Starscan

Johnson Space Center Astronomical Society

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Quick Release Wheelbarrow Handles For Your Dob

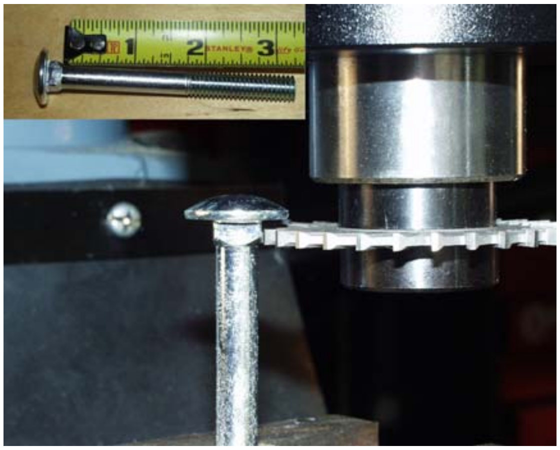
Ken Lester

The one thing about building your own scope is that you're never completely satisfied with what you've done. In 2000 Kurt Maurer and I built a 22" truss-tube Dobsonian following the general techniques found in the David Kriege and Richard Berry book, *The Dobsonian Telescope, A Practical Manual for Building Large Aperture Telescopes*. Even though we changed some of their design to suit our needs we did use the book's techniques for attaching wheelbarrow handles (with pneumatic wheels) to the sides of the rocker box to move the scope around. The wheelbarrow handles were attached to the scope with two long eyebolts, which had to be screwed/unscrewed 1 ½" to attach/remove the handles. The handles enabled me to roll the scope into a trailer or truck bed then roll the scope out to the field. No heavy lifting is required. Once in place the handles were removed for observing. At the end of the observing session, the handles had to be re-attached so the scope could be rolled up ramps into our trailer. Once in the trailer the handles were left on with plenty of room to load our other equipment.

In 2001 Kurt built a 16" scaled down copy of the 22" for my wife Lisa. Once again, wheelbarrow handles were used to move the scope around. However, we encountered a problem when we attempted to load the 16" and the 22" together. Fortunately, the 16" was narrow enough to roll in between the handles of the 22". However, with the handles still attached to the 16", we could not shut the door of the trailer. In order to make both scopes fit, we had to detach the handles on the 16" once the scope was in the trailer. To unload, we had to reattach the handles. While the attaching/detaching of the handles to the scopes is not a major undertaking, it is a chore that I wanted to take as little time as possible. I wanted a quick connect/disconnect system.

After much thought on the matter, I came up with a solution costing under $10. My idea was to replace the eyebolts with pins, which would be permanently attached to the rocker box. These pins would only protrude 1 ¾" from the sides of the rocker box (not out far enough to cause any tripping concerns). The handles would then slip onto the pins and be secured with hitch pins of an appropriate size. Building the prototype, then mass-producing seven more pins (for two scopes) took a total of 3 hours, including shopping for the raw materials. The sides of the rocker boxes on both scopes are 1 ½" thick. The 3/8" – 16 tpi eyebolts screwed into threaded inserts in the rocker box sides. I wanted my wheelbarrow handle pins to have a thread length of 1 ½" to match the thickness of the rocker box sides. I wanted the wheelbarrow handles to slip over an unthreaded section of the pin. The width of the wheelbarrow handles was also 1 ½". My difficulty was finding a 3/8" – 16-tpi bolt with at least 1 ½" of thread and an unthreaded shank of 1 ¾". The nearest bolt to those requirements was a carriage bolt 8" long. Not including, the head of the bolt, the unthreaded shank was exactly 1 ¾" long. I would have preferred stainless steel, but had to settle for what I could find.

To fabricate the pins, I had to shorten the threaded portion of the bolt and then remove the head

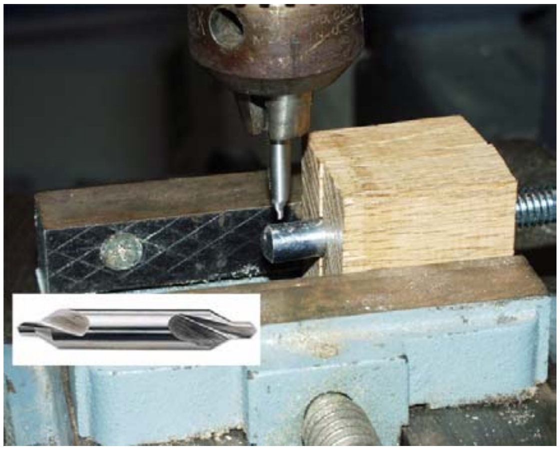


of the bolt. I then had to drill a hole for the hitch pin approximately 1/8" from the end of the unthreaded shank. Fabrication can be done with only a hacksaw, an electric drill, and a file but I used the tools I had available, a Cut-Saw (reciprocating saw), a drill press, a bench mounted combination belt and disk sander and a knee-mill. I also needed an assortment of vises to hold my work piece securely in place during fabrication. This included a homemade bolt block. The bolt block is a 1 ¾" x 1 ¾" bock of hardwood with a 3/8" hold bored through the center. The bock is then cut in half-length wise and centered on the hole. The result is a device, which will securely hold the bolt in a vise.

The first task was to shorten the threaded section of the bolt to 1½". I first threaded a couple of nuts onto the bolt past the cut point. If the cut is clean, the nuts will not be needed. However, if

the threads get distorted during the cutting process, just removing the nuts should restore the threads. I used tape to mark where my cut was to be made. I clamped the bolt in a vise using the bolt block and using a cut saw I made my cut. I then dressed the cut using the disk sander placing a shallow bevel on the end. I then unscrewed the nuts, which came right off, indicating that no thread damage occurred during the cut.My next task was to remove the head of the carriage bolt. Recall that I needed 1 ¾" of non-threaded shoulder. The 8" carriage had exactly that amount. I had debated the purchase of 10" carriage bolts, which had more than the required amount of non-threaded shoulder.

In retrospect I should have purchased the 10" bolt and used the cut saw to make all the cuts. It would have been a lot faster and would have only cost an additional $.11 per bolt. To remove the head of the carriage bolt and retain all the bolt shoulder, I used a saw on my knee-mill to make the cut. Notice the picture of the bolt in the mill ready to be cut by the saw. What you can't see is the bolt block and vice securely holding the bolt in place. Once the head of the bolt was removed, I used the disk sander to remove any burs and then bevel the edge of the bolt. The bevel will make it easier to slip the handles onto the pins. The last task to fabricating the pins was to drill a 7/64" hole approximately 1/8" from the end of the pin. I used two tools to make this job a snap. The first is a drill press. If you don't have one and your significant other won't let you buy one, then borrow one. Only as a last resort should you use a hand held drill.



The other tool of convenience is called a center drill (about $1 from Enco or Grizzly mail order tool companies). If you have ever tried drilling a hole with a small bit, especially on a curved surface, you will have noticed that the drill bit tends to wander all around where you want the hole to be drilled. This wandering is due to the very thin nature of the bit, which flexes when pressure is applied to get the bit started. A center drill consists of a very short bit on a large shank whose sole purpose is to start a pilot hole without the bit wandering. Once the hole is started, switch to the conventional drill bit to complete the drilling. I used the disk sander to clean up the burs from the drilling.

To complete the project, I screwed the pins into the threaded inserts in the rocker box then slid on the handles. 7/64" x 1 5/8" hitch pin clips through the holes keep the handles from coming off while moving the scopes. With the new pins, we have virtually eliminated the time it takes to connect and disconnect the handles. Since it's so fast and easy we now use a single pair of handles for both scopes.

Material List (1 telescope):
4 – 3/8" – 16 tpi 8" long carriage bolts (Recommend using 10" carriage bolts)
4 – 7/64" x 1 5/8" hitch pin clips

IMPOVERISHED TOWN HOPES CRATER MAKES AN ECONOMIC IMPACT

An eastern Kentucky town that has been struggling through economic decline is hoping that an out of this world attraction can help turn things around. Geologists in Kentucky have concluded that Middlesboro was built in a meteor crater and local officials feel sure that the discovery will pay huge dividends in tourism dollars.

William Andrews, a geologist with the Kentucky Geological Survey said erosion and vegetation have hidden most signs of the meteor's impact. But enough evidence remains. "You have the round shape, shattered rocks in the middle and deformed rocks around the sides that have been bent, folded or shoved", Andrews said. "That's pretty strong evidence that it was a meteor crater impact". Its enough to excite local tourism officials who are hoping people will come from across the nation to visit the town. They are now promoting Middlesboro as the only town in America built inside a meteor crater.

Middlesboro, historically dependent on the mining industry, has been in decline for decades suffering alongside coal operators. Mines have shut down. Shops have closed and workers have hit unemployment lines. More than 1 million people already come to Middlesboro each year to visit Cumberland Gap National Historic Park, home of the famed mountain pass that settlers traveled through in the nation's midsection in the late 1700s. Tourists can walk the footsteps of the famous frontiersman Daniel Boone who led the way through the Gap for a flood of settlers to come in to Kentucky and beyond.

Nearby is the Los Squadron Museum, home to a World War II fighter plane that spent half a century in the icy heart of a glacier. Some 20,000 people came to Middlesboro last year to see the P-38 Lightning fly for the first time since being pulled out of 268 feet of ice and snow in Greenland. A local restaurateur spent $3 million to recover and rebuild the plane. These two

attractions keep Middlesboro hotels and businesses active. When word spreads that people have the opportunity to see an actual meteor crater, it is thought visits may skyrocket.
More than 60 geologists arrived in town earlier this month to survey the crater. They are confident that the valley is in fact, a crater. "Middlesboro is in this strangely round valley in the middle of Appalachia. You don't get round valleys. Its not normal."
While the shape of the valley initially drew the interest of geologists, they soon found stronger evidence. Rocks were found near the center of the basin in 1966 that were so shattered that something out of this world had to have occurred. The theory is that a meteor more than 1500 feet in diameter struck the earth here some 300 million years ago creating the crater 4 miles in diameter.

Deep Sky for Oct 2003

Chris Randall

This month's list is straying from the normal format due to the Fort McKavett Star Party. For you that are going, I have developed a list of objects to delight and tease you when you arrive. This list covers many areas of the sky and object types. Just observe and enjoy the night sky. If you make the observations and turn them into me, you will receive a special 2003 Fort McKavett Observing Certificate. The detailed list of objects and instructions are below. Most important, have **FUN** observing at the Fort.
One other mention is not to miss the Lunar Eclipse here in Houston on November 8, 2003. It starts before the moon rises at 5:24 PM, and ends around 10:22 PM. The table below shows key points throughout the eclipse.

Lunar Eclipse Nov 8, 2003.

Times are CST for Houston.

Penumbral Begins: 16:15
Partial Begins: 17:33
Total Begins: 19:07
MAXIMUM Eclipse: 19:19
Total Ends: 19:31
Partial Ends: 21:05
Penumbral Ends: 22:22

Wanted!!!

Paul Maley is in the market for a used C-8 telescope. If there is one out there looking for a good home and some wild adventures, please contact Paul at pdmaley@yahoo.com

Important Astronomers, their Instruments and Discoveries

Paul M. Rybski

Merkets and Waterclocks

Babylonian observations (1500 BC?) recorded solar and lunar eclipses as well as planetary observations using merkets and water clocks. Macedonian philosopher Thales of Miletus (575-532 BC?) predicted a solar eclipse using Babylonian observations and mapped out constellations to aid navigation. Alexandrian astronomer Eratosthenes (260-201 BC?) measured the circumference of the Earth using comparative shadow rod measurements in two places and knowledge of the distance between them.

The Cross-Staff

Alexandrian astronomers Aristillus and Timocharis charted the positions of the brighter stars (284 BC), producing the first star catalog using a Cross-staff. Aristarchus of Samos (250 BC?) calculated the distance of the Sun from the Earth and the Moon and Sun's sizes relative to Earth by observations during solar and lunar eclipses and at first quarter Moon using a Cross-staff.

Armillary Spheres

Eratosthenes (204 BC) catalogued more than seven hundred stars using one, and possibly two, armillary spheres. Hipparchus of Rhodes (c. 150 - 125 BC) used the equatorially mounted Armillary Sphere for a variety of measurements. He determined the distance from the Earth to the Sun by two methods (129 BC). He established a new star catalog complete for his latitude and to the limit of human vision when a "new star" appeared in the sky in 134 AD; containing some 8000 entries, this catalog remained the most complete stellar catalog until Edmund Halley undertook in 1677 observations of the southern skies from an observatory in St. Helena that yielded a catalog of 341 stars. He discovered the precession of the equinoxes by comparing his star catalogs with two earlier ones (125 BC). This remained the most precise calculation of equinoctial precession until it was redetermined at Samarkand by the Arabic astronomer Ulugh Begh in 1450. He measured the lunar orbit, determining lunar orbital precession and orbital eccentricity (125 BC?). He measured the solar orbit, proposing the Sun did not move in a circular path around the Earth (125 BC?).

The Quadrant and Triquetrum

Alexandrian astronomer **Ptolemy's** (c. 100- c. 178 AD) preferred the Quadrant to a complete circle because of easier construction and use. He designed one but never built it. To simplify altitude measurements further, Ptolemy designed the Triquetrum (also called "Ptolemy's Rules"), which was easier to construct, and more portable than the Quadrant. Arabic astronomer Abu Abdullah al Battani (Albategnius) invented the Mural Quadrant, used in a 20-foot version by Abul Wefa at Baghdad; also used was a 56 foot stone sextant (900-1050 AD?).

The Azimuth Quadrant and The Torquetum

Arabic astronomer Nasir ed Din al Tusi (1005-1072?) began his career as an astronomer at Baghdad, became the captive astrologer of Shaikj al Jebel, from whose imprisonment he was freed by Hulagu, grandson of Genghis Khan. al Tusi then worked in an observatory started by Hulagu at Meragha, close to modern Tabriz. Here al Tusi invented the Azimuth Quadrant and the Torquetum. The Azimuth Quadrant allowed simultaneous measurements of an object's altitude and azimuth. The Torquetum was an astronomical calculator with the ability to measure simultaneously an object's right ascension and declination from a single measurement of its position on the sky, once the observer's latitude was calibrated into the machine. Uzbekh astronomer **Ulugh Begh** at Samarkand (1450 AD) constructed large masonry quadrants with which he determined the obliquity of the ecliptic and data for the construction of new solar tables.

The Astrolabe

Ptolemy designed the astrolabe (c. 150 AD) as an armillary ring, held vertically, on which was fit a diametrical cord with one sight at each of its ends. Arabic craftsmen (9th-11th centuries) improved the astrolabe to determine time from stellar or solar observations without use of tables, though it was limited to one century and one latitude. English poet Geoffrey Chaucer describes an astrolabe in detail in his Treatise on the Astrolabe (1381).

The Geometrical Square, "Jacob's Staff" and Regula

German astronomer Georg Purbach (14XX-14XX?) invented each of these instruments. The Geometrical Square was designed to measure altitudes like a quadrant; unlike a quadrant, this device had a square shape and was marked off at arbitrary intervals rather than in degrees of arc. The "Jacob's Staff" was a modification of Ptolemy's Triquetrum. The Regula was designed for measuring the altitudes of the Sun and Moon. So great were the instrumental and observational errors in these devices that combining their results produced a position estimate whose uncertainties were larger than 6 degrees of arc. Polish astronomer Nicolas Copernicus (1473-1543), or Nikolaus Koppernick, built an eight-foot-long triquetrum. Despite the accuracy possible with it, Copernicus did not pursue planetary measurements long enough to discover the significant errors in predictions based on Ptolemy's model for the solar system. So great was Copernicus' trust in Ptolemy's observations that he quoted Ptolemy's incorrect value for the horizontal parallax of the Sun of 3 arcminutes rather than remeasure it. Had he done so, Copernicus would have discovered the value too small to measure with his instruments; today we know the value to be 20 times smaller than Ptolemy's value -- only 8.8 arcseconds.

Instrumental Improvement and Astronomical Discovery

Danish astronomer **Tycho Brahe** (1546-1601) improved on all of these instruments. His first azimuthal quadrant was 19 feet in radius. Built for his friend Peter Hainzel, mayor of Augsburg, Germany, in 1568, it featured divisions to one arcminute; destruction by fire only five years later prevented this instrument from making important observations. Just as a "new star" in 134 BC prompted Hipparchus to create the world's first vision-limited star catalog, so a "new star" appearing in Cassiopeia in 1572 -- whose parallax measurements by different observers were so discordant that Michael Mästlin's measurements in Tübingen, made with only a piece of thread and which revealed no parallax, were considered the most trustworthy -- prompted Tycho Brahe to devote his life to improving astronomical instruments and to making the best measurements with them. Tycho's observations of the nova of 1572, published in 1573, and lectures on astronomy he delivered in 1574 in Copenhagen, convinced the Danish king Fredrick II to grant Tycho an island on which to build an observatory, money to construct the needed instruments and a lifelong pension to run it. The facility he constructed was equivalent in function to a modern observatory. Tycho used equatorial armillary spheres for determining declinations and hour angles of objects anywhere in the sky. He also employed large azimuthal quadrants for a similar purpose. Tycho used an early form of vernier scales -- called transversals -- and compound sights on his instruments to measure objects to an accuracy of three arcminutes, better than his contemporaries by factors of 10 to 50. He further reduced this error by averaging the several results of each of several observers and by correcting these measures for atmospheric refraction, the first astronomer to do so. His smallest correction for refraction was one arcminute (one-sixtieth of a degree).

Toward the Refracting Telescope

Invention of glass occurred about 3500 BC; it was first seen in Egypt. Working glass dates to 2000 BC when Phoenicians produced it in quantity. Earliest Greek references to optical properties: Aristophanes' "The Clouds" in 424 BC; Euclid on water flasks (250 BC?); Archimedes on military use of mirrors (XXX BC?). Arabic astronomer al Hazen (950-1025 ?) explained atmospheric refraction on shapes of Sun and Moon close to the horizon. Italian astronomer Vitello (1230-1275) explained twinkling in stars and tried to establish laws of refraction. Roger Bacon (1210-1294), a Franciscan monk working in Oxford, England, studied reflection and refraction in mirrors and lenses, respectively, suggesting lenses be used as magnifiers for close work. He also suggested the use of single lenses for viewing distant objects. He was imprisoned in his cell from 1281-1291 when results of his optical studies were condemned as witchcraft. Italian monk Alexandro della Spina or Salvino d'Armati invented spectacles between 1285 and 1300. English scholars Robert Recorde (1551) and Leonard Digges (1571) refer to use of "perspective glasses" to view distant objects, while Digges discusses mirrors being used similarly. William Bourne (1585) and Giambattista Della Porta (1589) claimed to have discovered a way to use two lenses to view distant objects, but neither manufactured a telescope.

Controversy over the Invention of the Refracting Telescope

Dutch spectacle maker Hans Lippershay filed a patent application in Holland on October 2, 1608, requesting exclusive rights to make and distribute "an instrument for seeing at a distance", consisting of a weak positive objective lens and a strong negative eyepiece. Lippershay constructed a telescope on request and was tested successfully; he received an initial contract for construction of up to three instruments. Dutch spectacle maker Jacob Adriaanzoon filed a counterpetition, claiming he had constructed a telescope of power equal to Lippershay's and would construct one if he were paid to do it. Given the success in dealing with Lippershay, the Dutch authorities declined to pay for the construction.

Dutch spectacle maker Zacharias Jansen claimed to have invented the telescope prior to Lippershay and that the latter should not be granted an exclusive manufacturing patent. Despite a lack of evidence for prior invention from Adriaanzoon and Jansen, the Dutch government decided the issue too confused and refused to grant Lippershay's application.

Earliest uses of the Refracting Telescope

Italian mathematician and physicist Galileo Galilei (1564-1642) built his own telescopes in 1609 and 1610, revolutionizing astronomical observation: in January - March , 1610, he discovered the satellites of Jupiter and that the Milky Way consisted of faint stars too close together on the sky for the eye to see separately; in July, 1610, he discovered but could not explain the rings of Saturn; from October - December, 1610, he discovered the changing shape of Venus, concluding that Mercury and Venus shine by light reflected from the Sun about which they revolve; in July, 1611, he discovered sunspots and solar rotation. German mathematician Johannes Kepler (1571-1630) studied and suggested improvements to the Galilean telescope (1611). From this study and from one of the eye, he suggested the use of a positive lens as an eyepiece. He also showed that spherically shaped lenses produce imperfect images due to their shape, a problem which can be eliminated by giving lenses hyperboloidal shapes instead of spherical ones.

Others built their own telescopes, corroborated Galileo's discoveries and extended them: Simon Marius discovered satellites of Jupiter (1609); Johannes Fabricius discovered sunspots (1611); Thomas Harriot determined the rotation period of the Sun (1611-1612); Fr. Christopher Scheiner developed an equatorially mounted telescope for solar observations (1612); Simon Marius discovered the galaxy M31 (1612); Johann Cysat discovered the Orion Nebula (1618); René Descartes studied plano-convex lenses (1637) using Willibrord Snell's (1621) law of refraction, showing that spherically shaped lenses can never provide a point focus for an object at infinity but that one with a hyperboloidal surface can; Giovanni Riccioli discovered satellite shadows on Jupiter and that Mizar in Ursa Major was a double star (1643); Anton Schyrle developed the terrestrial, or "image-erecting", eyepiece (1645) consisting of three lenses; several of these scientists suffered from the problem of late publication of discoveries.

Long-focus Refracting Telescopes

Observers discovered early on that they could minimize spherical and chromatic aberration by using telescopes of large focal ratio, i.e., small objective lenses with long focal lengths. Dutch physicist Christian Huygens (1629-1695) and his brother Constantine found telescopes then obtainable too short, constructing first a 12 foot telescopes of 2 inch aperture, then one of 23 foot focus and, finally, one of 123 foot focus, from 1655-1659, during which they were observing Saturn and other objects. Their longest telescopes were constructed with the objective lens and eyepiece coupled only by a cloth cord. The objective lens was attached to a moveable platform attached to a tall pole and the eyepiece was mounted on a stand carried and pointed by the observer. While easily maneuvered, these telescopes could not be used except in total darkness. Christian Huygens reduced significantly the chromatic aberration of the objective lens. He also introduced the use of optical stops that reduced light reflected by the telescope tube walls and unwanted light from outer, less well shaped portions of the objective lens. On March 25, 1655, Huygens discovered Saturn's largest moon Titan; in 1656, he independently discovered the Orion Nebula; in 1659, he published his analysis of Saturn's telescopic appearance in Systema Saturnium, announcing the discovery of its rings Johannes Hevelius (1613-1686?) of Danzig, Germany, a brewer by profession, established his reputation as an astronomer by publishing his lunar atlas Selenographia in 1647, made with telescopes of less than 12 foot focal length and 50 magnification. Reading Christian Huygens' "Systema Saturnium", based on observations made with telescopes up to 123 feet in length, convinced Hevelius to construct much longer focal length telescopes that were 60, 70 and 150 feet in length. Constructed of square wooden frames and maneuvered by several assistants using pulleys attached to towers, these were difficult to point and keep aligned in conditions of changing temperature, humidity and wind speed. Giovanni Cassini (1625-1712), while a professor of astronomy at Bologna, Italy from 1650-1671, made many planetary observations using telescopes built by the Italians Eustachio Divini of Bologna and Giuseppe Campini of Rome. By 1666, he had determined that Mars rotated in 24 hours 40 minutes; that Venus appeared to rotate in 23 hours 15 minutes; and that Jupiter revolved on its axis, was flattened with a polar or equatorial radius of 14/15 and had shadows of its satellites appear to cross its surface. On a visit to Paris in 1669, he improved the estimate of the Sun's rotation period with a Campini 17-foot telescope. In 1671 he moved to Paris to supervise the Paris Observatory, discovering a new satellite of Saturn. In 1672, using a 34 foot Campini telescope of five inch aperture, he discovered another of Saturn's satellites; using this same telescope in 1675, he discovered the division in the rings of Saturn that is now named after him. His last two discoveries of Saturn satellites occurred in 1684 using Campini telescopes of 100 and 132 foot focus. English astronomer John Flamsteed (1647-1719) began his career as an enthusiastic amateur before becoming Astronomer Royal at Greenwich in 1675; the Greenwich charter was to assist navigation by providing correct star positions and reliable tables predicting the positions of the Sun, Moon and planets on a yearly basis; compared to other observatories at that time, Greenwich was poorly equipped, largely equipped at Flamsteed's personal expense and that of his friend Sir Jonas Moore. With the equipment available, apart from the needed tables for navigation, Flamsteed produced the star atlas "Historia Coelestis" whose accuracy was not challenged for more than a century following its printing.

Proposals for Metal-mirrored Reflecting Telescopes

Italian monk Niccolo Zucchi proposed (1616) a concave mirror to replace the refractor's objective lens. The poor shape of his mirror, added to the lack of means of viewing the image without blocking the mirror, caused Zucchi to give up on the idea. French astronomer Marin Mersenne proposed (1630) developing a reflector that used two concave mirrors, the smaller secondary mirror to reflect the light through a hole in the center of the larger primary mirror. Unfortunately, he was dissuaded from working on it further by French mathematician René Descartes. Scottish mathematician James Gregory proposed (1663) a two-mirror reflector with a concave, paraboloidal primary and concave, ellipsoidal secondary, the secondary bringing light to a focus inside the telescope tube and a convex eyepiece delivering light to the eye. Sadly, he did not construct a working version because he could not find a craftsperson skilled enough to grind and polish the required mirrors.

Early Work on Metal-mirrored Reflectors

English mathematician and physicist Isaac Newton (1648-1727) designed and constructed a two-mirror reflector (1668), a concave primary delivering a converging cone of light to a flat secondary mounted at a 45° angle to the optical axis which directed the light to a focus outside the tube where an eyepiece could be placed. A second such reflector was built and presented to the Royal Society in January of 1672. Frenchman N. (or G.) Cassegrain proposed a two-mirror reflector (1672) with a concave, parabolic primary mirror and a convex, hyperbolic secondary, the secondary directing a converging cone of light out the centrally perforated primary like the Gregorian and to a focus outside the telescope tube. Subsequent analysis revealed that surface errors in the Cassegrain secondary can be made to cancel those in its primary, while this cannot be done in a Gregorian. Newton analyzed this system incorrectly, and his criticisms caused Cassegrain to withdraw the idea and sink into obscurity. British astronomer John Hadley (1682-17XX?) produced the first reflector (1721) equal in performance to the 123 foot refractor f 7.5 inch aperture donated to the Royal Society by Christian Huygens in 1692. Mirrors for this and a few later reflectors by Hadley were manufactured from metal alloys prescribed by British astronomer Samuel Molyneux. Hadley is remembered more for construction of the first navigation sighting device (the octant) which permitted position estimates accurate to one nautical mile, a device upon which the modern marine sextant is based. Scottish minister and optician James Short (c. 1708-1768) constructed the highest quality reflectors to that time, most of Gregorian design, from 1734 until his death in 1768. While he regarded as proprietary his techniques for parabolizing primary mirrors, his optical workmanship served as a standard to match or exceed in instruments constructed by others after his death. After Short's death, English physician John Mudge (17XX-17XX) and English minister John Edwards (17XX-17XX) perfected metal alloys for mirrors and created and published information on casting and polishing them, information Short must have possessed but which he destroyed before his death.

The Best Metal-mirrored Reflectors

William Herschel (1738-1822), who became the greatest observational astronomer of the late eighteenth and early nineteenth centuries, was born in Hanover, then an independent port city, to a father who taught his sons to be musicians in the band of the Regimental Guard. Loss of Hanover to the French in 1757 propelled William and his brother Alexander to England, where in 1766 William became organist in the Octagon Chapel in Bath. His fortune made with plentiful concerts given and students instructed, William was able to devote some of his energy to his hobby of astronomy and could bring his sister Caroline to England in 1772. Herschel constructed four refractors of increasing aperture and length in 1773. Using a rented Gregorian, Herschel showed this telescope superior to the refractors in ease of use, so William tried unsuccessfully to make one himself; The results being poor, he instead made a Newtonian that worked very well on Saturn and the Orion Nebula. By 1774, two more Newtonians were constructed and in use, the first of 4.3 inch aperture and 6.5 foot focal length, the second of 9 inch aperture 10 foot focal length. Because his new telescopes produced images ten times smaller than those delivered by telescopes used to catalog star positions, Herschel began a survey of all cataloged stars to identify those which were truly single whose positions could be trusted from those which were multiple whose positions would have to be remeasured. Also he sought close pairs of extreme brightness difference to find evidence of stellar parallax that would yield a distance to stars exhibiting the effect. On March 13, 1781, he discovered what he thought was a new comet but which, on calculation of its orbit, proved to be a planet outside Saturn's orbit. This discovery got the attention of professional astronomers whose telescopes proved inferior when compared directly with Herschel's. This discovery also got the attention of the King who made him "Royal astronomer", freeing Herschel from ever again having to make his living in music.

Shortly thereafter, Herschel completed a 12 inch aperture telescope of 20 foot focal length, followed by a 19 inch aperture telescope also of 20 foot focal length. These he used to continue his double star research as well as to catalog all visible nebulae -- the latter triggered by the publication in Paris of French astronomer Charles Messier's catalog of 103 nebulous objects -- and begin a star counting project which would yield a picture of the structure of the stellar universe around the Sun. During his double star survey, he discovered "binary stars", stars that formed at the same time and were close enough to be orbitting one another. He extended our knowledge of the solar system by defining the direction of rotation of Mars and refuting claims of mountains on Venus. Herschel added to his meagre income as the King's astronomer by constructing reflecting telescopes for wealthy patrons. In 1786, Herschel began the construction of his largest telescope, one of 48-inch aperture and 40 foot focal length. On 27 August 1789, it was completed. On its second night's use, Herschel discovered the sixth satellite of Saturn, now named Enceladus. While the 40 foot remained the largest telescope in the world, Herschel completed most of his remaining research with the 20 foot and with a 24 inch aperture reflector of 10 foot focal length. The work completed by Herschel with these instruments was unprecedented in scope, volume and quantity: a second catalog of nebulae in 1789, a third in 1802; the seventh satellite of Saturn located as well as the determination of Saturn's rotation period; measuring the true brightness of stars, including the study of stars that vary their brightness; the first observation of spectra of stars beyond the Sun; the discovery that nebulae consisted of at least two classes, one consisting of stars and that appeared gaseous; study of the comets of 1807 and 1811; the discovery of infrared radiation; and finding the Sun was moving among the stars in the direction of the constellation Hercules.

His sister Caroline played an essential part in most of Herschel's telescopic discoveries, writing down his observations as they were made and freeing him to remain at the eyepiece; Caroline made important observations in her own right, having discovered six comets in her own work and having corrected many errors in Flamsteed's star catalog when they were discovered to be discrepant with Herschel's own. Herschel contributed to the discovery of minor planets ("asteroids" as he called them) by constructing a telescope used and copied by Johann Schröter, a minor official in the Hanoverian suburb of Lilienthal who started the Societas Lilientalica with the expressed purpose of discovering the "missing" planet predicted by Bode's Law between the orbits of Mars and Jupiter. Between 1801 and 1807, the minor planets Ceres, Pallas, Juno and Vesta were discovered by members of this society. Herschel appears to have been the first to investigate the resolving power of the human eye and that of telescopes. Given limited instrumentation, he found that telescope resolution was inversely proportional to aperture diameter; he did not determine resolution's dependence on the wavelength of the observation.

Ft McKavett Observing List

Chris Randall

This list covers many areas of the sky and object types. No formal logging is required for this program, just observe and enjoy the night sky. This list contains objects for beginners to experts and should be fun or a serious challenge whichever you choose. This list should be able to be completed using just binoculars. I recommend trying them first then progressing to the telescope.

Rules:

- Select from the list below 5 Open Clusters, 4 Globular Clusters, 3 Galaxies, 4 Nebulae, and 4 Solar System Objects to observe. Note some quantity exceptions are available in the solar system area.
- Find and Observe your selected objects in each of the five categories, mark the date and time observed and what instrument you used. For example; Naked Eye, 10x20 Binoculars, 4" Refractor, 22" Dob, or something with a hole in it.
- Although not required, **Share** your view of the objects with others on the field, especially the tough ones, and help others find these objects if they have trouble. So they can log on their log sheet.
- Helping each other is welcome, but **Light Leach Logging is not permitted**.
- All Observations must be done during the Fort McKavett Star Party.
- When you have completed the required 20 out of the 40 listed turn them into Chris Randall, you will receive a special 2003 Fort McKavett Observing Certificate. Don't forget to put your name on the sheet. The logs will be returned to you.

Most important, have **FUN** observing at the Fort.

Name: ____

Date Submitted: ________________________________

Instruments Used: ______________________________

Solar system (4* of 7)

Object	RA	Dec	Mag	Size	% ill	Con	Date/Time
Venus	15h 06m	-17° 24'	-3.9	10"	95	Lib	
Neptune	20h 51m	-17° 39'	7.9	2.2"	100	Cap	
Uranus	22h 05m	-12° 34'	5.8	3.6"	100	Aqu	
Mars*	22h 30m	-12° 19'	-1.4	16"	90	Aqu	
Asteroid Pallas (2)*	02h 04m	-12° 23'	8.4	---	99	Cet	
Saturn	06h 56m	+22° 03'	0.6	19"	100	Gem	
Jupiter	10h 54m	+07° 58'	-1.8	32"	100	Leo	

The coordinates for the solar system objects are for October 24, 2003 at 22:00 CDT.

* Mars observation requires a sketch of features viewed. Then no other objects required.
* Pallas must have 2 observations to confirm it moved. Only one other observation is required.

Open Clusters (5 of 12)

Object	Type	RA	Dec	Mag	Size	# Stars	Con	SA	Date/Time
Cr 399	OCL	19h 26m	+20° 06'	3.6	60'	40	Vul	8	
NGC 7380	OCL	22h 47m	+58° 06'	7.2	12'	40	Cep	3	
M 52	OCL	23h 24m	+61° 35'	6.9	12'	100	Cas	3	
NGC 7686	OCL	23h 30m	+49° 07'	5.6	14'	20	And	9	
NGC 7789	OCL	23h 57m	+56° 43'	6.7	15'	255	Cas	3	
NGC 129	OCL	00h 29m	+60° 13'	6.5	21'	35	Cas	1	
NGC 457	OCL	01h 19m	+58° 17'	6.4	13'	80	Cas	1	
M 103	OCL	01h 33m	+60° 39'	7.4	6.0'	25	Cas	1	
NGC 654	OCL	01h 44m	+61° 53'	6.5	5'	60	Cas	1	
NGC 663	OCL	01h 46m	+61° 13'	7.1	16'	80	Cas	1	
NGC 884 & NGC 869	OCL	02h 20m	+57° 08'	6.1, 5.3	29', 29'	150, 200	Per	1	
Cr 26	OCL	02h 32m	+61° 27'	6.5	21'	40	Cas	1	

Globular Clusters (4 of 9)

Object	Type	RA	Dec	Mag	Size	Con	SA	Date/Time
NGC 6229	GCL	16h 46m	+47° 31'	9.4	4.5'	Her	8	
M 15	GCL	21h 29m	+12° 10'	6.3	18'	Peg	17	
M 2	GCL	21h 33m	-00° 49'	6.6	16'	Aqr	17	
M 30	GCL	21h 40m	-23° 10'	6.9	120'	Cap	18	
Pal 13	GCL	23h 06m	+12° 46'	13.8	0.7'	Peg	10	
G 1	GCL	00h 32m	+39° 34'	13.7	0.5'x0.5'	And	3	
NGC 288	GCL	00h 52m	-26° 34'	8.1	130'	Scl	18	
M 79	GCL	05h 24m	-24° 31'	7.7	9.6'	Lep	18	
NGC 2419	GCL	07h 38m	+38° 52'	10.3	4.6'	Lyn	5	

Nebulae (4 of 8)

Object	Type	RA	Dec	Mag	Size	C. Str	Con	SA	Date/Time
NGC 6210	PLN	16h 44m	+23° 47'	9.3 (P)	30"	12.6	Her	8	
NGC 6572	PLN	18h 12m	+06° 51'	9.0 (P)	11"	13.1	Oph	16	
M 27	PLN	19h 59m	+22° 43'	7.6 (P)	6.7'	13.9	Vul	8	
NGC 7000	BRN	20h 58m	+44° 20'	----	120'	----	Cyg	9	
NGC 7293	PLN	22h 29m	-20° 50'	7.5 (P)	16'	13.5	Aqr	17	
NGC 7662	PLN	23h 25m	+42° 32'	9.2 (P)	37"	13.2	And	9	
NGC 1360	PLN	03h 33m	-25° 52'	9.6 (P)	6.4'	11.3	For	18	
M 42	BRN	05h 35m	-05° 25'	3.0	60'	----	Ori	11	

Galaxies (3 of 8)

Object	Type	RA	Dec	Mag	Size	Con	SA	Date/Time
NGC 7015	Gal	21h 05m	+11° 24'	13.3 (B)	1.5'x1.5'	Equ	17	
NGC 7838	MGal	00h 06m	+08° 21'	15.3	1.0'x0.3'	Psc	10	
NGC 1	Gal	00h 07m	+27° 42'	12.8 (V)	1.8'x1.2'	Peg	4	
M 31	Gal	00h 42m	+41° 16'	4.4 (B)	192'x62'	And	4	
NGC 253	Gal	00h 47m	-25° 17'	8.0 (B)	27'x6.7'	Scl	18	
NGC 300	Gal	00h 54m	-37° 40'	8.7 (B)	22'x16'	Scl	23	
IC 1639	Gal	01h 04m	+02° 07'	9.9 (B)	16'x14'	Cet	10	
M 33	Gal	01h 33m	+30° 39'	6.3 (B)	65'x38'	Tri	9	

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