



## Eye-piece Economics

By

Tom Ryan

Doug Scobel recently wrote an article in this newsletter about eyepiece aberrations, which prompted me to write an article in which I compared the optical performance of different astronomical eyepieces. (If you haven't seen these articles, please pay your dues to gain access to the archives.)

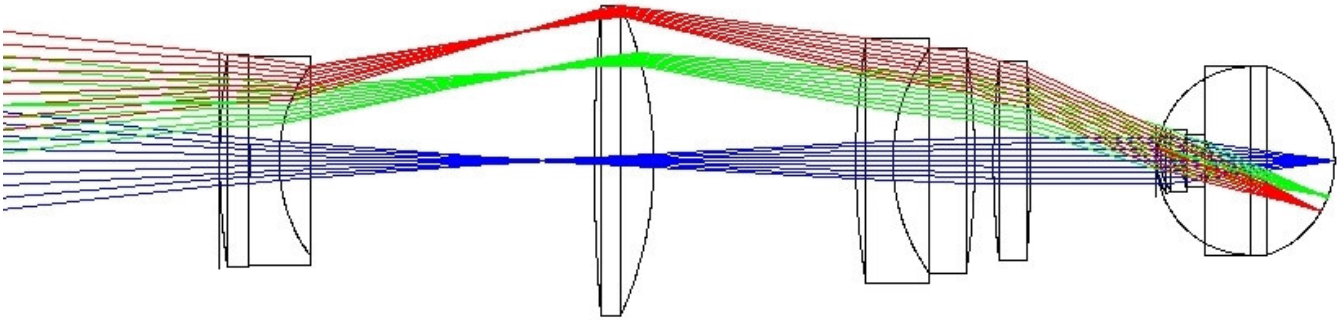
That second article showed that the sharpest eyepiece ever produced for short focus Newtonians is the Pretoria eyepiece, which corrects the coma of a Newtonian's parabolic mirror and makes star images sharp (on par with the limit of resolution of 20/20 human vision) right to the edge of the field. I have the good fortune to own one, having gotten it used from a seller who needed money to buy an eyepiece with a field greater than 50 degrees. (!!! Man, I hope he got what he wanted. I sure did. I'm still waiting for that person who wants to swap a Questar for a flat tire.) Unfortunately, the Pretoria has one major drawback. It is no longer made.

You might think that, because the optical prescription was published in Telescope Making Magazine and never patented (to the best of my knowledge, and I had a search done) that someone would be making these things. But no, no one is.

My vocation and avocation is optical design. I also own an improbable amount of equipment for making and testing optics, but that stuff is actually just an adjunct to the optical design business. Believe me, a mechanical designer becomes much more valuable if he has manufacturing experience, and the same is true of optical designers. (Imagine what your house would look like if the architect had never watched someone build a house. I've been brought in to fix optical designs that looked just like that house would, with the original optical designer banished to "Just Pick the Video Camera

from the Catalog”, Seventh Circle, Optical Hell.) The manufacturing equipment supports itself through a steady flow of jobs and indirectly through manufacturing enquiries which turn into design jobs. Design is more profitable, but is less constant, so I’m always looking for manufacturing jobs which will take up the slack. Hence, my interest in an excellent, overlooked eyepiece.

A few months ago I was asked to design an instrument that photographs the retina of the human eye (and which, incidentally, you will probably use, or more accurately, have used on you, before you die. And if I design it right, there will be more than 30 seconds between the two events), and what better front end to use than the Pretoria?



Think about it. An eyepiece forms an image of the object on the retina. (This argument might be clearer if you think of a microscope.) Why not just reverse the direction of the light, and form an image of the retina onto a CCD? A microscope actually does form an image of the retina on the microscope slide; it’s just not very bright, because the retina is about as bright as coal dust. Light up the retina with enough light, and the microscope slide or CCD can see it in sharp focus.

Most eyepieces are really Not That Good, but the Pretoria is an exception. It’s nearly diffraction-limited right out of the box, it’s in the public domain, and I want to produce a lot of them. Hence, I put one on the front end of the instrument.

It turns out that most of the glass types that were used in the original Pretoria are NLA (no longer available), so I redesigned it with currently available Schott preferred glasses. I also decided to take a leap of faith (something that the original designers considered but rejected – gulp!) and corrected the aberrations of the human eye. The eye is nearly diffraction-limited, but it has a lot of color error, removed by brain processing (salt water with a weak solution of proteins is not Calcium Fluoride, although the cornea *is* a gradient-index lens), so I corrected for the eye’s color error in the new design. After all, the CCD imager in this instrument can’t count on being followed by a 1000 terabyte processor to deconvolve images in realtime to remove blue halos around every image point.

I want to mention here that I’m looking forward to getting corneal implants when my own eyes get cataracts. I’m going to insist on achromatic implants, and thus free up about 90% of my brain’s image processing capacity for other uses; something I expect I’ll need about then. Also, I want Titanium and Teflon replacement joints.

While I was designing the rest of the instrument, an email went around the Lowbrow mailing list about TeleVue’s new Ethos eyepiece. Some people complained about its high price, so I thought I would make a rough cost estimate and see if their complaints were justified. My email analysis follows:

**Subject: Re: Ethos review**

Someone has probably already estimated the manufacturing cost of this thing, but just for grins, I will, too. I couldn’t find its design in the patent literature, so I’ll just have to guess at most of this.

In production quantities of 1000/yr, you can buy a single, arbitrarily shaped lens element of 1"-1.25" diameter for about \$45. (These are prices from US optics manufacturers.) Let’s say the Ethos has two of these. In the same quantities, a lens element that is 2"-2.25" diameter will cost a manufacturer between \$65 to \$105, depending on the glass type and whether or not the lens has to spend time on an automatic aspheric polisher. Let’s say that the Ethos has four or five of these, at an average price of \$75 (with only one aspheric element). A coating run costs \$1000 to open the chamber, so the price of coating an individual lens will depend on how many lenses will fit in the chamber, and how special the coat-

ings are. Let's say the chamber is 20" in diameter, and can coat 100 lenses at a time. The coatings will then cost about \$10 per lens element. So the glass cost will be about  $\$90 + \$340 + \$60 = \$490$ .

The lens barrel can be CNC machined from 6061-T6 bar stock on a nice lathe in about six minutes, threads, lands, machine unloading and all. Aluminum bar stock is solid electricity and costs about \$6.50/lb. The eyepiece looks to be about 3" in diameter and 6" long, so the material would cost about \$28. CNC time is about \$120/hr, so machining labor would be about \$12. A set of lens retaining rings might add another \$12, because they are fussy. Anodizing costs about \$100/batch, and you could get about eight or ten bodies in a batch, for \$10/eyepiece. Black anodized retaining rings add another \$2/eyepiece, because you have to have similarly sized items in a batch. Add an eyecup and special paint for another \$5/eyepiece, and the body costs about \$70.

Assemble the thing in a clean room at a rate of 5/hour, where the labor and overhead runs \$80/hr, and assembly costs you \$16.

Now you have made an eyepiece that costs you \$576, and you still have to advertise it, ship it, and handle returns, but those will come out of your considerable profit. Let's say you give your dealer a markup of 3%, so your before-profit costs are about \$593. To get some initial interest going, let's mark the first ones down to the bone, make \$27 on each one, and then, when enough people start to buy these, finally raise the price to the point where manufacturing eyepieces gives us a better income than working at Wal-Mart.

Of course, this exercise assumes US manufacturing prices. However, the cheaper prices that come from manufacturing overseas bring quality problems, which are the very last thing a boutique manufacturer wants.

It looks to me like the eyepiece is priced low right now. I'd like to own one, because I like wide field views when I (infrequently) observe, but I also like point images. I think I'll wait until I can try someone else's before I even start to think realistically about buying one (and even then, I'd like to buy one used). And Charlie, there is an astigmatism corrector that fits this eyepiece, for those of us who must wear glasses.

Tom Ryan

.....Well. Twenty seven dollars profit with \$593 at risk. So, how does that sound to you? Ready to put that \$593 into a passbook savings account? Still, that was just a guess, and I pressed on with the design of the instrument.

A week ago I had enough information to get manufacturing quotes from American lens manufacturers. Here is what one of them said:

I am writing to respond to your request for a ROM quotation for the Imager lens with 3 bonded doublets and 3 other lenses. For three sets coated lenses (standard visible coating specs) the price would be roughly \$13,585 with \$2000 of NRE/Tooling. For 10 sets of coated lenses the price would be roughly \$17,164 with \$2500 of NRE/Tooling. Lastly, for 100 sets the price would be roughly \$49,116 with \$4000 of NRE/Tooling. I feel that my lens fabrication pricing and coating pricing is quite sharp, however, our assembly area is swamped so I made some assumptions there rather than delay the process. Please let me know where we stand once you've had a chance to review this and what your probable timeline might be. Thank you for considering us for this work.

Let's look closely at this quotation. To make 100 sets of this instrument, it will cost  $\$49,116 + \$4000 = \$53,116$ , for a unit cost of \$531.16. This is just for the lenses. The total cost of the instrument will be much, much more. (I estimated glass costs of \$490 for the Ethos, but in all fairness, the above quoted instrument contains more lenses than the new Pretoria would alone.) Now, the investors will go ahead with this instrument, because, as I said, each of you will pay to use this instrument before you die, and there are a lot of you. (God, I love monopoly capitalism. (I sometimes hate it, too, but that's because I'm just on the edge of its benefits, sometimes in, sometimes out.)) But the same can't be said for an eyepiece.

High production quantities bring down the price of lenses. The rotten thing was that the retina instrument's design requirements changed the front end Pretoria to the point where it wouldn't correct for the coma of a Newtonian telescope

anymore, though its new form was excellent for the retina imager. It couldn't be extracted from the design and used independently on telescopes, and therefore the production costs of the new Pretoria eyepiece couldn't be piggy-backed onto the instrument's costs. It would have to stand alone.

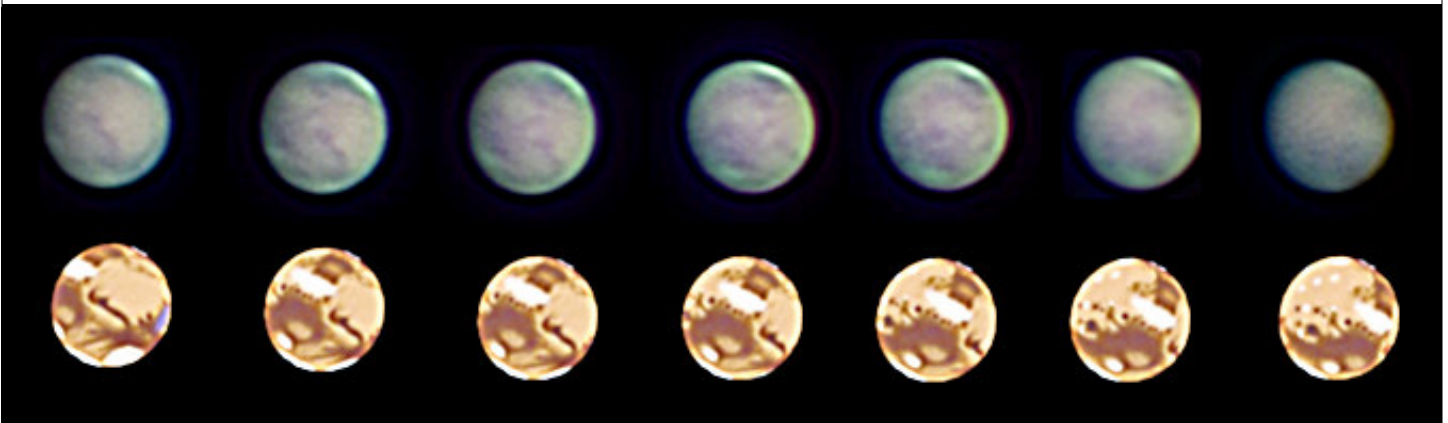
I'm a firm believer in experience (I believe that much, much experience + a jaded, intelligent eye = a slight chance at prediction), so I asked Jan Seyfried of University Optics why he didn't offer the Pretoria anymore.

Jan, as you may know, is the person who funded the manufacture of the original Pretoria eyepiece.

He said that he had to put a lot of money out to produce the original production run of 28 mm Pretoria's from his factory in Japan. They sold slowly, and it took a very long time for him to get his money back, a very long time, as in years. He was never tempted to repeat the experience.

Why did they sell slowly? Who knows? It could be that they were too expensive for their target audience twenty years ago, when we were younger and poorer. It could be that most people prefer flat tires to Questars. It could be anything.

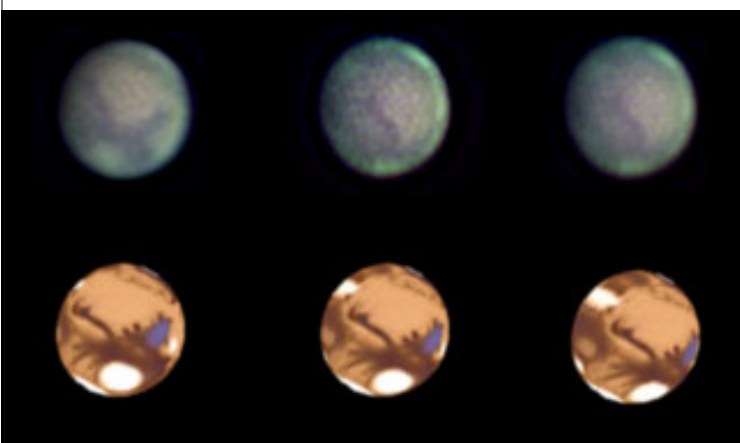
Circumstances may have changed. There may be a profitable market now for new Pretoria eyepieces. But someone will have to take a significant risk to find out.



### Aperture isn't everything

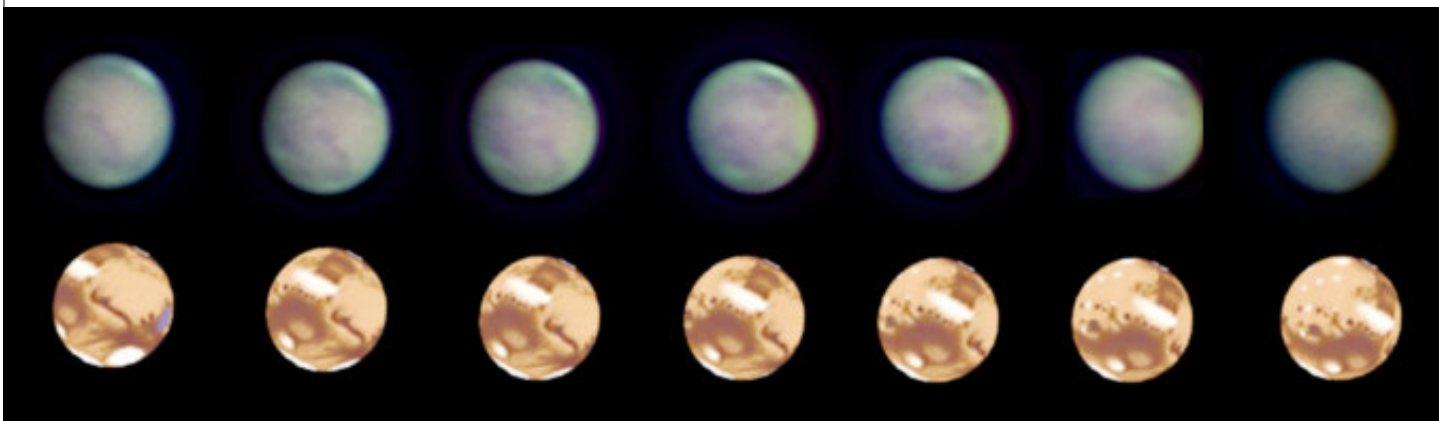
By Brian F. Close, J.D., LL.M., M.A., T.N.\*, Michigan Exile \*"Telescope Nut"

Last year in anticipation of the Mars opposition I started looking for a D&G Refractor. With the search magic of Astromart, which archives everything, I found a 5" F/12 D&G looking for a new home. The only drawback was that it was in Australia. The current owner hadn't been able to find any buyers, partly due to customs concerns.



Well, that didn't make any sense. D&G's are made in the USA, so reimporting it should be duty free. So a deal was made, a slow boat shipper found (cheaper to ship to LA than Seattle), customs declarations signed, a niece-in-law to pick it up in LA and hand it over to UPS, and here it is in Bozeman, Montana (Picture). (Though I'll never understand why I needed to pay a \$50 forklift fee for a package that weighed 28 lbs.) The whole thing with shipping cost me \$1000 US. (First light: the Lyra double doubles at 600 power!)

Onto the AP 800 Mount, and away to Mars we go. Attached are a series of images taken in January after I finally got my skill level up (Mars Preview images included for comparison). The refractor is a traditional crown and flint doublet, so chromatic aberration needs to be adjusted for, and is done by reducing saturation in K3CCD. It's a fine balance between real color, false color, and no color at all, and the adjustment becomes difficult as Mars gets lower in the atmosphere. I'd love to try an Aries Chromacor or Baader's Fringe Killer, but not on my budget.



So I'm very happy with my 5" D&G refractor, and I recommend the club find a used one too and put it on the 24" (D&G's come up on Astromart about twice a year). There will often be seeing conditions that won't justify using the 24", especially on planets, where a smaller aperture will receive better results.

Technical details as follows:

5" F/12 D&G Refractor, at f/60 w. Astro-systems 5x Imagemate Philips Toucam, 5 frames per second 900 seconds, K3CCD Tools, Gain zero, Saturation and Gamma at 50%.

Processed in Registax 4, saved as TIFFS, converted to BMPs and sorted in IMERGE (all freeware, except for K3CCD Tools, which is shareware).

Next up, Saturn!! (And 100 double stars).

*Here's Brian, and his Astrodog Max, outside his Bozeman residence. Brian runs his scope from the house and has observed at -20 deg. F.*

*(Note: Toucams shut down at around -15 deg. F)*

*Brian can be contacted at [taxatty@imt.net](mailto:taxatty@imt.net)*



### A Beginning Amateur Astronomer Part 3

By George W Ferrier

After starting out with only myself just looking at the Night Skies, I was able to get Two of the neighborhood children to view with me, and I was able to show them M42 ,The Pleiades and Mars. I now have Five to Seven Neighbors viewing with me; they range in age from 8 to 23 years old. We had a new family move in the neighborhood, but have not had a chance to talk with them as of yet. I know they have at least 2 children. One of the Gentleman who has been doing some viewing with us brought a friend and he has a 9x 63 Binoculars and we have been using them to do some viewing at Arbor Oaks Park which is on Champaign between our House and Bryandt School and we can see ORION quite clearly. I have started a project of Tracking Mars as it transits thru GEMINI, but because of the Sky Conditions, I have only 6 Viewing nights since November 18th. Sometimes the sky will be clear at 7:00 P.M. and until about 8:45 P.M. and we are able to view faint objects by "Sweeping the Sky".

As I stated previously I have been tracking Mars and sometimes I can only see 5 or 6 Stars of GEMINI, but most of the time I can only see 3 to 4 Stars. On December 5<sup>th</sup> I observed Mars just past Mebusta (which I learned from Mr. Deprest), then on December 12<sup>th</sup> to my AMAZEMENT plus adding to my confusion and frustration of understanding the Stars and Planets, after returning from Dinner with my Wife Patricia at 8:00 P.M. I noticed that the sky was clear, but I could only make out a few stars. I could only see Pollux, Castor, Gamma Geminorum and also Procyon of Canis Minor. I then noticed Mars which was at about a 3.0 magnitude, but to my surprise it was BELOW GEMINI and just above Canis Minor. And I cannot understand this. I have not been able to do any viewing lately because of the Weather so I was not able to plot Mars at these times The last time I Observed Mars on December 5<sup>th</sup> Mars just passed Mebsuta and then on the 12<sup>th</sup> it was below GEMINI.

Here are some of my Observations:

**December 3, 2007 7:45 P.M.**-I was able to view for a short period tonight and Mars was just above Mebsuta. I could only see 4 Stars of GEMINI and also could not see ORION.

**December 5, 2007 6:45 A.M. & 8:00 P.M.** - On Wednesday morning I was able to view a Triangle formed by The Moon, Spica & Venus. At 8:00 P.M. I observed Mars which was just passing Mebsuta and I was again unable to view GEMINI.

**December 17, 2007 6:45 P.M.** -Finally a clear night. I observed the ISS passing NW to NNW at about 23\* for 1 minute, at 7:10 P.M. I could view Mars which was only 23\* above the Horizon but not any Constellations.

**December 18, 2007 9:45 P.M.** I cannot believe it two clear nights. Mars, GEMINI and ORION both cleared the horizon, and Mars was 25 above Mebsuta and straight up from Betelgeuse. I looked again at GEMINI at 11:00 P.M. and noticed that Mars was almost straight overhead.

**December 23, 2007 6:35 P.M.**-Another Prately Cloudy Night, but I could see Mars which was 1\* below and left of The Waxing Gibbons Moon.

**December 26, 2007 11:20 P.M.**-A clear cloudless night with GOOD CLEAR Viability. Mars was just about overhead and really bright, if Betelgeuse is a -1 magnification then Mars would be a -2. Mars, Rigel and n (Eta) formed a Triangle and Mars was also straight up from Betelgeuse. The Moon was just below Betelgeuse but its glow did not interfere with my viewing. I was also thrilled to observe the ORION Nebula (M42& M43) which was quite clear and distinct and The Pleiades. I could make out six Stars in Pleiades which did look like the Little Dipper but with a faint star above (?). I was also able to observe 3 distinct fuzzy Haloes one-above-the-other in ORIONS Sword with the bottom one having a Bright Star at its center. I think that I now know why I was befuddled on December 12<sup>th</sup> when I thought I seen Mars below GEMINI. I think that when I observed Mars at 8:00 P.M. I mistakenly thought that Stars I seen at that time was not of GEMINI, and that GEMINI had not cleared the Horizon yet.

## University Lowbrow Astronomers Calendar of Events

- **Saturday March 15, 2008.** (10:30 AM). Saturday Morning Physics (hosted by the University of Michigan Physics Department). Professor Samuel C. C. Ting (1976 Nobel Laureate, MIT) “Encounters with Modern Physics.”
- **Saturday, March 15, 2008.** *May be cancelled if it's cloudy or too cold.* (Starting at Sunset). Open House at Peach Mountain.
- **Friday, March 21, 2008.** (7:30PM). Monthly Club Meeting.
- **Thursday, March 27, 2008.** (7:00PM). Public Lecture: “Exploring the Outer Solar System: Present and Future” (hosted by the Michigan Center for Theoretical Physics).
- **Saturday March 29, 2008.** (10:30 AM). Saturday Morning Physics (hosted by the University of Michigan Physics Department). Emeritus Professor Lawrence W. Jones (Physics, UM). “Cosmic Rays.”
- **Saturday April 5, 2008.** (10:30 AM). Saturday Morning Physics (hosted by the University of Michigan Physics Department). Professor Dragan Huterer (Physics, UM). “Dark Energy and the Accelerating Universe.”
- **Saturday April 5, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.
- **Friday, April 18, 2008.** (7:30PM). Monthly Club Meeting.
- **Saturday April 26, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.
- **Saturday May 3, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.
- **Saturday May 10, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.
- **Friday, May 16, 2008.** (7:30PM). Monthly Club Meeting.
- **Saturday May 31, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.
- **Saturday June 7, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.
- **Friday, June 20, 2008.** (7:30PM). Monthly Club Meeting.
- **Saturday June 28, 2008.** *May be cancelled if it's cloudy.* (Starting at Sunset). Open House at Peach Mountain.

*J.J. Fernandez's version of Comet 17P Holmes and NGC 1499 (California Nebula) use with permission*





*Total Lunar Eclipse  
February 20, 2008*

*Copyright 2008 Doug Scobel*

**Night Sky Network**

"Astronomy clubs bringing the wonders of the universe to the public"

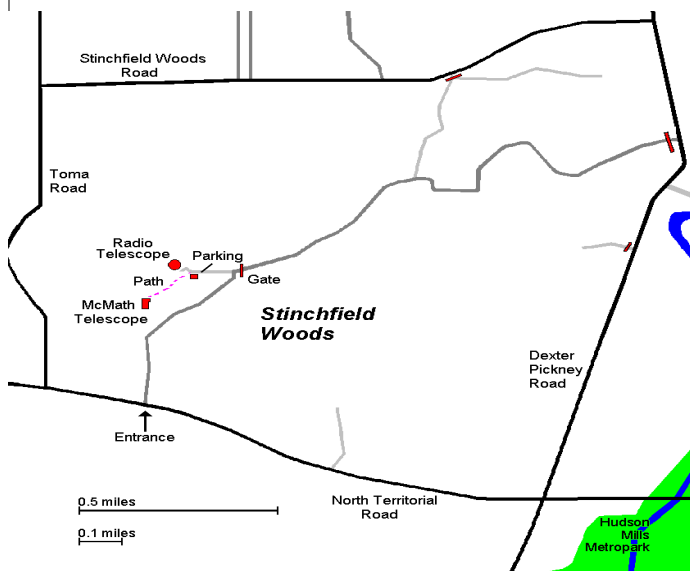




**Places & Times**

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 3<sup>rd</sup> 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 Astronomer c/o Yasuharu Inugi**

**1515 Natalie Lane #205  
Ann Arbor, MI 48105**

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](mailto:msdeprest@comcast.net) to discuss length and format. Announcements, articles and images are due by the 1<sup>st</sup> day of the month as publication is the 7<sup>th</sup>.

**Telephone Numbers**

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	Treasurer:	Yasuharu Inugi
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	Fred Schebor	(734) 426-2363
	Charlie Nielsen	(734) 747-6585
Webmaster	Dave Snyder	(734) 747-6537

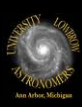
**Lowbrow's Home Page**

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

**Email at:**

[Lowbrow-members@umich.edu](mailto:Lowbrow-members@umich.edu)



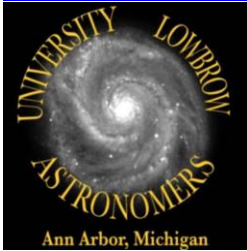


## University Lowbrow Astronomers

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### Reflections & Refractions

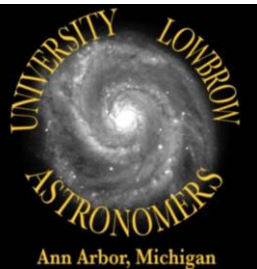


### Website

[www.umich.edu/~lowbrows/](http://www.umich.edu/~lowbrows/)



*Image of February 20—21, 2008 Total Lunar Eclipse this was taken at 03:08 UT during totality, by Mark S Deprest .*



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