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### How far is 'unimaginably far'?

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DLR Animation: Principle of (stellar) parallax

We often speak of 'astronomically high prices' – 'astronomic' is a common way of describing anything that is extremely large. As a matter of fact, units of measurement are used in the field of astronomy that are far greater than the scale we are used to in everyday life. The nearest star – Proxima Centauri – is around 40,000,000,000,000 kilometres away. This example already shows that the unit of length that we are familiar with, the (kilo-) metre, is completely unsuitable for describing distances in the Universe – but what units are more suitable?

Billions and trillions of kilometres are only a stone's throw in space, and these distances would bring us to only a small part of what is, for us, observable space. Therefore, in the field of astronomy special units of length are used, which are intended to make it easier to compare distances in space.

Within our solar system, astronomers typically state distances as a multiple of the average radius of the Earth's orbit around the Sun. This 'Astronomical Unit' (AU) is 149,597,870,691 metres. It has become widely used, as several measuring methods provide their results directly in astronomical units and not in metres. The planet that is closest to the Sun, Mercury, is 0.39 astronomical units away from the Sun; Jupiter is 5.2 astronomical units away and Neptune is 30.1 astronomical units away. The distance to Proxima Centauri is about 270,000 astronomical units.

#### Dimensions used for space – astronomical unit, light year and parsec

A better-known unit of distance is the light year. The distance that light travelling in a vacuum covers in one year is 9,460,730,472,580,800 metres, or around 9.5 trillion kilometres. The unit 'light year' also indicates how far back into the past we are looking when we observe distant cosmological objects. When we look at the Sun, we see it as it was around 8.3 minutes ago. Light needs 4.22 years to reach us from Proxima Centauri.

On the other hand, the unit usually used for distances between stars and galaxies is the 'parallax second', or parsec (pc) for short. It is based on the measured distance between stars that are close to the Sun. As a consequence of the Earth's annual orbit around the Sun, the position of a star of this type appears to change against the background of fixed, far away objects. This is called 'parallax' (see animation). Over the course of a year, the star appears to move in a tiny ellipse (or a circle) in the sky. The further the star is from the Earth, the smaller this circle appears. If the radius of the circle is so small that from Earth it appears to span only a tiny angle – one 3,600th of an angular degree (an 'arc second') – then the star is exactly one parsec away. One parsec corresponds to 3.26 light years. The star Proxima Centauri has the largest parallax, as it is closer to the Earth and also to the Sun than any other star. Its parallax is 0.772 arc seconds, which corresponds to a distance of around 1.3 parsecs. The distance between galaxies is normally many millions of parsecs and is therefore specified in megaparsecs (Mpc).

#### Related Contacts

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