The Objective View

March 2006

Newsletter of the Northern Colorado Astronomical Society

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Next Meeting: March 2, 7:30 PM
Observing Charles Wood's Lunar 100, Part 1

Lee Gregory, NCAS

NCAS Business at 7:15 PM

Meeting directions Discovery Science Center
703 East Prospect Rd, Fort Collins
http://www.dcsm.org/index.html

In Fort Collins, from the intersection of College Ave and Prospect Rd, head East about 1/2 mile. See the Discovery Center sign to the South. Enter the West Wing at the NE corner. From I-25, take Exit 268, West to Lemay Ave, continue West 1/2 mile, see Discovery Center on the left.

Discovery Science Center Starwatch
703 E Prospect Road, Fort Collins
March 3 6:30 pm
May 5 8:30 pm

Observatory Village Starwatch
3733 Galileo Drive, Fort Collins
April 16

NCAS Programs, Discovery Science Center
April 6 Jim Bergstrom Mars Recon Orbiter HiRISE
May 4 NCAS Members Show and Tell

Other Events

Little Thompson Observatory Star Night, Berthoud
March 17 7 pm
http://www.starkids.org

CSU Madison Macdonald Observatory Public Nights
On East Drive, north of Pitkin Street
Tuesdays 7:30-8:30 pm if clear, when class is in session

Cheyenne Astronomical Society, Cheyenne Botanical Garden
March 17 7 pm
http://home.bresnan.net/~curranm/

Chamberlin Observatory Open House, dusk to 10 pm
Mar 4, Apr 8, May 6, Jun 3, Jul 1, Aug 5, Sep 30, Oct 28, Dec 2, Dec 30 303 871 5172
http://www.du.edu/~rstencel/Chamberlin/

Longmont Astronomical Society
March 16 7 pm FRCC, 2121 Miller Rd
http://longmontastro.org/

About our March 2 Speaker
Lee Gregory is a retired HP engineer and maintains the NCAS library. He has authored two books on Colorado scenery: *Colorado Scenic Guide, Northern Edition* and *Southern Edition.*

About our March 2 Program
In the April 2004 edition of Sky and Telescope magazine, lunar columnist Chuck Wood presented an observer's list of 100 lunar features: The Lunar 100 --- a selection of telescopic sights to ignite interest and enhance understanding. "Presented here is a selection of the Moon's 100 most interesting regions, craters, basins, mountains, rilles, and domes. I challenge observers to find and observe them all and, more important, to consider what each feature tells us about lunar and Earth history." This month's program is a slide show of a sampler of about 30 of the objects on the Lunar 100 list.

NCAS Business
February 2 2006
President Greg Halac called the meeting to order. Public observing nights were announced at Observatory Village on Feb 25 and Discovery Science Center on March 3. The telescopes donated by Steve and Irene Little were distributed. The 60mm refractor was given to a visitor, and Nate Perkins received the 4 inch reflector with thanks for a $100 donation to NCAS. The treasurer's report by David Chamness indicates that members have helped make their $15 annual dues current with the January due date. Steve Little announced that a donor is funding a memorial observatory at Estes Park High School. The operation is taking guidance from Little Thompson Observatory in Berthoud. It will initially operate with a 12.5 inch LX200, with plans for a larger scope.

Best Looks

Moon	By Mercury 2/28 pm and 3/27 dawn by Mars and Pleiades 3/5; Near Saturn 3/10 by Jupiter 3/19; by Venus 3/25 and 3/26
Mercury	Low in W at dusk 1st week; low in ESE at dawn last week
Venus	Low in SE predawn
Mars	High in W at dusk
Jupiter	In S at early am hours
Saturn	High in middle of night. By Beehive cluster
Neptune	Near Venus predawn 3/26

Construction of a Lightweight Coopered Dobsonian

contributed by Nate Perkins, Fort Collins, Colorado

12" f5 lightweight Dobsonian telescope, constructed primarily from mahogany and Peruvian walnut hardwoods. The bottom mirror box employs a lightweight coopered tube, and the entire scope weighs approximately 55 lbs.

Background

Over the last 25 years, I've used a variety of scopes in the 6" to 8" aperture range. I always delighted in the view that those scopes afforded. But in my later years I have had the opportunity to look through scopes of larger aperture. And like so many other amateur astronomers, I found that a few looks through an 18" Dob were enough to radically change my outlook on the hobby. With the quest for aperture on, I was naturally led to consider amateur telescope making.

Fortunately, my route to amateur telescope making was complementary to my second hobby in woodworking and furniture making. For me, it's a race between whether my latest issue of Sky and Telescope arrives before the current month of Fine Woodworking. Among woodworkers, Baltic birch is considered to be superior to hardwood in terms of dimensional stability, but inferior to hardwood in terms of strength, stiffness, and weight. I wanted to test the hypothesis that a scope constructed mostly from hardwood, using traditional furniture woodworking techniques, could be equal to or better than a scope constructed from the more traditional Baltic birch plywood. In addition, the idea of making an instrument of its own beauty appealed to me.

The result of my first ATM effort is the 12" Dobsonian shown in the photo above. The scope saw its first light on April 15, 2005, and has been producing excellent views of a variety of DSOs, lunar, and planetary sights. Weighing in at about 55 lbs, it is easily transportable for a quick look in the back yard or a night at the dark sky site. The scope uses relatively short trusses loaded under compression and exhibits very little flexure in any component. The scope moves smoothly with roughly equal friction in both axes, and I frequently do planetary observations with manual tracking at upwards of 300x. A thump to the secondary cage will cause vibrations that damp in 2-3 seconds.

Design and Construction

The design shown here is strongly influenced by previous ATMers, particularly the designs of Albert Highe (later commercialized by Plettstone Telescopes), as well as some 4-truss lightweight designs produced by Tom Mittler. Elements of the ultra-light secondary cage and baffle were pioneered by Bruce Sayre and Mel Bartels (among others), and are now fairly common in lightweight scope design. The scope uses four aluminum straight trusses, which are loaded in slight flexure by offsetting the holes in the secondary ring. Two trusses are 1" and two are 1.25", so the smaller trusses may be nested inside the larger for storage and transport.

Optics

The selection of 12" as the aperture was made considering a variety of factors. Since I desired to do observing without a ladder, I was not interested in mirrors beyond the 14-15" range. Ideally, I would have located a 14" or 15" mirror, but these were not easy to find and were relatively costly. I noticed that 12" mirrors at a very reasonable price were recently made available out of China (Guan Sheng) for under $400. I had some considerable trepidation and a little doubt regarding the quality of these Chinese mirrors, particularly after reading malignment of these optics in places such as sci.astro.amateur. And although I wanted a Swayze mirror, I could not justify the cost of one for my first ATM project. So I gulped and placed an order for a Guan Sheng through the good folks at Hardin Optical. After a wait of some weeks (they were backordered and had to wait for a new shipment), one finally arrived. I am pleased to say that my doubts about the purchase of a Chinese mirror were much misplaced, and the mirror appears to have very good optical quality (well less than 1/4 wavefront as well as I am able to determine by star test). I can see no obvious signs of abberation in the infocus versus outfocus diffraction patterns for my 12" Guan Sheng, and certainly it is well within the 1/4 wavefront limit advertised.

Since I desired a scope that would be suitable for planetary as well as deep sky observing, I opted against using the stock 2.9" secondary that normally comes with this mirror. It seemed to me that investing in an appropriately sized higher quality secondary mirror was a worthwhile choice. The discussion in Richard Suiter's book "Star Testing Astronomical Telescopes," as well as the freeware program "Abberator" (plus several other sources) suggested using a secondary that would result in less than 20% central obstruction. After verifying the illuminated field areas using the NEWT software program, I chose a 2.14" secondary mirror (18% central obstruction). This I obtained from Randy Cunningham at Astrosystems (1/10 wave enhanced type), and also obtained a secondary holder, secondary heater ("DewGuard"), and a four-vane spider to fit my design. Astrosystems is only a 25 mile drive from my home, so I got the opportunity to chat with Randy in person (plus my young son thoroughly enjoyed the chance to visit the Astrosystems fab shop).

Assuming a 6mm maximum exit pupil, this scope is configured to use a 30mm eyepiece as the largest focal length (exit pupil = f.l./f-ratio). I have a surplus Zeiss 30mm 75degree eyepeice, which produces 50x and a field of view of 1.5 degrees in this scope. On the high magnification end, a 5mm eyepiece produces 300x and a 4mm eyepiece produces 375x (although this is rarely useable in the atmospheric conditions along the Colorado Front Range). My favorite eyepiece is the fantastic 5-8mm Speers-Waler, which produces between 180x and 300x in this scope.

Construction Summary

The design is somewhat unusual in that it utilizes hardwoods for most of the construction.

Because of my interest in woodworking, I decided to try a hardwood construction. I wanted to test the idea that a hardwood scope could be lighter weight and stronger than the traditional Baltic birch plywood (which has a relatively poor strength to weight ratio compared to monolithic hardwoods). Dimensional stability was assured by following conventional rules for wood movement everywhere – for example, the upper and lower rings on the mirror box are made from mahogany that is nearly quartersawn (very little expansion and contraction with humidity change), as well as crosslaminated with a 4" maximum span. For areas requiring little to no expansion, the wood grain was oriented longitudinally, and in areas where the wood grain was oriented tangentially an expansion/contraction of 1/8" per foot width of solid wood was allowed for in the joinery. There are some critical areas that require no dimensional change, and these regions were constructed from veneered Baltic birch (this includes the altitude bearings, the base of the modified "rocker box," and the secondary ring.

The mirror box and ground board sections are all made from mahogany and coopered Peruvian walnut, the secondary ring is veneered with Peruvian walnut, and the ground board is Baltic birch veneered with mahogany. Coopering the tube produces a strong, lightweight structure that I was very pleased with. I would recommend coopering as a lighter, easier substitute for fiberglass casting (my own experiment in fiberglass casting was a disaster).

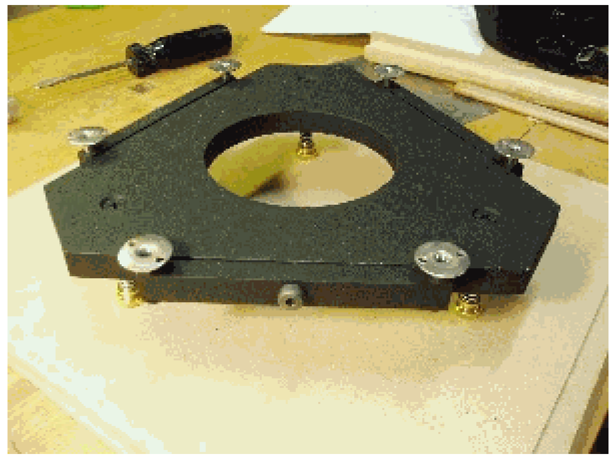
The mirror cell is fairly open on the back, and includes an integrated backside fan. The cell is of the six-point type, copied from the one specified by Albert Highe and based on the PLOP program. The adjustments use push-pull bolts. The tube clamps are of my own design and sort of a hybrid between the ones used by Highe and the ones described in the Kriege book.

Obviously, this is *not* the easiest way to make a lightweight Dob, but it is the way you might choose if you enjoy astronomy and woodworking as your hobbies! Similar ideas shown here have been used by (in fact I have copied them from!) others who made ATMs using more conventional materials with more conventional tools, and aspects of this project could be duplicated in the conventional way.

Construction Details and Photos

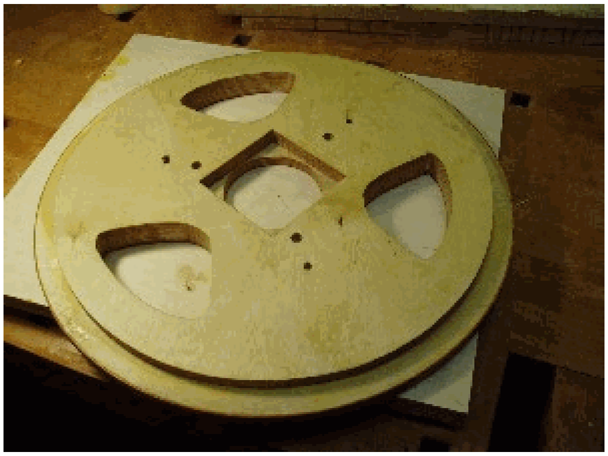
Mirror cell and mirror cell mounting board construction

The mirror cell design is an approximate duplicate of the six point cell used by Highe (as derived from the PLOP program). The material used was 1/2" aluminum sheet, cut using a scrollsaw to a six-sided figure (rather like a hexagon with three sides shorter than the other three). A large center hole is cut through the middle of the cell, to aid in ventilation and to permit good installation of a 12V cooling fan. Aluminum is readily cut with standard woodworking equipment (a wood bandsaw is excellent for cutting aluminum, in my experience).

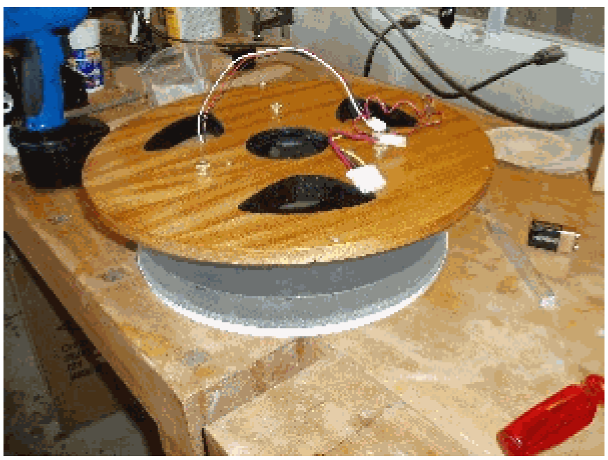


The mirror cell, assembled and painted. Note the six threaded flange inserts, which are elevated appx 1/4" above the main plate. These six inserts form the support points for adhering the mirror. The cell is adhered to the mirror back using silicone RTV (spacers are used to maintain a thickness of about 1/16" of RTV).

I used a circle-cutting jig on the bandsaw to cut the circles for the mirror mounting baseplate, as well as the other circles in this project. A nail is set through any scrap of plywood (circular in my case, but it could have just as well been any arbitrary shape). A nail is positioned through the scrap at one circle radius from the blade. The piece to be circle cut is drilled through in the center with a small hole, and the piece is then placed over the nail. The nail acts as a pivot point for rotating the piece to be circle cut.



The rough cut cell mounting plate. The mounting plate is made from two sheets of glued 1/2" Baltic birch. The sheets were then cut using the circle cutting jig. The edges were rabbeted with a router, and cutouts were added for the fan and for holes to improve air circulation. Note the three sets of drilled holes, which are later used for the push-pull bolts for adjusting the mirror cell.



The mirror cell mounting plate, after being veneered with shopsawn mahogany, with the mirror cell and mirror in position. The front side of the mirror is facing down on the bench, and is protected by the white plastic cap. The wires are for the fan, which has been mounted in the center. Springs mounted below the three push bolts (between the cell mounting plate and the cell) help provide force during collimation. Three additional push screws were later installed in the three remaining holes, to lock the mirror in position after collimation.

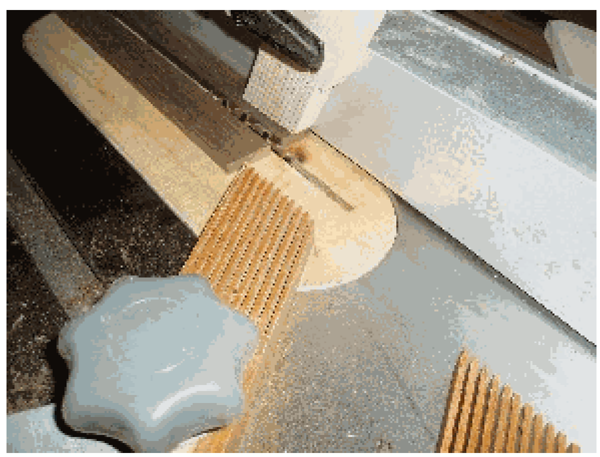
Construction of the mirror box end caps

The mirror box end caps are made from double laminated 3/8" mahogany. Hardwood was chosen over Baltic birch because of the relative strength to weight advantage. Dimensional stability is assured because the grain directions are opposing, and expansion for opposing grain is acceptable because the maximum span of crossgrain laminate is relatively small (4" or less).

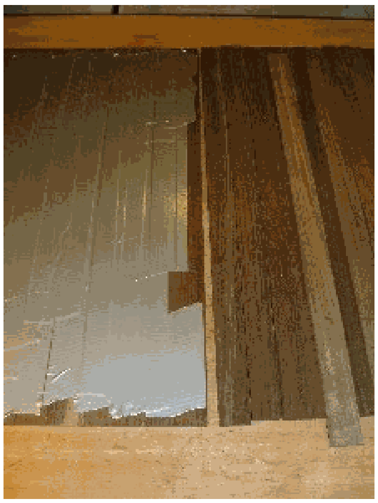
A template for the mirror box endcaps is made from 1/4" hardboard. This template provides a consistent form for making the top and bottom endcaps.The template is applied to the rough cut endcap using hot glue or double-sided tape. Then a router with a flush trim bit is used to smoothly cut the end cap to the exact shape of the template.

Coopering the tube for the mirror box

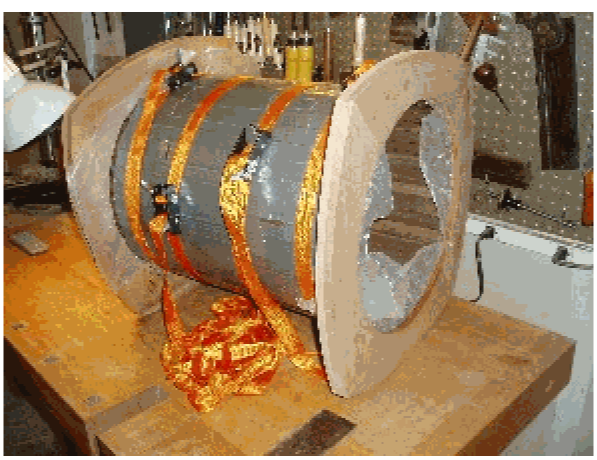
My first attempt at making a tube for the mirror box involved fiberglass casting. What a disaster. Fibercasting is a smelly, messy and imperfect method for making a lightweight tube. A faster and equally lightweight method for making a tube involves coopering from thin strips. Pictures for this method are shown below. If you have a table saw, I recommend coopering as a good alternative for making lightweight telescope tubes.



I used 1/4" thick strips of Peruvian walnut for this job. Each strip is 1" wide. To figure the number of strips required, just take the circumference of your tube divided by the width of the strip (e.g., my tube ID was around 14.5"; pi*14.5"/1" = appx 46 strips. Each strip is also cut with a slight bevel; the bevel angle being 360 degrees/#of strips = about 7.5 degrees. Cutting narrow wooden strips on the table saw can be a tricky operation. Follow the right safety rules. Use featherboards on three sides and a pushstick (the featherboards also insure a consistent cut, which is important). The blade should tilt away from the fence to prevent offcuts from trapping between the fence and ejecting backwards. Remember to use the right body position to the left of the blade. Work at your leisure and don't take any safety shortcuts!

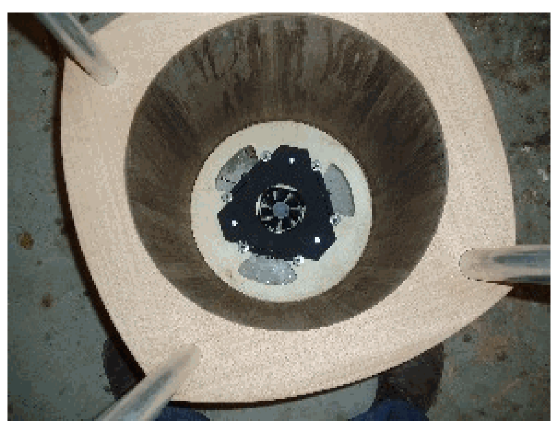


The strips are placed bevel-down on a flat surface, and taped edge to edge with the edges aligned square. Duct tape is excellent, as any viewer of the Red Green show will tell you. To glue the tube strips together, flip them over and squeeze a thin bead of glue into each bevel. Then bend it into a tube shape, and put tape on the last seam.



I rabbeted the inside of the tube endcaps (with a router), and used the tube endcaps as a form to hold the tube perfectly during glueup. Wax paper keeps the tube from sticking to the endcaps. Band strap clamps put pressure on the tube to keep it round and tight. After the tube was removed from the endcaps, I scraped the excess glue from the inside of the tube using a curved scraper, and smoothed the outside of the tube with a spokeshave. The tube was held suspended on a long dowel. The tube is reasonably strong at this point, but without the endcap supports it could be crushed if you applied weight.

Following smoothing and sanding, I used a Forstner bit to drill the holes through the top tube endcap for passing the truss poles through. 2 are 1", 2 are 1.25". Next, seats are drilled into (but not through) the bottom endcap to receive the truss holes. Two long tenons (one on each side of the tube) are installed with a mortise joint to each endcap. This tenon-on-endcap approach results in a very strong and lightweight mirror box (this tube/endcap/tenon structure weighted around 4-5 lbs at this point). Below is a view of the mirror endcap with the mirror cell and mirror cell mounting plate installed, looking down the tube. The cooling fan and ventilation holes are visible.



Building the secondary ring

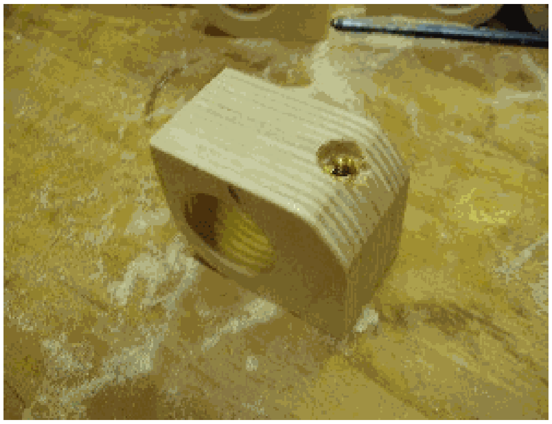
The same template is used to make the secondary mounting ring as was previously used to make the mirror box endcaps. The secondary ring is cut from 1/2" Baltic birch, and then veneered over with Peruvian walnut to match the mirror box tube. Next, I chose to drill through

holes in the secondary ring to permit the truss tubes to pass all the way through the secondary ring. I figured this would allow the use of a binoviewer more easily in the field (by just sliding the secondary closer to the primary using the same trusses).

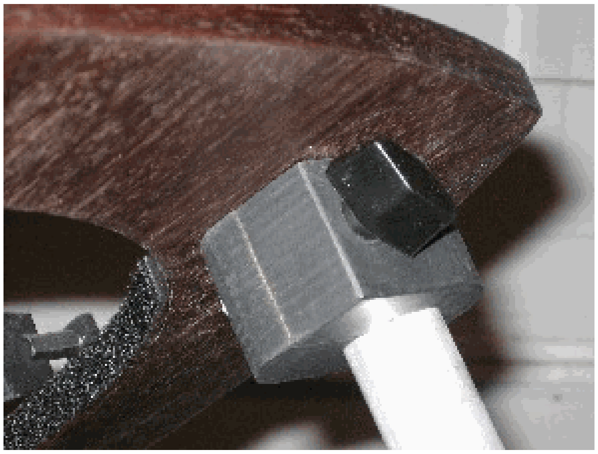
A final note: Following the advice of Highe, it is advisable to **offset** the holes in the secondary ring by about 1/4" inward from those in the mirror box ring. This places the trusses under some slight lateral compression, which increases the effective stiffness of the tubes. Keeping the tubes in lateral compression is essential to improve the rigidity of the structure and reduce damping times.

Making the tube clamps

I made the blocks from laminated 1/2" Baltic birch, to avoid end grain problems. The blocks were also reshaped to allow slightly more room for attachment to the secondary ring and mirror box tube ends. Note: Central holes were drilled with a Forstner bit, prior to cutting out.



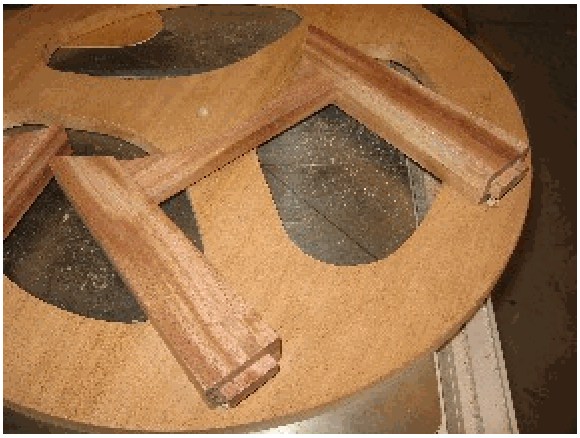
A tube clamp, with the brass insert for the hand clamp knob installed. On the backside of the clamp, two other brass inserts are installed to allow the clamp to be mounted to the secondary ring face.



Bottom view of the tube clamp installed to the underside of the secondary ring. The tube clamps are not as critical in this design as in some other Dob designs, because the truss poles pass through holes in the mirror box end caps and through the secondary ring itself. It was designed this way to make infocus adjustable, and to make the use of binoviewers possible using the existing trusses.

Building the ground board and rocker box.

The piece that serves as the ground board is made up of three legs, set at 120 degree angles, and affixed to a central post via a sliding dovetail joint. The three furniture glides shown were later replaced with teflon pads. A Teflon washer goes on the center bolt.



The base of the rocker box is fabricated from 1/2" Baltic birch, cut on the circle jig and with several holes cut out to save weight. It is not essential that this piece be extremely rigid, because it is later reinforced by the mortise and tenon design of the rocker box. The sides of the rocker box are made from solid mahogany and joined with strong mortise and tenon joinery. Note how the top of the rocker box is curved to match the altitude bearings.

A solid wood stretcher tenon is curved and joined between the sides of the altitude box. Solid wood is much stronger than an equivalent weight of Baltic birch, and the mortise and tenon joinery is stronger than reinforced Baltic butt joints or even biscuit joinery. Ebony Star formica is then glued to the bottom of the rocker box and bottom of the altitude bearings, using contact cement. The Ebony Star is then flush cut to the ground board using a router with a flush trim bit.

Fabricating the altitude bearings

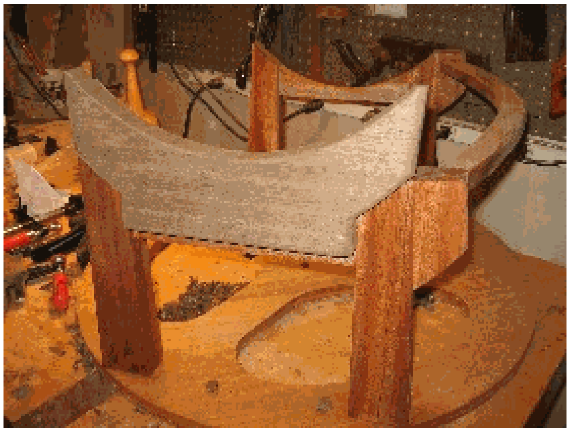
The altitude bearings are made from circle-cut double laminated 1/2" Baltic birch (chosen because Baltic birch is less likely to warp).

The altitude bearings after laminating with mahogany veneer and after cutting out excess weight. This was my

first Dob construction; the altitude bearing could have easily been made at 180 degrees. If I were to do it again, I would make this bearing the more conventional semicircle. This photo shows the bearings prior to sanding and finishing.

Rocker box height modifications

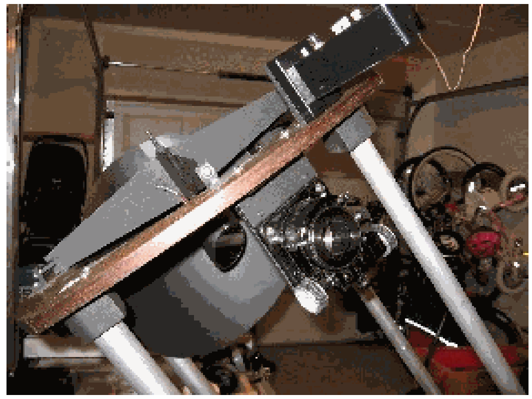
Upon temporary assembly of the altitude bearings to find the center of gravity, I tested the scope motion and height. There were two large problems with the initial setup: first, the height of the scope was low to my eye by about 4." But worse, I found that the height of the front tenon stretcher caused the mirror box to hit the rocker box, limiting altitude to elevations above about 20 degrees. This was a problem that had to be fixed, and was solved via a height addition to the rocker box sides.



The extension block was fabricated from thick walnut to match the mirror box tube. The outlines of the mirror box were traced and laid out on the extension block. The block was rough cut on the bandsaw. A rabbet was cut by hand using saw and bench chisels . The extension was then fitted and glued to the rocker box. This block successfully raised the scope closer to eye level, and also provided clearance for the truss tubes to avoid the front stretcher tenon.

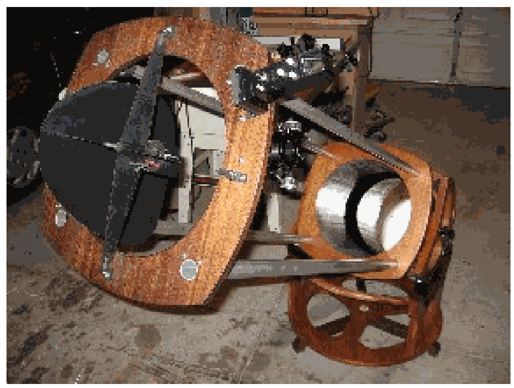
Focuser board and Rigel finder brackets

The focuser board was made from 1/4" aluminum, which was bolted to a tapped aluminum angle. The center hole was cut with a hole saw, after the method of Highe. The focuser shown is a JMI NGF-DX1. To mount the spider, a series of small aluminum brackets were bandsawn from aluminum angle.



The Rigel finder is attached in a similar way, using an angle bracket that is attached to the secondary ring. You can see that the brackets have been painted black and a black light baffle has been installed behind the secondary.

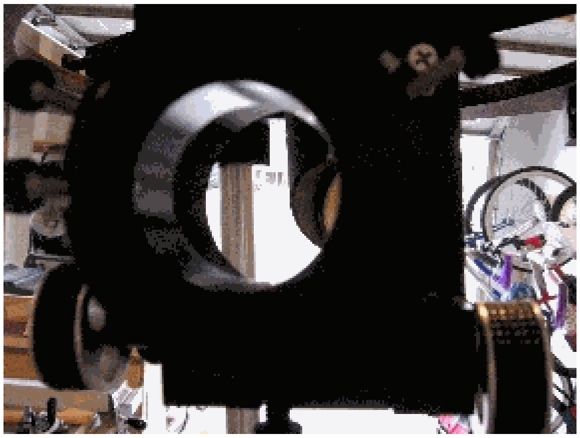
Spider installation



The Astrosystems spider attached via the angle brackets, to the secondary ring. The secondary uses an Astrosystems DewGuard heater (useful considering the exposed secondary).

Fine tuning

Without a backside light baffle, a huge amount of stray light that comes in through the focuser. A baffle was fabricated to go behind the secondary, following the method of other ultralight designs such as those by Bartels and Sayre. The baffle attaches to the secondary ring with Velcro.

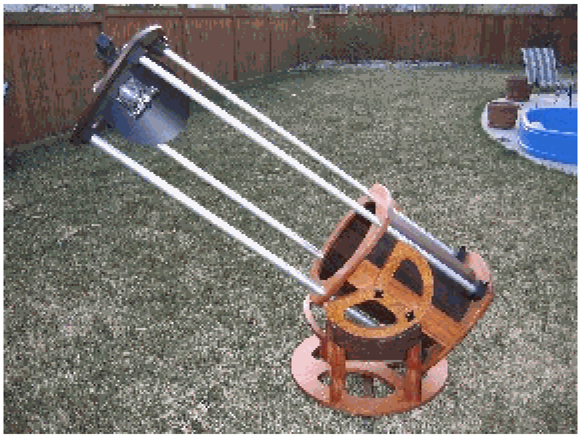


View through the focuser after installing the baffle:

Transportation

The scope including the mirror box, secondary cage, trusses, focuser, etc but excluding the rocker box weighs in at about 44 lbs. The rocker box weighs about another 5-8 lbs.

The mirror box and secondary ring for the scope fit neatly on the passenger seat or back seat of my small Saturn sedan, and the rocker box/ground board assembly fits in the back seat or trunk. Following the advice of Highe again, I made a set of stub truss tubes that allow the secondary ring to stack on top of the mirror box for transportation. The mirror box combined with secondary ring is the heaviest component, and is quite manageable at 44 lbs. This makes transportation to the dark sky site easy.



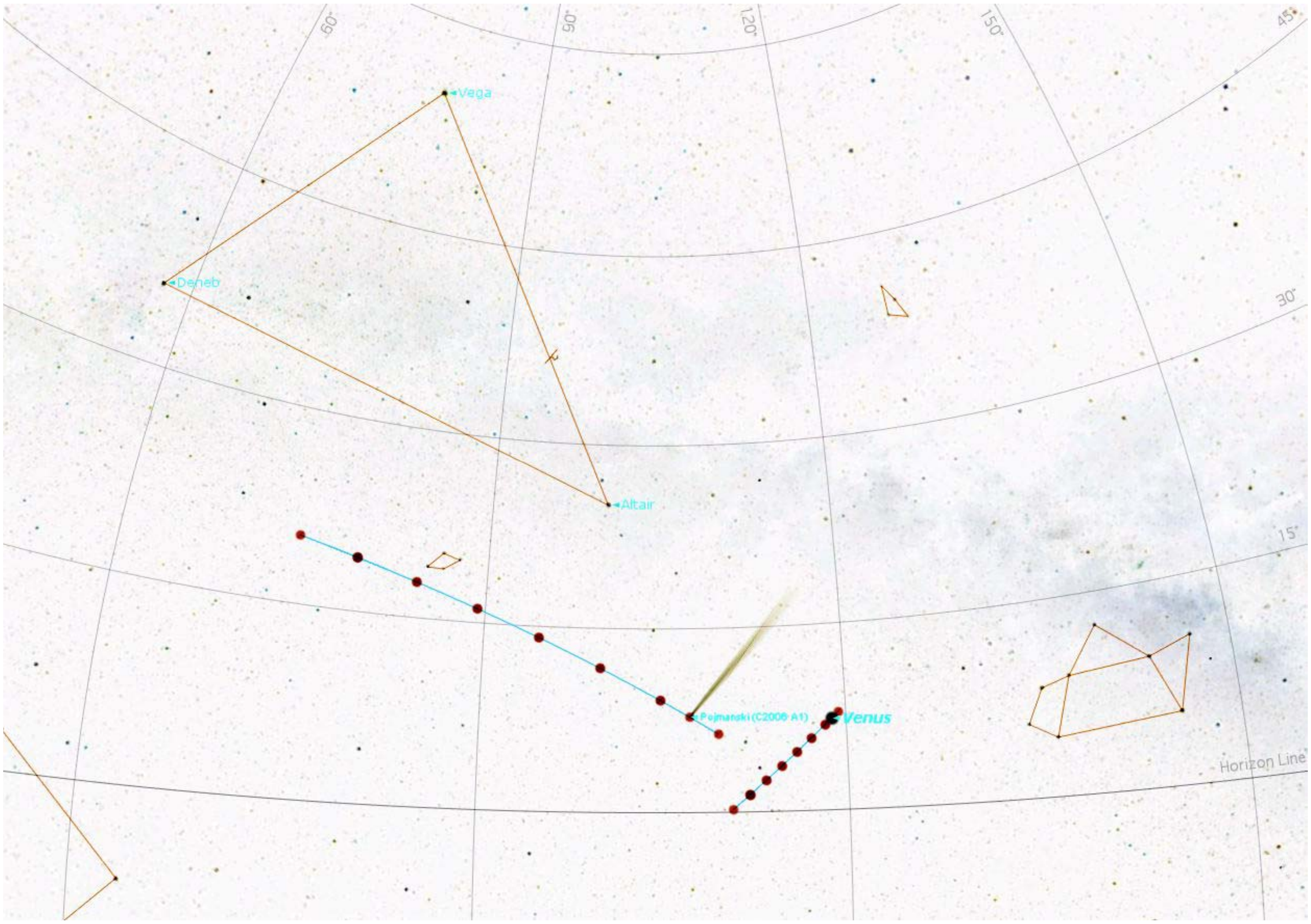
Here is the scope, set up for some backyard viewing. Shown is my heaviest eyepiece (a large Zeiss 30mm 75º eyepiece from military surplus, via Markus Ludes in Germany). The scope is slightly backside heavy, and when using lighter eyepieces, I add some frontside counterweights (large knurled steel nuts that fit ideally in the inside of the truss openings).

Through the eyepiece

On my first night of extended observing, I was fortunate enough to be treated to a rare night of steady skies here along the Colorado Front Range. Magnifications of up to 400x were briefly supported by the viewing conditions. During that period, I snapped the photo below of the lunar region around Mare Frigoris and the Alpine Valley.

The spring and early summer of 2005 have been excellent for Jupiter observing. The 12" aperture permits much more ready observation of Jovian features including festoons, barges, and detail around the GRS.

The views at the dark sky site have been equally gratifying. Views of the larger globular clusters such as M13 and M3 have been simply spectacular using the 8mm setting on my Speers-Waler 5-8. The extra aperture makes searching for planetary nebula much easier. And the Coma-Virgo cluster is a revelation with larger aperture. It's easy to get lost!


60°
90°
120°
150°
45°
30°
15°
Vega
Deneb
Altair
Pojmanski (C2006 A1)
Venus
Horizon Line

International Space Station Passes for Loveland – Fort Collins 2006 March

Date	Mag	Starts Time	Alt	Az	Max. Altitude Time	Alt	Az	Ends Time	Alt	Az
24 Feb	0.6	18:33:28	10	S	18:35:53	23	SE	18:37:14	17	E
25 Feb	-1.0	18:57:20	10	SW	19:00:16	86	ESE	19:01:24	33	NE
26 Feb	0.8	19:21:59	10	W	19:24:38	31	NNW	19:25:14	28	N
27 Feb	-0.8	18:10:37	10	SW	18:13:29	88	SW	18:16:25	10	NE
27 Feb	1.9	19:47:07	10	WNW	19:48:46	16	NNW	19:48:46	16	NNW
28 Feb	0.8	18:34:54	10	W	18:37:31	30	NNW	18:40:09	10	NE
01 Mar	1.8	18:59:40	10	WNW	19:01:32	16	NNW	19:03:26	10	NNE
02 Mar	2.2	19:24:46	10	NNW	19:25:31	11	N	19:26:17	10	N
04 Mar	2.1	18:36:11	10	NNW	18:36:54	11	N	18:37:37	10	N
06 Mar	1.9	19:22:45	10	N	19:23:39	11	N	19:23:49	11	NNE
07 Mar	1.8	19:44:40	10	NNW	19:45:35	14	N	19:45:35	14	N
08 Mar	1.8	18:32:42	10	N	18:33:30	11	N	18:34:19	10	NNE
08 Mar	2.2	20:06:37	10	NW	20:07:11	14	NNW	20:07:11	14	NNW
09 Mar	1.3	18:54:12	10	NNW	18:56:06	16	NNE	18:57:18	13	NE
10 Mar	0.2	19:15:45	10	NW	19:18:21	31	NNE	19:18:39	30	NE
11 Mar	-0.6	19:37:21	10	NW	19:39:53	67	NW	19:39:53	67	NW
12 Mar	0.3	18:24:10	10	NW	18:26:43	29	NNE	18:29:15	10	E
12 Mar	1.4	19:59:15	10	WNW	20:01:02	23	WSW	20:01:02	23	WSW
13 Mar	-1.0	18:45:22	10	NW	18:48:11	83	NNE	18:50:48	12	SE
14 Mar	1.0	19:06:49	10	WNW	19:09:17	27	SW	19:11:45	10	SSE
17 Mar	2.7	18:36:18	10	SW	18:36:32	10	SW	18:36:45	10	SW
29 Mar	1.9	05:02:09	10	S	05:04:05	17	SE	05:06:01	10	E
30 Mar	0.0	05:19:19	10	SW	05:22:09	49	SE	05:24:54	10	ENE
31 Mar	2.0	04:04:42	12	SSE	04:05:37	13	SE	04:07:03	10	E

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