Planets that do not orbit the sun but distant stars are called “extrasolar planets” or “exoplanets”. Although it has long been suspected that there must be numerous planetary systems other than our solar system, the first evidence of these celestial bodies was not found until 1995. Indeed, the search for exoplanets poses enormous challenges for observational astronomy, mainly because of the vast distances of these celestial bodies. The following tasks illustrate this.

Task 1:

Distances and lengths in astronomy are often not given in metres but rather in light years (ly) or in parsecs (pc). A parsec means: $1\ \mathrm{pc} = 3.08568 \cdot 10^{13}\mathrm{km}$.

a) Describe in words: What is a light year?

b) Calculate:

1. How many kilometres is a light year?
   (Use: Speed of light $\mathrm{c} = 299792458\,\frac{\mathrm{m}}{\mathrm{s}}$, 1 year = 365.25 days)
2. How many light years is a parsec?

c) Some typical values for exoplanets are given below.
Convert the data into parsecs, light years, and kilometres:

1. The distance of the exoplanet HD-17156 b from Earth is $255\ \mathrm{ly}$.
2. The distance of the exoplanet Corot-10 b from Earth is $345\ \mathrm{pc}$.
3. The distance of the exoplanet Kepler-5 b from Earth is $3 \cdot 10^{13}\ \mathrm{km}$.

Task 2:

a) Suppose we observe the planet Jupiter from Earth when it is 600 million km away.
Calculate: How many times further away from us is the exoplanet HD-17156 b than Jupiter?

b) Let us further assume that we have scaled down our solar system in a model so that Jupiter would be exactly one metre away from Earth in the situation described above.
Calculate: At what distance from Earth would exoplanet HD-17156 b be located in this model?

If you have calculated correctly, the last task should result in the following:

If Jupiter was 1 metre away from Earth in the model, we would find the exoplanet HD-17156 b at a distance of about 4,000 km. This is to show you how incredibly far away exoplanets are from us compared to the planets in our solar system. The fact that they can nevertheless be detected is thanks to extremely sensitive measurement technology, mathematics, physics and, not least, ingenious ideas on the part of astronomers.

There's a reason why the two Swiss astronomers Didier Queloz and Michel Mayor, who were the first to detect an exoplanet in 1995, were awarded the 2019 Nobel Prize in Physics for their ground-breaking work in this field. This "first exoplanet" bears the name "51 Pegasi b", it is 50 light years away from us, and orbits its central star in an extremely narrow orbit. In the third and fourth worksheets of this lesson unit, you will learn which method the two researchers used to find this exoplanet and which properties can be read from the measurement data. First, the following worksheet will deal with the "transit method" – a detection technique based on a simple idea and with which a great many exoplanets have been discovered in the meantime.