University Lowbrow Astronomers
Ann Arbor, Michigan

REFLECTIONS / REFRACTIONS

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University Lowbrow Astronomers

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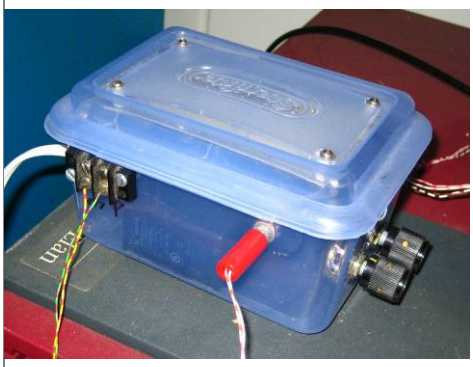
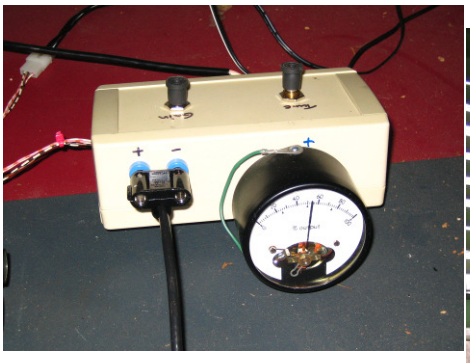
Volume 34 Issue 7

SIMPLE RADIO ASTRONOMY

By "Seldom Seen" Dave Benham, McMath-Hulbert die-hard

A few of us at McMath-Hulbert Solar Observatory (you remember, that old place where you guys stole the McMath scope from?) recently got involved with monitoring US Naval submarine communications VLF stations in order to track SID's (Sudden Ionospheric Disturbances). We did this with homemade "Gyrator" radios and homemade loop antennas. The Gyrators are inexpensive, very simple, easy to build, VLF receivers the designs for which can be found online ("Gyrator II" and "Gyrator III"). FAR Circuits has boards for them and the parts are easily obtainable. The loop antennas are roughly 20" square with about 140 turns of #30 wire and they are tuned with 365 pf tuning condensers like you would find in an old AM radio. The output of these Gyrators is fed through an analog to digital converter and into the serial port of a computer. Below are photos of our versions of the Gyrator II on the left and Gyrator III on the right. The loop antenna is shown below that.





Lately we have become involved with a project called SuperSID which is run by Stanford University and SARA (Society of Amateur Radio Astronomers). They provide a "receiver" (actually a low-noise pre-amp) to be used with a 96 KHz soundcard and special software that monitors VLF frequencies, records data once every 5 seconds, 24 hours/day, then automatically sends the files to Stanford at the close of the day. The beauty of the SuperSID soundcard setup is that several stations can be monitored at once, rather than just one as with the Gyrators (or any other true radio receiver). The SuperSID Project has several of these "receivers" all around the globe, each with their own ID and each submitting daily data to Stanford. These reside at high schools, universities, public institutions, and even some individuals' homes. Below is a photo of the SuperSID hardware which looks sort of like a can of breath mints.

At McMath-Hulbert we are currently monitoring the following stations:

NAA, 24.0 KHz in Maine.

NAU, 40.75 KHz in Puerto Rico.

NML, 25.2 KHz in North Dakota.

NLK, 24.8 KHz in Washington state.

NPM, 21.4 KHz in Hawaii.

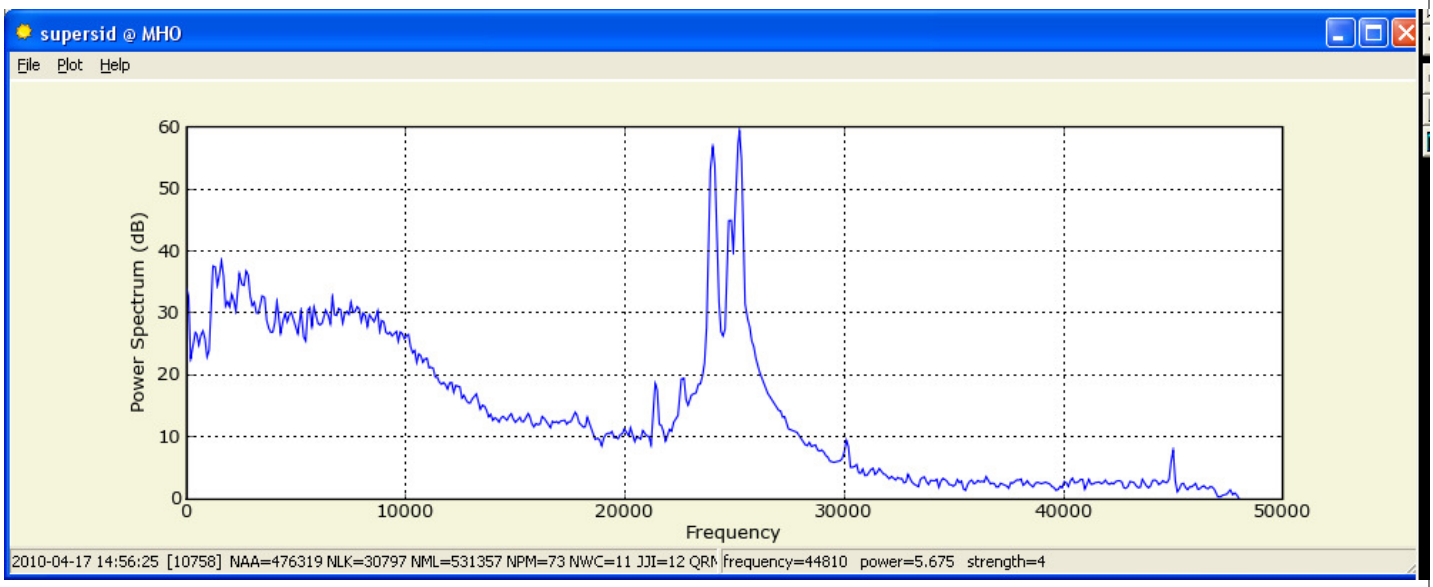
NWC, 19.8 KHz in Australia.

Two stations in France and one in Japan.

And open frequencies at 20, 22.65 and 27 KHz in order to track the noise floor.

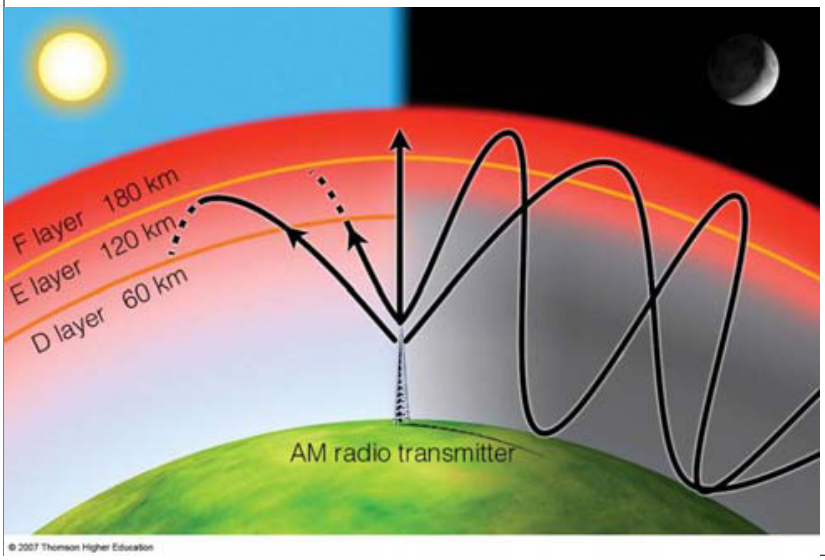
Below is a screenshot of one sample from the SuperSID software. The spikes at 22.65, 30 and just above 45 KHz are not stations and are associated with unknown noise sources. This particular sample prominently shows NAA, NML, NLK

and NPM which are the most reliable day-to-day stations received from this area.

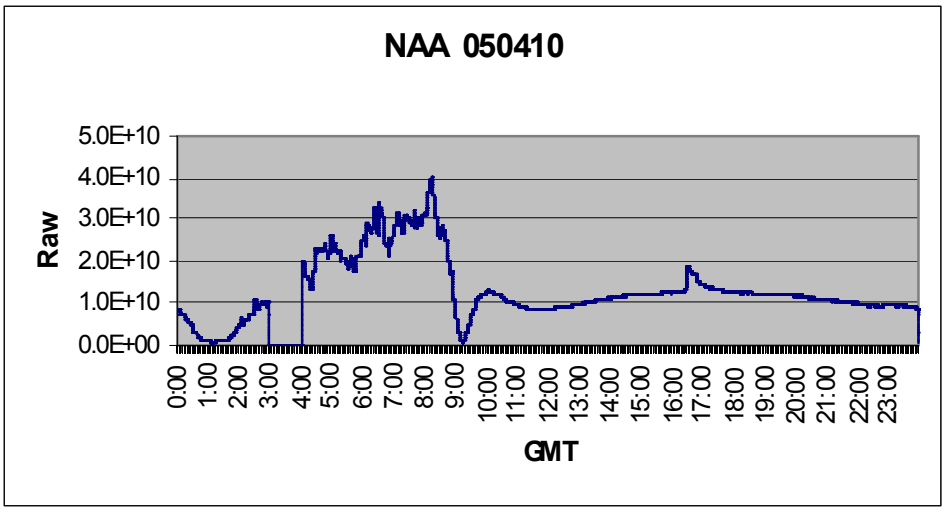


The signals are stronger during the night but our interest is daytime since the solar disturbances affect the daytime ionosphere. Samples of the signal strength of the stations are taken every 5 seconds, recorded by the software and saved into an Excel .csv file where it can be later analyzed and plotted. So the resultant daily file has 17280 rows of data for each frequency monitored. There is no interest in the content of the transmission – it is data, encrypted FSK at 200 baud. NAA is said to be the most powerful VLF transmitter in the world at 1800 KW. There is an interesting Wiki article on NAA which shows its elaborate antenna system and its history -- http://en.wikipedia.org/wiki/VLF_Transmitter_Cutler

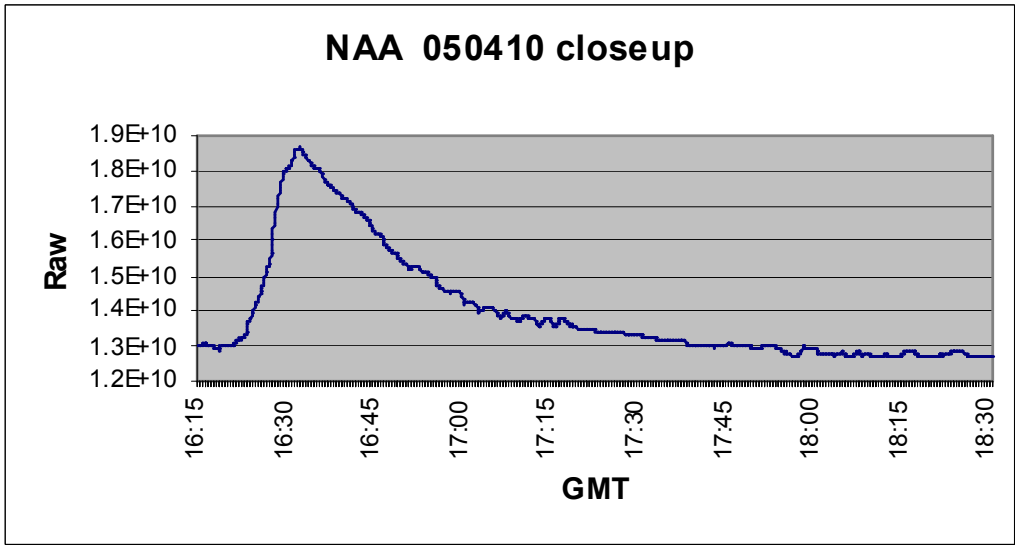
The nighttime ionosphere basically consists of the F layer which is about 180 kilometers high. Signals reflect off the F layer and bounce back to Earth. During the day when the sun energizes things, the ionosphere becomes comprised of, roughly, 3 layers – the F (highest), E (middle) and D the lowest at about 60 kilometers. Normally during a quiet solar day, the VLF signals go through the D layer to the higher mid-level E layer, then lose energy as they reflect and pass back through the lower D layer on their way back to earth. SIDs are caused by solar activity abruptly increasing the ionization of all layers of the ionosphere. The normally less active, and lower, D layer of the ionosphere is energized to the point that it briefly becomes the daytime bounce point for VLF signals rather than the E layer. Signals bounce cleanly off the D layer during the SID, briefly increasing the received signal strength on the monitor. See the illustration below which shows quiet day behavior.



The resultant daily plots can be analyzed for spikes during the daytime for this solar activity and then compared to the GOES (Geostationary Operational Environmental Satellite) data -- http://www.swpc.noaa.gov/rt_plots/xray_5m.html. In the example below recorded from station NAA, which is plotted on GMT or UTC, the spike between 16:00 and 17:00 shows a SID. The portion between about 02:00 and 09:00 is the nighttime "signature" which is generally quite sporadic in appearance and generally stronger than the daytime signal. Between 03:00 and 04:00 is an apparent daily maintenance shutoff done at NAA. Between about 08:30 and 10:00 is the daily sunrise signature apparent on most station signals.

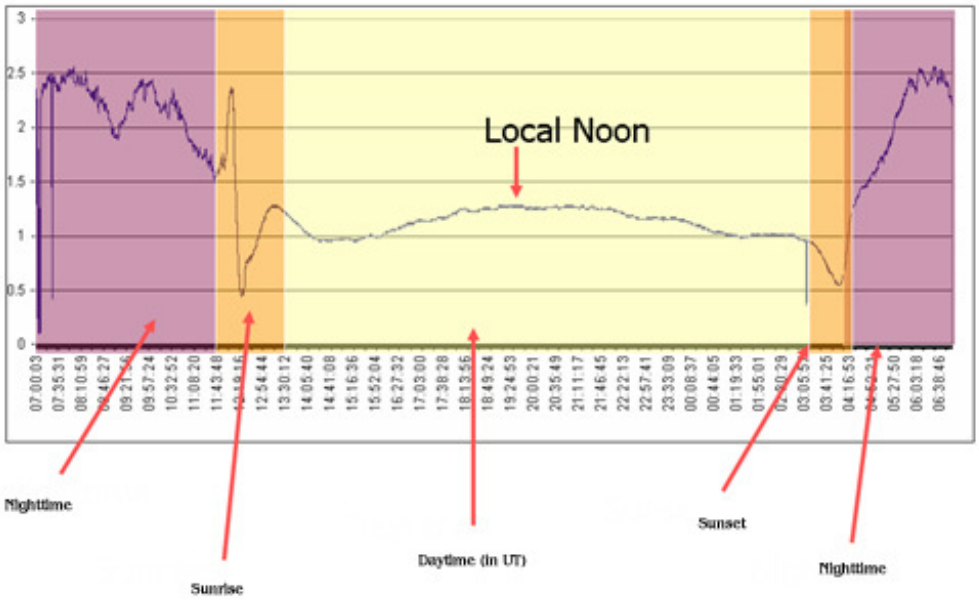


One hazard in monitoring these stations is that their prime reason for existence is to provide encrypted submarine communications, so power levels, maintenance downtime, etc., are totally under the Navy's control and are not published. Hence some apparent anomalies are due to the station parameters, not solar disturbances. Fortunately, the shape of a SID is quite repeatable and recognizable despite station issues.



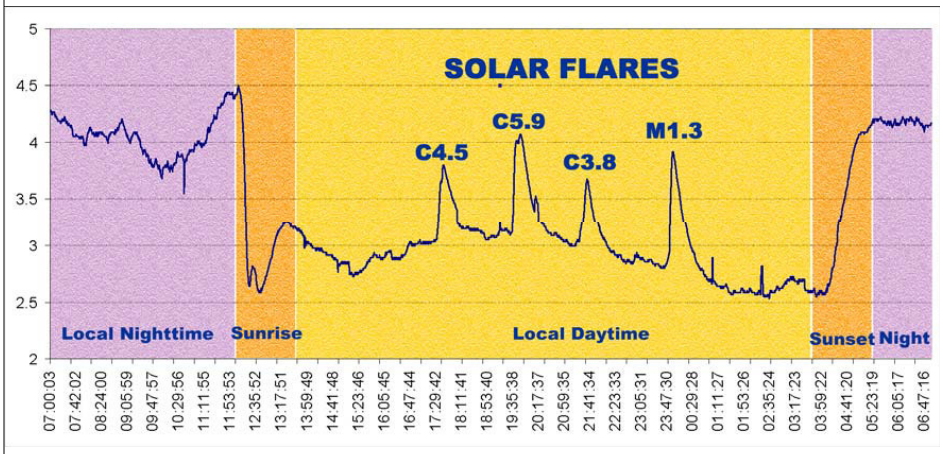
Left is a closeup of the SID on May 4, 2010. The rise and recovery rates are typical for a SID signature.

Normal 24 Hr. Day (No flares)



Left is the 3 day GOES Xray Flux chart that is available online. Note the spike on May 4 that corresponds to the spike on our SuperSID chart.

Below are two simulated plots that show a 24 hour day with no flares and another day with 4 flares.



Believe it or not, this indirect method of observation qualifies as radio astronomy and the data are used by solar researchers which we can only hope will be shared with us in the future. You may visit:

www.mcmathhulbert.org for some more photos.

The McMath 24" Telescope and the University Lowbrow Astronomers

Written June 29, 2010 by Charlie Nielsen, President, University Lowbrow Astronomers

Approximately 25 years ago the University Lowbrow Astronomers became aware of the existence of a 24 inch Classical Cassegrain reflector located at the University of Michigan's Portage Lake Observatory. The telescope was built by Robert R. McMath in the late 1930's and was originally located at McMath-Hulbert Observatory, near Pontiac, Mi. This U of M observatory is famous for having produced the first motion pictures of the Sun. The 24 inch telescope was designed for lunar and planetary study, and was moved to its current location in the 1950's.

The University Lowbrow Astronomers is an amateur astronomy club comprised of about 120 members, and meets monthly in the Dennison Building. The club is an official outreach program for the Astronomy Department. When the McMath telescope was "discovered" the club was much smaller and comprised mostly of U of M students. A subgroup of the club visited the site, now commonly referred to as "Peach Mountain Observatory", and was horrified by what they saw. In a roll-off roof building located 700 feet to the south of the U of M's radio telescope was the badly deteriorated McMath telescope. Sometime later the club gained the University's permission to completely dismantle and recondition the telescope, which they did very well.

Since then the University Lowbrow Astronomers have maintained and improved the telescope and building. The facility and grounds continue to be used by the club to conduct public open houses, which are scheduled twice a month. These events draw a minimum of 25 people and often around 100. Many times we have a crowd of multiple hundreds. Over the years the club has worked extensively on the telescope. The original 4 inch finder scope was replaced with a 6 inch, F/10 refractor built by one of our club members. Several of the eyepieces used with the telescope were built by that same member. A light and moisture shroud was made for the open frame optical tube and a secondary mirror cover was built by another club member. Encoder wheels and a digital database box were added to make object location easier. The club has removed the primary and secondary mirrors for recoating 3 or 4 times, and is scheduled to do so again this September. In the last 3 years the worm that drives the Right Ascension gear was replaced along with some design and bearing improvements. Shortly after that the clock drive electronics were redesigned, constructed and installed by another club member. The last two items have resulted in the most accurate and backlash free performance the telescope has ever experienced. The author expects that after the upcoming recoating project the McMath telescope will be in the best mechanical and optical condition in its long history.

In addition to the maintenance and improvements outlined above, the University Lowbrow Astronomers has performed some work on the building. This involves the replacement of the cable that drives the roof rollers, lubrication of the rollers, maintenance of lights and fixtures, some minor cement repairs, and repainting of the entire building.

The University Lowbrow Astronomers have enjoyed and look forward to continuing as an outreach program for the Astronomy Department, and as such to be excellent representatives and advocates. We also look forward to creating an additional and similar relationship with AOSS as we make progress toward the future.

More information and pictures are available at: http://www.umich.edu/~lowbrows/theclub/mcmath.html

"The Unmounted Lens," Continued

By: Liz Calhoun, June, 2020

(Poem used with permission of the University of California Regents/Lick Observatory.)

The late 19th century witnessed a dizzying acceleration of U.S. industrialization. Although the nation did not balance its urban and rural populations until a few years into the 20th century, nevertheless, the Industrial Age was starting to over-shadow agrarian simplicity by the end of the Civil War.

The Lick Observatory was not simply a good place to observe and catalogue stars and ruminate on the mysteries of the galaxy: it was an important component of the *business* world of the 1880s. How so? Because the "paying" work of a major observatory was TIMEKEEPING. "The work of astronomers is usually very far removed from what is called practical utility," states the "Hand Book." "The American public is highly interested in all scientific results which can be stated in popular form, including those in astronomy, but there is almost only one point where the work of astronomical observatories touches the business interests of communities directly. This point is in the distribution of time by electric signals from an observatory to railroad and telegraph companies, to city and tower clocks, to private business firms and manufacturing and other corporations, for commercial purposes" (*Hand Book*, p.98)

Therefore, when you read these next two stanzas "To the Unmounted Lens," try to appreciate the grudging embrace of applied science by sincere spiritual reverence. Not without a fight will the romanticism of religious enthusiasm give way to a world of pistons and boilers and sweep-second-hand sterility. The unmounted lens once established and operating will reveal Heaven and the heavens in their timeless perfection.

II.

O blindfold, O enfettered, now hath Time
Unto its golden fullness come – along
The dim horizon glows the dawn – awake,
O slumber-held; unclose, O wondrous Eye,
A world awaits the breaking of thy sleep.
O bright Evangelist come forth! Earth's way
Lies lonely thro' the trackless void; a waste
Of cloud and storm, and darkness vast and deep,
Betwixt her and the stars, and far beyond
The farthest glint of star lies Heaven – so far
We cannot see the road the souls must tread
Who thither go. Perchance that thou mayest span
The gloomy sea, and set the Gates of Death
A little way ajar. Perchance that thou
With cloudless vision slowly sweeping up
The mighty Nave that cleaves the galaxy,
God's visible Tabernacle in the skies,
Star-built from shining undercroft to dome,
Past pillared pomp of worlds, and columns wrought
With fair entangle of amethyst and pearl,
Thro' jacinth portals hung with mist of stars,
And fiery fringe of suns – mayest come at last
Even to the Chancel of the Universe;
And so thro' glories veiled and far, behold

The Choral Stars that sang so loud and sweet
On the first morning when Creation sprang
In dewy beauty from Jehovah's hand.
Mayhap that thou, with swiftness unconceived,
Wilt overtake the light and see the things
That have been, and that shall be nevermore;
Follow the dying star in her swift flight
Athwart Eternity; track the lost world,
That drifting past our ken, still gleameth fair
Upon the confines of some far off realm;
Perchance the Star which first spake peace to men
Will dawn through thee upon the waiting earth;
And O far-seeing Eye, perchance mayest thou
Reveal the City Beautiful which lies
Foursquare in midst of heaven, whose shining walls
Are of fairer jasper builded and pure gold;
Whose battlements are crystal, and whose ways
Are sapphire-paven, and whose gates are pearl.
IIII.
Thou answerest not; but this we know – that thou
Wilt life the world one step nearer heaven.
Thou art the topmost pace of that vast stair,
Builded by Titan souls up thro' the gloom
Of churchly tyranny and priestly scorn;
Still standeth Galileo at the base,
Forever, straining his grand sightless eyes
Towards the light, groping with shackled hands
For the next step, where Newton stands and weighs
The Universe. Slow climbed those God-like souls,
Building this mighty stairway as they went
One step between the cradle and the grave.
Leverrier set this landing, whence he saw
Uranus swerve a hair-breadth from its path,
And cried, "A world! A world! No eye has seen,
Behold 'tis such a weight. 'tis such a size!"
And lo! The world is there – and Herschel, this –
Grand, patient Herschel, watching thro' the years
The rhythmic revolutions of the spheres,
Seeing in the store house of the Infinite,
The star-dust of the uncreated worlds.
[to be continued …]

Images by Elinor Gates & Tony Misch of the Big Snow of 2001

Reflector Prices to Rise

By Tom Ryan

One of my customers recently asked me to price two 18" telescopes; an f/4.5 Newtonian and a specially designed Cassegrain with an f/2 primary. The f/4.5 is a standard, off-the-shelf telescope, and several manufacturers were able to give me prices on the primary mirror. The 18" f/2, however, is not standard, and I would have to buy a blank and grind and polish it to make an f/2 primary mirror.

So, I called several telescope mirror makers and got firm quotes from John Hudak of Galaxy Optics and Karl Zambuto of Zambuto Optics. Both companies supply excellent mirrors, and there are few enough manufacturers at this quality level that I expected their prices to be very similar. And, indeed, they were. One came in at about $3200, and the other at about $3600.

For the f/2 blank, I called a couple of glass suppliers whom I know have 18" mirror blanks. They quoted me prices of $3300 and $3100 for the mirror blank alone.

Now, even a Lowbrow like myself can figure out that either one set of prices is too low, or the other is too high. Otherwise, the mirror manufacturers are giving away their mirrors for free and throwing in a hundred dollar bill with every order, or at best, making an 18" f/4.5 mirror (and coating it) for a couple hundred dollars, which is ludicrous. Nowadays, a hundred dollars won't even buy someone's attention.

A call to Advanced Glass Industries (one of the glass suppliers) informed me that Corning shut down its Pyrex manufacturing plant, sold off the equipment, and bulldozed the site. But before it closed, AGI and United Lens bought all of the Pyrex glass. Trainloads of Pyrex. Tons and tons of it.

That was about four years ago, and now it's all gone. (The fact that Corning had a four or five year supply of Pyrex on hand says a lot about why they closed the plant.) In any case, it's all gone now. AGI said they were now buying an equivalent glass called SuperMax from Schott Glass Works in Germany, and United Lens was trying to find a supplier in China, but the Chinese glass has terrible quality issues (say: "bubbles, inclusions, stria and strain, when shall we three meet again?"*), and the Schott glass, which is perfect, now costs three times as much as Corning's Pyrex.

One thing to note: Whoever bought the brand name "Pyrex" is selling kitchenware by that name, but is not using the same kind of glass. Instead of using low-expansion (and thus heat-resistant) borosilicate glass, they are using cheaper tempered window glass, which is not heat-resistant and will break if scratched. (Once again, they got your Dollar, and you got something that's probably broken by now. Try Googling "Pyrex broke" for more info, if you haven't already had your monthly exercise from Reader's Digest's "That's Outrageous" column.)

OK. Back to telescope economics. I called the mirror makers and asked them how they could sell a finished, coated mirror for $3400 and pay $3300 for the blank. They said they couldn't do that, and weren't doing that. The mirrors they're offering today were made from blanks that cost $1100. And they've only got a few left, as in, like, ten. Since they sell about one of these mirrors a month, the world supply of (relatively) cheap telescope mirrors will last about one more year, or possibly less.

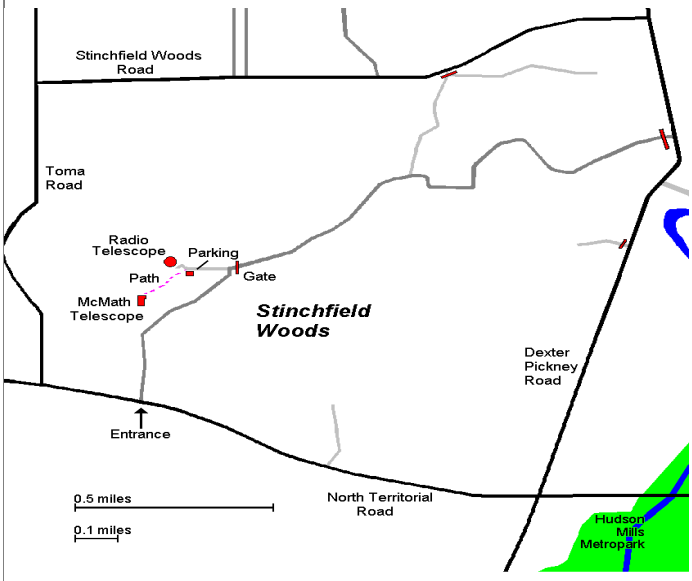
When those mirrors are gone, an 18" f/4.5 primary is going to cost about $5600. Unless it's from China. So don't wait! Do your part for the Economic Recovery, and do yourself a favor as well. Buy one now. As an investment, it's probably better than gold, and you have my word on that.

*My apologies to Wm. Shakespeare and the prescient witches in his most excellent play, Macbeth.

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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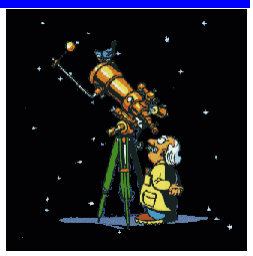
Reflections & Refractions



Website

www.umich.edu/~lowbrows/

Cover & Back-Page images of A. Krishna Rao taken by Mark Bialek for a possible feature story about the Lowbrows and things to do around Ann Arbor. Look for it in the Ann Arbor Observer Magazine.

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Check your membership expiration date on the mailing label