Parallax & Pluto

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INTRODUCTION:

Parallax is the apparent displacement of an object caused by a change in the viewer's position. In other words, when you extend your arm out and hold a pencil vertically, it appears to shift back and forth when you close one eye and then the other.
Using the same principal, but in the scale of the stars and the planets in the sky, parallax was used in the discovery far away celestial body in our own galaxy.

Parallax is also helpful for estimating distances here on Earth, and we will explore this, somewhat more practical use, as well.

PURPOSE:

The purpose of this lab is to answer the following questions:

1. What is parallax?
2. How can it be used to estimate distances?
3. Why is it of particular use in astronomy?

MATERIALS & EQUIPMENT:

- ❒ 2 yard or meter sticks
- ❒ 2 picture of Pluto
- ❒ 1 set of Stars pictures
- ❒ Tape
- ❒ Computers with internet access
- ❒ Painters' tape to mark positions on the ground

HYPOTHESIS:

What is parallax?

I hypothesize that parallax is an effect in which an object seems as if it has changed when it is viewed from more than one place.

How can it be used to estimate distances?

I hypothesize that it can be used to estimate distances by using the relationship between the two points you are viewing the object from, and how the size of the object appears.

Why is it of particular use in astronomy?

I hypothesize it is of importance in astronomy because it is currently impossible to measure the distance of a star or galaxy by pulling out a measuring stick, therefore we have to use this method.

PROCEDURE:

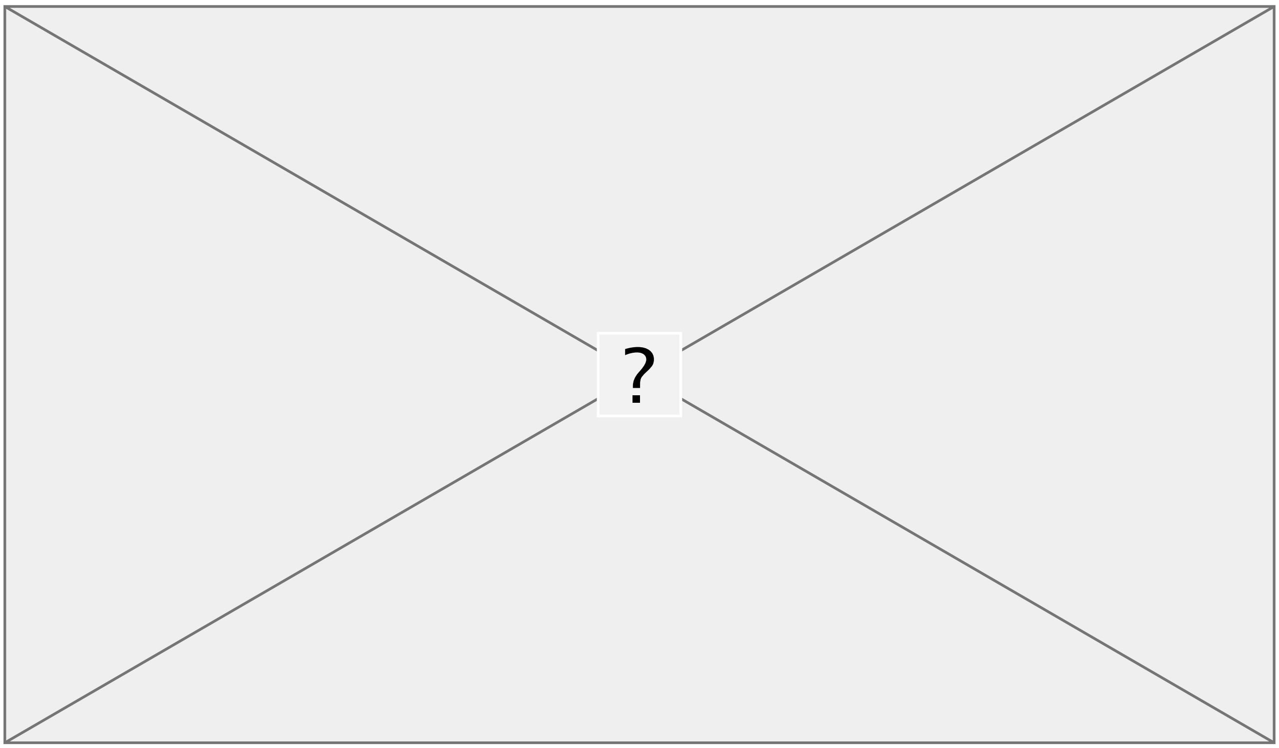
PART A:
Observing Parallax

1. Stand at one of the four viewing locations
2. Look over the top of Pluto with both eyes open
3. Record which color of star Pluto is in front of

4. Move to the adjacent viewing location
5. Look over the top of Pluto with both eyes open
6. Record which color of star Pluto is in front of

7. Now pretend you are a bird flying near the ceiling of your classroom. The diagram below is what the classroom looks like. Label your POSITION 1 by writing a number '1' next to it.
8. Label your POSITION 2 with a '2'.
9. Color in or label the colors of the stars like they were on the wall during the activity.
10. Draw a small circle where Pluto was located.

11. Draw your line of sight from both positions!(hint: draw a line from where you were standing at POSITION 1 to the star you saw from that position, but make sure it goes through Pluto.



QUESTIONS TO CONSIDER:

1. Looking at your diagram, is Pluto covering (or nearly covering) the same color star in both diagrams?

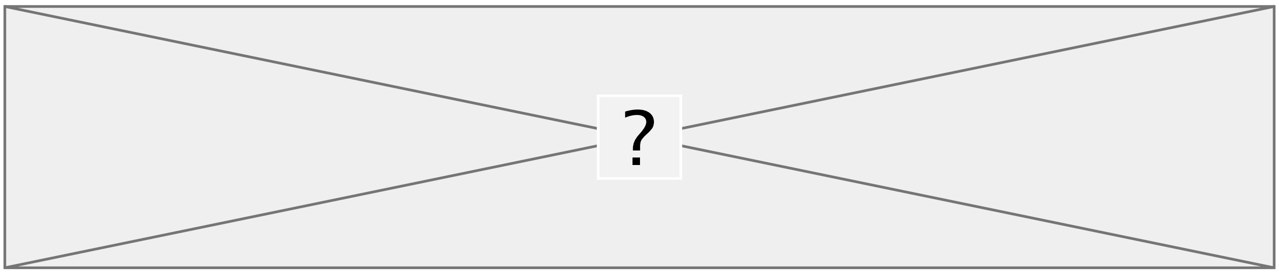
   No, Pluto is covering (or nearly covering) different stars when veiwing it from different places.

2. What actually moved and what remained stationary during your two observations in the activity?

   Both the Pluto and the all of the stars remained stationary, the only moving part was us going from one observatory to the next.

3. Why does Pluto appear to be in front of different stars in Position 1 and Position 2?

Because your looking at the same object that is in the same position but you are standing in different places, it's all relative.



PART B:
The Blink Comparator

This online interactive website was created from the actual images of the night sky that were taken in 1930. These images were placed in an instrument called a "Blink Comparator". Two pictures from about a week apart are loaded into the instrument, and it quickly switches back and forth, to one image, then the other, and back. You will have to use what you have learned about parallax, the distance to the stars relative to the distance to the planets, and this interactive to answer the following questions. But before you answer the questions you must discover Planet X using the interactive Blink Comparator at the web link below:

http://www.patchyvalleyfog.com/blinkcomparator/blinkComparator.html

QUESTIONS TO CONSIDER:

Why was Planet X, now known as Pluto, blinking in the interactive?

The reason it was blinking was because the machine was flashing two seperate pictures over one another to easily recognize the difference between the two. Therefore it would seem that the things that did change were blinking to more than on place.

How much time passed between when the first image was taken and when the second image was taken? (Note: this information is provided in the online interactive, but you might have to hunt for it!)

The amount of time that passed was about 6 days, the first was on Febuary 23rd, and the second was on Febuary 26th of 1930.

What moved most during that time?

The object that moved the most out of that time period was Pluto.

Why is Pluto the only object blinking in the interactive Blink Comparator?

Because it was the only object close enough to us for us to see it the difference in the two pictures.

PART C:
Estimating distance outdoors

Source: http://www.phy6.org/stargaze/Sparalax.htm

Here is a method useful to hikers and scouts. Suppose you want to estimate the distance to some distant landmark--e.g. a building, tree or water tower.
The drawing shows a schematic view of the situation from above (not to scale). To estimate the distance to the landmark A, you do the following:

1. Stretch your arm forward and extend your thumb, so that your thumbnail faces your eyes. Close one eye (A') and move your thumb so that, looking with your open eye (B'), you see your thumbnail covering the landmark A.
2. Then open the eye you had closed (A') and close the one (B') with which you looked before, without moving your thumb. It will now appear that your thumbnail has moved: it is no longer in front of landmark A, but in front of some other point at the same distance, marked as B in the drawing.
   Estimate the true distance AB, by comparing it to the estimated heights of trees, widths of buildings, distances between power-line poles, lengths of cars etc. The distance to the landmark is 10 times the distance AB.

QUESTIONS TO CONSIDER:

Why does this work?

This is answered in my Data Analysis.

Try this on two more distant objects, record your estimates, measure the actual size of the object and compare your estimate to the actual value?

Number	Object	Estimate	Actual
1	Water Bottle	30 feet	25 feet
2	Flag Pole	120 feet	133 feet

DATA TABLES:

Number	Color Of Star
1	Orange
2	Green

Number	Object	Estimate	Actual
1	Water Bottle	30 feet	25 feet
2	Flag Pole	120 feet	133 feet

DATA ANALYSIS:

Determining the distance to a star or celestial object because we obviously can't travel to the object and measure the distance directly. But instead astronomers must be very clever in how to measure the distance indirectly. One of the wasys they accomplish this is by using the method of Parallax. This method is certainly not limited to astronomy but can be used to measure the distance between you and an object on Earth.

In astronomy, Parallax measurements take advantage of the fact that, s the Earth orbits around the Sun, near-by stars appear to move relative to the very far off stars. Now this is the same thing that happens when you look at an object with a close proximity with one eye, and then with the other. It appears to move because your eyes are obviously not in the same place. They are on different places on your face meaning that when you look at an object with one eye, their is a difference in the angle than when you are looking at it with the other eye.

And if you were to hold out your thumb with your arm extended you would find that the shift is not as great as when your thumb was closer to your head. The same thing happens to stars. The closer stars appear to shift more than the farther stars. We compare them to the stars that appear to be fixed which is what makes the blink comparator possible. These background stars are not really fixed, they are just so far away we cannot distinguish their apparent shift. This apparent shift of the stars is called their Parallax.

Paralax is simply the apparent change in the position of an object due to a change in the location of the observer. In order to measure the parallax of stars which are very far away, we mastrnomers just use the largest basline possible. (The baaseline is the distance between the two points where we take the measurements. For the experiment we performed with your thumb, the baseline was the distance between your eyes). A larger baseline results in a larger shift, which means that we can measure the parallax of stars which are further away. The largest baseline we can use for ground based observations is the diameter of the Earths orbit.

Using the Earths orbit , we make one measurement of the position of the star in, let's say June, and the second measurement in December (which is sixth monthes later because the Earth rotates around the sun one every 365 days, meaning that the second threw mark is 6 monthes after the initial mark). The smallest shift we can reliably measure from the Earth is about 0.02 seconds of arc, whch corresponds to a distance of about 50 parsecs. So, stars farther waay than 50 parsecs do not appear to move and constitute the “fixed” background stars we use in the measurement. If we were to increase the baseline we could theoretically detect movement of stars that are farther away than 50 parsecs.

Now that you are aware of the term parallax I’d like to explain to you what we did in our expierement. In part A of the expierement we were instructed to take position in one of the four veiwing locations. We then looked over the top of the Pluto that was set up in front of us with both eyes open and recored what star we saw above it. Then we moved to a different observing area and preformed the same steps. You could relate what we did to what astronomers do to find the distance from us to stars. For instance each observational platform represented the two points that are half a year appart, and we are trying to find the distance to the stars on the far wall.

Then we used an online activity to compare two seperate images that included Pluto. The stars and galaxies in the background were essential to the blink comparator because they allow us to see what has moved and what has remained stationary. This device allowed us to discover Pluto.

We then preformed the final step of this lab which was part C. We did this by extending out arms and sticking our thumbs up. We then closed one of our eyes and then the other and used our figures to measure the distance that our thumb appeared to move. We then rotated our fingers 90 degrees and estimated the size our fingers were adjusted to. We took this length and multiplied it by 10. Giving us an estimated distance we were from the farthest point.

Sources of error include incorrect estimations of the size of the objects we saw and incorrect messurements of the distance between the two thumbs we saw with our eyes.

CONCLUSIONS:

My hypothesis was mostly correct, most parts of the statements I made were correct. I learned what the definition of parallax is. I learned how I can use parallax in everyday life to improve my estimations of distances from me to object, which can certainly help. I learned how astronomers use parallax to calculate the distance between celestial objects such as far off stars and planets.

WEB LINKS:

http://www.phy6.org/stargaze/Sparalax.htm

http://www.ast.cam.ac.uk/~mjp/parallax.html

http://www.patchyvalleyfog.com/blinkcomparator/blinkComparator.html