REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers

February 2012

Volume 36 Issue 2

Science Cafes

Dave Snyder

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Science Cafes provide an opportunity for audiences to discuss current science topics with experts in an informal setting. All Science Cafes take place at Conor O'Neill's Traditional Irish Pub, 318 South Main Street, Ann Arbor. Hors d'oeuvres at 5:30 pm; program 6-7:30 pm.

Science Café Schedule as of February 1, 2012

Wednesday, February 22, 5:30-7:30 pm

Evolution and Infectious Disease

Conor O'Neill's Traditional Irish Pub, 318 South Main Street, Ann Arbor Details to be announced.

Wednesday, March 7, 5:30-7:30 pm

Evolution, Obesity, and Public Health

Conor O'Neill's Traditional Irish Pub, 318 South Main Street, Ann Arbor Details to be announced.

Wednesday, April 11, 5:30-7:30 pm

Evolution, Poverty, and Public Health

Conor O'Neill's Traditional Irish Pub, 318 South Main Street, Ann Arbor Details to be announced.

Schedule for Saturday Morning Physics, February and March, 2012.

The Saturday Morning Physics lecture series is located on the Ann Arbor campus. The seminars will be held Saturday mornings, 10:30-11:30 AM in rooms 170 & 182 Dennison on the U-M central campus. All talks are free and refreshments will be served from 10:00 to 10:30 AM before each talk begins. Each talk is followed by a 20 minute Q&A session.

The Church Street Parking Structure is available at a cost of $2.00 per vehicle.

February 4, Roberto Merlin

Peter A. Franken Collegiate Professor of Physics and Professor of Electrical Engineering and Computer Science From Negative Refraction to Wireless Power Transfer: The Path of the Superlens Professor Merlin's talk takes us from the late 1800's, when Abbe published his ground-breaking paper on the limit of resolution of an optical instrument, to the turn of the 20th century, when the field of near-field optics experienced tremendous growth, emphasizing recent work on subwavelength focusing using negative-index slabs. In the second half of the talk, he introduces the concept of near-field plates. These are grating-like planar structures, which provide focusing well beyond the diffraction limit, at arbitrary frequencies.

The subwavelength electromagnetic-field distributions of the plates closely resemble those of negative-index slabs. Practical implementations of these plates hold promise for near-field data storage, non-contact sensing, imaging, nanolithography and wireless power transfer applications. Experimental results on a microwave near-field plate will be presented, which demonstrate focusing of 1 GHz radiation at a resolution of LAMBDA/20.

February 11, Gordon Kane,

Victor Weisskopf Distinguished University Professor of Physics String Theory and Our Real World Professor Kane gives us a primer on string theory. It is an exciting field because it can address most or all of the questions we hope to understand about the physical world, about the quarks and leptons that make up our world, the forces that act on quarks and electrons to form our world, cosmology, and much more. Professor Kane explains why string theory is testable in the same ways as the rest of physics, why many people including string theorists are confused about that, and how string theory is already or soon being tested in several ways, including LHC physics and Higgs boson physics.

February 18, Professor Henriette Elvang

Quantum Field Theory: The Language of Particle Physics Quantum field theory is the mathematical language of particle physics.

It models the interactions between elementary particles in Nature and the forces through which they interact. The agreement between the theoretical predictions of quantum field theory and experimental results is remarkable, and currently new results are anticipated with excitement from the Large Hadron Collider. Professor Elvang illustrates the ideas of quantum field theory, why we need it, and how it is used in particle physics. Feynman diagrams will be explained, and she also outlines some novel approaches that reveal a surprising and enticing mathematical richness in particle scattering processes.

March 10, Dr. Brian Nord Jr.

Research Fellow The Shape of our Universe: The Complexity of Large-Scale Structure and Large-Scale Science In the first of Dr. Nord's lectures he examines questions such as what is the size and shape of our universe? How do we know? What kind of experiments can we actually perform? The universe's shape and internal structure are primarily driven by the force of gravity and by the mysterious dark energy. Over the last century, dramatic strides have been made in our understanding of large-scale cosmic structure, in part due to successes in computational endeavors, which have produced intricate and complex simulations of the observable universe. He discusses both the cosmic web of structure in the universe and the webs of knowledge that support the modern paradigms of complex problems, like those found in physical cosmology. Finally, he examines the changing nature of the scientific endeavor--for example, the evolution of astronomy from the early days of lone observers to large modern collaborations.

March 17, Dr. Brian Nord Jr.

Research Fellow Cosmic Engines: The Complex Evolution of Galaxies In his second lecture, Dr. Nord discusses galaxies, which are the building blocks of our universe's cosmic web. They are held together by invisible dark matter, house supermassive black holes in their cores, and act as homes to solar systems like our own. With such diverse aspects, the evolution of galaxies is a very complex process:

it includes periods of passive growth, as well as epochs of turbulent upheaval. Moreover, the energy released by a galaxy often affects the environment far outside its confines -- potentially shutting off life in neighboring galaxies. Many complex systems are hard to understand, because physics at small scales strongly impacts physics are larger scales. Using both simulations and observations, Dr. Nord tells the tale of a galaxy's life, from birth to death; and discusses parallel scientific challenges that are closer to home, like the exploration of Earth's climate change.

March 24, Professor Finn Larsen

String Symphonies in the Sky: Understanding Black Holes Using String Theory Professor Larsen speaks to us about the gravitational forces near a black hole. Apparently, they are so strong that they can activate the smallest imaginable structures in matter. In this domain, quantum properties dominate and gravity must be interpreted in terms of unfamiliar fundamental strings. Recent research gives convincing accounts of black hole properties by appealing to the intricate vibrational patterns supported by strings.

Some Thoughts on Eyepieces

By Tom Ryan

Eyepieces occupy a special niche in amateur astronomy. Everyone knows what eyepieces are (unlike, say, hyperspectral scanners), and everyone who has a telescope has at least one, and probably more than one, of them. Most people have a favorite eyepiece, and many people constantly buy and sell them, perhaps hoping to find that perfect match between eyepiece, sky, telescope, and observer. The price of eyepieces lends itself to this practice, being neither so high as to be entirely out of reach, nor so low that there is no pride in ownership.

Eyepieces have two unusual characteristics. One, they are an optical system with an external pupil and, take my word for it, that's unusual. The pupil is where the iris goes. In a camera lens, the f-stop iris is in the middle of the lens assembly. In an eyepiece, it is external to the lenses and is where the iris of your eye goes. Two, in a hobby where about half the adherents have made their own optics, or telescope tube assembly, or mount, or drive, or observing aid of one sort or another, almost no one has made their own eyepiece, and almost no one has a good understanding of how they work.

The reason why people commonly don't make eyepieces probably has to do with the prices of commercially-produced eyepieces, which are very low compared to the time and labor an individual would need to devote to making both the optics and their housing. The absence of amateur eyepiece makers certainly isn't for lack of knowledge or skills. In the Amateur Telescope Making series of books, several chapters are devoted to making small lenses and mounting them into eyepiece barrels. Just as with making telescope mirrors and, less commonly, telescope objective lenses, the steps are laid out, along with several example designs and helpful advice on how to make the parts.

In the entire history of the Lowbrows, only one member (of whom I'm aware) has made his own eyepiece. That person is Mark Cray, and the eyepieces (More than one!) that he made are presently in use at the McMath Observatory. They are the massive objects that are placed in the draw tube of the 24" F/25 telescope, and do a magnificent job of reducing its power to Human Scale, and also of serving as focal reducers for photography. (In fairness to other Club members, I should point out that Mark also built his own half scale wooden Viking ship, complete with mast, sail, side mounted shields, and dragon's head, and he sails it out on Lake Erie (or is that Lake Eerie?) when the weather is appropriately foggy and overcast. I tell this to people occasionally, and one person thanked me for it, because he had seen Mark's boat out on the water one dark, cloudy evening as the sun was setting, and had been afraid to mention it to anyone.)

Mark, who is a machinist by trade, made his eyepieces by looking though a box of large surplus achromatic lenses, selecting some that looked likely, and trying them out in various combinations. When he found a combination of lenses he liked, he machined a housing for them, and the rest is history. They perform magnificently in the McMath.

Previously, the Club was making do with a 50 mm focal length eyepiece purchased from University Optics, and everyone agreed that it was a nice eyepiece, but it only reduced the scope's power to 300X, which was still a bit much for many sky objects. Mark's custom eyepieces reduce the power of the 24" to the point where someone isn't forced to use the 6" refractor simply as a finder scope, because the field of view through one of his eyepieces is now actually bigger than the apparent diameter of Jupiter.

When Mark announced that he was going to make an eyepiece for the 24", I'm ashamed to say I was skeptical. I had just purchased a professional optical design program, and every dimension in the program was carried out to seven places past the decimal point, and to sixteen places internally. What did this say about the precision required to make optical instruments? How could Mark build something this precise? I doubted that his eyepiece would work at all, but if it did, I felt certain that the view would be extremely blurry around the edges of the field.

**This follows a standard line of thinking that gets used all too often; Your idea won't work, and if it does work, it won't work the way you think it will, and if it does work the way you think it will, it will have bad unintended consequences, and if it doesn't have bad unintended consequences, it is still morally wrong. And finally, it is just wrong. I can't explain why, but it is.*

When proposing a new idea to someone, it is often fun to see how far down this chain of objections they get. It is harder to catch yourself doing it.

However, when he finished the two eyepieces and we all looked through them, they were pronounced an unmitigated success. They appeared to be sharp to the edge, had a flat field, and reduced the power down to a manageable value. My stunned reaction to this was to think "Yes, this works in practice. But what about in theory?" I then humbly realized that I needed to review some basic facts about optics, because I clearly didn't understand the first thing about why Mark's eyepieces worked so well.

This is actually the major theme of my life. First, I'm confident that I know what I'm doing (usually because I'm ignorant and have an opinion). Then comes an embarrassing and humiliating failure, and eventually I'm forced to actually learn something. (Objective reality can be a wonderful check on arrogant ignorance, especially if it happens fast enough so that not too much harm is done.) Although, at the time, I didn't learn much. I attributed the success of Mark's eyepiece to the slowness of the McMath's focal ratio. Most people who use eyepieces know – or quickly find out – that the eyepiece that works so well on their F/10 telescope isn't quite as good on their F/4.5 telescope. So how much easier must it be to have something that is just thrown together work well on an F/25 telescope? And indeed, the telescope's long focal ratio is part of the eyepiece's success, but only a small part of it.

I was reminded of these events when I was recently asked to design an optical system that replaces the original gunner's sight on a Bradley fighting vehicle. The entire sight consists of a telescope objective and an eyepiece (and some other stuff which isn't relevant to this story). The primary contractor did not have a very good idea of what the optical system was doing, and after reaching a certain spending limit while working through their own failures of understanding, asked their sub-contractor (me) if I could design something for them that worked well and was cheap.

The system I was to replace was not cheap (the eyepiece alone cost the taxpayers about $3k) and the original manufacturer would not give me the prescription for the sight (If you're on the gravy train, you're not going to show someone else the way to the station), but I was fortunate enough to recognize the fact that part of the integrated optical system that was the sight was also an eyepiece. An eyepiece that looked a lot like Mark Cray's design. An eyepiece which could be built using standard, off-the-shelf, out-of-the-box lenses.

A prototype was built, the system worked very well, and I was declared a genius. Or, at least, a useful idiot. Thanks, Mark! I owe you one ;-)

The eyepiece was a Plossl design, which consists of two achromats which face each other. If you put the lenses together in any way other than facing each other, it doesn't work very well. (By "facing each other", I mean that the most curved surfaces of the doublet lenses need to nearly be in contact with each other.) When I analyzed the design to determine how well the lenses had to be positioned in the tube, it turns out that they can be moved around by a sixteenth of an inch or so, and it's possible to see this, too, when you are playing around with the lenses.

Just to be safe, I analyzed the performance of a number of other designs, but none of them were as good or as cost-effective as the Plossl. So we went with that, and taxpayers saved a bundle. Or maybe I should only say that the primary contractor's costs were reduced from what a custom design would have cost. Where those savings eventually went I will leave as an exercise for the reader's imagination.

You can actually make a Plossl eyepiece yourself, just as Mark did. The general design procedure is as follows: Just decide what focal length eyepiece you want (in millimeters; for example, a 12mm eyepiece), multiply by two (that gives 24mm), and buy (or find) two achromats whose individual focal lengths are that last number (24mm or so – the exact number isn't critical), and whose diameters are small enough to fit into a draw tube. Put them in a tube of some sort, facing each other. If they don't fit perfectly, just wrap tape around them. Remember, we are Lowbrows! You might need a lot of tape. Now enjoy your new eyepiece, secure in the knowledge that you are now One of the Few.

Mark's success in eyepiece design was, in part, due to the long focal ratio of the McMath. But his success came mainly from the good choices he made in lenses and to the fact that he actually did something and followed through with his plan, rather than spending all of his time thinking up theories about why the thing that he wanted to do wouldn't work. And, in this respect, we can all learn a lot from him. I know I have.

The Mirror Machine

By Russell M Vente

Hi Lowbrows. I'm writing this article for the newsletter after hearing Mark's plea for some material at the last club meeting. It probably has a small audience and may only be interesting to those who have ever "pushed glass". So my focus will be to point out what is different between making a telescope mirror by machine vs. by hand. There is nothing you can do by machine that you can't do by hand. It's just one hell of a lot less work.

The Machine

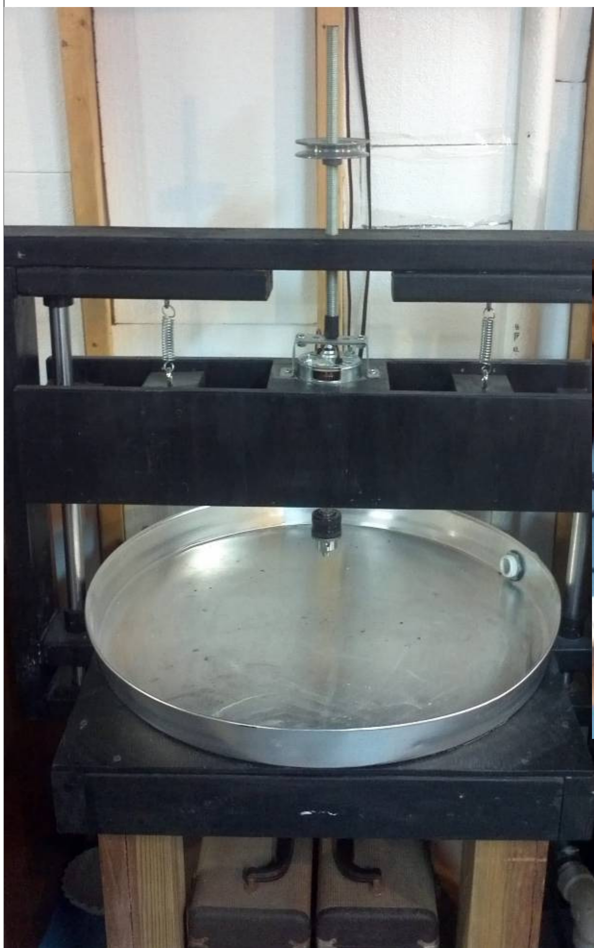
A while back, ten years so, I wanted to make a new telescope, a DOB with a 16" mirror. I already had a 8" Newtonian that I had made in my youth about thirty years ago and thought it was time to get back into the hobby and grind and polish a 16" mirror. The laborious process of rough and fine grinding then polishing a 16" mirror convinced me to try and make a machine. Being an engineer this actually sounded like fun. I searched the net for ideas and settled on the design by Dennis Rech called the Mirror-O-Matic (M-O-M). I choose his larger machine with a 20" turntable. Bought the plans and was soon in construction.

The design by Dennis is a marvelous machine and he has a large following with a Yahoo news group. The one thing I didn't like about it is the turntable and eccentric arm were driven by a single AC motor and a number of pulleys and belts. This requires one to make several belt changes during the process from rough grinding to polishing to get different combinations of speeds for both the turntable and eccentric arm. I choose to redo the drive mechanics using two DC treadmill motors and two DC power supplies to get the speed combinations. Now no belt changes.

Beginning Process

The selection of a mirror blank is the same as before, a good blank with parallel faces etc. The blank should have a flat bottom if not grind it flat, by machine of course, and bevel the edges. Beveling the edges is a simple process with the mirror on the rotating table.

One very important next step is to make a small hole in the bottom side of the mirror. Let me explain. When machine grinding and polishing it is very important to place the mirror back in exactly in the same spot on the turntable after you have removed it from the turntable for cleaning between steps etc. There are probably other ways to do this, but I choose to do a small hole.

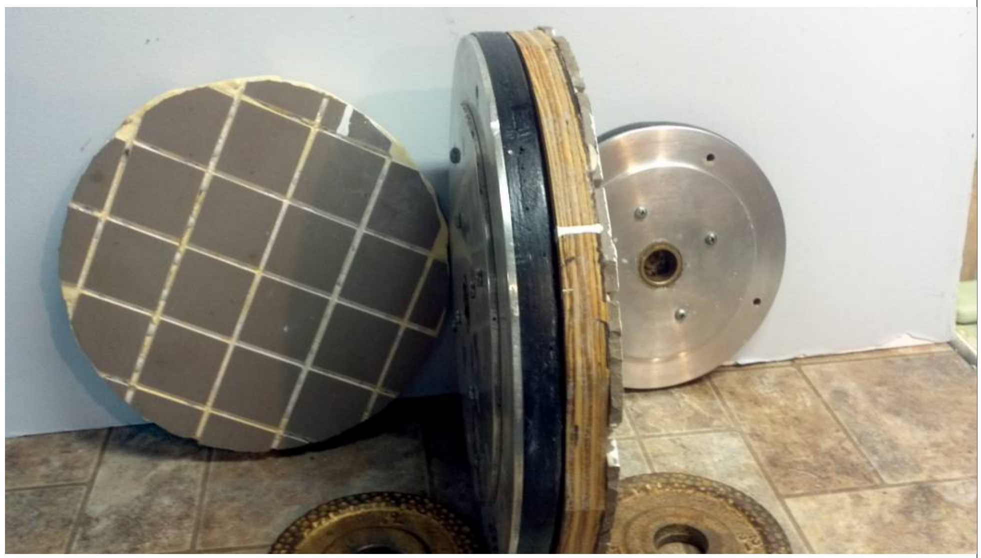


The hole defines the center, its 1/4" in dia and about 1/8" deep. I make the hole with a carbide bit on my hole making machine. I built the hole making machine to put holes through the center of mirrors. I have a great fascination with cassegrain type design for scopes and plan to make one in the future. On the turntable I have a 1/4" acorn nut screwed on a screw that I drilled and tapped into the center of the shaft that rotates the turntable.

Wa La , the mirror is always in the center of the turntable and in the same spot. Before placing the mirror on the table, I put down a cushion for a soft support for the mirror *(see picture below)* and adjust the height of the acorn nut just enough so the mirror hole can find it but not resting on it. The cushion is cut from a cheap thin yoga mat.

Grinding and Polishing

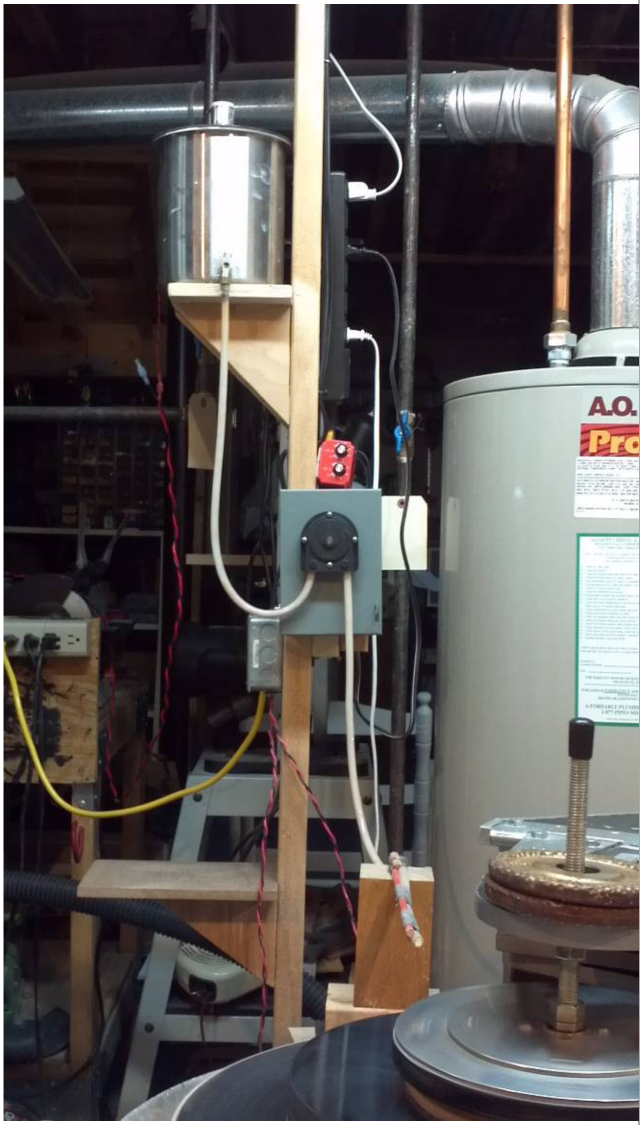
All mirror work is done with the mirror on the turntable, mirror on bottom and the tool on top. The tools are all sub diameter, between 50% and 75% of the diameter of the mirror. The tools are in two pieces. A top half made of aluminum and wood with a hole in the top for the control arm. The bottom half is 3/4" plywood where you adhere the tile for grinding or pitch for polishing. The bottom and top are screwed together. Later on the bottom half can be thrown away if you don't want to clean it off for another project.



There are two advantages to machine mirror making. The first is to speed up the mirror making process. A flat 12" plank can be rough ground (hogged out) to a depth for an F5 mirror in about five hours, say one day. Fine grinding takes another three to four hours. I generally do 30 min for each grit size. The fine grinding step if done correctly produces a spherical curve in the blank. This is checked with a 1/10,000 spherometer during the fine grinding process so all totaled that's another day. All I have to do is sit there and feed the machine grit and water during these grinding stages. So in two days I'm ready to polish.

Polishing is quite easy because I don't have to sit there. I made a cerium dispensing system consisting of a tank, a peristaltic pump and an on-off timed relay. Polishing out a 12" blank takes three to five hours, after which initial testing can be done. I use the Ronche test at this point.

The second advantage to machine mirror making is that it is very unlikely the mirror surface at the end of polishing will have any astigmatism. The mirror at the end of polishing ideally would be perfectly spherical. I have not managed to achieve that yet. I usually end up with an under corrected figure, sometimes with a raised center and sometimes with a turned edge, but no astigmatism.



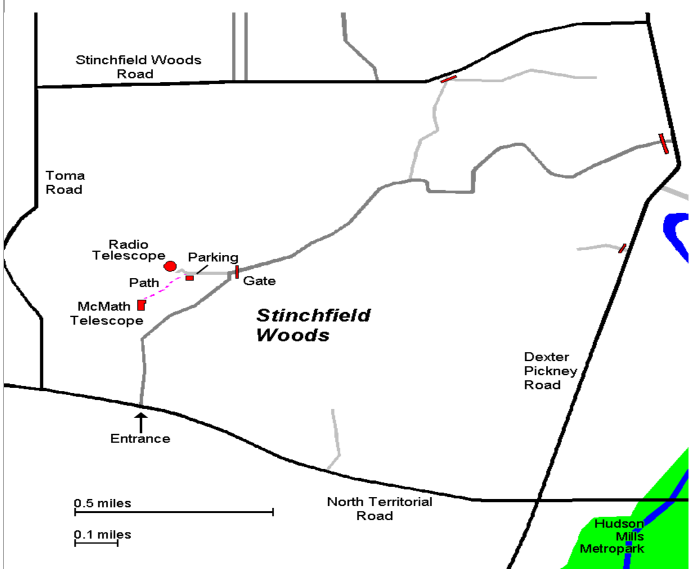
Conclusion

So has all this machine building been worth it? People who know me know I like to build things; the journey is 50% of the fun. The answer to the question is YES. Have I finished any mirrors including figuring with the machine, NO. I have ground and polished four mirrors from 4" to 16" mainly to practice using the machine. I have not figured these mirrors yet, I also want to do that part with the machine. I have fiddled around enough now to tackle two projects to completion. I purchased two 14" fused quartz blanks, one I'm going to make a Newtonian DOB and the other a classical cassegrain. I have an 8" F21 classical cassegrain now that I can use in the meantime. It's a great planetary scope. I did not make the optics for this, they were purchased but I did make the optical tube assembly.

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

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

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: **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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THE HELIX NEBULA (NGC 7293)

Picture was taken last fall from Brian Ottum's backyard in Saline. It represents about 80 minutes' worth of exposure. Given the light pollution around his house, he was limited to 2 minute exposures. So that means he took 40 separate images. The camera is a Canon 20D that has had its infrared filter removed so that the deep reds from glowing hydrogen gas clouds in space can come through. The telescope is a Taiwanese-made 10" f/5 Newtonian reflector. A small refractor piggybacked on top contains a simple autoguider (Orion Star-Shoot) that feeds to an old laptop running a free autoguiding program (PhD Guide). He used ImagesPlus software and PhotoShop to process the image. The processing & tweaking probably took him four hours (not unusual to spend more time processing than actually shooting).

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