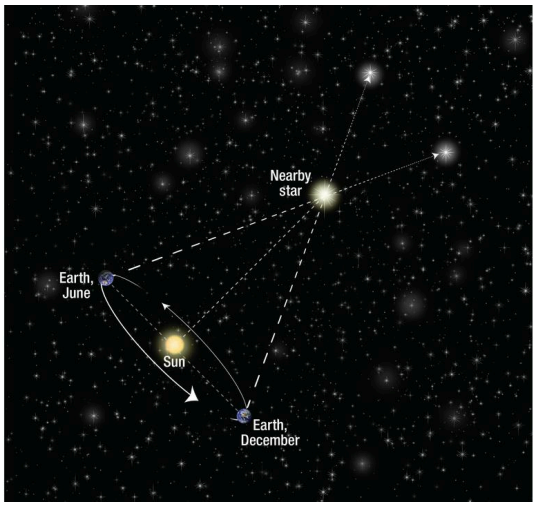
Stellar Parallax method



The principle of this method is that nearby stars always change their position with respect to the distant stars when viewed from two different locations of Earth in its orbit around the Sun.

The distance of the nearby star is determined accurately with respect to the distant background stars; this observation is repeated after six months. During these six months, the Earth moved halfway around the Sun in its orbit. Nearby stars appear to shift in their position against the background of distant stars. The apparent change in position observed from E_1 and E_2 position is called Stellar parallax. By using simple trigonometry, the distance to the star S from the plane of Earth's orbit can be calculated.

Let's consider p is the parallactic or parallax angle.

d is the distance to the Star from the plane of the orbit of the Earth.

b ($= 1\ AU$) is the average distance between the Earth and the Sun.

From the figure,

$$\tan p = \frac{b}{d} = \frac{1AU}{d} \qquad \text{..... (1)}$$

For very small p, $\tan p \approx p$ (in radian)

$$\therefore p \text{ (radian)} = \frac{1AU}{d} \qquad \text{.....(2)}$$

$\because$ 2π radian $= 360^0 = (360 \times 60 \times 60)''$

$\Rightarrow$ 1 radian $= \left(\frac{360\times60\times60}{2\pi}\right)'' = \left(2.06 \times 10^5\right)''$

Therefore, from Equation (2),

$$p'' = \frac{2.06\times10^5\ AU}{d}$$

Or, $$d = \frac{2.06\times10^5\ AU}{p''} \quad \text{.....(3)}$$

In this way, the distance of nearby stars can be measured with the help of the trigonometric parallax method or the stellar parallax method.

This method is applicable only for the nearby stars. This is because, as the distance of the star increases the parallax angle decreases in such a way that one cannot measure the parallax angle accurately.

If for a star $p = 1''$ (1 arc second), $d = 2.06 \times 10^5 AU$

Parsec: If a star makes a parallax angle of 1 arc second, the distance measured is known as 1 parsec.

Astronomical Unit: The average distance between the Earth and the Sun is known as the Astronomical Unit (AU).

Note:

1. With the help of the stellar parallax method or trigonometric parallax method, a distance up to 300 ly can be measured.

2. Relation between different units used for astrophysical calculation:

1 AU (in km)	1 ly (in km)	1 pc (in km)	1 mile (in km)	1pc (in ly)	1 pc (in AU)
1.496×10^8	9.46×10^{12}	3.08×10^{13}	1.60934	3.26	2.06×10^5

Sample questions

1. Show how the parallax method is used for determination of stellar distances. Why is it not possible to very distant objects with this method.
2. Explain one method used for determination of distance of nearby celestial bodies.
3. Parallax of Barnard's star is 0.522. Calculate its distance in parsec, light year, astronomical unit, mile, and kilometre.

   [hint: $d = \frac{1}{p''}$ (distance in parsec), $d = \frac{2.06\times10^5\ AU}{p''}$ (distance in AU)]
4. What is stellar parallax?