REFLECTIONS / REFRACTIONS
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Lightholder Bucket--Part III

Less Huntin' and More Lookin'!

by Doug Scobel

If you recall, at the end of part two of this series of articles, I included a picture of me with my finished scope. I then asked the question "But is it really done?". As you may have guessed, considering that you're reading another article that I've written on the project, the answer is "Of course not!".

In this, the final installment in this series, I'll let you know what I've been up to since I "finished" the scope. Plenty, as it turns out. Some good, some not so good, and a lot of work, but in the end it's all good. Very good.

Initial Enthusiasm

First off I want to thank John Causland and Mike Radwick for my inspiration on this portion of the project. A couple years ago at one of our meetings they presented a cute little app named SkySafari that runs on mobile devices. "Cute little app" indeed. SkySafari, by Southern Stars, has seemingly overnight become the de facto standard observing guide in use by visual observers today. Mike and John demonstrated how you can hold in the palm of your hand the equivalent of the best printed star atlases currently available. How you can easily find objects, get information on those objects, zoom in and out on the object to see star fields and surrounding deep sky objects, and create observing lists. Perhaps the best part is that your mobile device can communicate wirelessly with your automated telescope to have it go to specific objects. Having done all my deep sky observing using the tried and true but slow "Armstrong" (i.e., manual) system, I was almost spellbound. I couldn't believe what I was seeing. I was almost giddy. "I've gotta get in on this!".
It was right then and there during that presentation that I resolved to finally catch up with the 21st century and automate my scope. I was already using it on an Equatorial Platform I had purchased from Tom Ozypowski. So I did have tracking, which is in and of itself a big improvement over nudging the scope a few times a minute to keep objects in the field of view. But it didn't have Go-To. It didn't have digital setting circles. And dang it, even if I had SkySafari, I couldn't make it talk to my scope. I'd still have to hunt down objects using the manual system of charts and finder scopes. What an unbearable situation. How primitive! How last millennium!

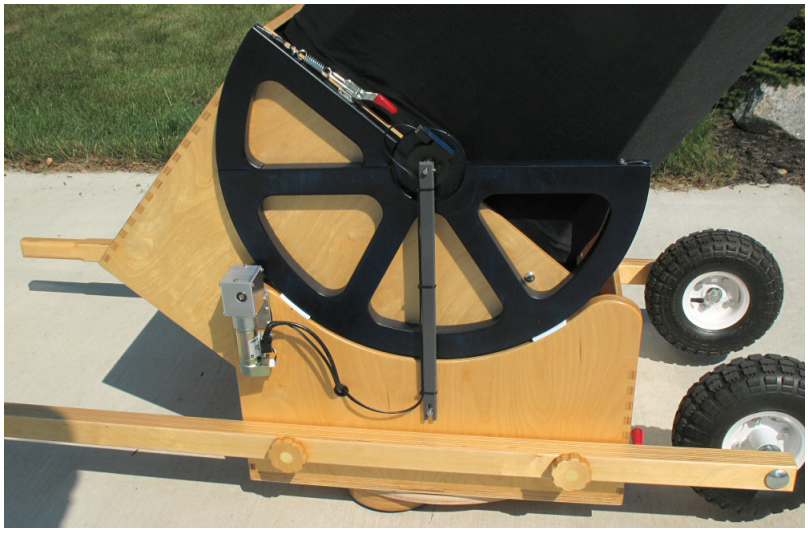
Knowing that AstroSystems, manufacturer of the TeleKit, also sells drive systems (ServoCAT and Sky Commander) for their Dobs, I checked out their web site. It was just like when I was a 10 year old looking at telescopes in the Sears catalog. I could just imagine what it would be like. Once I calmed down I called up AstroSystems and ordered a ServoCAT Junior drive system made by StellarCAT, and Sky Commander digital setting circle bundle. Not cheap, so I ended up selling Papa Smurf (my going on 30 years old 13.1 inch workhorse Dob) and the equatorial platform on which it rode for the previous couple years, to pay for most of everything. This is going to be great!

Reality Sets In

Once everything arrived reality set in. Opening the box revealed a lot of parts. And a lot of cables. And some not-too-clear instructions on how to install and connect it all and make it actually work. Some instructions were very clear, but others were not. Mainly they supplied (some from StellarCAT, some from AstroSystems) a CD and a DVD with a lot of instructional files. In some cases there were multiple (that is, newer and older) versions of the same instructions. It took

a while to sort through everything, figure out what was relevant, ignore what wasn't, and get a mental picture of how it all goes together. There were some good things though too. AstroSystems supplied a nice booklet describing how to install the components into their TeleKit. And there were several directories of images showing folks' installations in several makes of scopes, such as Obsession, Discovery, TeleKit, and others. Pictures really help. But one thing that was most obvious in its absence is there's no schematic diagram showing the wiring layout. The installation photos helped, but it still took not a small amount of study to figure it all out.

Before installing the drive and DSC system I had to first do some mechanical retrofitting to the scope. I had originally ordered my TeleKit with the round ground board, but not the power pass-through hardware to get the needed 12 volts into the rocker box to drive the computers and motors. And the motor side altitude bearing needed an extension for the altitude motor to have something to attach to when pointing the scope near the zenith. So I included those items with my order. The powered ground board kit installed easily and works great. I had to dye the altitude bearing extension to the same depth of blue as the existing bearing, but after doing that, and finishing and installing it, it looks like it was part of the original construction.



Here's the altitude drive side of the scope. The altitude drive motor is mounted to the left side of the rocker, and the altitude encoder is mounted to the center of rotation of the altitude bearing. The drive cable tensioning lever is mounted to the top of the newly added bearing extension as described in the text. The vertical gray bar holds the shaft of the encoder stationary while the scope moves up and down in altitude.

Here's a peek inside the rocker box. The azimuth drive motor and its tensioning spring is seen at rear right, the azimuth encoder is mounted to the center pivot, the power distribution panel is seen at far center, and the ServoCAT computer is the black box seen at near center. Everything is kept low enough to not interfere with the bottom of the mirror box as the scope moves up and down in altitude.

Even though the instructions took some pouring over to figure it all out, eventually I got all the ServoCAT and Sky Commander components installed, and it all worked pretty well. The first couple times out with it at least. But then I noticed that the drive would sometimes slip a little in azimuth when slewing counter-clockwise. Curiously, clockwise it worked just fine. The troubling part was that the slippage seemed to be getting worse every time I took the scope out.

This was during late fall of 2012, so over the winter I did some work to reduce the azimuth friction. In indoor tests it didn't slip. Excellent, I thought. Until I got it outdoors under the stars the following spring. Now it slipped worse than ever! At this point I'm at my wits' end, so I called up Gary at StellarCAT, to discuss the issue. Gary gave me a whole laundry list of items to check, and after hanging up the phone and doing some investigation it didn't take long to identify where the problems were.

To understand the problems you need to know how the azimuth drive works. The azimuth motor drives a knurled roller that bears via spring-loaded pressure against the edge of the round ground board. The roller "grips" the edge of the ground board, almost like a gear would, and rotates the scope as it travels around the board's circumference. If something causes the "bite" the roller gets into the edge of the ground board to be insufficient to move the scope, then it will slip. And due to the configuration of the motor assembly, if the drive is going to slip, then it will slip when driving the scope counter-clockwise.

My investigation revealed two problems. The first was that the roller wasn't getting enough grip on the edge of the ground board, and the second was that there was too much friction in azimuth for the roller to overcome.

This picture shows the knurled roller (attached to the azimuth drive motor) protruding through the bottom of the rocker. Spring pressure pulls it against the edge of the round ground board. The roller needs a good "bite" into the edge of the ground board for the drive to work properly.

Earlier Ignorance Comes Back to Bite

During my original build of the scope a couple years earlier, I figured that eventually I would be installing a ServoCAT on the scope. Hence the round ground board. But due to my ignorance regarding the finer points of the drive system, there were a couple of "mistakes" I made while building the kit that came back to bite me in the you-know-where.

First, in my zealousness to completely seal all the wood parts against moisture, I sealed the edge of the ground board with polyurethane just like everything else. After all, it's close to the ground, and is exposed to a lot of moisture on typically dewy Michigan nights. Wrong! Cured polyurethane is very hard and slippery (it's a plastic after all), and according to Gary it almost acts as a lubricant. It's too hard and the knurling on the roller simply cannot get a good "bite" into the wood. Result – slippage. What's worse, if the scope stops moving in azimuth with the motor still going, then the roller sits there in the same location and grinds away at the edge of the ground board. Result - it grinds a nice little divot into the wood. And the next time azimuth rotation carries the roller back to that divot it gets stuck there again and grinds it even deeper. So I not only had a slippery ground board, I also had one with numerous divots in its edge.

The second issue was that my scope simply had too much friction in azimuth. Gary told me that the force needed to rotate the scope (measured tangentially at one of the corners of the rocker box) should be no more than four pounds, and ideally two pounds. I measured mine, using a fishing scale, and it was over five pounds, even without the primary mirror installed. With the scope fully assembled my guess is that the force was closer to six pounds. It was simply too much friction to overcome, slippery ground board or not.

Remedial Work

First I had to clean up the edge of the ground board. To remove all the polyurethane and all the divots I had to remove about a millimeter or so off its diameter. But how to do that and keep it perfectly round? At Gary's (of StellarCAT) sug-

gestion I fastened the ground board center pivot to a stable platform (an old sink cutout) and clamped the cutout to the platform of a large disk sander. (As luck had it my neighbor has a really big disk sander.) By gradually feeding the edge of the ground board to the flat, rotating sanding surface of the disk sander, and slowly and constantly rotating the board, it resulted in a slightly smaller, perfectly round circle with a fresh, bare, and perpendicular edge. No more polyurethane and no more divots! After sealing the bare wood edge with a transparent stain/sealer, it's still moisture-resistant, but the roller can still get the necessary bite into it.

Reducing the rotational friction was a bigger job. In my "wisdom" when building the scope originally I used fiberglass reinforced panel (FRP) as the laminate on the bottom of the rocker box, bearing against three Teflon® pads. I wanted to go back to using the single Teflon® pad and two roller bearings as the kit is designed. But the FRP was waaaay too bumpy to bear against the roller bearings, producing a jerky motion in azimuth. So I had to remove the FRP before installing something smoother. In case you don't already know this, objects fastened together using contact cement are really, really hard to get apart! A heat gun, and a couple hours' worth of heating and prying and heating and prying, finally got the FRP off. Of course now there's a lot of gummy, lumpy contact cement left on the bottom of the rocker box. After applying liberal amounts of methyl ethyl ketone (MEK), persistent application of a putty knife, and copious amounts of elbow grease, after a total of about four hours of work I finally had a clean surface onto which to install a new piece of very mildly textured laminate.

Success At Last!

After re-assembly, I now had a ground board with a nicely re-surfaced edge, without divots, and a smooth bearing surface for the roller bearings. To my delight the latter resulted in greatly reduced rotational friction, right around the ideal two pounds. A small adjustment to the azimuth gear ratio uploaded to the ServoCAT computer to compensate for the smaller ground board radius and I was back in business. I've since had the scope out a few times since finishing the repairs, including last year's Black Forest Star Party and Astronomy at the Beach events, and the drive now works splendidly. The azimuth drive now works perfectly in both directions! Yippee!

So what can I say about finally having a true Go-To telescope? After more than 40 years of hunting down deep sky objects using nothing more than star charts, a finder scope, and my bare hands, I think I can claim that I've paid my dues. Having the scope and computer "find" objects for me is definitely luxurious in comparison. Not only do I save time finding objects, but once found the ServoCAT's tracking takes over and the object stays in the eyepiece. This lets me take as long as I want studying the object, taking notes, even leaving the eyepiece for a while and coming back to find that it's still in view. Not to mention how much more convenient it makes public viewing sessions – there's no need to cut in front of the folks in line every minute or two to re-center the object.

The bottom line? Don't expect me to apologize for saying I love it! While observaytin' I now spend less time huntin', and more time lookin'! And isn't that the point?

Now Is It Done?

Well, not quite. There is one little item I need to complete before I can call it truly done. I still have to implement a wireless connection from my tablet running SkySafari to the ServoCAT/Sky Commander combo on the scope. After speaking with Gary at StellarCAT I discovered that my ServoCAT computer has to be modified with an additional serial port so that a Bluetooth adapter can be connected to it. (My Android tablet can only use Bluetooth – so SkyFi isn't an option.) Now that winter seems to have settled in for the long haul, and Comet ISON has fizzled, I'll be sending my ServoCAT in soon to have it retrofitted so that I can make it all happen. Hopefully it will be all back in working order before our first open house in March.

Lowbrow Monthly Meeting February 21, 7:30 PM

Here's the author with his (finally) finished Lightholder Bucket. At long last - less huntin' and more lookin'!

[Please visit
https://plus.google.com/photos/111032310141460224074/albums/5939846224563043329?authkey=CISr57Srq7vrHw

for a pictorial account of how I added the drive system.

Also, visit
https://plus.google.com/photos/111032310141460224074/albums/5617854692496249889?authkey=CPX9uOuHhY7m1QE

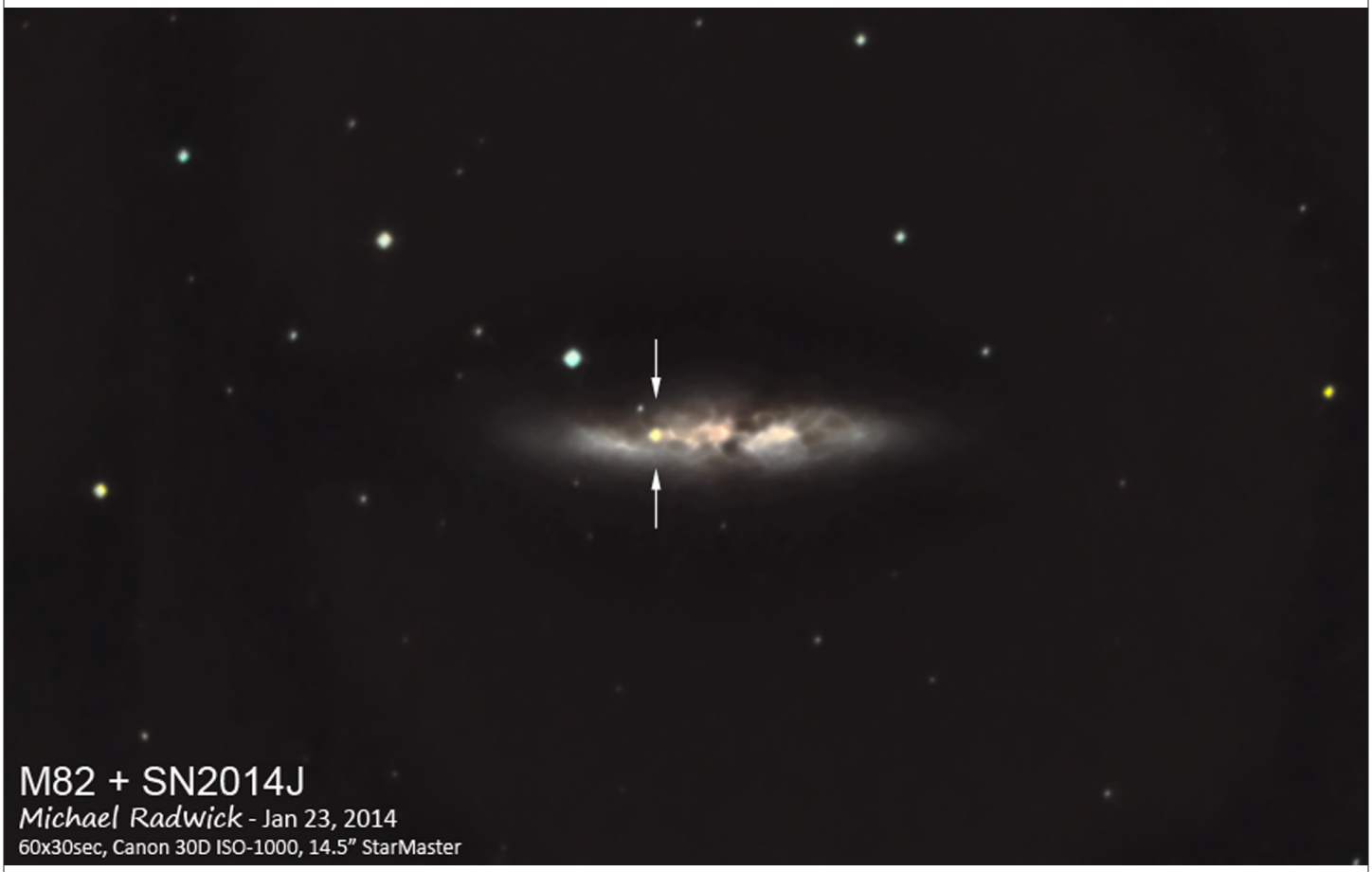
and
https://plus.google.com/photos/111032310141460224074/albums/5813656521679654913?authkey=CM3-9Y6gjaqREw

for pictorial accounts of construction and finishing, respectively, of the scope

SN 2014J

Super Nova in M82

by Mike Radwick and John Causland



Mike writes:

On Thursday, Jan 23, the weather forecast at noon indicated we would have clear skies. Motivated by the opportunity to observe a recently reported supernova, John Causland and I notified the ACNO group that we would gather at his house at about 7pm.

The last time I had done any observing was Dec. 6. Due to the holidays, all my observing gear had been squirrelled away in various parts of my house. So it took a little while to find everything, pack into my car, dress appropriately, and drive out to John's house.

When I arrived (at about 7 pm), the sky was clear, fairly transparent, but only moderately steady. John already had his 61 cm scope setup, in addition to a few others ready for use by ACNOs. The main drawback was the temperature: about 7 degrees F and dropping. Fortunately there was no wind to speak of.

I also found that John had invited a number of other guests in addition to the Lowbrows. John will have to provide a list of everyone's names, but I remember at least two families with kids, one about-to-be first-time dad, another astrophotographer, and Lowbrow member Amy Cantu.

In short order I had my on scope setup. However, I discovered that in the twenty minutes or so it took to assemble the scope, the LCD display of my digital-setting-circles computer (A Sky Commander) had frozen and could not display anything. So off John went into his house with my DSC to warm it up.

In the meantime I decided to go looking for M82 the old fashioned way; by star-hopping. The pressure was on, as John's scope was setup where M82 was behind his house, and there were all those cold kids waiting to see the supernova. All those previous Messier Marathons paid off and I found M82 in short order. Sure enough, the supernova was easily recognizable!

At this point, I gave everyone else a chance to look at the SN. At this point John came back out with my DSC, and I was surprised that it was warmed up so quickly. John then informed me that his warm-up involved "baking" it on an oven grill mounted over a space-heater. But it did not seem melted. So I hooked it back up to the scope, aligned it, and found it worked just fine. I pointed the scope back to M82, and let the tracking system take over.

I then grabbed my photography gear and went inside to warm up and start assembling the components I needed to take pictures. A short time later I was back outside, focusing the scope and hooking up the camera. All went surprisingly well. Within a few minutes, the camera was clicking away and I could see the supernova in my photos. I set it up to take 30 photos, and then I just watched. Every photo seemed perfect.

When the first set was complete, I setup the computer to run another set. But shortly after starting, I noticed that the camera would not take any images. Turned out that there was no power, the battery had froze. I put my spare in the camera, restarted the imaging, and sent the cold one inside to warm up. I stayed inside to warm up as well.

When I came out, I found that both camera and computer had stopped running. So I put the warmed-up camera battery back in the camera and found that I had a total of 72 photos, and every one looked great. So I finished by manually taking the various other photos needed to stack the images of M82. The computer's battery was also dead of cold, so I just put it away (all was well the next day after it had a chance to warm up).

By the time I was done, the thermometer on my car said the temperature was -8 F. Burrrrr!

Each photo in the stack was 30 seconds long, taken with my unmodified Canon EOS 30D at ISO-1000.

John adds:

Glad I got home early enough to set out all the scopes and set up the battery power to heat the eyepiece box. But, I could never find the Rigel red dot finder for the smaller Dobs. Mike arrived about 7 p.m. along with Amy Cantu from the public library and 2 new younger Lowbrows! We need that Young Blood. Tim Kaselitz is 28 and a resident doc in peds and internal med and may be around for several years - his wife 8+ months pregnant. About 8 pm, Marise and Lance Clark from Interfaith came with 9 yo Dimitri, wide eyed, very bright kid.

It was a bit discouraging at first as M43 was not showing tight stars at 7 pm. But it was already about zero degrees and there was a faint high frozen haze brightening the sky. Mike's Sky Commander was also frozen up, so I brought it up to the space heater to warm up. When I came back down, Mike had already found M82 and the new Supernova, appearing just as the photos and .gif's showed it. Perhaps Mag 11. We took a warm up break and Mike got the young geeky Lowbrows up to some speed on his astro photography techniques.

This is just when the Clark family showed up so Dimitri saw Jupiter in the 61. He immediately spotted a perpetual "hurricane storm" as he saw it, as the Great Red Spot had just rolled into view. This was without coaching. His grandparents, Marise and Lance both saw the SN easily. It was harder for Dmitri to realize that the faint whispy streak of M82 was a galaxy to be able to see the SN and stars at the edge. Must be interesting for a kid to "see" a galaxy for the first time... When we warmed up later in the kitchen, somehow my early experience in Chicago with a small scope came up, as Dmitri also has a small scope and we encouraged him to come back so we could show him how to use it, as it may have optical problems. But I also went and found my really dusty original refractor (40mm or so) from when I was 7 yo. and saw Jupiter and its moons from my Chicago backyard.. Later, partly because of the cold, I could barely get Jupiter in view in that little scope. How I ever saw Jove's moons through that crappy optic as a kid is amazing, but I actually vaguely remember the experience of doing just so! Before the Clarks left, Dimitri also saw Andromeda. But this was their first time here, and they'll be back with Dmitri. Yet another budding Young Lowbrow in the making.

Mike and his "student Lowborws" got his camera rig set up and for hours took dozens of photos while we looked at a few other objects. Debbie eventually showed up after taking a nap. By then, the 61 was in a position to see the SN but the Clarks had just left as Deb was pulling in. Deb got to see Jupiter and the Eskimo nebula and soon after she and Paul bailed out near 11 pm, but Deb took a photo of the "Frozen 4" Lowbrows first. Tim stuck around as we tried to get the Eskimo at 3mm, about 900 power. But the eyepiece froze up. At least Deb saw it. The most appropriate object for this cold night. For the old guys, it was just me and Mike - amazing to me that no other formerly hard core observer Lowbrows made the effort, but we had 2 younguns and the really youngun future Lowbrow Dmitri.

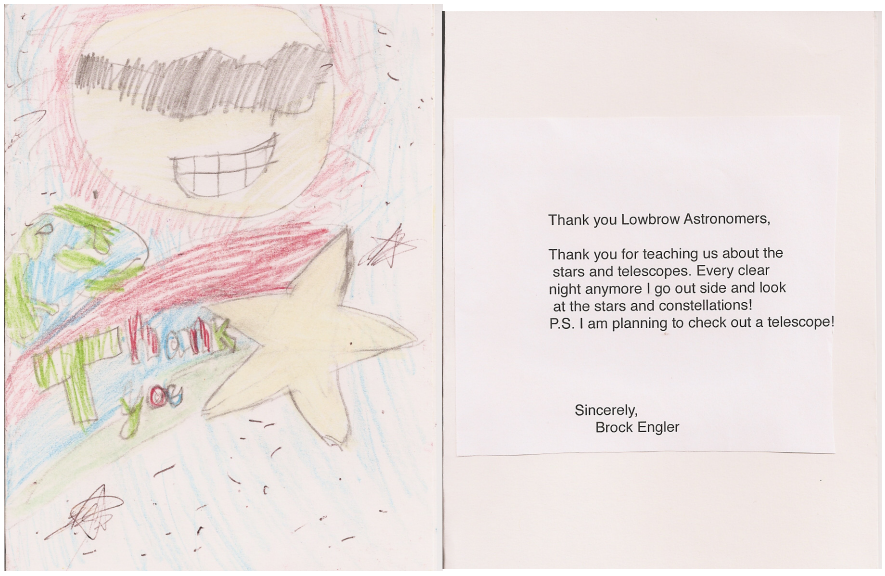
When Mike left at midnight it was minus 11. Mike was so cold and tired that we rolled his 14" scope into the garage for the first time ever and didn't disassemble it. And still he'll get up at 5 am. And the clouds rolled in just as we packed up. A perfectly wonderful night!

Addendum to the Supernova story.
Second viewing, Jan. 29.

M82 and the SN were a bear to find in the cold and breeze on this our second viewing. Even though it was 7 degrees warmer than the zero of a week ago, I couldn't get the electronics to work right. Like Mike and his frozen Sky Commander, I had to do it the old fashioned "push to" way. Something about 82 being low, 33 degrees up, and not being able to see the whole dipper ladle below the roof line. Finally got a galaxy in view and said, that ain't it. But I knew there was a fainter galaxy close by 81. Checked Sky Safari and sure enough it was 3066 (mag 10), so knew all I had to do was push the scope up a little. Those Sky Safari folks are owed a debt of gratitude everywhere we look.

Anyway, looking for the latest SN magnitude. I simply couldn't find/Google a site that was documenting day by day brightening. Most estimates in odd articles were suggesting 10.7. But I also saw estimates as low as 8.6. Which didn't make any sense since that should be about the brightest it would get. So, tonight, using Mike's photo from a week ago and Sky Safari, I would agree that it must be about 10.7. It's about as bright as the 2nd pointer star away from the SN. But it's dead on obvious, and is way brighter than a week ago.

Editor's Note: *The Lowbrow Any Clear Night Observers (**ACHNO**) group includes both members and non-members who can be persuaded, at least on occasion, to come out to an unscheduled observing session away from Peach Mountain. These sessions are usually called late in the afternoon the same day they take place. To be added to the **ACHNO** email list, contact Dave Snyder (dgs@umich.edu)or Kurt Hillig (khillig@umich. edu).--Jim Forrester*



Lowbrows make astronomy presentations in local elementary schools. Here is a generous thank you from an appreciative fifth grader.

iTelescope to the Rescue

by John Manney

As I write this, I can see Jupiter from my kitchen window. Nearby is Orion with its Great Nebula. We haven't had too many clear nights this winter. This may be my chance to go out and observe... Well, I think I will pass on it: the temperature is -4° F and the windchill is -20° F.

But there is a remedy for the clouds and the bone-chilling cold. We can sit back at our computers and operate remote telescopes!

After numerous attempts to observe comet C/2013 R1 (Lovejoy) in the morning, I became concerned that I would miss its entire period of visibility. I resorted to iTelescope, and used a fine instrument located in New Mexico to image it. I was startled at what a good image was obtained. The image shown here is the "preview" which is automatically provided by the system.

I would like to share my experiences with iTelescope. There are other services available, but this is the only one I have tried.

iTelescope has sites in New Mexico, Spain, and Australia, so there are telescopes available at most times, unless weather interferes. There are several ways to use them. The easiest is the "one click" image, where you select a deep sky object from a menu, and the system will make a five-minute exposure for you. Another method is to log onto an available scope, and enter your desired exposure times, filters, focusing options, etc., and give the command to begin imaging. If you don't want to be on line for the session, you can have the system launch a pre-planned session at any time.

When a run is completed, a preview image is emailed to you, along with weather, session log, and billing information. The data files are obtained through an FTP program which is easy to operate. The raw data is provided, along with data that has been corrected with "darks" and "flats". I haven't developed the skills for processing image data, so I just use the preview images.

They offer a free introductory imaging run with one of their small refractors. Who can turn down a free session? I couldn't turn it down, and was very pleased. I signed up for their cheapest plan, which costs roughly $20 US per month, and gives you 20 "points" to use to buy telescope time. A small refractor requires around 1 point per minute, whereas a 17" reflector runs around 4 points per minute. Only the imaging time is billed, not the time for slewing and setting up the scope. If an image is spoiled by clouds or other problems, they will refund the points on request. If you discontinue your subscription, your unused points are preserved for use if you reactivate your account within a certain time period.

I did experience a few "hard knocks":

1. It takes a while to learn the ramifications of your choices. For example, I didn't check a certain box, and as a result I didn't receive data in the "tiff" format. Another time I bought excessive scope time because I entered the wrong numbers in some boxes.
2. Their instruments are too sensitive for Moon and the larger planets. Even with a very short exposure, Jupiter and Mars turn out to be a plain white circles.
3. If you are operating "live" and encroach on time reserved by someone else, your session will be suddenly closed. To avoid this, make a reservation yourself, or check to see what times are reserved by others.
4. The observatories have high walls which obscure the low portions of the sky. This is a problem for imaging comets close to perihelion. Tech support is helpful in finding the instruments positioned for the lowest altitudes.

The iTelescope web site has a large number of pages for information and for user input. The site is attractively laid out, and enables the user to perform common tasks efficiently. Less-used features, however, are often difficult to locate. Emails with questions or problems are replied promptly. They don't mind taking the time to help you through the learning curve.

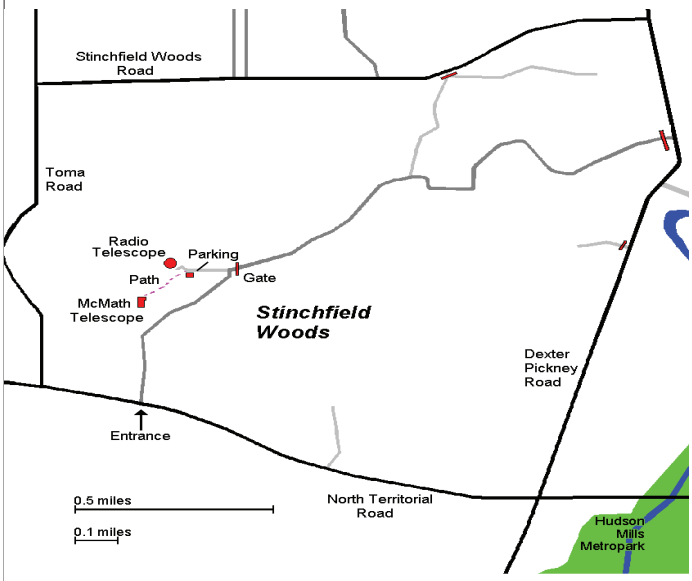
Remote astronomy has many advantages: access to "high-end" equipment, a variety of telescopes to choose from, dark sky locations, and coverage of both hemispheres.

I prefer visual observing, but I have found iTelescope to be very helpful, especially when the weather is bad. Some of my favorite projects were M51 with and without the supernova of 2011, motion of Pluto from successive images, and a color image of M57. I have just made reservations for a series of images of M82, which should show the progress of the supernova discovered late in January 2014.

Places & Times

Dennison Hall, also known as The University of Michigan's Physics & Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. Dennison Hall can be found on Church Street about one block north of South University Avenue in Ann Arbor, MI. The meetings are usually held in room 130, and on the 3rd Friday of each month at 7:30 pm. During the summer months and when weather permits, a club observing session at the Peach Mountain Observatory will follow 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 which is maintained and operated by the Lowbrows. The observatory is located northwest of Dexter, MI; the entrance is on North Territorial Rd. 1.1 miles west of Dexter-Pinckney Rd. A small maize & blue sign on the north side of the road marks the gate. Follow the gravel road to the top of the hill and a parking area near the radio telescopes, then walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.



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 $20 per year for individuals or families, $12 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.

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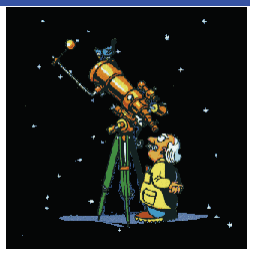
Reflections & Refractions



Website
www.umich.edu/~lowbrows/

Aseem Doedhar *shot these star trails over Devil's Tower last summer. Read about his initial experiences with astrophotography in next month's newsletter.*

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