REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers

AUGUST 2015

VOLUME 39, ISSUE 8

Home Built 8” Dob

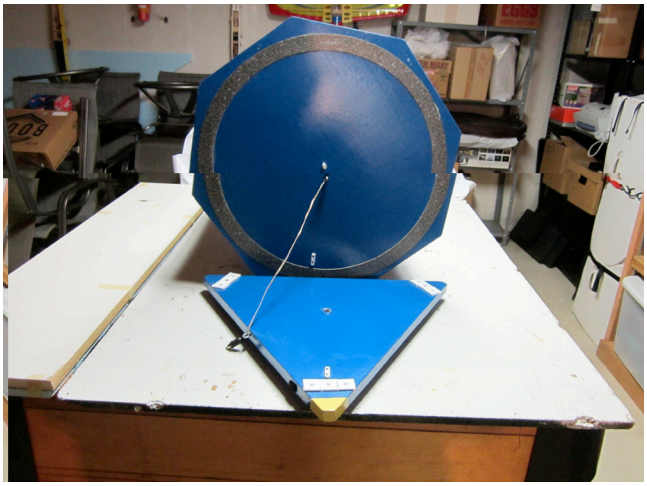
By Don Fohey

After many years I finished my 8” mirror, see the article “A Mirror Tale” in the January 2015 issue of Reflections. The 8” would be my travel scope to be taken on our camping / kayaking trips. It would use the same base that I had made for my 10” Orion XT telescope and the design would nest the upper cage inside the mirror box for a compact unit to transport. It would use materials available at my local hardware store, the exceptions being the secondary mirror holder, spider and focuser.

The base was built several years ago to replace the particle board base that came with my 10” Orion XT . The panels were made by sandwiching 3/4 inch polystyrene foam boards between 1/8 Baltic birch plywood. I cut strips from 1 x 4 inch pine boards (3/4” thick) and used them to form a frame. The foam board was cut to fill the inside of the frame. The Baltic birch was then glued to both sides of the foam board and frame using wood glue with books and magazines to weight the assembly until the glue dried. Vacuum bagging the panels was unsuccessful so I resorted to the weight of the books. I was very pleased with the fatness and rigidity of the panels. The panels were assembled into the base which weighed 15 lbs versus 30 lbs for the particle board base.

The first attempt used Ebony Star and Tefon for the azimuth bearing. I was disappointed in the stiffness of the motion. A lazy-susan type ball bearing (not in photo) was added. That moved too easily so I then increased the pad thickness to the Ebony Star surface to add a nice amount of drag.

Continued on Page 3



Above: Completed telescope. Note the eyepiece box and the stalk for Don’s tablet.

Left: Ground board construction ***Photos by the author***

Order Your Cap Now!

Be the slickest Lowbrow on *your* block.
Deadline: August 23

See page 2 for details

Coming to a Web Store Near You:

Spiffy Lowbrow Caps!

by Doug Scobel – Lowbrow Treasurer

Hi, everyone, the new, spiffy Lowbrow caps are now available for ordering! To get your very own, simply go to Sunrise's web store here:
https://www.agpestores.com/sunrisewebstores/groups.php

Enter the access code 7293 (recognize it?) and click "Go". You can then make your selection(s), add them to your cart, and check out just like on any other web store. How easy is that?

If you do not have Internet access, then simply call me on the phone and I'll order what you want. My phone number can be found on the second-to-last page of this newsletter.

The AH70 twill cap is an unstructured, low profle cap with strap adjustment in the back, making it "one size fts most". It sells for $18.00 each.

The 6580 FlexFit cap is a structured, medium profle cap that resembles a ftted cap. It sells for $20.00 each. Note that when ordering you'll need to select a size for the 6580 FlexFit cap.

Both caps sport a logo designed by our very own Kathy Hillig, who also designed the logo for our shirts. If you are wondering where the galaxy went, it's because it would be too difcult to embroider in such a small area. Also note that the logo shown on the web store and below is simulated. The logo will actually be embroidered.

The logo shown here (on the AH70 low profle cap) is approximate. The actual logo will be embroidered and will probably be a little smaller than shown. For those reading this in black and white, "University" and "Astronomers" are stitched in white, and "LOWBROW" is in yellow. The cap is navy blue.
Orders on the web store will close at midnight, the evening of Sunday August 23. Don't procrastinate! You don't want to be the only Lowbrow without an awesome, custom designed Lowbrow cap!

The fne print:

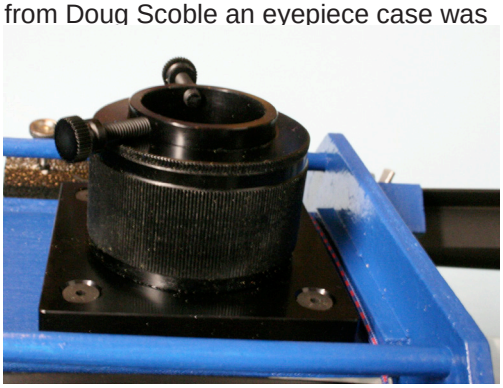
- You'll pay for your cap(s) on the web page using your credit or debit card.
- I will only order caps for, and accept money from, those of you without Internet access. In other words, I will do it only for those of you whose only means of reading this is on a printed hardcopy of Refections.
- After orders close and Sunrise produces the caps, I will pick them up and distribute them just like I do with our T-shirts. Sunrise will not ship the caps to you.
- For you out-of-state-ers If you want me to ship them to you then I will, but I will have to charge you what it costs.
- You can get any color you want as long as it's navy blue.
- If you have questions, contact me, not Sunrise.

Happy ordering!

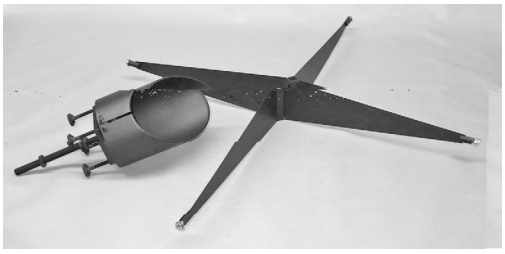
Home Built 8" Dob: Continued

Since the same base is used for the 8" and 10" telescopes, the same digital encoders are used for both. The altitude encoder are attached to the 8" with the same 1/4-20 thread that the 10" uses.

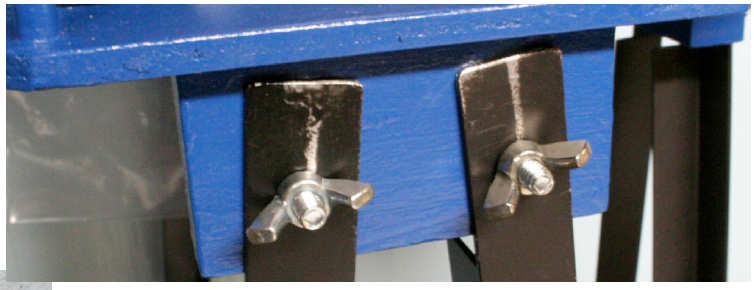
The azimuth encoder of course is on the base. The base now has a stalk to hold an Andriod tablet with Sky Safari. The base photo shows the encoder blue tooth box , the azimuth encoder and wiring for the dew heaters. With inspiration from Doug Scoble an eyepiece case was constructed for the side of the base.



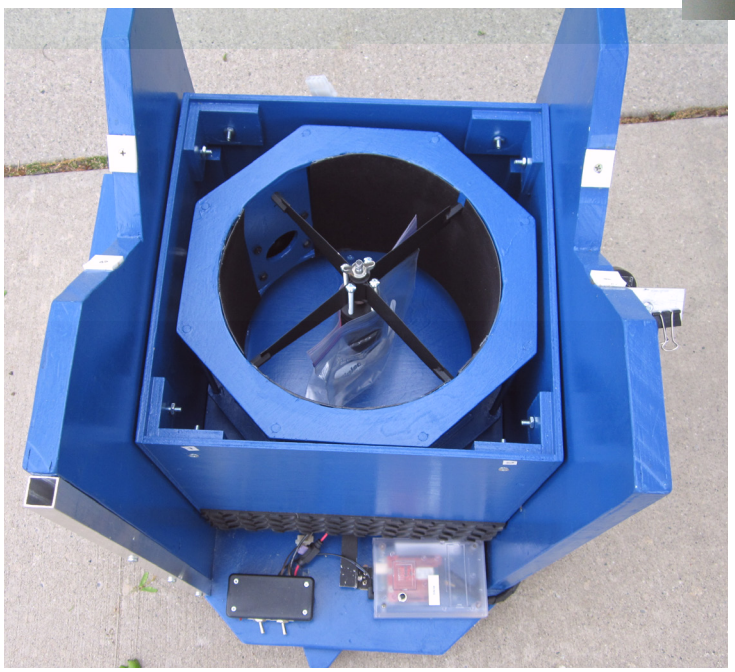
The design stage made it clear that a low profle focuser would be required in order to nest the secondary cage inside the mirror box. I chose the Lumicon LH2000 with a 2" dimension above a fat base.



I initially order my secondary holder from ProtoStar. After six months or so I canceled the order and placed an order with Astrosystems. I am very pleased with both the focuser and spider. The spider and holder are custom ordered to your specifc dimensions.



The aluminum angle trusses are held in place by #10x32 bolts and wing nuts. I pleased with the stiffness of the structure.



The nested upper secondary cage makes for a compact system to transport. A cover (removed for photo) completes the storage. The blue tooth encoder case in this photo has been replaced with a smaller one.

And *You* Thought the Higgs Boson Made You Safe

The Pentaquark

By Dave Snyder

I wrote on the subject of particle physics a while back (see Dave Snyder, February 2000. “Essential Physics or What is Everything Made of?” in Refections of the University Lowbrow Astronomers). A conversation with John Causland prompted me to revisit this topic. Recently there was announcement from the LHC (Large Hadron Collider) in Geneva about “pentaquarks.”

To explain the signifcance of this announcement, I frst have to explain the standard model. The standard model is a theory of sub-atomic particles. It states that all the matter in the universe is composed of three types of particles: bosons, leptons and quarks. Bosons and leptons will not be discussed further in this article.

Quarks come in six different “favors:” up, down, strange, charm, bottom and top. In turn each favor has two versions: quark and anti-quark. This makes 12 different kinds of quarks. up, anti-up, down, anti-down, strange, anti-strange and so on.

Quarks group together to form larger particles; take a quark and an anti-quark (not necessary of the same favor) and you get a meson. An up and anti-down OR a down and anti-up form the frst mesons to be discovered: the positive pi meson and the negative pi meson respectively. Other combinations lead to other mesons. All mesons are unstable, and rapidly decay into other particles.

If you take three quarks or three anti-quarks, you get a baryon. The two lightest baryons, the frst to be discovered, and the best known are the proton and the neutron. There are many other baryons. Except for the proton, all decay into other particles. The neutron takes about 10 minutes to decay, heavier particles decay much more quickly. (Note the electro-weak theory predicts that the proton should be unstable, but with a very long half-life. The decay of the proton has never been experimentally detected, in spite of four decades of attempts).

In turn you can combine protons and neutrons to form a larger structure: an atomic nucleus.

There are rules for how quarks combine. These rules come from quantum mechanics and the concept of asymptotic freedom. The later is a feature of Quantum Chromodynamics (QCD). One of the rules can be summarized as follows: if you count each quark as +1 and each anti-quark as -1, and you add up all the quarks/anti-quarks in a quark structure, the sum must be zero, a positive multiple of 3 (such as 3, 6, 9 etc), or a negative multiple of 3 (such as -3, -6, -9 etc).

The sum will be 3 for all baryons, -3 for all anti-baryons and 0 for all mesons and all anti-mesons. Note that this rule prohibits a single quark or anti-quark from existing in isolation, but allows any combination of two more provided there is an appropriate mixture of quarks and anti-quarks.

In case you are wondering, forget about breaking a meson or baryon apart to obtain individual quarks. This is forbidden by asymptotic freedom and QCD.

Ignoring occasional claims for the discovery of tetraquarks, or pentaquarks (which I’ll explain momentarily), these are the only quark structures known from experiments. Are other structures possible? There doesn’t seem to be any theoretical reason why not.

The frst possibilities to look for are the “tetraquark,” a combination of two quarks and two anti-quarks. Or a “pentaquark,” a combination of four quarks and one anti-quark. As I said a moment ago, there have been occasional claims for tetraquarks and/or pentaquarks, but these claims have typically been found be false.

Fast forward to July of this year. Another claim of a pentaquark. This was not the result of a deliberate search, but rather of experiments conducted at the Large Hadron Collider (LHC) in Geneva. These experiments were designed to probe the properties of a particle known as Lambda (1405). This particle has generally been considered to be a baryon (with three quarks); however there was an idea (not universally accepted) that Lambda (1405) might be a pentaquark (with 5 quarks).

The end result of the LHC experiments strongly suggest that Lambda (1405) is in fact a pentaquark. These results await peer review and could turn out to be false, though these results are much stronger than earlier claims.

An unresolved question: are tetraquarks, pentaquarks and larger structures (assuming they really exist) just formless bags of quarks, or are they built up from combinations of mesons and/or baryons? There is strong reason to believe the latter is true. Computer simulations suggest not only that the Lambda (1405) is a pentaquark, but a pentaquark formed by combining one meson with one baryon. Also we know that the atomic nucleus is a combination of baryons, so there are already examples of quark structures composed of baryons. It is not a great leap to consider other quark structures.

This story is not fnished; there will no doubt be additional developments over time.

For more information read the following…

http://physics.info/standard/
http://hyperphysics.phy-astr.gsu.edu/hbase/particles/qbag.html
https://www.sciencenews.org/article/exotic-particle-turns-out-be-quark-molecule
http://home.web.cern.ch/about/updates/2015/07/discovery-new-class-particles-lhc

Lowbrow Calendar

Friday, August 21, 7:30 PM--**Lowbrow Monthly Meeting--**Room 2306 Mason Hall, University of Michigan, 435 South State Street, Ann Arbor, Michigan--Chris Sarnecki (University Lowbrow Astronomers): “Astronomical Devices Gleaned from the Olde World-*.* in parts 1 and 2.” ***PLEASE NOTE ROOM CHANGE!***

Saturday September 5 and Saturday September 12--**Open House on Peach Mountain-** Begins at sunset, may be cancelled if cloudy.

Friday, September 18, 7:30 PM--**Lowbrow Monthly Meeting--**Room G115 Angell Hall, University of Michigan, 435 South State Street, Ann Arbor, Michigan--Doug Scobel and Don Fohey (University Lowbrow Astronomers): Black Forest Star Party Report.

Saturday, September 19, 8:00 PM--**Observing at Leslie Science Center--**1831 Traver Rd, Ann Arbor, MI 48105

Friday, September 25 and Saturday, September 26, 6:00 PM -- 12:AM--**Astronomy At The Beach--**Maple Beach, Kensington Metropolitan Park, Milford Township, Michigan. 50 telescopes. Speakers, observing and more. Michigan’s largest annual astronomy event.

Sunday, September 27, 7:30 PM -- 10:30 PM--**Lunar Eclipse Hike--**County Farm Park, 2330 Platt Road, Ann Arbor, MI 48104. Public hike to enjoy the deep lunar eclipse. Hosted by Washtenaw County Parks and Recreation.

...To A Dark Site

Have Scope, Will Travel

By Paul Walkowski

Paul's new scope, looking east in the evening twilight over Long Lake near Alpena, MI. The structure is an ultra-light kit from Dob-Stuff. The focuser is facing the camera. A Rigel 1x reflex finder is perched on the upper cage. Note coffee table. ***Photos by the author***

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Most years we spend a restful week's vacation in a cottage on Long Lake near Alpena, Mi. This is when I do most of my yearly astronomy due to the long daily commute to my job and other demands on my availability. Weather permitting, I usually get in 3 good nights of observing, but this year I took my two week's vacation together and hoped to double my observing time.

A lot had changed since last year including my telescope and getting cataracts removed so I knew that this would be a different kind of year. My 10" hexagonal plywood tube Dob called "woodscope" is 20 years old and the mirror had become a tan colored and less reflective over the years. I sent it out for re-coating but knew I would regret using the scope because of back injury that had lasting effects combined with the 85# weight of the scope and took a lot of the joy out of the hobby.

I spent the winter searching the web for ultralight telescope designs and settled on a 10" DobSTUFF 3 pole design that I had tried out at GLAAC last fall. I breathlessly rushed the construction during the month of June to get it ready for my trip and in spite of rotten cloud cover for the middle two weeks of June I was able to complete it 2 days before we were leaving.

The trick was that I needed to build temporary sliding length poles in order to bring the optical tube into focus in the middle of my

focuser range, and then cut the actual aluminum poles to match. Immediately after having the OTA completed, it went to a seamstress for a week to get a spandex-like shroud or dew cover added. Finally I got together with Mike R. for whipped cream and cherry on top: digital setting circles that work with my iPhone and sky safari. I was sure that I'd get to see the last few dim objects on my Telrad Most Overlooked Objects book this year. I disassembled the scope into a bundle of tubes and a 14' round rest-of- scope package and headed off into the great wilderness. Well actually a line of a dozen rustic cabins on a gravel road that dead ends on a grassy point that sticks out into Long Lake. By rustic I mean that in 800 square feet you have a kitchenette, 2 bedrooms, a living dining area, and a bath with a stand up shower and a 5 (yes I said FIVE) gallon hot water heater. If you want WiFi, cross the park and stand within 15 feet of the office, but be prepared for perhaps 600 baud. In plain English waiting for an email to DL sounds something like here-comes-a-letter over and over again. For cell phone service either stand on the point holding your arm high waving it around over your head and hoping for a skip wave from the ionosphere or just drive to 20 minutes to town. Even the McDonalds WiFi is bad, apparently too many locals camped there so they put a clamp on transfer speed after you are on line for 5 minutes.

My first 2 nights observing were different than usual. Sunday was warm and dry, no dew, no wind except from the wings of thousands of mosquitoes. A foretaste of things to come was a thick ground haze: Venus was a dull orange crescent and nearby Jupiter was missing completely in the haze. Saturn was also dull orange and any cloud bands or the Cassini Division was invisible. Because of the proximity to the longest day of the year, only a few stars were visible before 11:30 PM. At that time it was apparent that clouds or fog were obscuring all but a 30 degree region of the sky centered at the zenith. But I was on vacation and was determined to have a good time so I persevered. I covered myself with DEET and moved on to trying out the Digital setting circles. In spite of my best efforts and countless reboots I could not get the azimuth encoder to give correct indications. No matter what I did it only indicated a difference of +/-1 degree all evening. Still determined to see some darned DSO (Deep space objects, not the Detroit Symphony Orchestra) I went back to the dead-reckoning /star hopping approach after about an hour and a half. I have used this technique with more than moderate success for perhaps 20 years.

I measured the sky darkness with John's meter at 12:15 and it registered 21.2 mag/arc sec^2 pointed straight up. At that time I noticed that I had lost considerable open sky while fiddling with the electronics. I searched the southern sky for clusters and there was no starry sky beneath Altair or Arcturus. Apparently the moon also rose behind thick clouds in the east but I never saw it. I did see the ring, a pretty sight and while in the neighborhood I looked at Alberio. I searched for any traces if the North American, Pelican, and the Veil which are sometimes naked eye visible up here but tonight they were not even with the new 10" f/5.2 Dob or binoculars.

I looked for my old friends M-81/82 but they and Polaris were lost in the haze. I searched for the great cluster in Hercules and relearned what a pain in the tush a really small scope can be. First get down on all fours to and crane your neck like an owl to look straight up thru the Rigel, then up on your feet and bend 90 degrees at the waist to look thru the eyepiece only to not find the cluster in your EP. Repeat this process as needed. Sighting objects near the vertical is called working in the Dobsonian hole because that is the most difficult orientation to rotate the azimuth bearing (no leverage) and few scopes over travel beyond 90 degrees in altitude meaning you have to rotate the scope 180 degrees in azimuth to search slightly to the other side of vertical. My old scope was engineered so the eyepiece (EP) was at just the right height for me to use standing upright and my Telrad was just a tad lower and a few inches off to the side. I longed for those ergonomics again as the knees of my jeans soaked through in the damp ground. Well this annoying little cloud came by in the middle of the 90 degree azimuth dance and obliterated the entire keystone of Hercules, so I called it a night.

A few days of cloudy and rainy weather set me to trouble shooting the electronics on the scope and the conditions that I experienced laying in the wet grass that first night duplicated themselves in plain daylight. I systematically jiggled wire connections and tugged on solder joints to no avail. I took the lid off the electronics box and looked for obvious loose connections, but it was rock solid. I knew I was at the limit of my electronics repair skills and did not want to take the chance that by fiddling around I'd accidentally let the smoke get out. Everyone knows that once the smoke gets out of electronics it will never work again. It was not until I switched around the altitude and azimuth encoders and wiring that I was able to diagnose the problem. The fault followed a set of gender changing connectors that bridged the gap between Mike's electronics and the encoder. But I was not equipped with miniature soldering pencils, spare connectors, phone cord crimpers, and swing arm magnifying lens lamp in a rustic cabin. Mike agreed to dispatch the problem in short order when I got back.

After a day and a half of rain and clouds I set up in what was supposed to be a 9 mph breeze-- pointing at Jupiter. The breeze caught the cloth shrouded 10" Dob like a wind sock and straightened it up against the stops vertically. I did an collimation alignment and learned that what appeared to be a good alignment vertically is off with the scope horizontally and vice versa. I tightened up the spring

loaded secondary and eliminated 75% of the issue but in so doing I drove the 3 diagonal mirror set screws into the balsa wood secondary holder. Clearly a washer is needed in there, maybe on my next trip to town. I bought a seemingly rigid plastic end table to set the scope on top of but the plastic table legs spread apart on the wet grass like a giraffe on roller skates. I tried setting my scope on the card table that I use for charts n EPs and that was equally futile. Nudge the scope toward you and the legs load up like torsional springs. Let go of the scope and after 3-4 orbits on wobbly legs we are pointed right back where we started. Predictable, but I had to try something. Jupiter was in a light haze, 2 moons and cloud bands were visible and it was perhaps 5-7 deg north of Venus which was a brilliant white crescent. I must have spent an hour viewing Saturn in the twilight easily seeing a moon 2-2.5 diameters ahead of Saturn and another trailing 4 diameters behind. Five different brightness cloud bands and Cassini Division were visible in all EPs but the 24mm Televue Panoptic and 10 mm Radian were sharper, more black and white and less gray than my new 15mm Explore Scientifc. The sharpness difference remained even when using a 2x Barlow of unknown pedigree. Btw the 10 mm with a barlow gave 264x which was all the scope and sky could handle on Tuesday. I tried a 3mm TV zoom and the views were considerably worse. The sweet spot for pleasant views was 130x using the 10 mm Radian alone, the contrast was the best to see the cloud bands and rings.

John's 24 mm Panoptic and my scope are a marriage made in heaven. What a bright and expansive view. Hugely Mind blowing. I never knew what it was like, the glory of a huge blinking eye full vs a 45* FOV plossl. The difference is like when Mark Deprest frst put a 1.25" EP on my frst .975" toy refractor and I could see a whole feld of stars, not just a pinhole of them along the optical axis. I never knew what it was like, but I recalled that old Televue ad about their wide feld EP being like looking through a porthole into space. It makes me wonder about the 84* and 100* EPs that ES and TV are selling now. And for a mere $4-500 each, maybe I should collect the whole set? No wait, renting this cabin for a week cost about the same as one of those EPs. I'll have to wait for the prices to drop when newer EPs take their place. I'm super pleased with how the scope works with Radian and Panoptic EPs, and I can buy those used.

A few degrees down and I was at M-4 and M-80 in Scorpius. They were not the famous diamonds on black velvet, but rather a squirt of light gray spray paint on medium gray paper. I wondered if the washed out contrast was the new scope or the sky, so I looked at the double cluster in Perseus which was naked eye visible, and the double cluster was perfect, just as I remembered. So I must have thin clouds lurking in the south, but the sky was dark enough to not refect light off the cloud so I could not see the clouds. There was no wind and only a few mosquitoes so I looked at my sky maps and made my plans. First to M-8 and M-22 and on to the Lagoon, but wait Sagittarius was missing. Drat, darn clouds. Well I spent the next few hours reacquainting myself with old celestial friends that had disappeared into my cataracts a year of two ago, glad that I could see them again. I was rewarded with great views al evening, the new scope was paying off. Heaven on earth for a good two hours. Now the air and ground were not only wet from rain but also from dew. It felt cold, and I had a fannel shirt, hoodie, and a warm jacket layered over me along with hiking boots to keep my feet warm. I checked the car thermometer and it said 47F at midnight on July 7 (must be those darn politicians and their mixed up global warming). Add to that a foggy brain and numb limbs and you gave a perfect recipe for stupidity. I started to search for the great cluster in Hercules. I should call that the dance of the stupid because again it was high overhead. After crawling under the Rigel to look up my fngers were covered in mud and my jeans were soaked from ankle to knee. I went to the car and found a rag and did the dance one more time and still had never viewed the cluster in my scope. Fiddlesticks. The square of Pegasus and the arcs of Andromeda were rising in the East and it was too pretty a night to leave. I looked for Andromeda in binoculars and then in the new scope, expansive and pretty for sure, but no match for the Hubble photo. I studied my charts for more targets. Some day I need to make an observing plan, too late to start tonight though. I looked for the Heart & Soul nebula, Pelican, Veil and North American in binoculars but they were still hiding. I got out a UHC flter and started shivering. Ok, the scope works but this is not fun anymore this night is over. The unheated cabin was only a few degrees warmer than the observing feld. I thought about making hot chocolate but remembered the electric stove heating elements would probably not heat water until the dawn broke. I did not warm up until I showered the next morning. Back to the search for the perfect coffee table.

Last night was mostly overcast and good night for freworks. A group of 4 families went together and spent their kids inheritance on a display that took over an hour. 6 foot mortars staked into the ground, a small fence of 10 inch tubes that each threw out a constant barrage of whistles, bangs, showers of sparks, rockets, and exploding shells. In between they had small Roman candles and ground effects, including a 4 foot pinwheel that broke free charging across the park and raced vertically up a tree perhaps 20 feet. The point in the lake where I do astronomy was the epicenter, and smoke and glowing phosphorous embers saturated the area for another hour. What a mess.

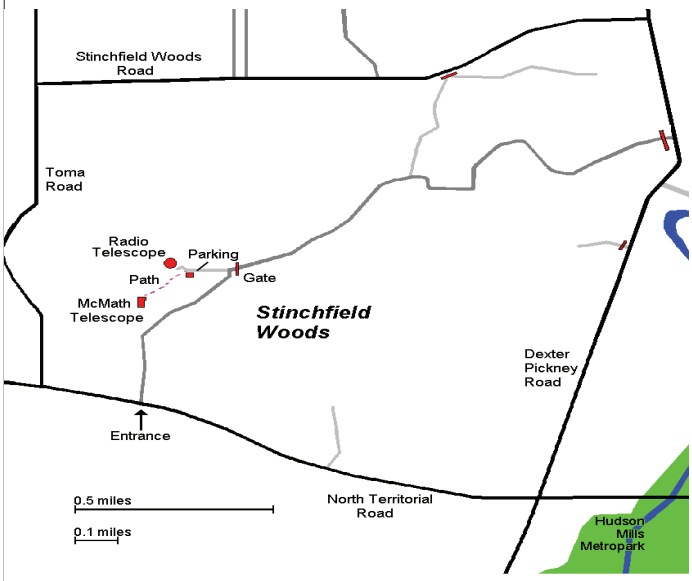
I went to various resale shops (6 in the area) and looked at end tables to get my scope off the ground so I don't have to pose like a dog to see Jupiter. I fnally found a solid one, let's call it a plumber's patio table. Envision a 2x3 foot hunk of laminated plywood with four 2" ID threaded solid cast fanges in the corners, each held in place by a full compliment of 6 wood screws. Thread in 2" steel pipe legs (the heavy gauge stuff swing sets are made of in parks) and put oversized cast metal pipe caps on the end of each leg. I gave it a kick in the second hand store to see if it was sturdy and it did not budge, but I'm still limping a day later. If I had to guess I'd say that the legs were flled with concrete. Slather the legs with a handsome coat of surplus battleship gray paint and there you have it, a real man's end table that can hold a Dob or two full kegs. Handsome it's not, but I'm pretty sure a woolly mammoth could give birth on that thing and not defect it any. I can't wait to try it out, I fgure that if I tie a come along to a tree I can pull it out of the car. It will put the eyepiece at comfortable chair height for Jupiter, at standing height for viewing at the zenith and put the Rigel at a convenient spot at any altitude, just like my old wood scope.

Paul has promised more pix of his new scope. More on the scope and his vacation next month?--ed

Places & Times

Monthly meetings of the University Lowbrow Astronomers are held the third Friday of each month at 7:30 PM. The location is usually Angell Hall, ground floor, Room G115. Angell Hall is located on State Street on the University of Michigan Central Campus, between North University and South University Streets. The building entrance nearest Room G115 is the east facing door at the south end of Angell Hall. A club observing session at the Peach Mountain Observatory, weather permitting, often follows the meeting.

Peach Mountain Observatory is the home of the University of Michigan's 25 meter radio telescope as well as the University's McMath 24" telescope, maintained and operated by the Lowbrows. Located northwest of Dexter, MI; the entrance is off North Territorial Road, 1.1 miles west of Dexter-Pinckney Rd. A maize and blue sign marks the gate. Follow the gravel road to the top of the hill to a parking area south of the radio telescope, then walk About 100 yards along the path west of the fence to reach the McMath Observatory.



Public Open House / Star Parties

Public Open Houses / Star Parties are generally held on the Saturdays before and after the New Moon at the Peach Mountain observatory, but are usually cancelled if the sky is cloudy at sunset or the temperature is below 10 degrees F. For the most up to date info on the Open House / Star Party status call: (734)332-9132. Many members bring their telescope to share with the public and visitors are welcome to do the same. Peach Mountain is home to millions of hungry mosquitoes, so apply bug repellent, and it can get rather cold at night, please dress accordingly.

Membership

Membership dues in the University Lowbrow Astronomers are **$30** per year for individuals or families, **$20** per year for students and seniors (age 55+) and $5 if you live outside of the Lower Peninsula of Michigan.

This entitles you to the access to our monthly Newsletters on-line at our website and use of the 24" McMath telescope (after some training).

A hard copy of the Newsletter can be obtained with an additional **$18** annual fee to cover printing and postage. Dues can be paid at the monthly meetings or by check made out to University Lowbrow Astronomers and mailed to:

The University Lowbrow Astronomers

P.O. 131446

Ann Arbor, MI 48113

Membership in the Lowbrows can also get you a discount on these magazine subscriptions:

Sky & Telescope - $32.95 / year $62.95/2 years

Astronomy - $34.00 / year or $60.00 for 2 years

For more information contact the club Treasurer at:

lowbrowdoug@gmail.com

Newsletter Contributions

Members and (non-members) are encouraged to write about any astronomy related topic of interest.

Call or Email the Newsletter Editor: Jim Forrester (734) **663-1638** or jim_forrester@hotmail.com to discuss length and format. Announcements, articles and images are due by the 1st day of the month as publication is the 7th.

Telephone Numbers

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	Dave Jorgenson	
	Don Fohey	
	Ken Ruble	
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Observatory Director:	Jack Brisbin	
Newsletter Editor:	Jim Forrester	(734) 663-1638
Key-holders:	Jim Forrester	(734) 663-1638
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	Charlie Nielsen	(734) 747-6585
Webmaster	Krishna Rao	

Lowbrow's Home Page

http://www.umich.edu/~lowbrows/

Email at:

Lowbrow-members@umich.edu

University Lowbrow Astronomers

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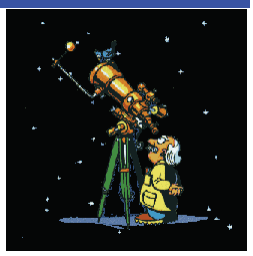
Reflections & Refractions



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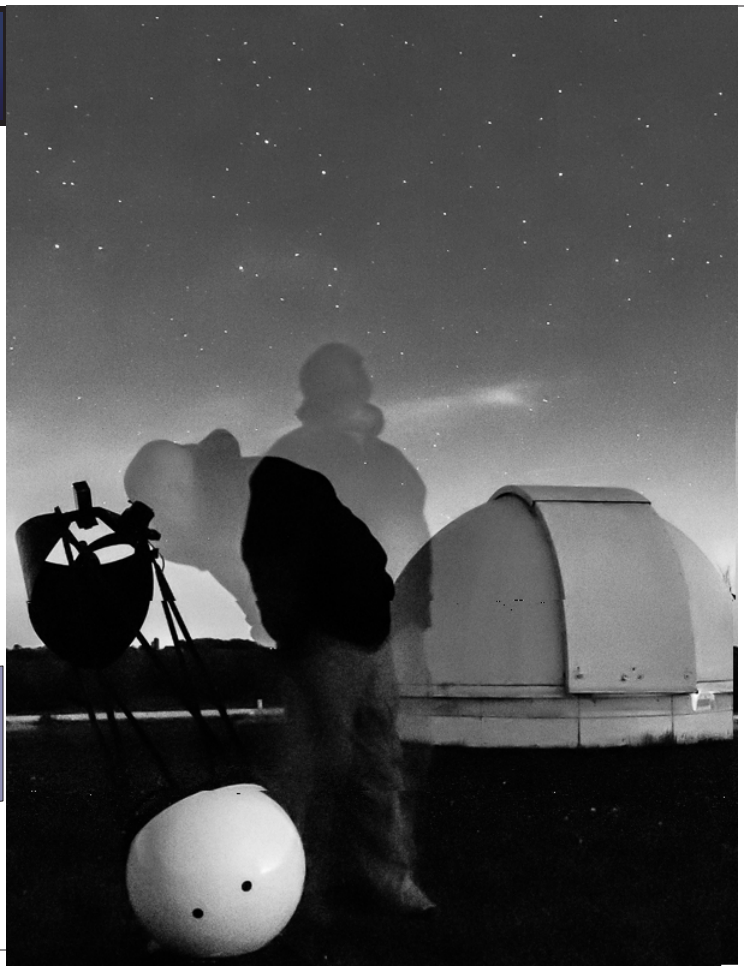

REVEALED!!!

How does Nathan Murphy get it all done?

There's two of him!

Self portrait taken Memorial Day, 2014 at Wyalusing State Park, Wisconsin

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