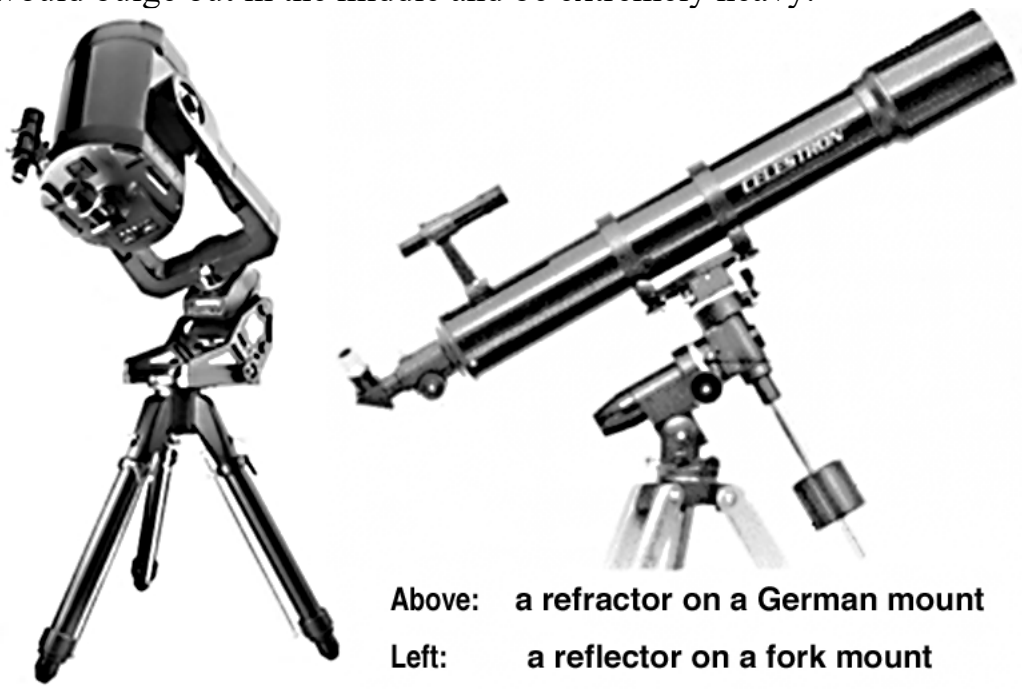
Lab #2: Visit Kennon Observatory

Astronomical telescopes come in two types, according to what their main optical element is: (i) refractors, which use a lens to collect light and form an image of the observed object, and (ii) reflectors, which use a concave mirror for that purpose. They serve the two main purposes of astronomical instruments: (1) collecting as much light as possible, and (2) seeing as small details as possible. The most important factor for both of these purposes is the diameter of the lens or mirror. Modern 21st century telescopes are all reflectors, because it is just too hard to make a lens (which has to be supported at the edges and sags) larger than a yard in diameter. You can immediately tell whether a reasonably large telescope is a reflector or a refractor by the way it looks (see the pictures): refractors normally come in very long tubes because their lenses have long focal lengths. It would be very hard to make a good large lens with a short focal length since it would bulge out in the middle and be extremely heavy.



Above: a refractor on a German mount

Left: a reflector on a fork mount

The main telescope in the large dome of Kennon Observatory is a 15-inch refractor. At the time when it was built (1892) it counted as a research-grade telescope. Of course, it has historical value only in the 21st century, but it is still used for educational purposes.

As a classical refractor, it has a very long focal length (*f = 180 inches*). Through such a long tube you can see only a very small part of the sky at a time, so this telescope is not very convenient for viewing extended object such as galaxies or nebulae, but it is ideal for observing binary stars, the planets and the Moon – everything where good resolution matters. In really calm weather when the blur due to the atmosphere (called "seeing") is little, this lens can resolve details as small as *1/3 arc second*; it allows a detail-rich image even at as high magnification as 400 – 500 ×. On most nights, however, the motion of the air limits the resolution and only lower magnification can be used.

Astronomical telescopes must be supported by very firm mounts. Any little shaking renders even a good quality lens completely useless, because the shaking is magnified by the telescopes as much as the observed object is. The mount should allow the telescope to turn around an axis that is parallel to the axis of Earth (the *right ascension* axis) at a steady rate of one turn a day to

track the stars automatically as they move in the sky. A *clock drive* is built into the mount to do this. In order to point at a star of the observer's choice, the telescope can be turned around another axis (the *declination* axis) as well. This arrangement of a mount is called an *equatorial mount*. There are two types of mounts normally used for all but the very biggest telescopes: (i) the fork mount, and (ii) the German mount (see the picture). German equatorials are usually more expensive to make, but they are also more precise and more robust – the 15-in refractor is on a German equatorial mount.

In the late 1850s the University of Mississippi, under the leadership of Chancellor Barnard, decided to build the world's largest telescope. The design of the building to house the telescope followed that of the famous Pulkovo Observatory built in 1839 outside St. Petersburg, Russia. In January 1863, Alvan Clark, of Massachusetts, who later made the largest lens in the world (the 40-inch refractor in Yerkes Observatory in Wisconsin), finished grinding and polishing Barnard's 19-inch lens and tested it on Sirius, the brightest star in the sky. During this testing he made one of the most important discoveries in 19th century astronomy: he discovered the white-dwarf companion star of Sirius, now called Sirius B. This star is as heavy as the Sun but only as large as Earth! Unfortunately, the Civil War broke out, and Mississippi could not muster the payment due on the lens that would have made Ole Miss the leading astronomical institution in the country. It ended up at Northwestern University in Illinois.

By the time Barnard Observatory received its telescope in 1893, the 15-inch refractor, built by Sir Howard Grubb of Dublin, Ireland, did not make it among the largest telescopes of the world. Observatories also started to be built in locations with much better seeing, less moisture and fewer clouds on mountaintops. No more cutting-edge observational research was possible in locations like Oxford.

The 15-inch telescope was relocated to the Kennon Observatory in 1939. Its outdated mechanical clock drive was replaced by an electrical drive in 1953, and modernized again in 2010. As the telescope was designed for research work to observe the same object for days at a time, setting it up and aiming it at a new object is a slow process. For this reason it can be used in astronomical teaching laboratories only a few times a year.

PROCEDURE AND LAB REPORT

Date:_____ Your name: _____Partner's name: _____ Section: ___/___

Maximum two students may work together as partners!

1. ***Read the review, and listen to your instructor's introduction***.

2. ***Answer the following questions about telescopes:***

-- What are the two main purposes of a telescope in astronomy?
1 _____, 2 _____

-- If a telescope has a very long and narrow tube, its main optics must be a _____.

-- The telescope in the large dome is a ref___ctor, its main optics is a _____, and in very good weather it can use a magnification as large as _____.

-- The telescope should be turned by the clock drive one turn per _____ *hours* to track the stars around the _____ axis which points at the _____. The other axis is called the _____ axis, and a mount whose axes are arranged this way is called an _____mount.

3. ***Answer the following questions about our telescopes:***

-- What famous discovery was made with the telescope that had been made on the order of Ole Miss Chancellor Barnard? _____

-- Why has this telescope never arrived at Ole Miss? _____

-- How old is the telescope in the large dome? _____years. How large is it? _____

-- Is the telescope in the large dome good for research?
Give a reason: _____

4. ***Now follow your TA to the large dome for a visit.***

5. ***Answer the following questions about your visit:***

-- The large telescope in the large dome is a ref__ctor, which means that its main optical element is a _____.

-- The way we refer to the telescope is "the ___-inch telescope", and the number refers to the _____of its main optical element.

-- The mount of this telescope is a(n) _____.

-- The slit on the dome is closed when it is raining. How do you think observations are done at those times? _____