Worksheet 3:

Capturing the invisible – the great challenge of astronomy

In the introductory video "Light and optics II: What is light? – The electromagnetic spectrum (2019)", you learned that the electromagnetic spectrum is divided into seven regions:

- radio waves
- microwaves
- infrared
- visible light
- ultraviolet
- X-rays
- gamma rays

Exercises:

1. Look up the **wavelength range** of these seven types of radiation on the internet and write down the results in your notebook.

During your research, you may encounter units of length that you are not familiar with. You can refer to the following infobox:

Infobox: Units of measurement for very small lengths

millimetre: $1\text{mm} = \frac{1}{1000}\text{m} = 1 \cdot 10^{-3}\,\text{m}$

micrometre: $1\mu\text{m} = \frac{1}{1000\,000}\text{m} = 1 \cdot 10^{-6}\,\text{m}$

nanometre: $1\text{nm} = \frac{1}{1000\,000\,000}\text{m} = 1 \cdot 10^{-9}\,\text{m}$

picometre: $1\text{pm} = \frac{1}{1000\,000\,000\,000}\text{m} = 1 \cdot 10^{-12}\,\text{m}$

femtometre: $1\text{fm} = \frac{1}{1000\,000\,000\,000\,000}\text{m} = 1 \cdot 10^{-15}\,\text{m}$

2. Only one of the seven categories of waves is within the visible region. Nevertheless, the other six are still extremely important for observational astronomy because many processes in the universe (for example during the birth of stars, the various phases of the life and death of stars, galaxy formation, the acceleration of interstellar gas and dust clouds near black holes, and many other dynamic processes) create energy that is released as radiation. Depending on the amount of energy, this radiation can vary from radio waves to gamma rays.

To learn as much as possible about the universe, to formulate new theories, and to understand physical relationships, astronomers are extremely interested in every type of radiation travelling through space. Today, we have a variety of new telescopes and measuring instruments to capture the vast amount of invisible radiation present in the universe alongside visible light.

Look up on the internet which processes generate each of the seven types of radiation in the universe (one or two examples each are sufficient) and what equipment is typically required to receive and detect them.

For those particularly interested:

Some of the types of radiation mentioned above are absorbed by the Earth's atmosphere and do not reach the ground, or only in very small quantities. For life on Earth, this is greatly beneficial – the atmosphere acts like a protective shell against high-energy radiation. But it also means that astronomers have to set up their equipment at high altitudes or even outside of the atmosphere in order to detect and record the radiation.

Look up which wavelength ranges require you to set up your telescopes on very high mountains, aeroplanes, or satellites.

