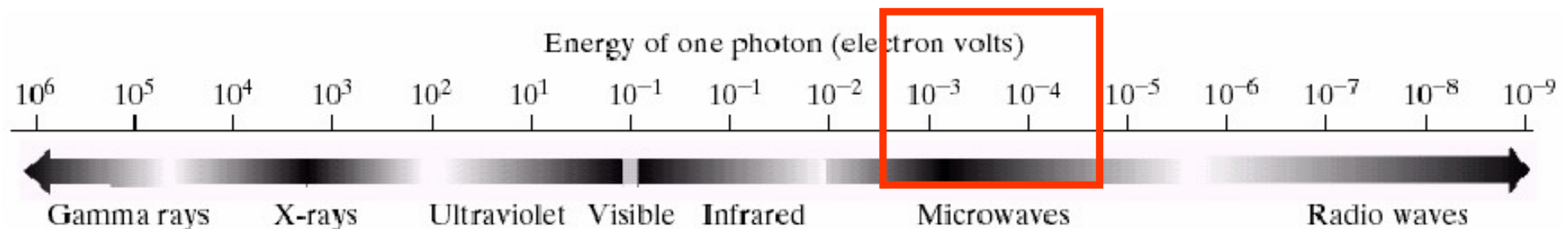
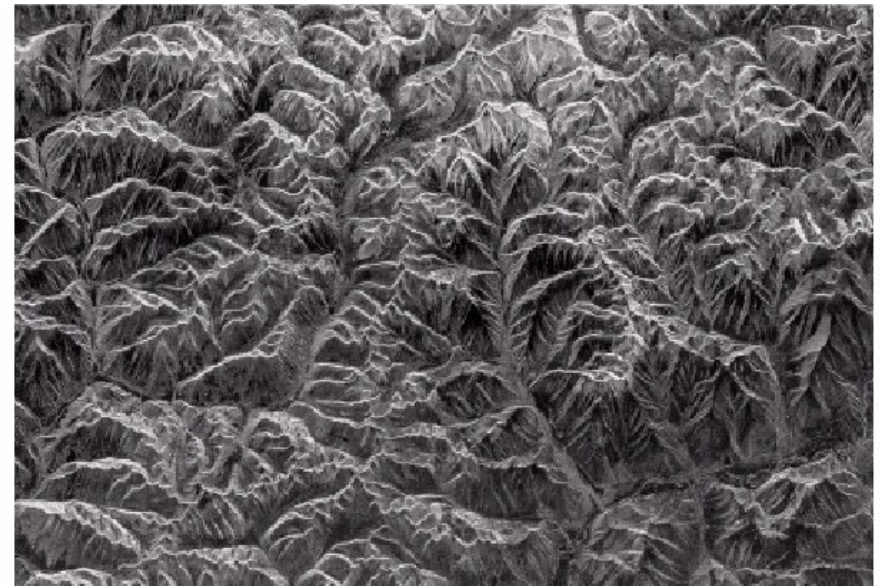
--Used in Astronomy, Industry and remote sensing.



6) Microwave

Electromagnetic waves with a wavelength on the order of a few inches. Microwaves are longer than infrared radiation and shorter than radio waves. Microwaves are used extensively for communication, both in satellite television and for the transmission of long-distance telephone signals. -- Used in NDTE, concealed weapon detection, through-the-wall imaging.

Radar



An electromagnetic wave having a wavelength between 1 millimeter and 30,000 meters, or a frequency between 10 kilohertz and 300,000 megahertz.

7) Radio Waves

--Have the longest wavelengths and the lowest frequencies. Non-ionizing radiation.

--Used in: RADAR, cooking food, satellite transmissions, **MRI**

