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

- 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.

Galileo Galilei

The objective that discovered the Galilean Moons
Types of Telescopes

- Early telescopes were “refractors” with 2 lenses
- Later mirrors were used for larger “reflectors”
How Does a Galilean Telescope Work?

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

**J** is where the object would have appeared without the eyepiece.

**I** is where the image actually appears, it is strongly magnified and erect.
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 $f_1/f_2=magnification$.

- 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 lens
  – 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
• 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

• 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 $f_1=500\text{mm}$ at point “5” in the above picture).

The Keplerian **eyepiece** has an effective focal length of $f_2=20\text{mm}$.

**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…
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!
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.

Galilean Vs. Kepler Telescope Image Quality and Chromatic Aberration

Modern 8inch reflector telescope (mirrors have no chromatic abb.)

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.

Focus slide

Eyepiece, curved sides face in, flat sides face out.
Rules for using a Galileoscope:
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Tips for using a Tripod:

- Elevation control (up down)
- Azimuth control (right to left)
- Leg extensions (height control)

**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**

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

**Focus control**

(Piston in and out)

**HINT:** Don’t touch the scope when taking measurements

**Put Jupiter here**

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