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Telescopes

April 25, 2012

History:

Galileo created the first telescope in 1609.(Telescope History) Galileo’s Original Telescope was composed of a concave objective lens and convex eyepiece lens. That created an image that was correct in orientation, but with a narrow field of vision. (Optical Design) The telescope produced blurred images, but was able to see mountains and craters on the moon as well as wisps of the Milky Way. (Telescope History) Johannes Kepler then showed that with the eyepiece also being concave, that there was a much wider field of vision, and the fact that it flipped the image was of no consequence since they were observing celestial bodies. (Optical Design) Telescopes then proceeded to becomes bigger and more complicated. This complication was aided by Newton. After a certain point no amount of complicated lens adjustment would help due to distortions created by the atmosphere which is one of the reasons why space telescopes such as Hubble were created. They provided more accurate images or celestial bodies. (Telescope History)

To further explore space scientists are moving away from optics and towards measuring gravitational waves. Gravitational waves are extremely difficult to measure but are quite accurate over time and distance because they are never significantly absorbed even near the big bang. This makes observing them quite useful in reference to Electomagnetics Waves, light, because light can be absorbed or scattered. The electromagnetic waves are being detected by a Laser Interferometer called LIGO. The next step from LIGO is LISA which is essentially a bigger LIGO that is also in space taking the same progression as their earlier counterparts the telescope. (Thorne)

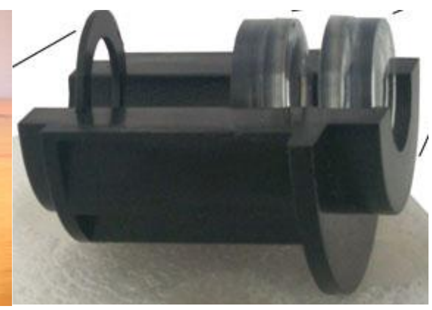
The Construction:

I built two telescopes. The first was a simple two lens telescope. Its creation required two cardboard tubes, two lenses, tape, clay, and felt. The lens had focal lengths of 17.5cm and 6.3cm. First, the tubes had to be cut to size. Each had to be less than the measured combined focal length of 23.8cm or else focus could not be achieved. One had to have a smaller radius than the other so it could slide inside allowing for adjustment of focus. The eyepiece lens was attached to the wider tube because it had a larger radius than the other lens. It was attached with tape. The objective lens was inserted into the smaller tube and held in place with clay. Then in order to center the smaller tube and prevent it from falling out, I wrapped it in a felt sheet. That makes it possible to adjust focus without the smaller tube falling out. That was one telescope completed.

The second was a Galileoscope and it came from a kit. The Galileoscope has seven lenses. The largest was a convergent lens with a focal length of 48cm. The construction started with the main tube. It was laid out in halves and had the large objective lens inserted into the premade groove. Next the focuser tube halves were joined a main tube clamp was inserted around the halves which were then clamped by O rings. The focuser tube was then placed on the half of the main tube, with the lens in between the baffles so it would remain a part of the telescope. Then the top half of the main tube was adjoined with the first, and clamped with more O rings. The main tube clamp that was around the focuser tube was also used to attach the two halves of the main tube. At this point the instructions highly encouraged the application of a do not look at the sun sticker. Then a dew cap was added onto the front.

The eyepieces were then assembled. There are three different configurations that the instructions give of which I used only one to obtain data. That eyepiece was configured by having four lenses and a much smaller tube that was in halves. The four lenses were then combined into two pairs and inserted into premade slots. There was also a field stop inserted into another slot. Then the two halves of the small tube were attached and held together with two clamp rings. The eye piece was then inserted into the adjuster tube, and the Galileoscope was completed.

This required no glue or tape or any unchangeable bindings for the Galileoscope. The most difficult part was making sure each lens faced the right way, because the instructions were have the thin lenses face center. This was difficult because it required seeing the difference between thicknesses of lenses which were being held together, and not all that different in thickness.

Data:

This data is the distance at which each of the devices made it able for me to discern two dots from each other. The two dots were of a 1cm diameter, and were 2cm apart at center.

Device	Distance(m) where the points were resolved	Moving Away or Closer
Eyes	22.519 m	Away
Eyes	25.118 m	Closer
Eyes	22.519 m	Away
Eyes	20.787 m	Closer
Eyes	22.519 m	Closer
Simple Telescope	31.181 m	Away
Simple Telescope	33.779 m	Away
Simple Telescope	31.181 m	Away
Simple Telescope	33.779 m	Closer
Simple Telescope	30.315 m	Closer
Galileoscope	130.787 m with the focuser tube extended 5 cm (Length of the Gardens)	Away

Simple Telescope:

How it works:

The simple telescope works by taking in parallel rays through one lens, which is the objective, and having where they cross be at the focal length of that lens. The light rays then continue at that angle through a second lens which also has its focal length at the point where the rays cross. The second lens then bends them back to parallel, but the rays are now closer together. The joint focal point is the secondary focal point for the lens, because it is where the parallel rays cross, and is the primary focal point for the second lens because it is where the light source is gives out rays and they become parallel. This is demonstrated in the attached ray diagram. This necessity makes the enlargement greatest where the lenses are the distance of their focal lengths added together apart.

Off axis rays help give magnification as well. The ratio of the angle of the ray with respect to the normal of the first lens, to the angle with respect to normal of the second lens is also a calculation of magnification. The angle is larger after the second lens creating a wider image. To make the magnification larger the objective should be the lens with the larger focal length, and should be longer than the eyepiece focal length. As the ratio becomes larger the magnification is increased. This is due to the fact that magnification is equal to f_o/f_e.

Calculation:

Focal Lengths: Objective Lens-.175m; Eyepiece-.063m

Theoretical Magnification Power:

1. f_o/f_e=.175m/.063m=2.778x

2. α_s/α_u=5.83˚/2.1˚=2.778x

Actual Magnification Power: (Distance Telescope could Resolve)/(Distance Eyes could Resolve)

Average Distance Eyes could resolve: 22.692m

Average Distance Telescope could resolve: 32.047m

32.047m/22.692m=1.412x

Galileoscope:

Focal Length of the Objective Lens: 48cm

Theoretical Magnification Power(provided by instruction manuel): 25x

Actual Magnification Power: (Distance Telescope could Resolve)/(Distance Eyes could Resolve)

With 5 centimeters of focuser tube still unused the distance resolved was 130.787m

Distance eyes could resolve: 22.692m

130.787m/22.692m=5.76357x