Making a low cost Refractor Telescope and simple Astronomical experiments

Abstract:
It is well known that the Galileo invented Refractor telescope in 1609 and has since then been upgraded to be used for various scientific purposes. It is observed that even after 402 years of its invention, Telescopes have not yet reached common man. We demonstrate a simple method of making a low cost refractor Telescope and conducting astronomical experiments with it. The materials used are cheaply available in ordinary shops. The magnification of this telescope is 20. I will discuss techniques to determine the diameter of the sun, observation of sun spots, safely watching Solar Eclipse and astrophotography activity with Moon.

Materials required:

(a) Lens

- Convex lens of Large Focal length (say 100 cm) – acts as Objective lens
- Convex lens of small Focal length (say 5 cm) - acts as Eye Lens

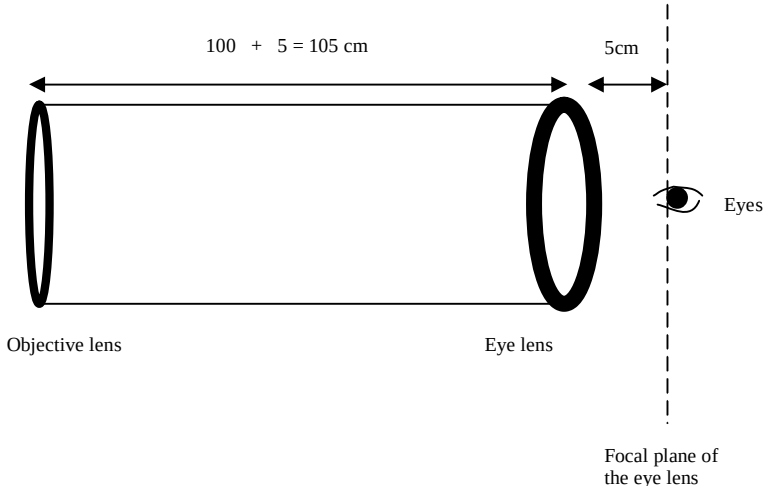
(b) PVC pipe

- Diameter –Equal to the diameter of the lens –Generally 2 inch
- Length - Equal to the sum of the focal lengths of the two lens (100+5 =105 cm in this case)

(c) A stand to hold Telescope

Method:

1. Fix the objective and eye lens coaxially at the two ends of the PVC pipe. Ensure that lenses are held firmly.



2. Fix the Telescope to a stand (a tripod stand would be better) and watch terrestrial objects. Initially if the image is not clear, the eye lens may have to be moved either inwards or outwards to get the focused image. This is due to the manufacturing error in the focal lengths of the lenses. Generally there could be 2 % variation in the lenses available in ordinary shops.
3. Magnification of this telescope M = Ratio of Focal lengths of the Objective and Eye lens = 100/5 = 20

Activities:

1. Watching Sun spots

Sun spots are the dark regions on the surface of the Sun. Sun's rotational period is studied by analyzing sun spots position over a long period. It must be remembered that **Sun should never be watched directly with naked eyes or through the telescope as it will cause permanent blindness**. Safe method is to project the suns image formed by a telescope onto a screen and watching it. (Fig. 1). Bigger image can be obtained by moving the screen away from the focal plane of the eye lens. Sun spots if present on a given day will appear as dark dots on the suns image.

2. Watching solar eclipse

Same arrangement as in Fig 1.
An excellent image can be cast on the screen if the region behind the eye lens is made dark by using a card board. Refer to the Fig 2 for the Annular Solar Eclipse (26.01.2009) photo taken with this telescope.

3. Finding the diameter of the Sun

Same arrangement as in Fig 1. The screen may be moved backwards to obtain a bigger image. Accurately measure the diameter of the suns image (D) and distance of the image (d) from the focal plane of the eye lens.

$$\text{Diameter of the Sun} = \frac{D}{d.M}.A \text{ meters}$$

Here m is the magnification of the telescope, A is the distance between the Sun and Earth = 1500×10^8 meters

4. Watching Moon

Moon's craters can be observed through the telescope of this magnification. We can get introduced to Astrophotography techniques by learning to photograph moon. Refer to Fig 3 for the photo taken by Digital camera kept at the focal plane of the eye lens.

Fig. 1 Arrangement for projecting Suns image from a telescope onto a screen

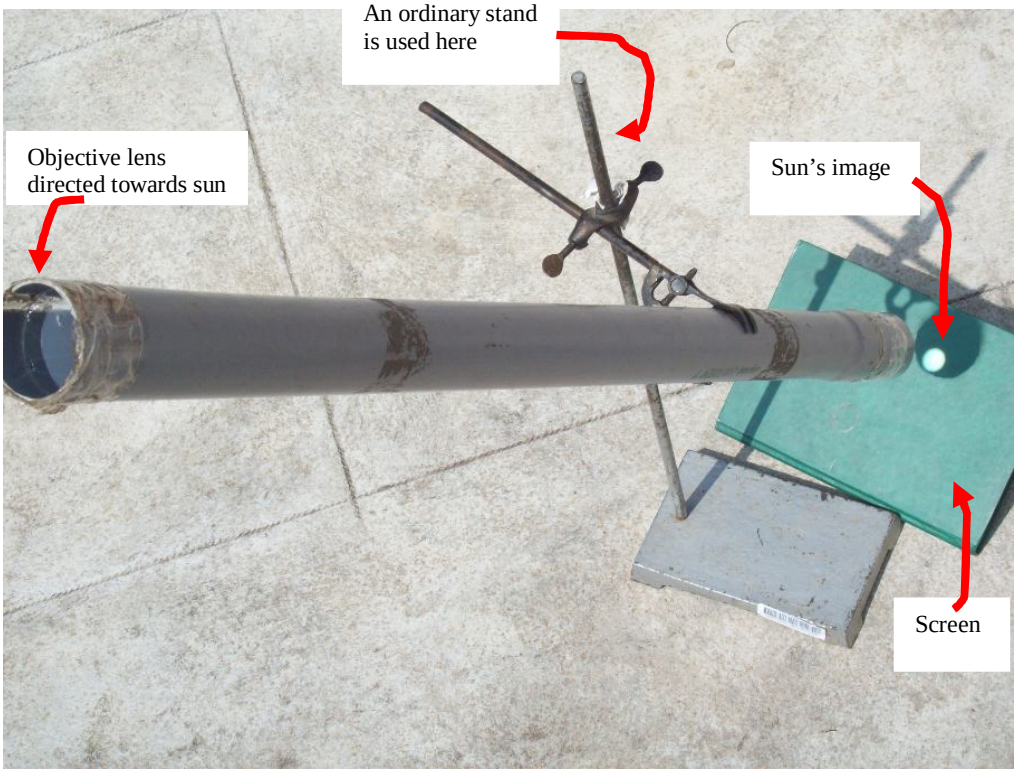
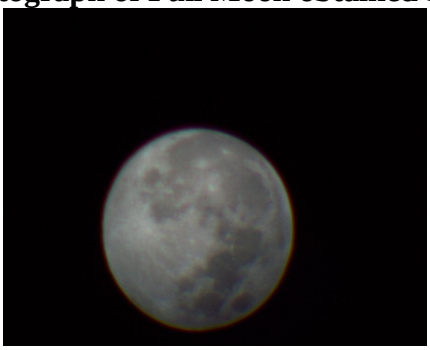
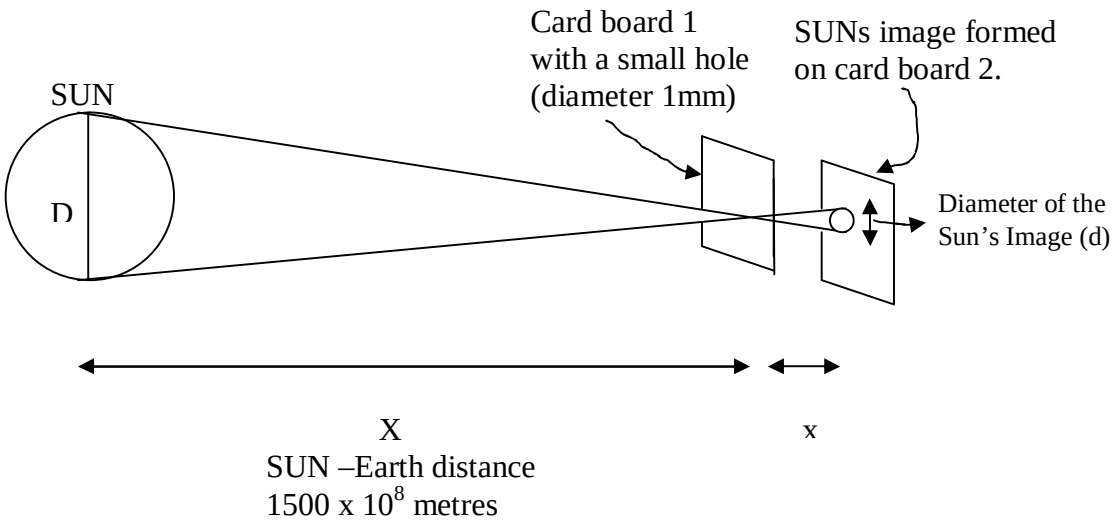


Fig 2. Annular Solar Eclipse on 26.01.2009 from Bangalore

Fig 3. Photograph of Full Moon obtained by this telescope



Watching solar eclipse and Finding Diameter of SUN



PIN HOLE CAMERA SET UP

d=diameter of the SUNs image on the card board in meters

x=distance between the two card boards

D=diameter of the SUN X= SUN – Earth distance =1500 x 10^8 m

(All the parameters are in metres)

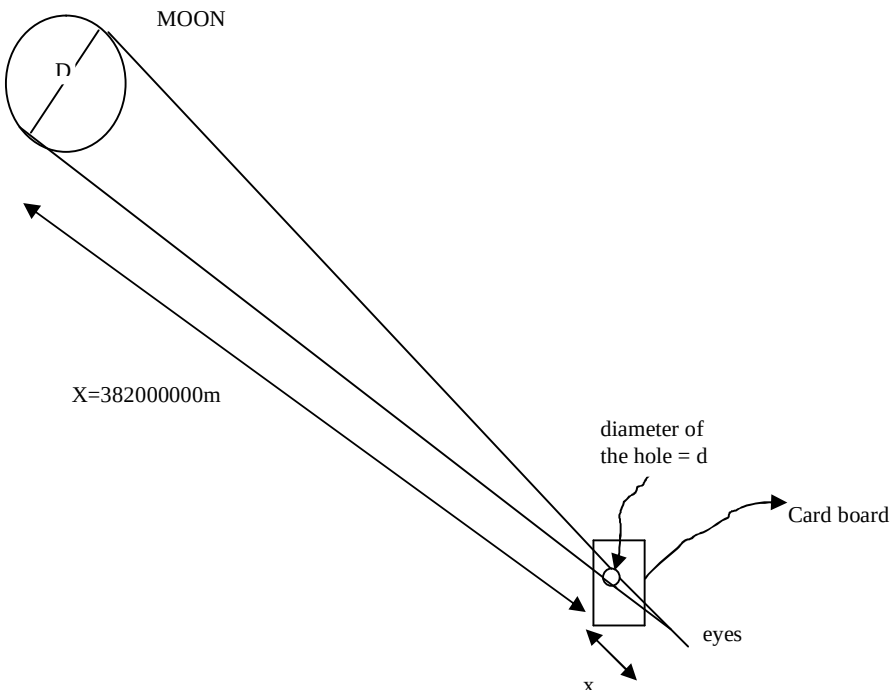
Procedure:

1. A card board 1 with a small hole of diameter of 1mm is held perpendicular to SUNs rays.
2. The rays pass through the hole and cast the image of the SUN on the card board 2.
3. Measure the diameter of the image.

   Diameter of the SUN D = X. (d / x) meters

Note: NEVER WATCH SUN DIRECTLY OR THROUGH TELESCOPE AS IT CAUSES PERMANENT BLINDNESS.

Finding the diameter of Moon



d=diameter of the hole on the card board in meters

x=distance of the card board from the eyes in meters

D=diameter of the moon in metres

X= Earth-Moon distance =382000000 metres

Procedure:

1. On a full moon day, hold the card board with a single hole in front of eyes and observe the Moon through the hole.
2. Move the card board away from the eyes such that the circumference of the Moon coincides with circumference of the hole on the card board. In this position the hole completely encloses the MOON.
3. Measure the distance between the eyes and the card board (x).

   Diameter of the moon = X. (d / x) meters

Few more experiments planned:

1. To Study monthly variation of SUN – EARTH distance.
2. Study daily motion of Sun.

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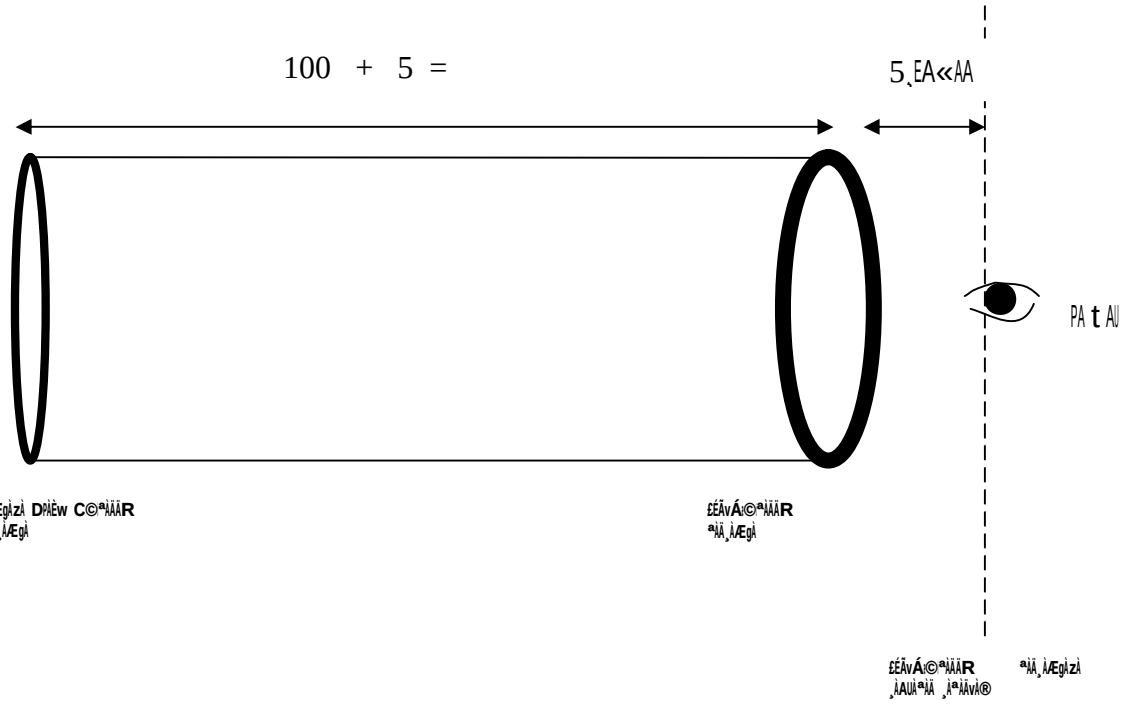

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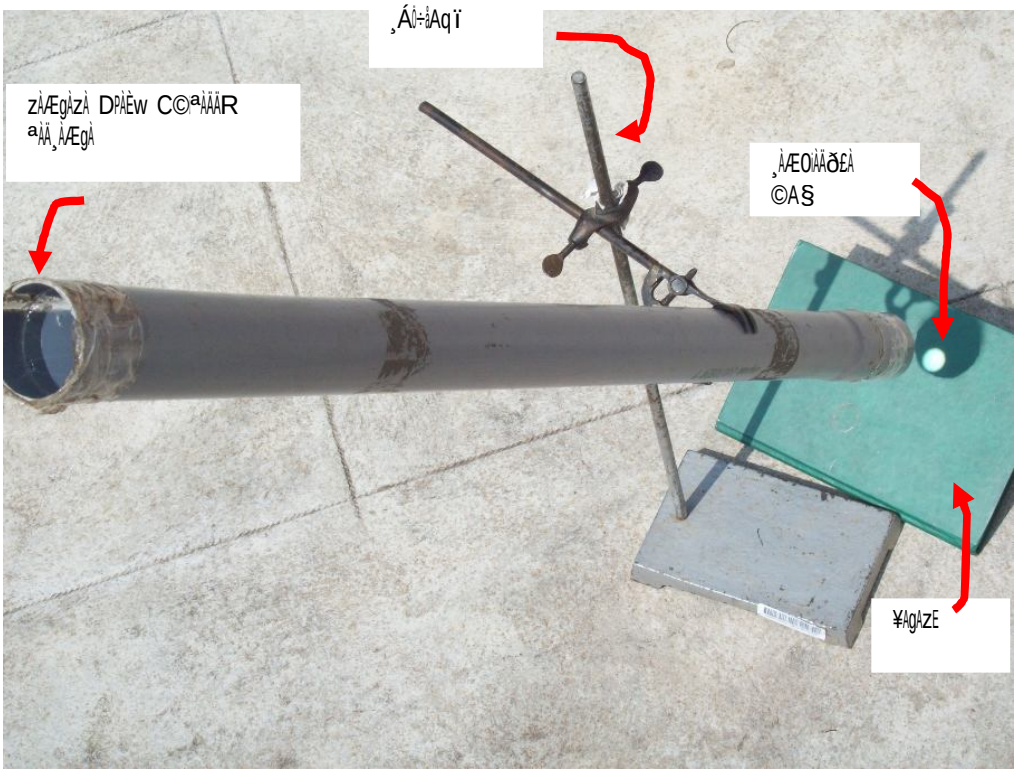

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