**Parallax Project**

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The concept of parallax is the foundation for most distance determinations in astronomy. This concept is also useful here on the earth, from determining distances across waterways and other hard-to-cross terrain features to (in a subconscious way) how we know how far away to reach when attempting to pick up a glass. The following exercises will demonstrate the basic concepts of parallax.

Setup:

To do these activities, you will need to print out the supplied file 'Parallaxchart.pdf', then attach it to a wall in a large room. Make sure that the title “Parallax Project” is horizontal and at your eye level if you are standing. Then stand on the opposite side of the room to take the measurements for steps 1-4. The chart will represent 'distant' objects for comparison to nearby objects.

Angular size:

1. Hold you hand up, close to your face. Now move it slowly further away from your face. What happens to the apparent size of your hand? [If you wish, use the scale on the chart to compare the size of your hand in the close versus far positions.]

\_\_\_\_the size of my hand gets smaller as it gets further away from my face and closer to the chart. \_\_\_\_

Determining distance:

Using parallax to determine the distance ‘D’ to an object depends on measuring the apparent angle between an object at ‘infinite’ distance and the target object. Graphically, what is done is to measure the angles (A & B) shown in the following sketch. These measurements, combined with the distance ‘d’ between our two viewing points, are then used to determine the distance ‘D’ to the object.

A

d

B

D

To demonstrate this, we first need to be able to measure an angle in degrees. Follow the following steps to convert the dot scale shown on the chart to a degree scale:

1. Close your hand into a fist. Holding your fist up, at arm’s length, measure the apparent width of your fist on the scale on the chart on the far wall.

Width of fist in dots: \_\_\_\_12\_\_\_\_

1. Your closed fist held at arm’s length represents an angle of approximately 10 degrees. Divide 10 degrees by the number of dots you determined the width of your fist to be to give you an estimate of the number of degrees represented by each dot interval on the screen.

Degrees per dot: \_\_0.83333\_\_\_

*CHECK your calculation by multiplying the scale you just computed by the previous measurement of your fist. You should get 10 degrees.*

We can now demonstrate the methods used by astronomers to measure the distances to stars by determining the length of your arm using parallax. The two observing points in the diagram will be your two eyes, used separately. The star will be represented by a pen held in your hand, and the point at ‘infinite distance’ will be the zero point on the chart. Typically, the distance between the two human eyes is about 6.5 cm. We will thus set ‘d’ = 6.5cm, set up our measurements so that angle B is zero, and measure angle A by doing the following:

1. Holding your pen at arm’s length, cover your *left* eye and move the pen tip so that it covers the dot marked ‘Zero’ on the chart. Now, ***without moving the pen,*** cover your *right* eye and record the pen’s position on the chart.

Pen’s position on chart: \_\_\_11\_\_\_

1. Now, to determine the angular shift for the parallax determination, multiply the position above by the degrees per dot scale you calculated earlier.

Angular shift: \_\_\_9.16667\_\_\_

1. Now use the distance ‘d’ given above and the angular shift in degrees that you measured in the following formula to determine the length of your arm.



Arm length: \_\_\_40.6309\_\_\_

Astronomers do the same thing, except that the two eyes are replaced with the Earth on opposite sides of the Sun, the pen tip is the star, and the chart is (typically) far-away galaxies. The angular shift of stars is also much less than you observed, typically measured in fractions of an arcsecond rather than degrees. Below you will determine the distances to several stars by using data from your MS-Excel spreadsheet.

7) For the following Star Ids on your MS-Excel spreadsheet, copy down the requested information (just transfer the numbers from the spreadsheet to here for reference). \*NOTE: the V magnitude information is requested just as a check that you copied down the correct star's numbers, and isn't used in the distance determination.

Star ID V mag Parallax angle

797 14.4222911 0.0001032

855 14.7697719 0.0029326

1127 12.3436028 0.0072993

1279 7.48179915 0.0081967

1634 16.3422295 0.0005365

8) Now use the formula from the notes for stellar parallax (d = 1/p where d is the distance in parsecs and p is the parallax angle in arcseconds) to find the distances to these stars.

Star ID Distance

797 9689.92248062  
855 340.994339494  
1127 136.999438302  
1279 122.000317201  
1634 1863.93289842

Submit the completed worksheet to me as specified on the assignment link on Canvas.