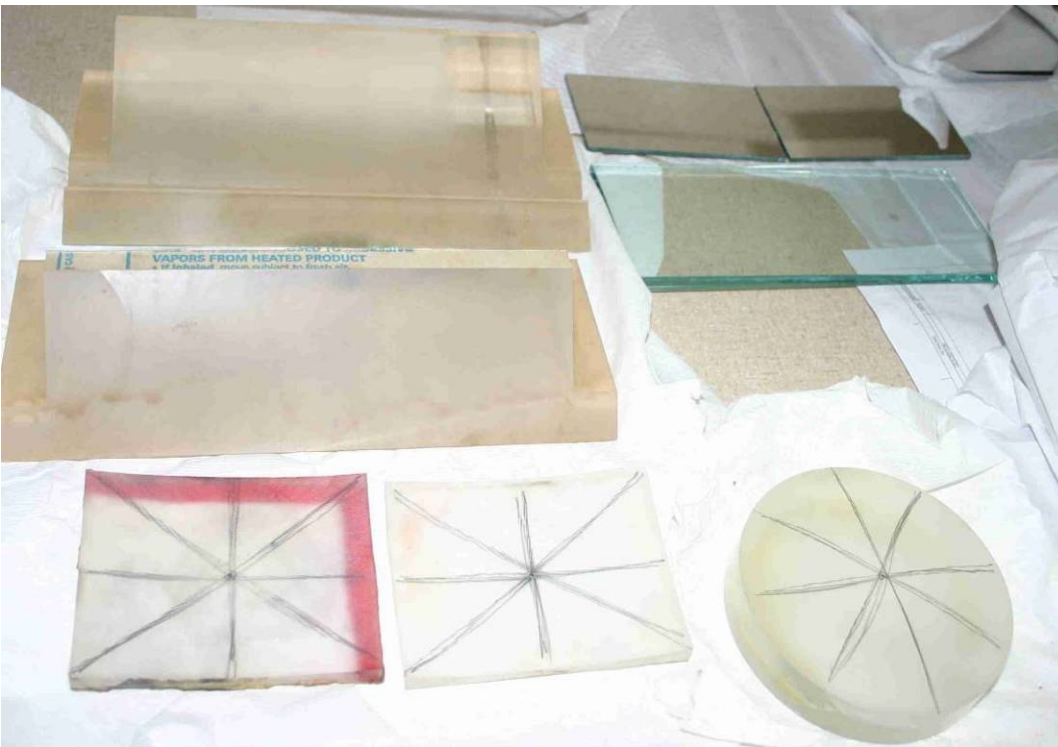


Making Square Mirrors

By Tom Ryan

I recently had the opportunity to make a pair of square mirrors, and to make them twice, because they didn't turn out very well the first time I made them.

Everyone knows that most optical elements are round. There are several reasons for this. Round elements are easier to manufacture. They are also easier to mount, if you have lathes available, rather than CNC milling machines, which was the situation for most instrument makers throughout history. And finally, their diffractive image points are symmetric, which is both pleasing to look at and best for making measurements of the images. However, sometimes a round element will not do the job, and the optician is faced with deciding whether to grind and polish a round element and then cut chords off to square it up, or to cut the chords off first and then grind and polish a square element.



Until recently, I had only tried the first method. However, running a finished element through a diamond saw, and then grinding the edges until they are square and to size, requires an excellent surface protection tape and a great deal of luck to prevent scratches. I knew the success rate of that approach, and I decided to try the second method.

Two BK-7 optical glass blanks were purchased, cut to the correct shape on a diamond saw, ground to size, and the 12" radius curves were diamond generated on one face, the other being flat. Tooling was made, in the form of a 12" radius (round) Pyrex grinding tool, an alumi-

num backing plate for the mirror blanks, and a 12" radius, 6" diameter aluminum polishing tool.

The mirrors were approximately 3" x 4" x 0.375" thick, and the rule of thumb when machine polishing with the element on top is to grind and polish against a tool that is 6/5 bigger in diameter than the element. This ratio gives the optician control over the element's radius of curvature when polishing. If the element and tool were the same diameter, the one on top would simply grow progressively more concave, as anyone who has hand-ground a mirror can verify.

The Pyrex grinding tool was 4.25" in diameter, because that was what I had available, and because the mirror and tool can be flipped while grinding to control the radius. Polishing is another matter, because flipping the elements while machine polishing is just not convenient.

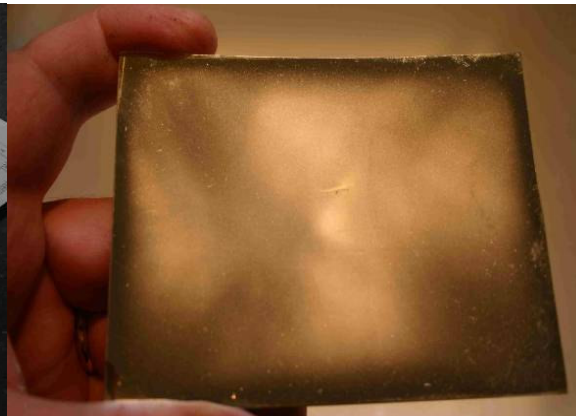
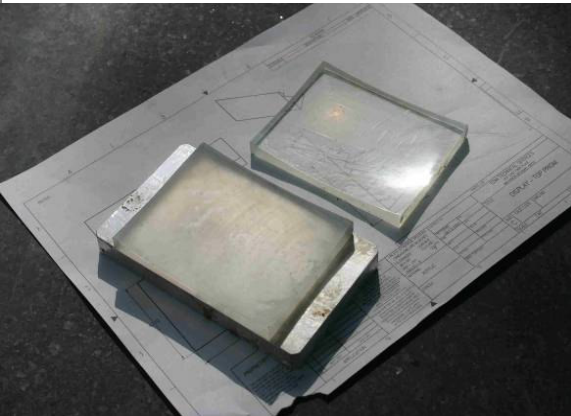
But what is 6/5 of a rectangular mirror? I chose to call the mirror's diameter the diagonal measurement, which was 5", and this dictated a polishing tool diameter of 6".



Because these mirrors were part of a prototype which needed to be made fast, rather than good, as long as good was good enough to prove the concept, they were ground fast and polished fast. Their edges polished out first, but a dime-sized spot in the middle never did polish

out. (Remember, polishing with the same size mirror and tool deepens the mirror; a bigger tool flattens the mirror out. 6/5 is neutral.)

To polish out the centers, I let the polishing machine run on for several hours, hoping for even stock removal. That didn't happen. The centers never did polish out. Instead, the corners of the rectangular mirrors rounded off as if they had been polished on a buffing wheel. I silvered the mirrors, but the customer and I agreed that their surfaces were now far too distorted to allow us to verify the quality of the optical design.



The picture does not do justice to the horribleness of the end result.

I returned both mirrors to grinding, and ensured that the correct radii were restored and the surfaces were fully ground out and spherical. However, time was passing, and the customer still

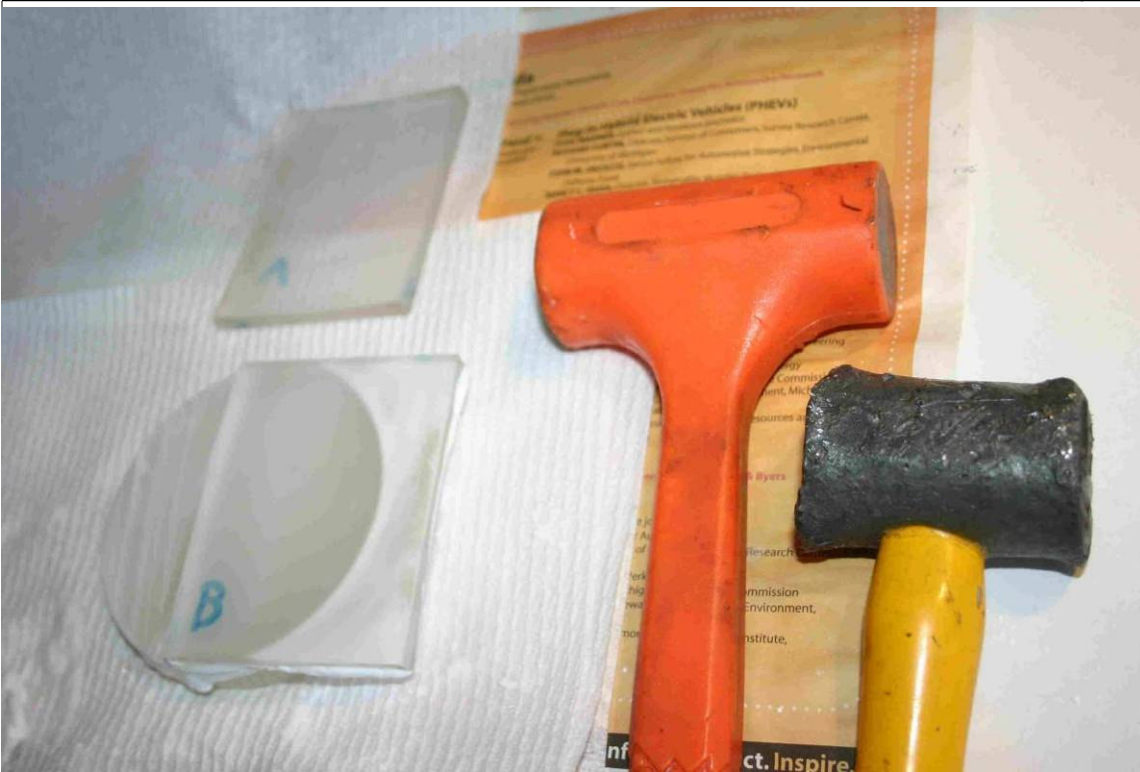
wanted the design to be verified ASAP. I decided to reduce the polishing time by fine grinding with much finer abrasives.

Normally, if an optician has a week or two to produce an optic, he will diamond generate the rough curve in the glass, and then will fine grind with 30 micron abrasive, and may or may not follow that with 9 micron abrasive, before he starts to polish. This leaves a lot of glass to be removed by the very, very slow polishing process.

The reason for stopping the grinding process with 9 micron grit is that the mirror and tool tend to stick together when grinding with finer abrasive grades. Sometimes, they'll stick with 9 micron. This happened to me when grinding these mirrors the first time, and it does not make you calmer to have the mirror and tool lock together when you have a deadline to meet. There are several methods recommended for separating the two pieces of glass. One involves placing them in the freezer overnight. I didn't have time for that. I used a lead hammer. The plastic one didn't work at all.

Now I planned to grind even finer with 5 micron, because a few minutes spent there can save an hour or two when polishing. The trick is to prevent the parts from sticking together. I've read that some people think the parts stick together because of suction. I don't believe that. Rather, I think the glass parts are welding together.

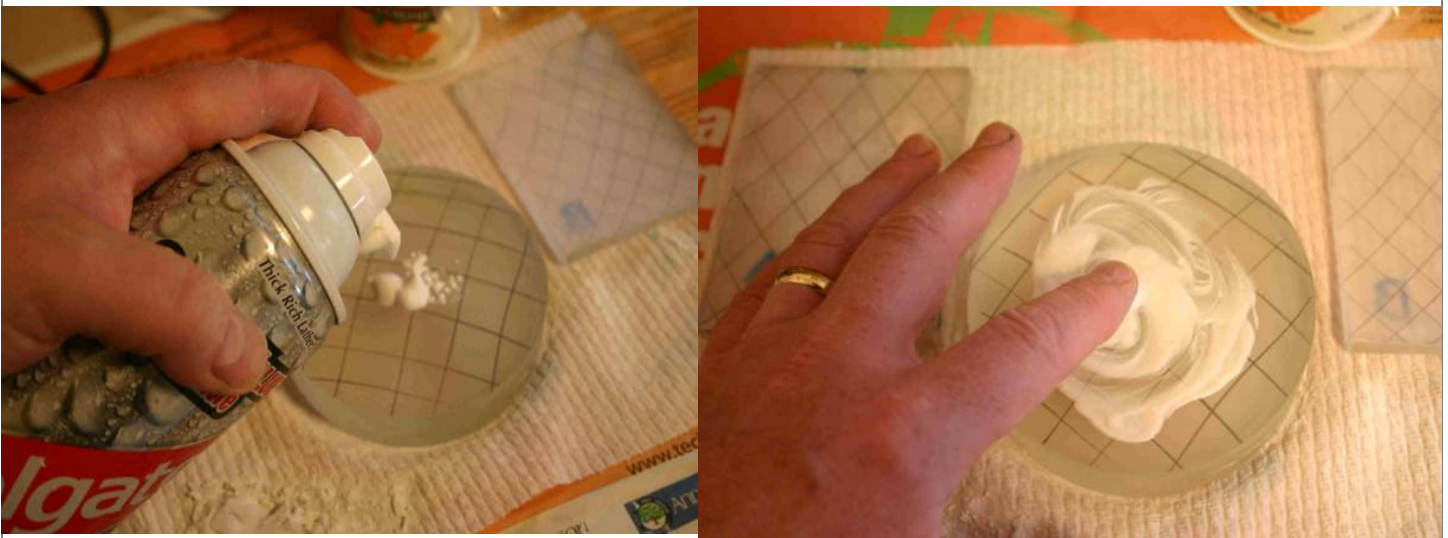
Machinists have these things called Johanssen Blocks, or Jo Blocks for short, which are length standards they use to check their micrometers. Being length standards, the blocks are stackable and have their ends finished to optical tolerances. Even though they are not magnetic, it is possible to join these blocks, flat face to flat face, and hold them out horizontally and have them stick together, supporting their own weight, because they bond through microscopic welds. (When I showed that to family members, they thought it was a trick, and wanted to know how I did it.) The blocks can



then be disassembled simply by pulling them apart. They are an example of two surfaces that share so many points that they start to think they are a solid body.

I think a similar process causes mirrors and tools to stick together. Polishing is not just a mechanical process. It has been proven to involve heat and the chemical dissolution of the glass itself. I theorized that the glass disks were dissolving on their surfaces in the water-alumina solution, and were cementing themselves to-

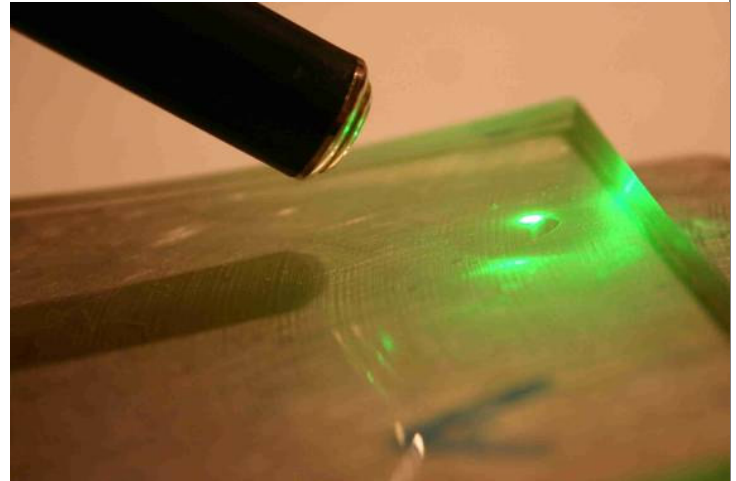
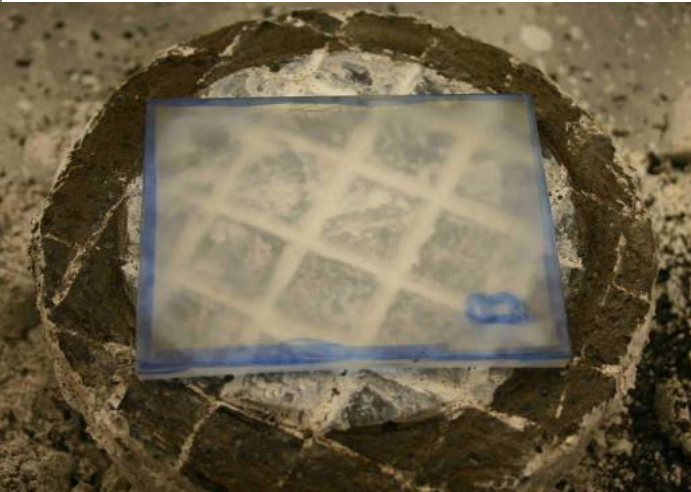
gether. The way to prevent this is to contaminate the surfaces with something that prevents them from bonding when they are in this very close contact.



I thought a silicone-based fluid would probably work better than hydrocarbon-based oil or metal cutting fluid, and the most common silicone-based fluid available around the house on short notice is in shaving cream. I therefore switched from a water-abrasive mixture to a shaving cream-abrasive mixture. It worked perfectly.

The mirrors exhibited no tendency to stick, as long as I kept sufficient shaving cream in the abrasive slurry. The shaving cream has the additional benefit of making it easier to prevent pits, because the elements have to be pressed together harder to start the grinding, and the bigger particles can be gently ground down before they do damage.

To better control the concave-convex polishing process, I cut the pitch lap down to a smaller diameter. (The first polishing attempt showed that the mirror's effective diameter is less than the diagonal measurement.) I then slowed the polishing machine down to about half the speed at which it had been running. These changes resulted in the mirrors polishing



out completely and evenly. In the picture with the laser pointer, the beam passes through the polished surface with very little scatter before hitting the ground surface on the back of the mirror. You have to look very closely to see the scatter off the front surface, and lasers are very bright.

If these mirrors had needed a laser-quality surface, I'd have polished for ten hours instead of two, and would have switched from alumina-based polishing compound to Cerium oxide. But they were for a throw-away prototype, and the customer preferred speed over absolute perfection.



The mirrors also polished out this time with fairly sharp edges. I attribute this to the slower polishing speeds. The edges weren't perfectly sharp, but they were pretty good for a job completed in two days, and after silvering, the mirrors proved good enough to test the prototype.

As for which manufacturing method I now prefer, I'd say the "polish-then-cut-square" method results in perfectly sharp edges on the mirror, but risks scratching the surface. I've never found a surface coating or tape which was 100% effective at preventing scratches to a polished surface when grinding was being done to some other portion of the part. The best defense against scratches is to do all operations of a given roughness at the same time. (And always use distilled water.)

The "cut-square-then-polish" method is a bit harder to pull off, in terms of getting the polished edge sharp and the surface figure good, but the surface polish quality is guaranteed. Which method I use in the future will depend on the circumstances. Until then, I'm going to try to stick with circular optics.

So, What's in a Name?

By Mark S Deprest

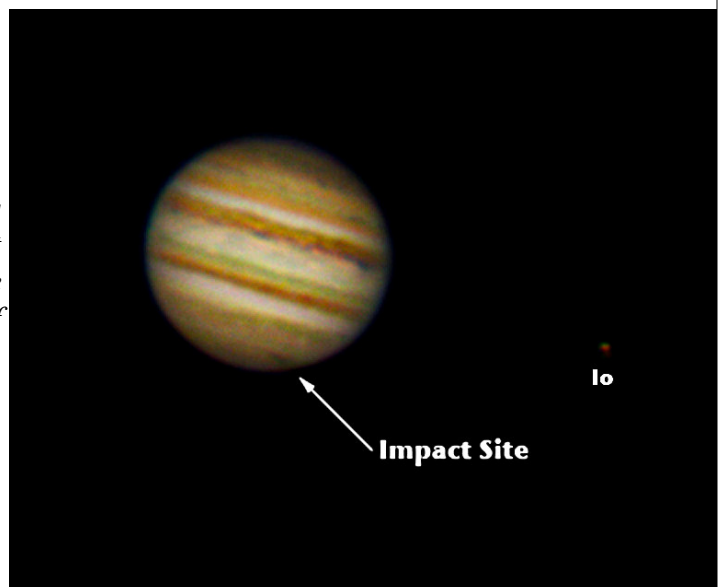
Most of you know that I like to name my telescopes and although it is a personal thing, it is not all that uncommon. In fact many amateur & professional astronomers name their scopes, for instance David Levy names all of his scopes with obscure names from mythology and religion like Minerva and Obadiah. Doug Scobel has named each of the scopes that he built; he has Papa Smurf, Smurfette, and The Mars Scope & Son of Mars Scope. Even John Causland gave his 24" Starmaster the moniker of "The 61" (as in 61cm of aperture). Chris Sarnecki has a 10" Orion Dobsonian that he added 18" legs to and now he calls it "The Weiner-Scope" (I'm not exactly sure why, but we don't need to know).

I have had a number of telescopes over the years and have always found that naming them made them not only personal but kind of gave them a little personality. My 8" Dobsonian has gone through a number of metamorphosis and with each new form came a new name. In its current configuration with its gold painted tube, I dubbed it "Gilda". When I had the 12.5" Bruce Ruben all aluminum truss tube scope (now owned by Yasu & Yumi Inugi), it had been painted red, so I always called it "Big Red". My 5" f/5 refractor with its rich fields of view has always been great for big open clusters and has the name of "The Cluster Buster RFT". A year or so ago I bought an 18" truss tube Dobsonian which was originally built by Pete Kron of Astronemics in Norman, OK and while I loved the scope in its original configuration, I knew that I would be making some changes to it as time went by. Because of its 457mm of aperture and the builder's name I decided to call this scope "The PK-457" not one of my more inspiring names but it worked for me. Besides somewhere in the back of my mind I knew that the name would change and so would the scope.

Now when I bought the PK-457 it was 10 years old and got lots of use during those 10 years, so there was the expected wear & tear, it also was made from a rather dark stained plywood, possibly red oak and although a good hardwood I suspect it was not of premium grade. I have never been a big fan of dark wood, so one of the first things that I did was to rebuild the rocker box with 13 ply Baltic Birch and put a Baltic Birch veneer over the existing mirror box, I also decided not to stain at all and leave it naturally blond with a satin polyurethane finish. I painted the altitude bearings flat black this made the light colored wood of the rocker & mirror boxes stand out. I also decided to remove the original drive system and replace that with a Tom Osypowski tracking platform, in addition to these changes I replaced the old style focuser the a Moonlite 2 speed Crayford type focuser. These changes didn't quite warrant renaming the scope yet, but the Baltic Birch veneer that I had was very pliable and that gave me an idea. I could use it to replace the black kydex material that was used in the upper tube assembly and then paint the two rings and support tubes flat black, I also used black flocking paper on the inside of the UTA to help prevent any internal reflections. The results are that I now have an 18" truss tube Dobsonian that is mostly a light blond Baltic Birch with flat black accents. I now feel that enough of my own personal touches have gone into the original "PK-457" to justify a new name. So the next time you see me out observing with my 18" scope come one over and I'll introduce you to "Blondie"!

Our very own Robert Wade managed to capture this wonderful image of Jupiter and Io with the Impact bruise just rotating into sight. Contrast and colors are enhanced, Robert used the cameras and scopes of Slooh to grab an incredibly detailed image.

Nice Job! Robert.





The Seventh Annual
Great Lakes Star Gaze

September 17th – 20th, 2009

“A Star Party with Dark Skies”

Held at River Valley RV Park Gladwin, MI

GENERAL INFORMATION:

Location and dark skies are the main attractions of this star party. Gladwin's central location provides excellent observing without traveling hours into Northern Michigan. Limiting magnitudes are estimated to be around 6.5 at zenith with some minor light domes from the cities of Mt. Pleasant and Midland, some 30 miles away. This is a star party for the astronomer who loves to observe and mingle with other astronomers. Some practical and interesting talks are scheduled to enhance your weekend experience.

GETTING TO RIVER VALLEY RV PARK:

2165 South Bailey Lake Ave., Gladwin, MI 48624

From US-10

From US-27

Travel 6-1/2 Mi. E. from Lake George Exit.

From M-61 travel 2-1/2 Mi. S. on Bailey Lake Ave.
(Midway between Gladwin and Harrison).

WHAT IS INCLUDED WITH REGISTRATION?

Camping on the observing hill, **tents only!**

Participation in presentations and observing.

Hot coffee/chocolate in welcome tent.

One ticket for door prize raffle per registration

Clean hot shower/restroom facilities.

TRAVEL TRAILER FEES:

Water & electric sites for travel trailers are available, register with

River Valley RV Park for a site in addition to our registration.

Full hook-up sites run \$25 per night **plus** our star party registration fee.

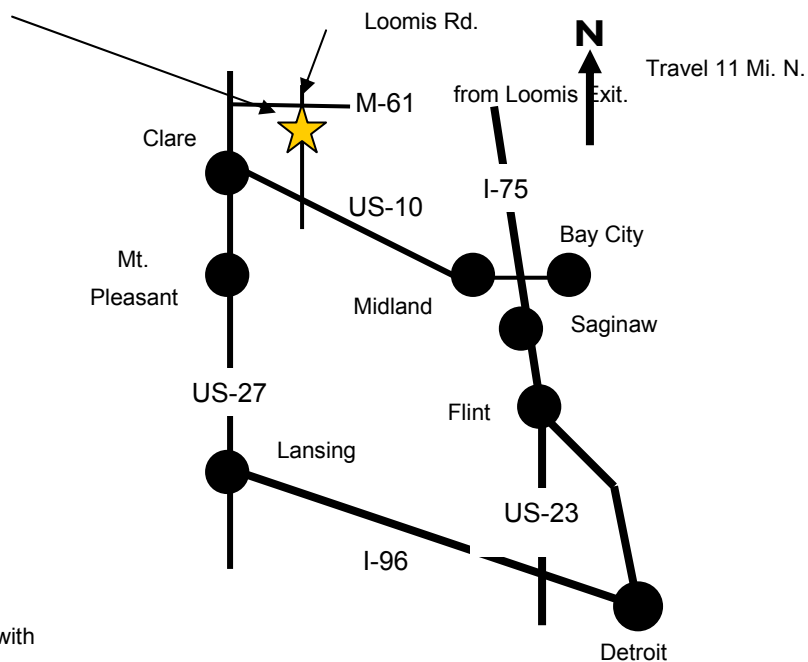
River Valley RV Park, Phone: (989) 386-7844 Website: www.rivervalleyrv.com

FOOD VENDOR:

“Lisa’s Lunch Wagon” Lisa and her family will again be present to provide breakfast, lunch, and dinner on the hill.

EARLY REGISTRATION:

Registrations postmarked on or before **August 21, 2009** will save **\$15.00** off the cost of the regular registration fee.



www.greatlakesstargaze.com

University Lowbrow Meeting 8/21/2009—Minutes by Ken Cook

Our meeting opened with a short presentation by VP Ken Cook of photos from an accidental trip to Lick Observatory on Mt. Hamilton just East of San Jose, California sometime in 1986.

President Charlie Nielsen introduced our featured speaker Sandra Macika from the Ford Amateur Astronomy Club (FAAC). Sandra gave a very nice presentation on some of the science results from Lick Observatory. Sandra's talk covered several important professional developments at Lick including early work on Adaptive Optics, Artificial Guide Stars, Colorimetry, Spectroscopy, Exo-solar planet detection via Doppler shift and proper motion, and Direct Imaging of Exo-solar planets. The Shane 3m telescope at Lick often serves as a test bed evaluating new technology prior to making changes at the Keck telescopes.

Charlie thanked Sandra and presented her with a Lowbrow's tee shirt - the club gave her a round of applause.

Charlie then called the business portion of the meeting to order.

A request came to Charlie that we share expenses with two other clubs when Brother Guy Consolmagno the Vatican Astronomer visits and does a presentation for our club.

A motion was made by Ken Cook and seconded by Doug Warshow that the Lowbrows offer \$100 to help cover car rental and gas expense for Brother Guy Consolmagno (Vatican Astronomer). The motion passed unanimously - D.C. Moons was in absentia.

Charlie requested that the club consider purchasing a laser optics teaching kit from Arbor Scientific and several accessories for demonstrating mirror and lens

concepts at our Night Sky Network outreach activities. The laser kit is \$99 and the accessories are less than that. A motion was made by Mark Deprest and seconded by Jason Maguran that the kit and accessories be purchased. The motion passed unanimously except for Mike Kurylo objecting on behalf of D.C. Moons.

Charlie mentioned that the Brother Guy presentation seems more likely and details will be emailed and posted on the website as they become available.

The logistics and administrative issues of recoating the McMath 24" primary mirror were discussed with the conclusion that photos must be taken of the primary mirror so that FLABEG USA (website; <http://www.flabeg.com/en/index.html>) can determine the feasibility and cost of recoating our historic mirror. They want to be very cautious when working with the mirror.

Charlie heard from John Kirchhoff who was originally scheduled to speak at our November 20th Monthly meeting. John has a conflict on that date and requested that he present in January. So we now need a speaker for our November meeting. VP Ken Cook mentioned that he had already sent a request to Tom Trusock of CloudyNights.com asking if Tom would be available for November 20th. Mark Deprest suggested that if Tom was speaking he could show an interview with Al Nagler of Televue.

Ken Cook asked for more speaker contacts - Doug Warshow suggested the Astronomy Department as a source of willing guinea pigs er.. graduate students who might have interesting topics to discuss.

We have several scheduling conflicts with star parties and outreach activities in September. Specifically, September 19th. We need Lowbrow's to cover these activities - please watch your email and help when you can.

Astronomy on the Beach is September 25th and 26th.

Newsletter Editor Mark Deprest claimed he didn't need any more articles! After we picked ourselves up off the floor he said that was just a little joke and he *always* needs more articles. The next newsletter is about half full - so keep those cards and letters coming.

Mark also spoke about Explore Scientific's selection of Riders Hobby Store (and specifically John Kirchhoff) as their only Michigan distributor with an introduction of a new eye piece at a recent Riders open house. Scott Roberts of Explore Scientific gave a 1.5 hour talk. Mark suggested that we work with the Hands-on Museum to bring Scott to the Lowbrows for a talk on Friday and a Hands-on Museum activity on Saturday sometime during 2010.

Treasurer Liz Calhoun said we have 108 members and more than \$8000 in the lowbrows account. She also pointed out that not everyone was responding to our renewal notice emails.

Dave Snyder, D.C. Moons and Mike Radwick were not present.

The public portion of our meeting adjourned and an officers meeting began.

These meeting minutes are posted in accordance with the club by-laws.



Western Veil Nebula in Cygnus (NGC 6960)
About 2 Hours total exposure time, 45 to 120 second subframes
July 09

Above: Image by Dave Tucker—Western Veil Nebula in Cygnus (NGC 6960) is a supernova remnant that covers an apparent area of over 3 degrees of sky!

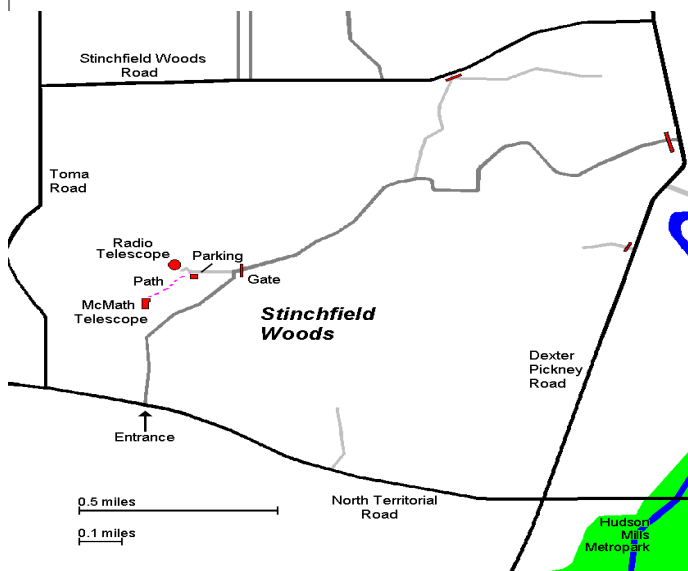
Below: Image taken at 10:52PM local time at Peach Mountain on Wed, Aug 12, 2009 by Mike Radwick who used a 17mm lens at F4.5 for 31 seconds at ISO 500. Camera was pointing Northeast, and Cassiopeia is clearly recognizable in the lower-right portion of the image. The meteor was traveling north to south directly below Cassiopeia.



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 \$12 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
c/o Liz Calhoun
P.O. 4465
Ann Arbor, MI 48106**

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

Sky & Telescope - \$32.95 / year

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

For more information contact the club Treasurer. Members renewing their subscriptions are reminded to provide the renewal notice along with your check to the club Treasurer. Please make your check out to: "University Lowbrow Astronomers"

Newsletter Contributions

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

Call or Email the Newsletter Editor: **Mark S Deprest (734)223-0262 or msdeprest@comcast.net** 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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- Ken Cook (734)769-7468
- Bob Gruszczynski
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- Liz Calhoun
- Treasurer: Mike Radwick
- Observatory Director: Mike Radwick
- Newsletter Editor: Mark S Deprest (734) 223-0262
- Key-holders: Jim Forrester (734) 663-1638
- Fred Schebor (734) 426-2363
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- Webmaster: Dave Snyder (734) 747-6537

Lowbrow's Home Page

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

Email at:

Lowbrow-members@umich.edu



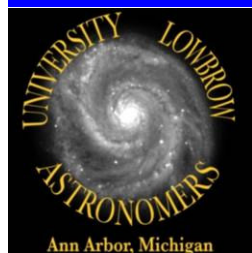


University Lowbrow Astronomers

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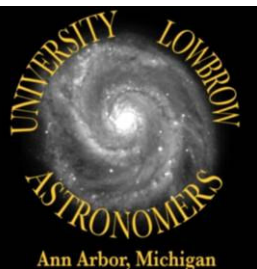
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Reflections & Refractions



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www.umich.edu/~lowbrows/



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THE UNIVERSE YOURS TO DISCOVER



INTERNATIONAL YEAR OF ASTRONOMY 2009

Check your membership expiration date on the mailing label