

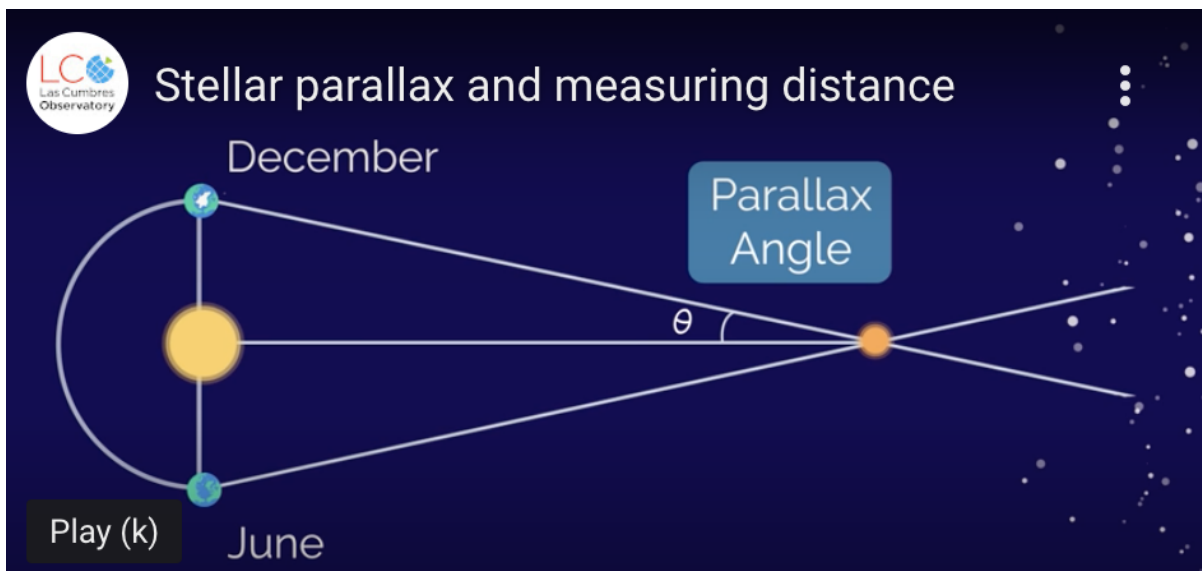
## Tangent Ratio and Parallax

Ancient Greek Mathematicians used trigonometry to calculate the Earth's distance from the Sun and the Moon. Today trigonometric ratios are still the fundamental mathematical concepts in astronomy.

For instance, to find the distance of a star, astronomers create a triangle between the star, the Sun, and the Earth.

They first measure the difference of the position of a Star viewed along two different lines of sight (opposite locations of the Earth around the Sun). This difference is called the **Parallax Angle**.

Watch the "[Stellar parallax and measuring distance](#)" video on YouTube by [Las Cumbres Observatory](#)

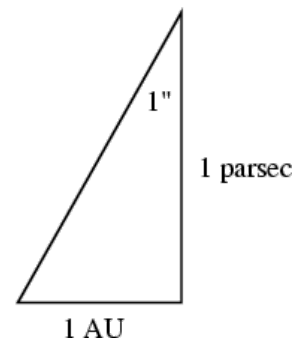


Let's focus on the right triangle here, we know the distance between the Earth and Sun is one astronomical unit (**1 AU**), and we are looking for the distance of the star.

- 1) For the angle  $\alpha$ , what is the trigonometric ratio that involves the distance of Earth from the star and the sun?

For instance, **Proxima Centauri** is the closest star to Earth even though it is light-years away. Its parallax angle is so small it can be expressed as with a unit which is 1/3600 of a degree called arcseconds (").

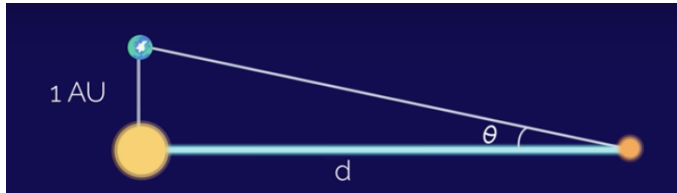
$$\tan(1'') = \frac{1 \text{ AU}}{1 \text{ pc}}$$



$$\tan 0.7685'' = \frac{1}{d}$$

2) Use your calculators to find the distance of **Proxima Centauri from the Sun.**

## Answers



1)

In the right triangle,

$$\tan \theta = \frac{[[1]]}{[[d]]}$$

In other words, all the nearby stars' distances can be calculated using the tangent of the Parallax angle.

2)

When we put this information in our calculator, we found it is 1.3020 parsecs (Parallax seconds) away from the Sun. (almost 40,208,000,000,000 km away)

Since expressing a star's distance in km requires too many zeros, astronomers use Parsecs (1 Parsec is 30.9 trillion km or 3.26 light-years) as a unit of distance.

Even Han Solo thinks of Parsecs as a unit of time, but it actually is a unit of distance.

