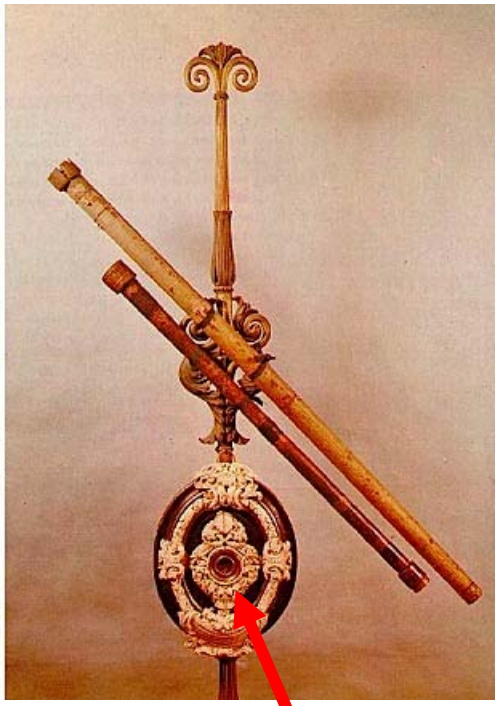
TELESCOPES:
An Introduction to Your Galileoscope

Telescopes and the group project

- As an exciting **new** experiment each group will build their telescope
- Then each of you will carry out an observing project to assess the likelihood of their being liquid water in the Galilean moons.
- We will accomplish this by careful observations of the Galilean Moons over a three week period ending on Nov 6.

History of the Telescope

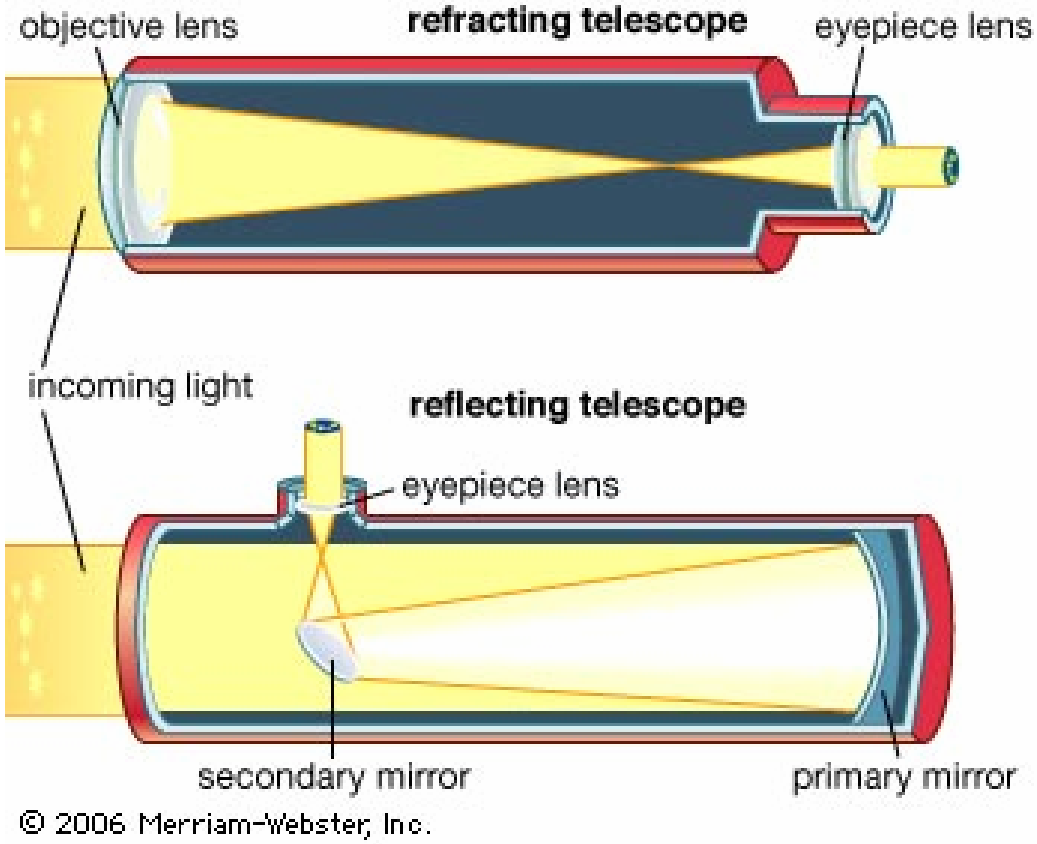
Galileo Galilei



The objective that discovered the Galilean Moons

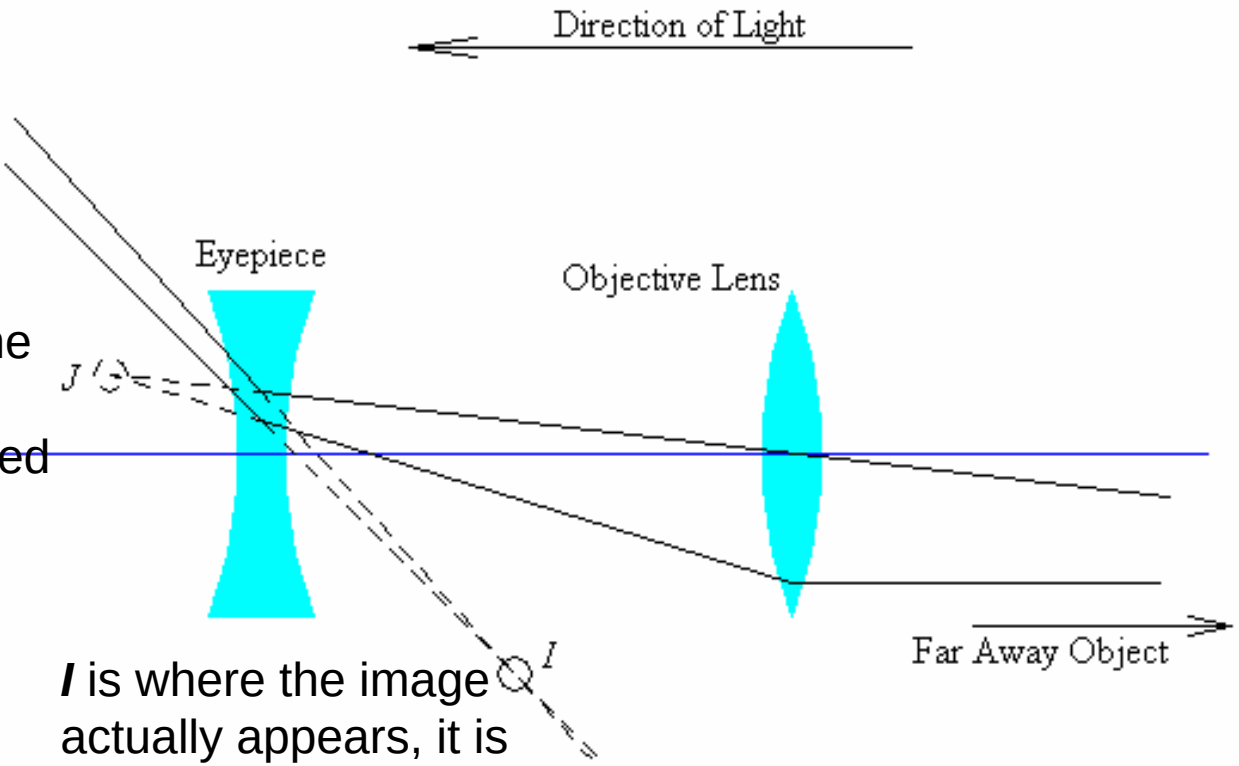
- A little over 400 years ago the Dutch invented “an optical toy” or “spyglass” that would be later known as the precursor to a scientific telescope.
- Then a math professor at the University of Padua, named Galileo Galilei based his optical instrument on spyglasses developed the previous year by the Dutch spectacle makers.
- Galileo is widely credited with being the first to seriously study the heavens with a telescope.
- His telescope was a very simple design but you must remember that very little was understood about optics around 1600. Certainly there was no clear understanding of the principals of optical design that we have today.

Types of Telescopes



- Early telescopes were “refractors” with 2 lenses
- later mirrors were used for larger “reflectors”

How Does a Galilean Telescope Work?

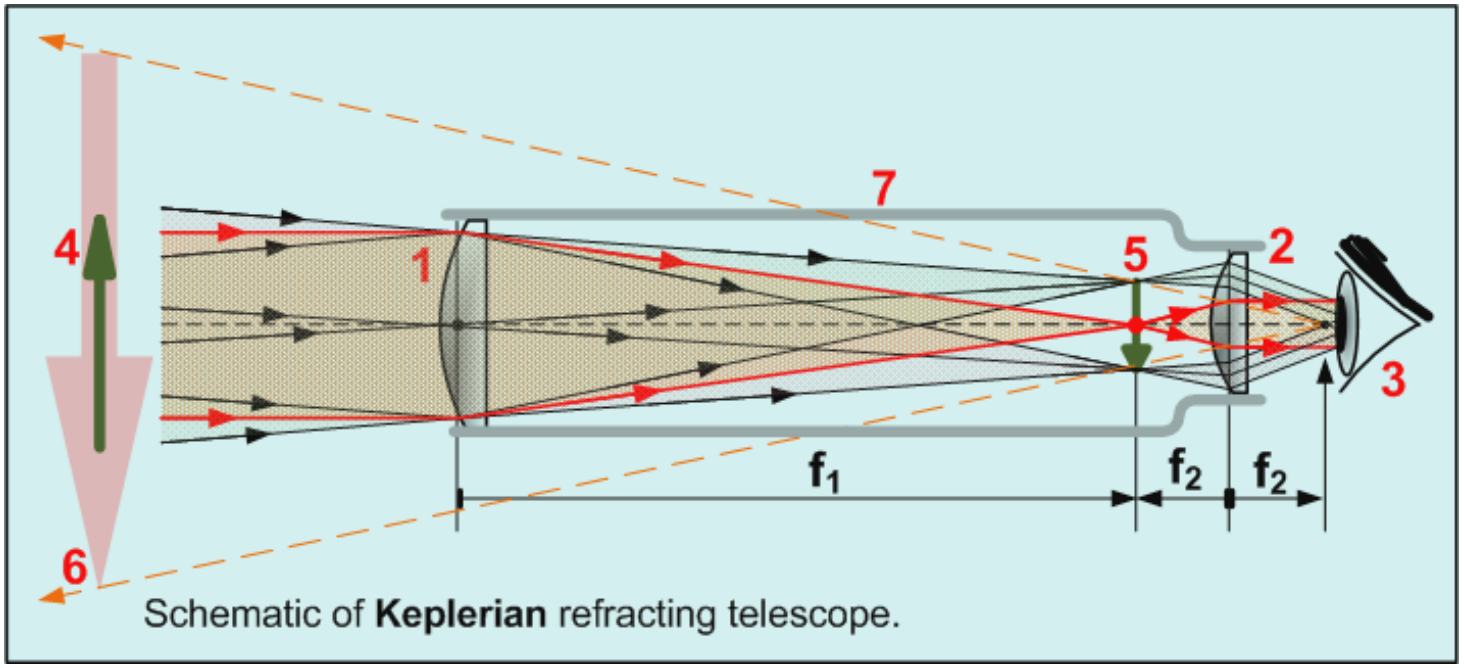


J Is where the object would have appeared without the eyepiece

I is where the image actually appears, it is strongly magnified and erect.

- http://www.math.ubc.ca/~cass/courses/m309-01a/chu/Applications/apps.htm

How Does a Keplerian Telescope Work?

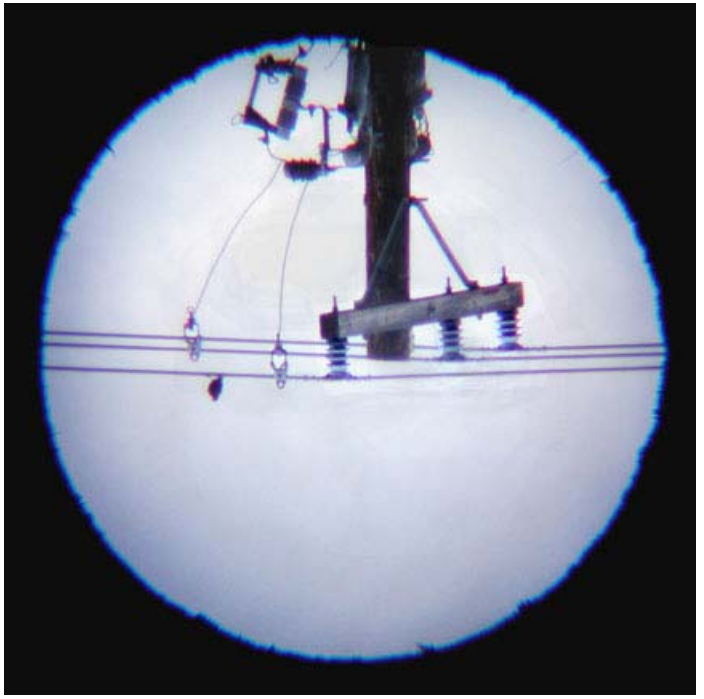


The RED arrow is where the image of the large green actually appears, it is strongly magnified and upside down. Note that the magnification of the telescope is simply the ratio of the f1/f2=magnification.

- wikipedia

The Field of View of a Galilean Telescope vs. a Keplerian

The Field of view of a Galilean is much smaller than that of a Keplerian

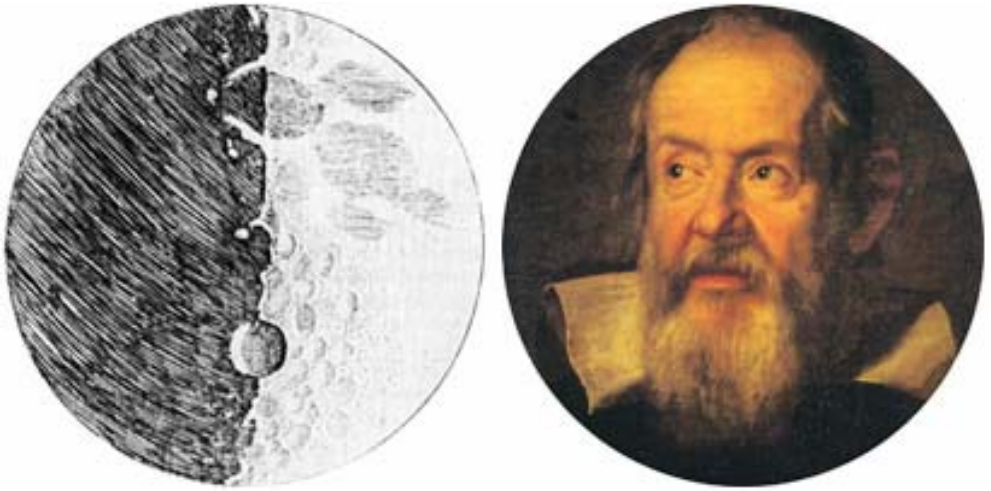


Keplerian FOV, note that the image appears upside down.

- http://www.pacifier.com/~tpope/Galilean_Optics_Page.htm

Summary Galilean Vs. Keplerian Telescopes

- The first telescopes were Galilean
- A Galilean has a big positive objective lens in the front, with a small *negative* eyepiece
  - They produce an erect magnified image
  - They have a small field of view, and so are not used any more
- A Keplerian telescope has the same Objective but it has a *positive* eyepiece lens
  - They produce an inverted “up-side-down” image
  - They have a much larger field
  - Most “spotting” telescopes are Keplerians with an additional “erecting” lens



Left: One of Galileo's Moon drawings from 1610.
Right: Portrait of Galileo by J. Sustermans (1597-1681).

The GalileoScope

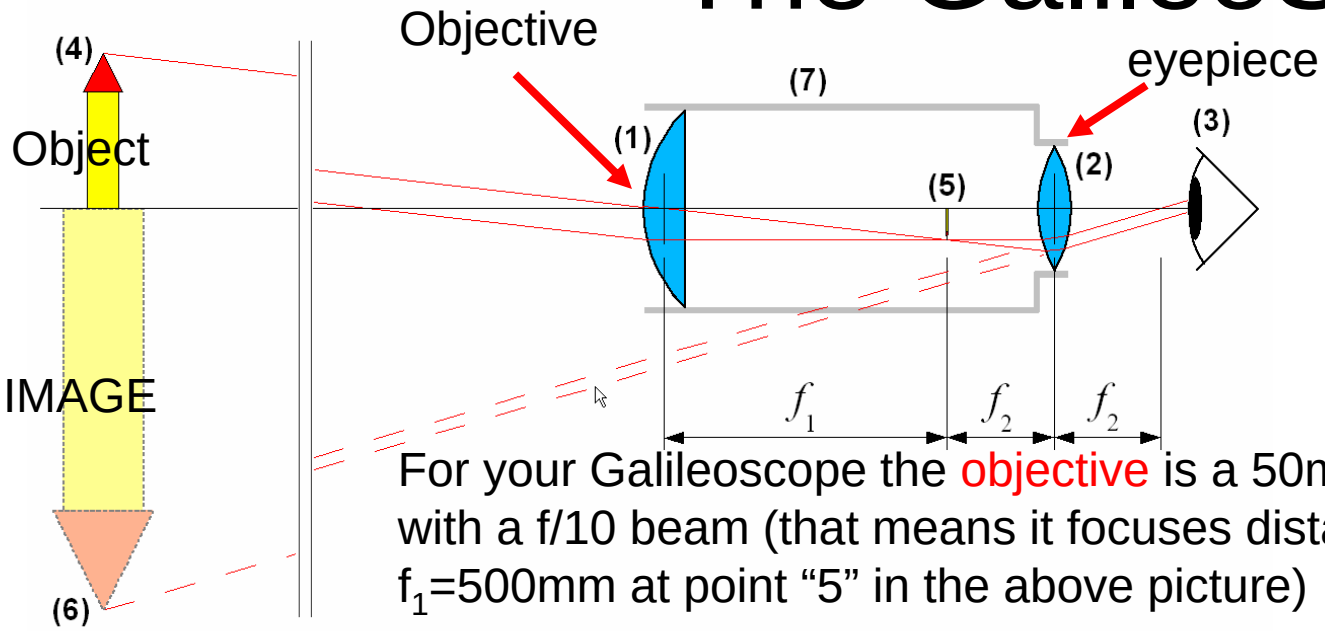
- In honor of the 400th anniversary of Galileo's telescope 2009 is the international year of astronomy (IYA2009).
- A keystone project of IYA2009 was the *development of a high quality yet low cost telescope*.
- This became the Galileoscope. Much of the Galileoscope was developed here by Tucson astronomers.

The GalileoScope

The Galileoscope has gone from concept to reality! Shown here is one of the first kits off the production line, along with the box it came in. By May 2009 the initial shipment of 60,000 units will be en route to customers worldwide. Photo by Rick Fienberg.

- Here it is, mainly PVC plastic with a nice 2inch (50 mm) objective and a 20 mm eyepiece

The GalileoScope



For your Galileoscope the objective is a 50mm lens (2 inches) with a f/10 beam (that means it focuses distant light at f_1=500mm at point "5" in the above picture)

The Keplerian eyepiece has an effective focal length of f_2=20 mm.

Therefore Magnification = f_1/f_2 = 500/20 = 25x

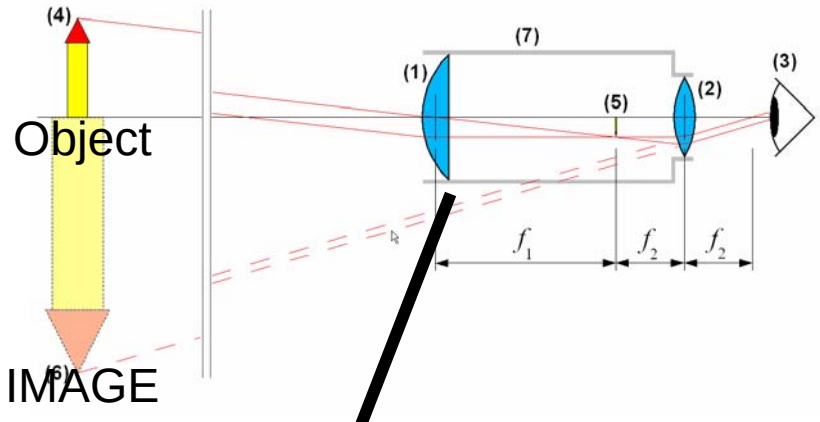
So this telescope would be called:

a 2 inch 25x refractor telescope.

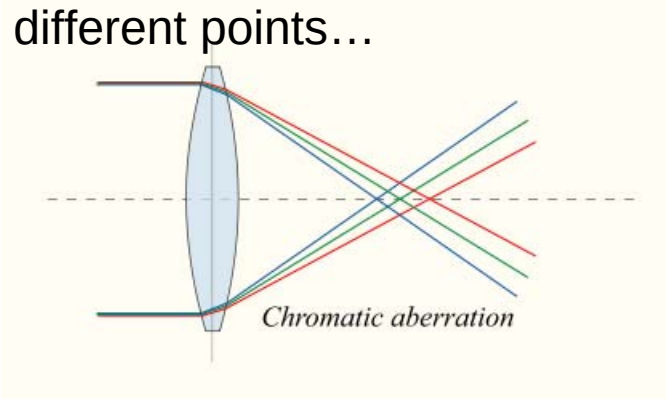
Or ***a 2 inch 500mm achromat refractor.*** Since many different eyepieces can be used for any one objective…

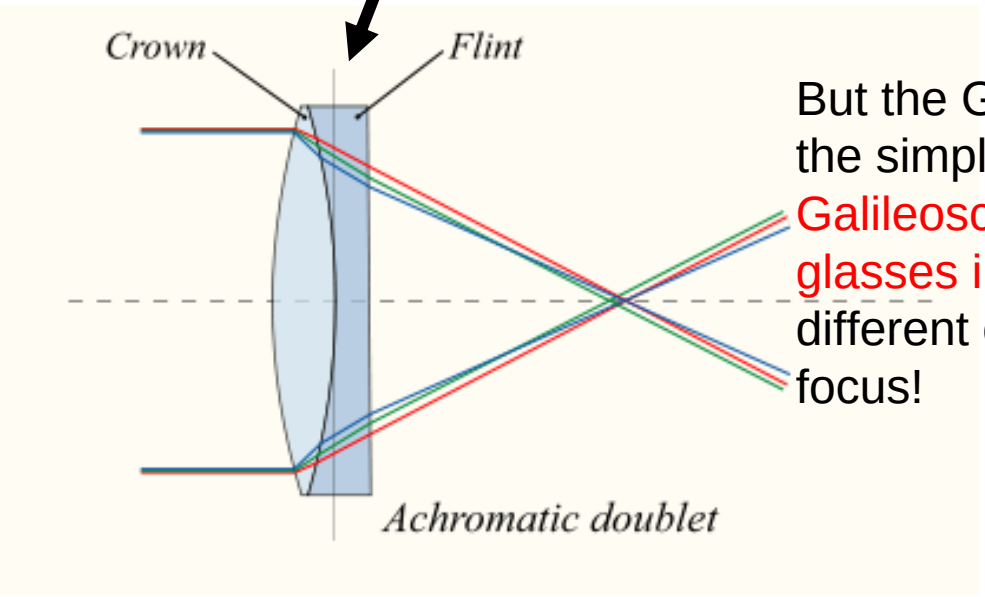
- http://www.starlightinstruments.com/images-reference/RefractorTelescope.png

The GalileoScope



This is what happens if just one glass is used – different colors focus at different points…

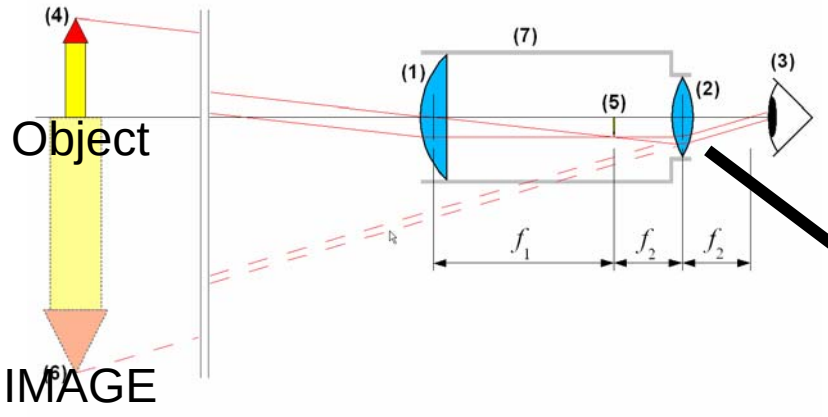




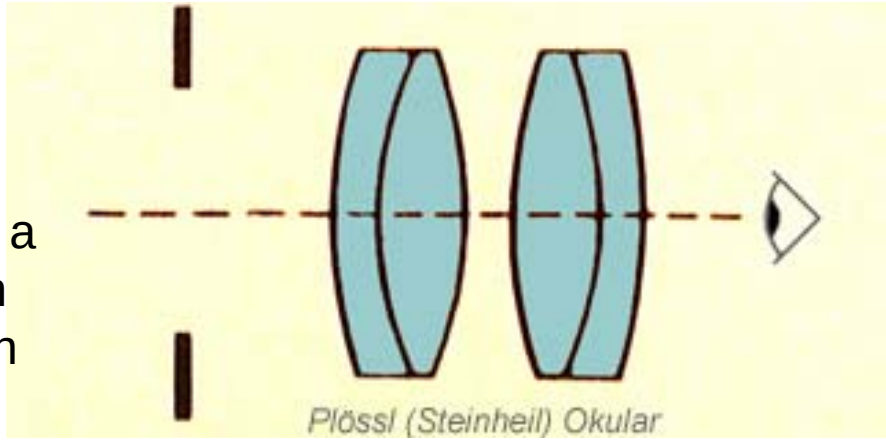
But the Galileoscope objective is better than the simple single glass design above. Your Galileoscope uses a mix of crown and flint glasses in the 2inch objective so all the different colors of light come to the same focus!

- http://www.starlightinstruments.com/images-reference/RefractorTelescope.png

The GalileoScope



Also the eyepiece is designed as two symmetric lenses (a plossl design) so that the aberrations of the strongly curved plastic lenses cancel each other while producing a short 20 mm focal length! Which in turn leads to a strong magnification of 25x with the 500mm objective.

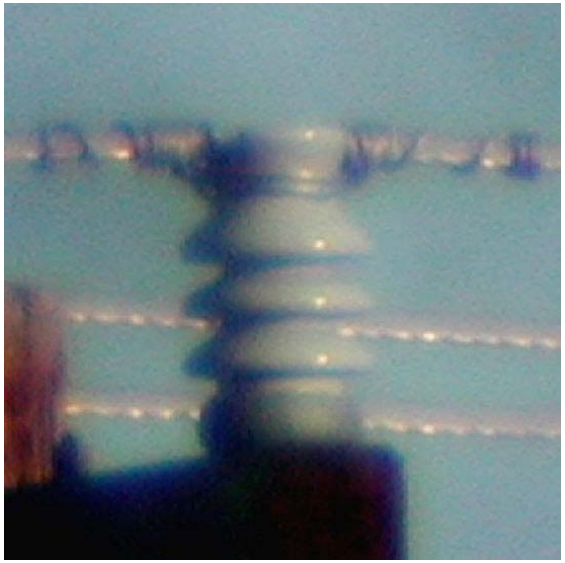


- http://www.starlightinstruments.com/images-reference/RefractorTelescope.png

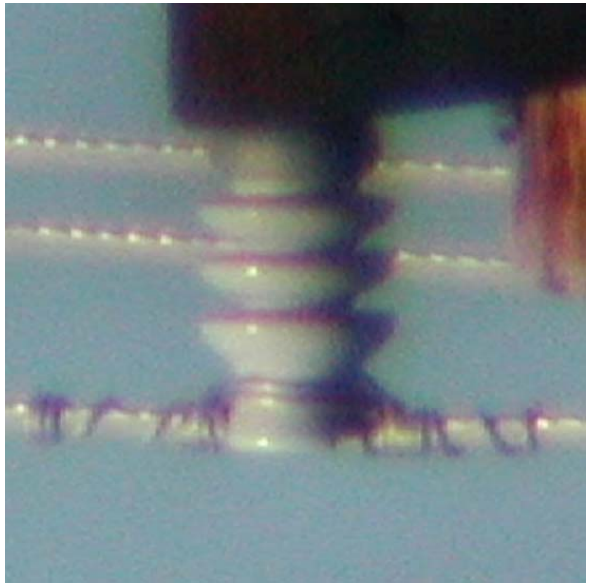
Galilean Vs. Kepler Telescope Image Quality and Chromatic Aberration

Modern 8inch reflector telescope

(mirrors have no chromatic abb.)



Galilean Telescope



Keplerian Telescope

- http://www.pacifier.com/~tpope/Galilean_Optics_Page.htm

Here is a real Picture of Finger Rock taken by Dr. Close's Galileoscope

This picture (which I've flipped right side up) was taken by a hand held (shaky) digital camera behind my Galileoscope.

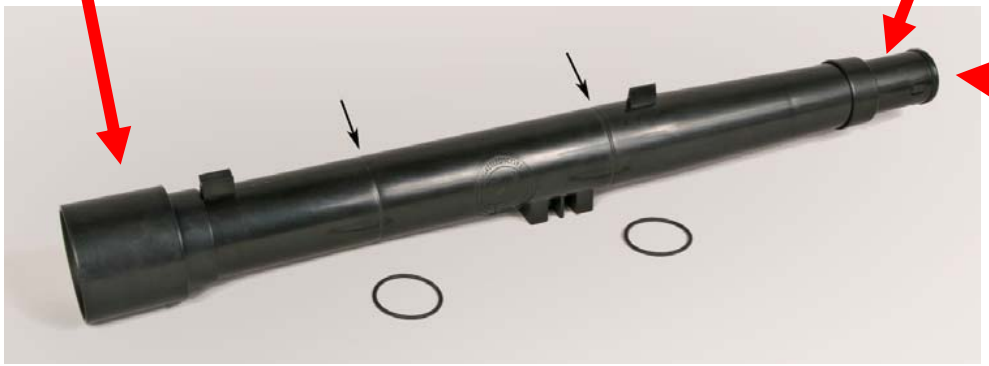
Note I used the Galileo Barlow 2x adapter. The Barlow lens cuts the filed of view down by half – but also decreases the effective focal length of the eyepiece to 10 mm. Therefore the magnification is 500/10 = 50x

You will not need the Barlow lens for the group project.

Building your Galileoscope:

Objective, thin crown glass facing out.

Focuser slide



Eyepiece, curved sides face in, flat sides face out

Rules for using a Galileoscope:

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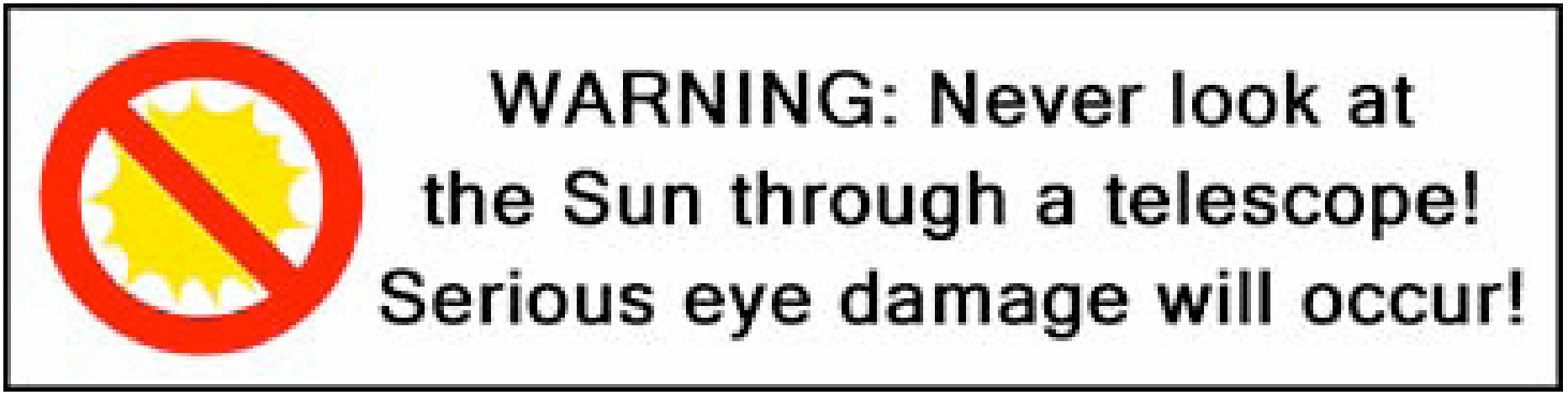


Tips for using a Tripod:

REMEMBER: don't move the tripod while locked, unlock then move, then lock

HINT: you will notice backlash as you tighten the knobs, so over shoot so that it will come back when tightened

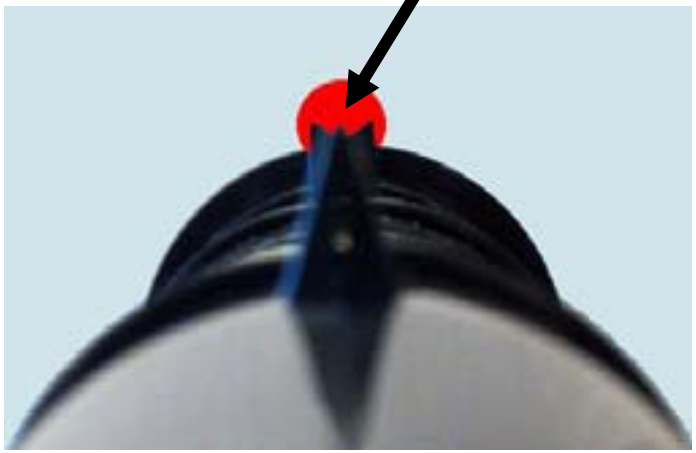
HINT: Move only one direction at a time

Tips for using a Galileoscope:

Sighting guides

Focus control (piston in and out)

Put Jupiter here



HINT: Don't touch the scope when taking measurements

By aiming the sighting guides at your target (say, Jupiter) it should appear in the eyepiece – or close to it.