NAME:________________________ **DATE: _____________________**

PARALLAX PRE-LAB

Using the preparation section, your lecture textbook, or any other acceptable source information, answer each question below in complete sentences. Be sure to define any relevant terms.

1. Explain the following terms related to parallax measurements.
   a. Baseline:

   b. Astronomical Unit:

   c. Parallax:

   d. Parsec:

2. Use the above terms to explain how we measure stellar parallaxes and determine the distance to nearby stars.

Name:______________________ Partners (face to face):__________________

Date: ___________________ ______________________________

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PARALLAX LAB EXERCISE

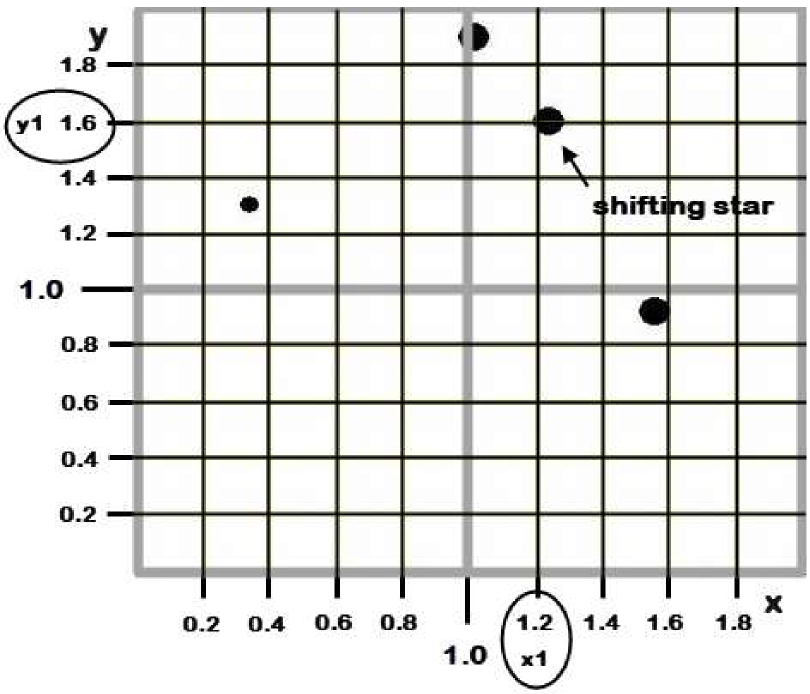
PREPARATION

GATHERING THE DATA

In practice, Astronomers measure the parallactic shift of stars as a linear distance, S, directly from the photographs. Then, knowing the ***scale*** (how many angular units correspond to one linear unit), they convert this linear shift to the angular shift in units of arc seconds. In the simulated photographs of this lab, the unit for the linear shift will simply be "grid units". Remember from the introduction above that the linear parallactic shift, S, of a star corresponds to the full angular shift, 2p, which will have to be halved to get the parallax, p, for the parallax-distance equation. All steps will be detailed below.

Go to the GSU Perimeter College Astronomy Labs (**http://sites.gsu.edu/astr1020lab/**) and click on the "Parallax Lab" link on the left menu. This brings up thumbnails of four images for three different star fields (four images labeled Field 1, four for Field 2, and four for Field 3). The first two thumbnails of each field show two perspectives six months apart, from opposite sides of Earth's orbit. The second set of two thumbnails for each field shows the same two perspectives with a grid overlayed. This grid will allow you to read linear x and y coordinates for the positions of the shifting stars before and after the shift. There are three (3) stars in each field that shift positions. The set without the grid makes it easier to spot the shifting stars. The easiest way to see which three stars are shifting is being able to click back and forth between the before and after images. In order to do so, have two browser tabs open with one tab displaying the before image and another tab displaying the after image. Now you can "blink" back and forth by simply clicking back and forth between the two tabs. You can track the shifting stars by noting their different brightnesses (stellar brightness is denoted by the size of the circle used for them in the simulation). Once you have identified the three shifting stars you can switch to the set of images with the grid and read off their before and after x,y-coordinates. Use the lower left corner as your origin (x=0, y=0) with x increasing to the right and y increasing going up. The before position is denoted with x1 and y1, the after position with x2 and y2. Read off each coordinate to the nearest 0.2 grid unit. Figure 4, below, shows an example of how to read off the x and y coordinates for a shifting star.

Figure 4



The smallest tick marks (blue lines on website) equal 0.2 grid units. The larger tick marks (red lines on website) equal 1 grid unit. The arrow points to the shifting star. It lies closest to the 1.2 grid unit mark along the x-axis and the 1.6 grid unit mark along the y-axis.

The star's coordinates are: x1 = 1.2 grid units, y1 = 1.6 grid units.

The "1" in the coordinate label means "before shift".

1. Start with Field 1 (click on its thumbnail for full version). After you have found the three shifting stars by blinking between the no-grid before and after images, go to the before and after images with the grid to read off their before (x_1, y_1) and after (x_2, y_2) coordinates. Record the position coordinates in the respective fields of the first data table on the worksheet page, and label it with the number 1 for Field 1.

After completing the first field, go to the next two fields and repeat the procedure for each. Record all data in Table I in the worksheet section below.

REDUCING THE DATA

2. After recording the before and after coordinates of the shifting stars in Table I, you will go through three steps to calculate their distances: first, you will determine the linear shift of the star in grid units; second, you will convert this linear shift to the trigonometric parallax; third, you will take the inverse of the parallax to find the distance in units of parsec. All steps are described in detail below and their results will be recorded in Table II.

Step1a): For each star on your worksheet, calculate the quantities ($x_2 - x_1$) and ($y_2 - y_1$) and record them in the proper place on the worksheet. These are the distances in grid units that each star has shifted on the x and y axes.

Step 1b): Determine the total linear shift, S, for all of your stars and put the answer in the column marked S on the worksheet by using equation 2 below. This is a version of the Pythagorean Theorem. Record your results in the proper place of Table II.

$$S = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad \textbf{(Eq. 2)}$$

Step 2: Since S is still the full linear shift in grid units, we must convert it to angular units and take half of it to get the trigonometric parallax, p. Use equation 3, below, to calculate the parallax, p, and record your results the column of Table II labeled “p”. Note: the scale of the screen is 10 grid units = 1 arcsecond. Since the parallax is half the measured angle, you must divide by 2.

$$p = \frac{S}{10 \times 2} = \frac{S}{20} \qquad \textbf{(Eq. 3)}$$

Step 3: Finally, use equation 1 from the preparation section to calculate the distance, d, for all shifting stars. Record your results in the last column of Table II.

3. The smallest shift you can reliably measure on the screen is about 0.2 grid units. This shift corresponds to the precision of positions measured with the best Earth-based optical telescopes. If you cannot measure an angle smaller than this, what is the maximum distance at which a star can be located and still have a measurable parallax?

4. If Earth orbited the Sun at the distance of Jupiter, the diameter of its orbit would be about five times greater than its actual value. Would this larger orbit affect the size of the parallactic angle measured for a given star? Why?

5. If Earth were orbiting at Jupiter’s distance, would we be able to measure parallaxes for: more stars/fewer stars/about the same number of stars (circle your choice)? Explain.

DATA TABLE 1

FIELD No.	STAR	x_1 (grid units)	y_1 (grid units)	x_2 (grid units)	y_2 (grid units)
	A				
	B				
	C				
	D				
	E				
	F				
	G				
	H				
	I				

DATA TABLE 2

FIELD No.	STAR	$x_2 - x_1$ (grid units)	$y_2 - y_1$ (grid units)	S (grid units)	Parallax (arcsec)	Distance (parsecs)