

Information on determining the distance of stars

Parallax:

The underlying concept for the determination of the distance of a star, as it is shown in the educational game, is the parallax. The parallax is the apparent movement of an object along two different lines of sight. A typical example is the reading of a scale. A different point of view „changes“ the position of the indicator.

Parallax in astronomy:

While observing the stars we will encounter the parallax, because the observer on Earth changes his position relative to the star. During the orbit of the Earth around the sun, we will observe the star from different angles. As shown in Figure 1, the observed star appears to move in an elliptic path in front of a background, that is fixed and (endlessly) far away. The shape of the ellipsis depends on the position of the star relative to Earth's orbit. If the star is at an angle of 90° to the plane of Earth's orbit (Figure 1), we will observe a perfect circular movement of the star. The smaller the angle gets, the more flattened the circular movement becomes and we can see an ellipse.

The parallax angle π can be measured between two fixed points. Closer objects have a larger ellipse and therefore a greater parallax angle.

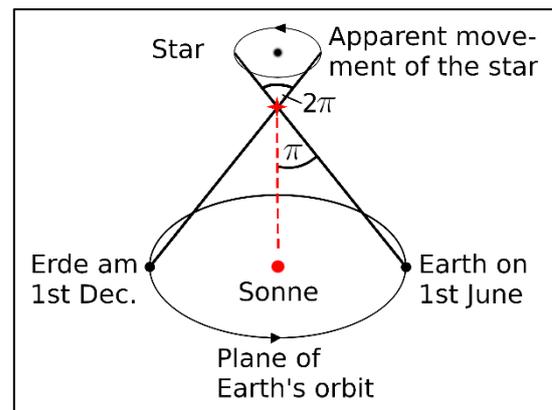


Figure 1 – Origin of the parallaxe

Determining the distance:

By using the parallax angle π , one can calculate the distance of the star. The trigonometric functions connect the distance r to the angle π according to Figure 2:

$$\tan(\pi) = \frac{1AE}{r} \Leftrightarrow r = \frac{1AE}{\tan(\pi)} \approx \frac{1AE}{\pi}$$

The last approximation is a result of the small-angle approximation of the tangent. The approximation is valid, because the parallax angles are very small. Within the game, the distance is not determined with the angle π .

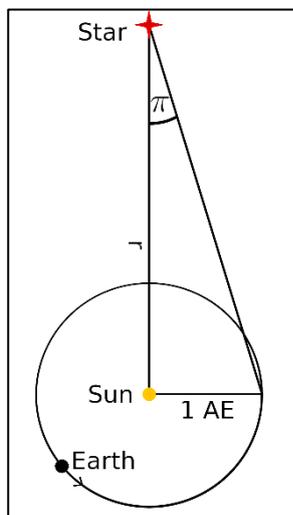


figure 2 – triangle for determining the distance

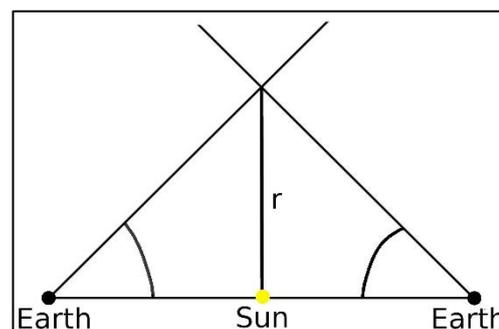


figure 3 – Konstruktion des Lernspiels

Instead, the angle of the telescope on earth is used (the angle on the bottom right of Figure 2). This allows the construction of a triangle which makes the calculation of the distance r with the tangent and a geometric construction of r possible. For that the baseline of the triangle is given by the distance of Earth and sun. The angles of the telescope are measured and drawn on the baseline. The triangle can now be constructed and with the use of a proper scale, the students can convert the measured length of r to the real distance of the star.