Stellar Parallax

Formulas & Theorems Covered Today:

Homework:

Notes:

Some common conversions

1 LY = 63241 AU

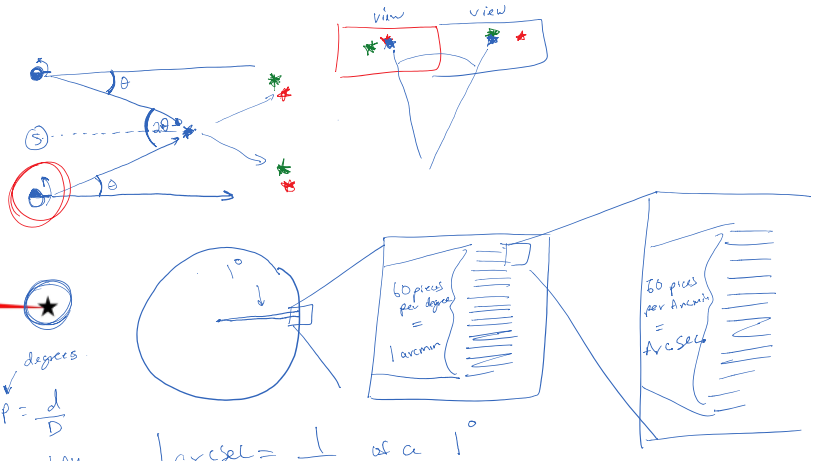
1 PC = 206265 AU

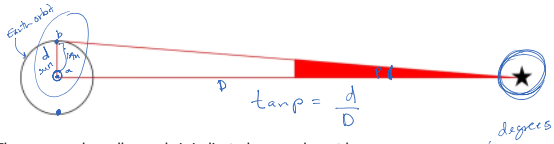
1 AU = 150,000,000 KM

1 LY = 9.46×10^{12} km

The Geometry of Stellar Parallax

The Sun, O, is at point *a* and the planet/location of the observer is at point *b*. The distance to the star is indicated by D and is expressed in parsecs (1 parsec = 3.26 lyr) The baseline distance between the Sun and the point of observation is denoted as *ab* and must be expressed in astronomical units (AU).





$\tan p = \frac{d}{D}$

The measured parallax angle is indicated as *p* and must be expressed in arcseconds (3,600 arcseconds = 1 degree).

The stellar parallax relation is

degrees

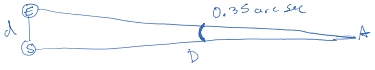
$\tan p = \frac{d}{D}$

$D = \frac{1\,AU}{\tan\left(\frac{1}{3600}\right)}$

1 arcsec = $\frac{1}{3600}$ of a 1°

D = 206264.8 AU = 1 parsec = 3.26 LY

Practice Problem 1: As seen from Earth, the measured parallax of a star is 0.35 arcseconds. How far away is the star in parsecs, ly and AUs?



$\tan p = \frac{d}{D}$

$D = \frac{d}{\tan p} = \frac{1\,AU}{\tan\left(\left(\frac{1}{3600}\right)(0.35)\right)} = \frac{1\,AU}{\tan(9.722 \times 10^{-5})} = 589328\,AU$

$\frac{x\,pc}{589328\,AU} = \frac{1\,pc}{206265\,AU}$

$x\,pc = 2.86\,pc$

Practice Problem 2: As seen from Earth, the measured parallax of a star is 0.051 arcseconds. How far away is the star in parsecs, ly and AUs?

$D_{pc} = \frac{1\,AU}{0.051\,arcsec} = 19.6\,pc$

$\frac{x\,AU}{19.6\,pc} = \frac{206265\,AU}{1\,pc}$

$x\,AU = 4044411\,AU$

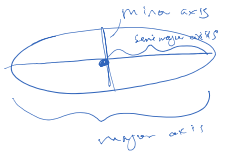
$\frac{3.26\,LY}{1\,pc} = \frac{x\,LY}{19.6\,pc}$

$63.9\,LY$

$$D_{parsec} = \frac{ab}{p''}$$

a faster calculation

Practice Problem 3: As seen from Mars, the measured parallax of a star is 0.405 arcseconds. How far away is the star in parsecs, ly and AUs? Note: The semimajor axis of the orbit of Mars is 1.52 AU.



$D_{pc} = \frac{1.52\,AU}{0.405\,arcsec} = 3.75\,pc$

$3.75\,pc \times 3.26\,LY = 12.2\,LY$

0.405 arcsec

$3.25\ pc \times 3.26\ \frac{Ly}{pc} = 12.2\ Ly$

$3.75\ pc \times 206265\ \frac{AU}{pc} = 774130.37\ AU$

Practice Problem 4: As seen from Earth, the measured parallax of a star is 0.25 arcseconds. What would be the measured parallax of this star as observed from Saturn? Note: The semimajor axis of the orbit of Saturn is 9.5 AU.

Hint: First find the distance to the Star using the Earth observation and then change to baseline distance to that appropriate for the Saturn observation and solve the stellar parallax relation for the parallax angle using the distance to the star you found from the Earth observation.

Practice Problem 5: You wish to measure the stellar parallax of a star at the galactic center 28,000 ly away. However, your best technology can measure parallax angles
only as small as 0.005". How far from the Sun must your instrument be placed in
orbit to measure the parallax of this star at the galactic center?

Hint: First convert 28,000 ly into parsecs, then using the minimum parallax angle measureable solve the stellar parallax relation for the baseline distance ab.