

What is the electromagnetic spectrum?

The energy from the Sun and other objects in the universe travels to Earth in waves that we call electromagnetic waves. All of these waves travel at the speed of light, which in space is 300 000 kilometres per second. Although the waves all travel at the same speed, they may go up and down quickly (have a **short wavelength**), while others go up and down slowly (have a **long wavelength**). You can also think of these waves as if they are made up of packets of energy, called photons, with different amounts of energy. Long wavelength waves, have low energy, while those with short wavelengths have high energy. **We call this entire range of waves of different lengths the "electromagnetic spectrum".** In this spectrum wavelengths vary from several kilometres long, to smaller than an atom. The frequency of a wave is simply the number of times that the top of a wave passes a point in one second. This is called "cycles per second" and the scientific unit is "Hertz" (Hz). The wavelength of an electromagnetic wave, times its frequency, equals the speed of light.

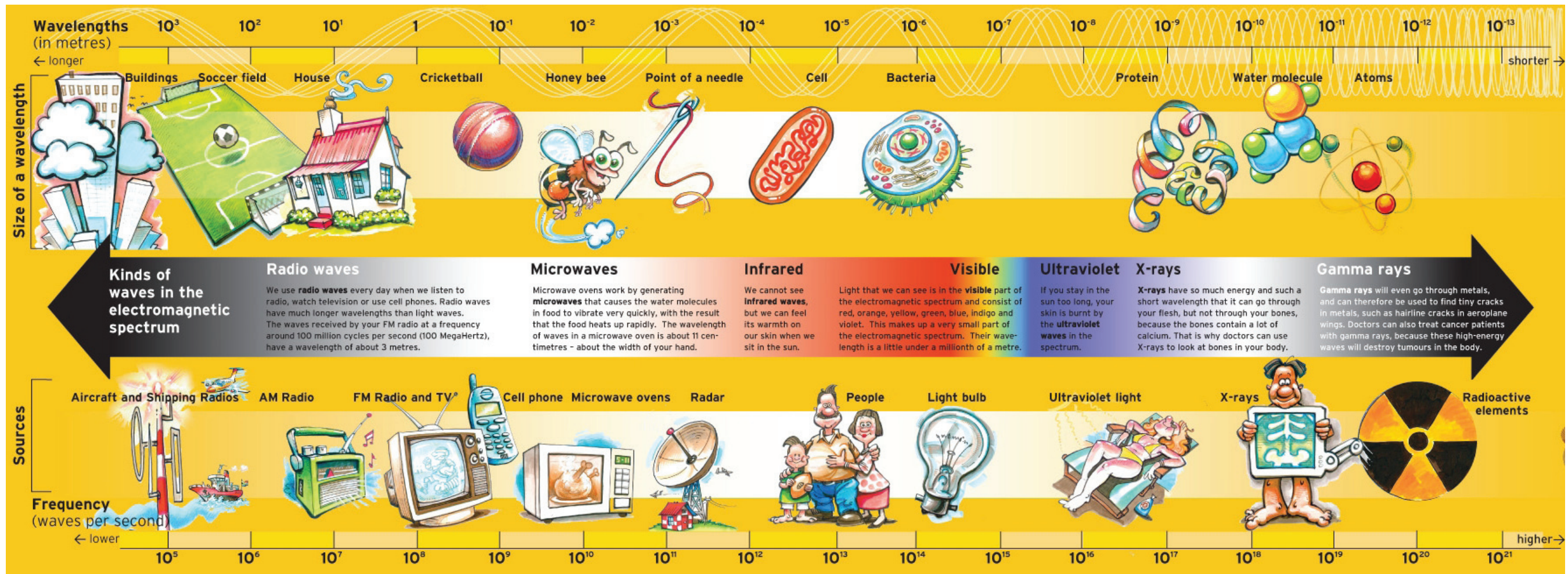
How does a radio telescope work?

A radio telescope is a very sensitive receiver of radio waves. It has two basic components to help us to understand the meaning of the radio waves that it detects:

1. A dish-shaped antenna is pointed to the sky to collect the radio waves. Because the strength of the radio waves that reaches the earth is very weak (they have come from a long way away!) the collecting area should be large. The curved surface of the antenna then reflects the radiation to the focus point of the dish, where it is received by a metal horn and fed to a sensitive radio receiver.
2. The receiver then amplifies the radio signal and digitises it (turns it into numbers) so that it can be stored in a computer. This information is then processed with the help of computers. To help make sense of the strings of numbers, astronomers turn the numbers into pictures. Each of these numbers represents information from a specific point in space. Astronomers often assign specific colours to these numbers according to the amount of information they represent. They then combine the colours to make a picture so that the information can then be "seen". These pictures tell us about many characteristics of the objects in the universe.

Radio telescopes usually study what is invisible to optical telescopes, and optical telescopes usually study what is invisible to radio telescopes.

THE ELECTROMAGNETIC SPECTRUM



How do radio astronomers use the electromagnetic spectrum?

Radio waves and microwaves pass through the Earth's atmosphere and can be detected by telescopes on the Earth's surface. Molecules in the Earth's atmosphere absorb many wavelengths at the millimeter and infrared wavelengths. Telescopes working in these bands are put on top of high mountains. Several infrared telescopes have been launched into space to avoid the problem of the atmosphere completely. Optical telescopes also work best on top of high mountains. This reduces the "twinkling" we see from the stars at night, which is caused by the atmosphere. Telescopes working in the far-ultraviolet and X-rays have to be put into satellites as the atmosphere absorbs these wavelengths. Gamma rays from space hitting our atmosphere produce a shower of blue light. Special optical telescopes on the ground can detect this. The HESS telescope in Namibia works in this way to indirectly detect gamma rays coming from the remains of exploded stars and from black holes in distant galaxies. Telescopes that detect gamma-rays directly have also been launched into space.