REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers

December 2008

Volume 32 Issue 12

A Simple Head's Up Display

By Tom Ryan

One of the reasons I like working on military stuff is that the military always seems to have the most advanced stuff. I first learned this from reading Starship Troopers back in 1964, but it is still (fortunately) true today. They had Head's Up Displays long before General Motors began advertising them as safety devices in cars (remember when cell phones were sold as safety devices in cars?), and if you think about it for a moment, it's easy to see why. Every soldier costs about a million dollars to train and equip, and it just makes sense to protect that investment and give him the best chance of bringing it back from the field.

Head's Up Displays are devices which superimpose an artificial view over a user's real view for the purpose of presenting the user with information in a very natural manner. Until we can directly stimulate the retina, we have to rely on external optical devices to arrange that. The artificial views can be such things as virtual reality worlds, weapon targeting information, automobile dashboards, infrared camera views of the area in front of the user, or anything else that can be presented as an image.

Head's Up Displays are simple to design in principle. You just need to collimate the light from a display (change the conical ray bundles coming from every pixel to be parallel so they appear to be coming from infinity) and use a beamsplitter to project the resulting light into the eye. A beamsplitter is used so the person can see both the projected image and the real world at the same time. The collimator is just a telescope in reverse, and the beamsplitter is just a beamsplitter. In fact, if you placed an illuminated slide of Saturn at the focal plane of your telescope and then looked in the end, you would see Saturn, apparently at infinity at the bottom of your telescope.

Of course, simple to design in principle is not always simple in practice. The HUD I was asked to design needed to be big enough for the user to be able to use both eyes when viewing the scenery, needed to have the artificial view in full color, needed to have a fairly wide field of view, and needed to fit into a very small space. Plus, the prototype couldn't cost very much, but it needed to work.

Using both eyes means that the diameter of the reversed telescope needs to be bigger than the interpupillary distance, which for most people is about 66mm. Since the user could be bouncing around somewhat, and perhaps too excited to be expected to perfectly center his head in the outgoing beam, the optics need to be bigger than this; about 200 mm in diameter. So we have an 8" aperture telescope. No problem.

The desired field of view is 40 degrees, so we need a telescope with a field of view of 40 degrees. Some astrographs have very large fields of view, so we're still OK.

The display is in full color, so the system, unlike the systems in fighter planes, needs to be fully color-corrected. This is harder.

There is about nine inches of space available into which our 8", 40 degree field of view achromatic telescope must fit, so our system needs to be about f/1.0. This severely limits the number of telescope designs which can be used.

A compact Schmidt system comes to mind, but space requirements place the aspheric corrector plate in a position where it also affects the outside view, so that won't work.

The design I settled on was a reflector-corrector system, with a mirror providing most of the focusing power and lenses to flatten the field. To get a sense of how the field curves (you want it flat) with different mirror and lens combinations, I set up a system using a fast mirror and lenses I had sitting around and my computer monitor as the display.

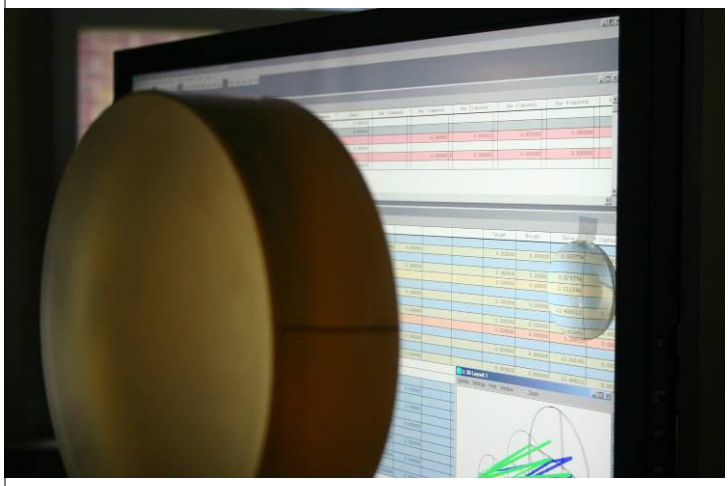


Figure 1. 6" f/1.4 mirror and field flattening lens

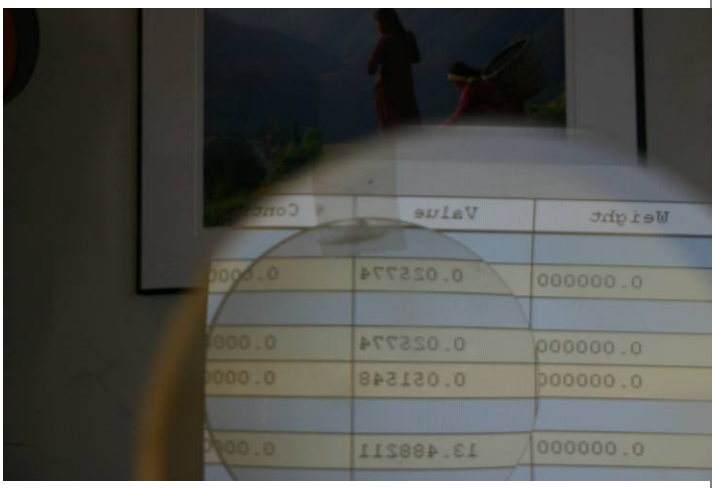


Figure 2. Field flattening lens unflattens the field too much.

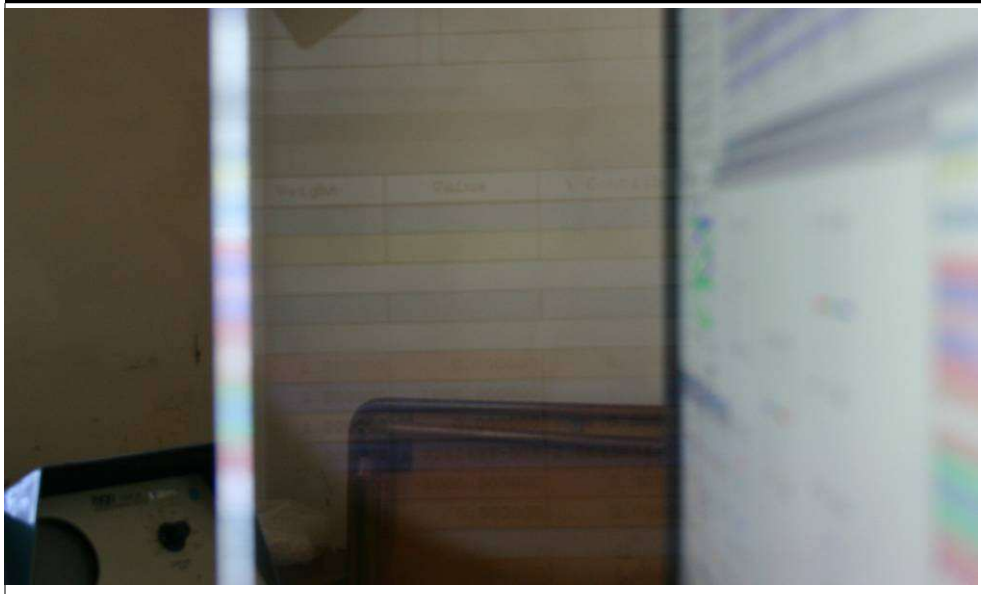
The first, small lens I used showed that the field could indeed be flattened, and the resolution of a system like this was visually very good. However, the lens was not well matched to the mirror, and it overdid the field-flattening job.

Figure 3. Mirror, large lens, and beamsplitter cut from window glass.

Figure 4. Mirror, 45 degree beamsplitter, lens and display.

I tried again using a bigger lens, and that worked better. I wanted to get a straight-on view of the image, so I cut a slice from a piece of window glass and used it as a beamsplitter.

The mirror and beamsplitter are not aluminized, so the image is not very bright. However, it covers a large angle (when you are close to it), it has excellent resolution, and the image is perfectly superimposed on distant objects regardless of head motion. This is the system I based my final design on.



A telescope based on this design would cover a 40 degree field of view with a flat focal plane, but would not have very good resolution. (To say nothing of the fact that it has a giant beamsplitter in the middle of it.) A HUD has to have good resolution when viewed by a human eye, which only samples a 5mm diameter bundle of light coming out of the telescope. That means that good performance can be had with optical element accuracies on the order of window glass, but it also means that aberrations grow very large when the pupil is expanded from 5mm to 200mm.

Figure 5. Collimated, wide and flat field and very dim display

I thought my first encounter with HUD's occurred when I did some optical design work for Kaiser Optical Systems, which makes HUDs for fighter planes. These were very expensive devices which stood between the pilot and his windshield. You can see the beamsplitter part of the HUD in the cockpit in plastic models of F-16's. Kaiser's HUDs use volume holographic mirrors to reflect light from a display which uses a special monochromatic phosphor, and the efficiency of such a device in see-through and projection is close to 100%. (Don't expect to see this in a GM car any time soon.)

However, as I began to design new HUDs for other customers, I realized that I had seen HUD devices much earlier than Kaiser's. I even owned one. You probably do, too. It turns out that a Telrad is a Head's Up Display. It superimposes a collimated target on the night sky.

Figure 6. A TelRad and two designs derived from it.

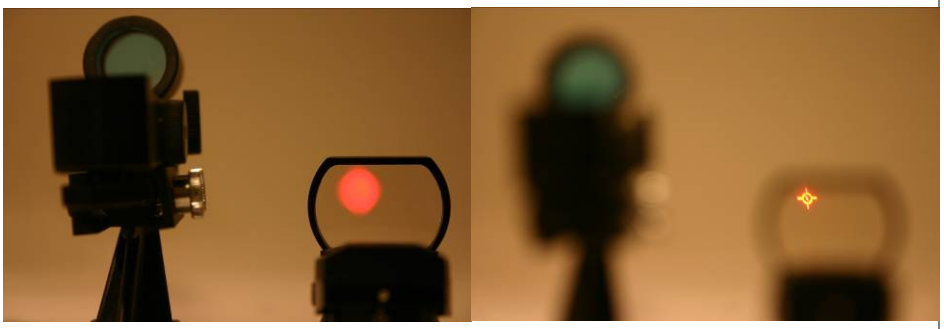
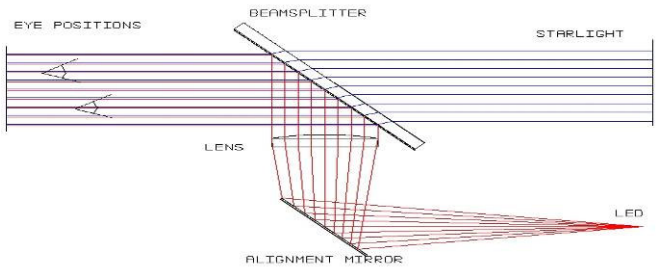
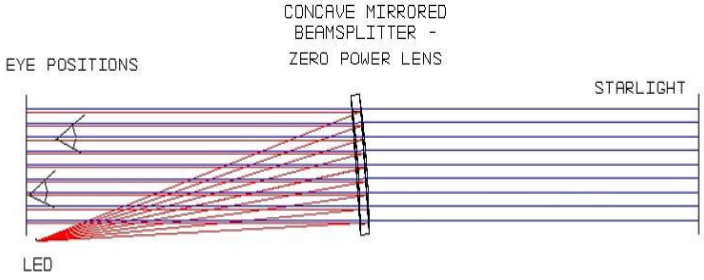


Figure 7. A view of the projected image in a Telrad derivative. Lots of off-axis astigmatism. Note also that the beamsplitter in the other device transmits green light; it is coated to reflect the red LED light, so it transmits red light poorly.



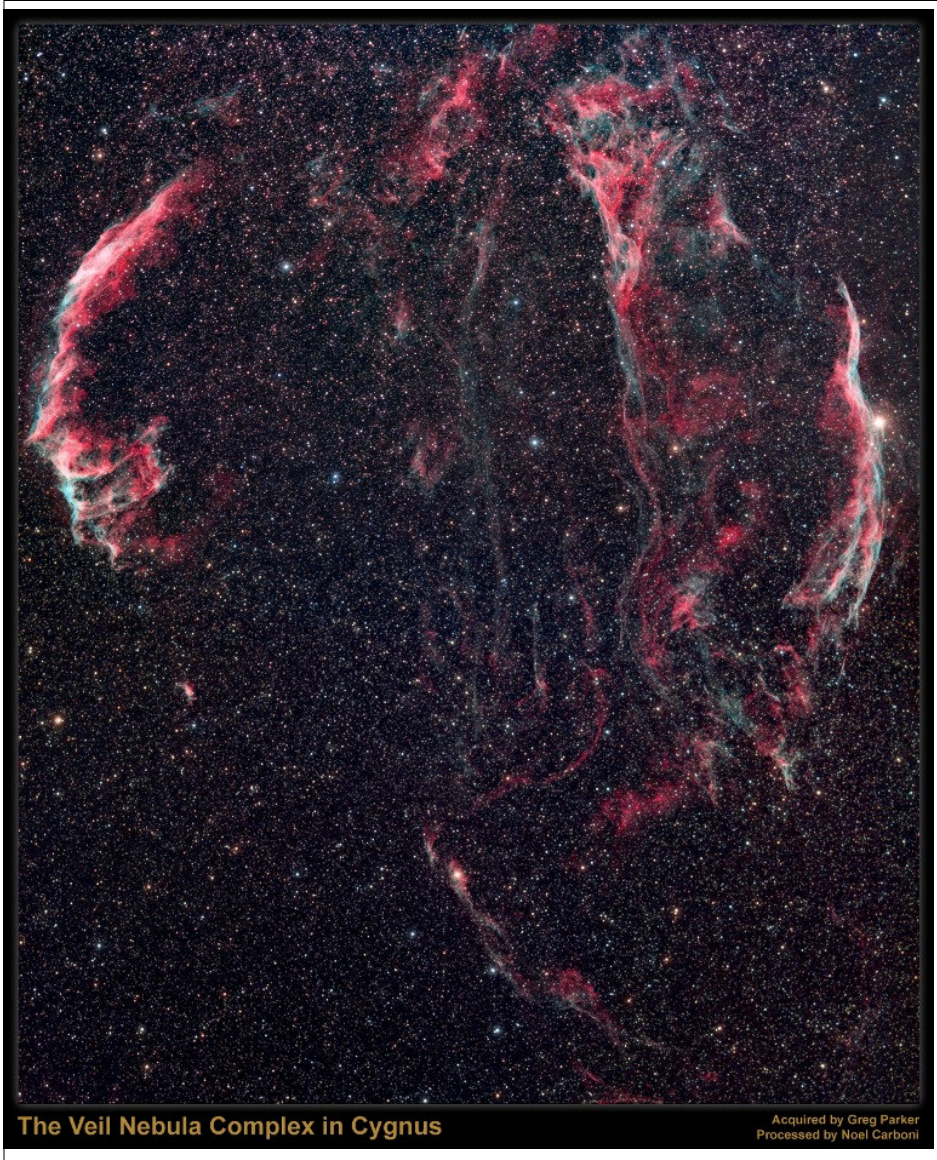
Refractive Telrad



Reflective EZ-Finder II

In both of the finders above, the lens or the mirror just collimates the light from the LED, so the eye perceives the image to be coming from infinity. The LED may illuminate a small crosshair or dot, to make target shooting more fun. No matter where your eye moves within the beam, the light always appears to be coming from the same direction.

Telrads have been around for a long time. They have been copied a lot, and there are even two companies in this area (Southeastern Michigan) which do nothing other than make modified Telrads for weapons. Obviously, there's more money in that right now than in Astronomy. I just hope the inventor of the original Telrad made out OK.



Veil Feelings for Non-Astronomers

By Bill Mclean

I had been reading about the Veil Nebula and the North America Nebula (NGC7000) in a past issue of The Sky at Night. I really wanted to observe these objects and studied the charts and they seemed easy to locate. The article's author suggested spending an evening on the Veil. That was the mindset I had when I went to York River, November 1st.

I pulled into the park just at sunset, which allowed plenty of time to set up and get comfortable. There were maybe 10 astronomers set up already and before it was completely dark, I went around, refreshed acquaintances, and introduced myself to others. Daryl Douglas asked if I would put my name in a log of folks there. With the Veil in mind, I expressed my intentions to him and he told me to come by and he would show me the nebula using his scope.

When it got a bit darker, I scanned the Veil area at low power but couldn't find it. I knew I needed fairly dark skies to see this nebula and after an hour or so, I went over to Daryl's scope ready for instruction. That's one of the things I like about astronomers in these clubs- they are most gracious and willing to help- there is no keeping secrets- they're happy to share. He showed me the Veil in his 15" so I'd have an idea of what to look for. There are two bright parts- the Witches Broom (6960) and the Complex (6992). He let me loose on his scope and I became familiar with that part of the sky as I slewed around. Then he let me borrow a 30mm EP (40x) and a nebula filter because I really wanted to use my own scope and wanted to spend some serious time on it without encumbering another's scope.

I excitedly installed the EP/filter in my 10" Dob and quickly found the Veil Complex. I did some things O'Meara suggests- hyperventilated and later forced my eyes to see with a dark cloth over my head during what has turned out to be a budding love affair with the Veil. I spent the better part of 5 hours viewing this and later the N. America. I'd observe for

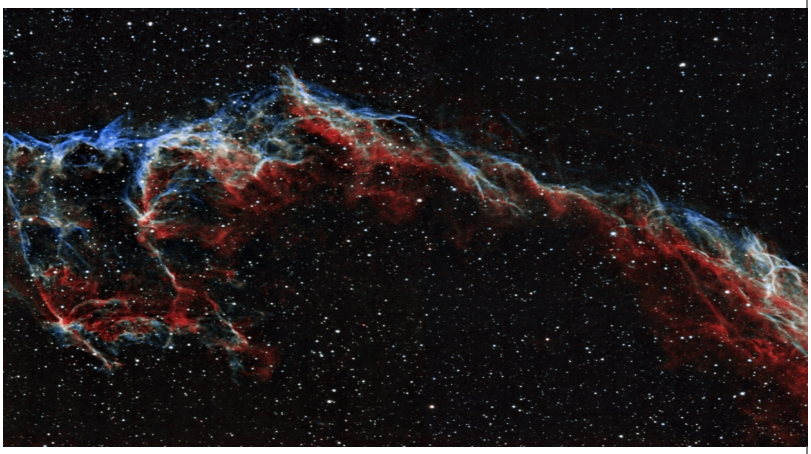
a while, taking it all in, scanning all the nebulosity in that area, sit in my new folding lounge chair, relax, read about the nebula and surrounding areas, eat a donut and then go back to viewing. I slowly scanned back and forth between the two sides of the Veil finding great, clouds of nebulosity. The excitement of getting to know a new friend and finding we have much in common.

Later that night I easily found the N. America and just as I did, Daryl was visiting the folks in the area of field where I was set up. He asked how I was doing and I told him I think I have the Yucatan Peninsula in the EP. He confirmed my find. After some time with that nebula, I was drawn back to the Veil.

I think I could spend a lifetime with this one object, but thankfully, I don't have to. I felt this way, but not as strongly over globs. Will this feeling of discovery, connectedness, and dare I say adoration ever stop?

That night I dreamt of the Veil.

"Witches Broom" 6960



"Complex" 6992 25 light years long!

Editor. Bill Mclean is a member of the Back Bay Amateur Astronomers, he and his son camped next to Yasu, Yumi and I at the Greenbank Star Quest this past summer, we all shared the night sky and Bill fell victim to the awesome beauty of Globular Clusters. It appears as though, now has a new love of Nebulae and who knows he could be seduced to "Dark-Side" (a.k.a. Dark Nebulae)! In any case, I for one hope that he continues discovering and falling in love with the night skies and continues to write. Its very refreshing to see his enthusiasm!

First Light of the "PK-457"

By Mark S Deprest

(Insert theme from 2001: A Space Odyssey)

From out of the foggy, darkest, all the way from Norman, OK via Dayton, OH it appeared with lots of warning in the drive-way of John Causland! *(Insert fanfare)* The "PK-457"!!

After waiting TWENTY agonizing, grey, overcast days my latest acquisition, an 18" f/4.5 Truss Tube Dobsonian Reflector received "first-light" on November 22nd! The scope, now known and the PK-457, was originally built by Pete Kron of Norman, OK. Pete works for Astronomics and back in the late 1990's he made number of "larger aperture" scopes in the Dave Kriege truss tube Dobsonian style. As you might have already figured out the "PK" is for Pete Kron and the "457" is

the aperture in millimeters. The original buyer / owner of the PK-457 was Al Roberts of Dayton, OH and he is the gentleman that I purchased the scope from. The primary mirror is a Pegasus Optics mirror and according to the accompanying documentation is 1/10 wave-front P-V, with a Strehl ratio of 0.9604. *(These are very good numbers)* Al Roberts added a drive system to the scope and enjoyed it for 10 years. However, Al wanted something a little more portable, so he moved from "big Dobs" to SCT's and put his Pete Kron 18" up for sale on Astromart. The timing, size, and price were all right and that's when I entered the picture. There was just one issue I hadn't saved up all the money I needed to cover cost of the scope. I have to say that I have the greatest wife in the whole world she supplied the balance as an early Christmas / Birthday present! So on November 2, 2008 Terri and I made the drive down to Dayton, OH to pay for and pick up the PK-457, which just fit into the back of my Saturn Vue. (My wife was a little worried about that at first, but I knew it would fit nicely! Well, I hoped it would.)

Okay, so now I own an 18" f/4.5 telescope that; I can barely lift up into my car, that it just fits into and although I helped take it apart for transport to its new home, I hadn't set it up yet. I had to wait until the next weekend before I got a chance to set it up for the first time. I spent some time working on it that weekend trying to determine all the things I want to do to it. You know all the little things that make the scope user friendly to you. Also, I wanted to test the drive system, as I was unfamiliar with it and the way it works. I made a few small improvements and cleaned up all the bearings so that everything moved nice and smooth. Now I was ready for a clear night and first light of the "PK-457"!!

Saturday, November 22nd looked like it was going to be at least clear enough to some testing of the optics and drive system. I have mentioned the drive system a couple of times now and I should probably tell you a little about it. The Tech 2000 DOB Driver II system is unique in that it does not require any kind of alignment. That's right, no two star, one star, or polar alignment of any kind. The system doesn't need to know what time it is or where it is, you only need to center your object, put it in "Track" mode and as the object begins to drift out of the field of view, simply re-center the object and the system learns how much to continuously move each axis to keep that area of the sky centered in your field of view! Once the system knows this you don't have to do anything else … the object stays centered! If you are using higher powers you may need to make some very fine corrections and the system then learns and is even that much more precise. The DD2 system can be used to track Planets, Moon, Sun, or Comets! How cool is that?!?! The DD2 system uses a motor powered friction wheel on the ground board for the azimuth drive and a motor powered belt and pulley wheel for the altitude drive. The system has internal encoders, so there is no need for any addition digital encoders to install on either axis. Both the altitude and azimuth motors have manual releases so that the scope can be used with or without the DD2. Because there are no additional encoders to install the DD2 system is less than $1000.00 to install on any Dobsonian scope. I was very anxious to try this system out and see if it really does what it says it does. I should add that the DD2 system does have the ability to use ASCOM and therefore allows you to computerize your scope and make it a true "GOTO" scope.

I had hoped to do my first light at Peach Mt. but as the temperature dropped and the skies looked like they might be marginal at best, John Causland's driveway seemed like a better place to set-up. That way if any mechanical issues came up I could go into John's garage and work on fixing them, plus as the temperature looked like it might drop into the Teens, the ability to warm up in John's house was very appealing. So as the sun was setting I began to set up the PK-457 in the driveway of John Causland (known to ACNO as the Causland Causeway). Although John was not going to be home until after 8:00pm, he told me to make myself at home (John is a very good friend!). As I finished the PK-457's assembly (only the 4th time for me), I needed to align the Telrad Finder and Altair was well placed in the southwestern sky, so I centered it in the eyepiece and then adjusted the Telrad Finder so that Altair was centered in the middle of the smallest circle. I then put the DD2 into "Track" mode and made the necessary centering corrections and "Presto" the scope began to track Altair! Very cool! I kept Altair centered for over 15 minutes in both low (74x) and higher (182x) powers, that made Altair part of the PK-457's "First-Light" night. The next object seen through the scope was M57 and its 14.8 magnitude central star which was actually fairly easy to pick out (extra aperture is good, extra aperture is wise!). After spending the next 20 minutes or so admiring the Ring Nebula, the clouds and haziness began to increase a bit in that area of the sky, so I used the "Pan" mode of the DD2 system to slew the scope over to a clearer patch of sky that just happened to be where M31 and company lived. By this time of night (7:30pm) M31 was almost 75 degrees above the horizon, this meant I could no longer stand on ground and reach the eyepiece, but one step up was all I'd need. I like the fact that I don't have to climb multiple steps up a ladder to reach zenith. Okay, back to M31 and environs which in the University Optic's 32mm MK-80 eyepiece just fits into the 65 arc minute FOV that it provides. I should probably mention something about the quality of the views the PK-457 was showing … does the word "eye-gasmic" help? After spend the next 45 minutes studying the intricacies of the Andromeda Galaxy and its two companions I decided to give the DD2 system a bit of a work out. So I began to slew it around to M15 which meant turning in azimuth almost 180 degrees and that when I found the first issue … I had a spot on the bottom of the rocker box that rubbed against the ground board and caused the drive motor to stall out. This was going to need fixing but for the time being I could disengage the azimuth drive and manually move the scope to my target. Once past the spot the scope moved freely and I re-engaged the azimuth drive and started tracking again. I was beginning to get some frost build-up on the exposed surfaces, this coupled with the fact that scope was out of balance because of the heavy eyepieces and the Televue Paracorr I was using made the UTA (upper tube assembly) want to nose dive. And now the altitude belt was beginning to slip (issue number 2), but this could be easily fixed with some counter-weight on the mirror box.

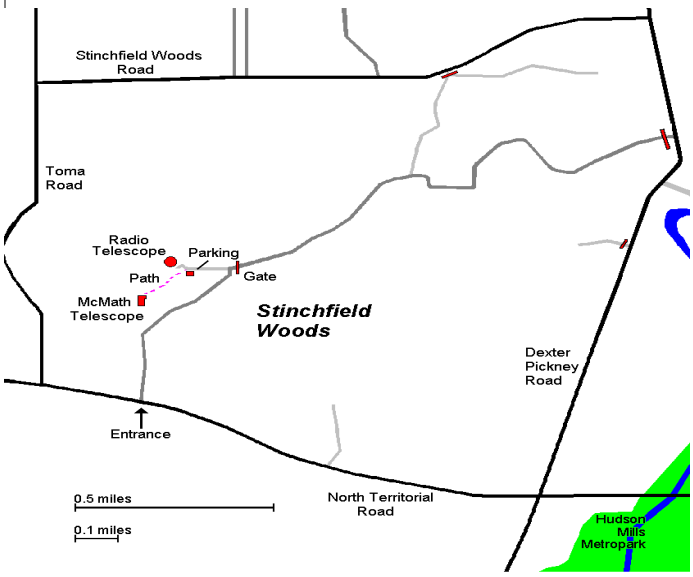
It was now about 8:30pm and Yasu & Yumi had shown up and John finally came home, so we all spent some time setting up scopes for Yasu and Yumi and John brought out the "61" a.k.a. his 24" Starmaster scope. After about thirty minutes Yumi was getting cold and decided to go in and make some tea for John and Yasu. I on the other hand I had noticed that the area of sky that was home to a Comet (that I had not seen yet) was now well above John's roof and was very clear. So as the three of them went in to warm up, I went about the task of hunting down my 71st comet. After about fifteen minutes of searching an area of sky that contained very few visible reference stars, I found it! Comet C/2006 OF2 (Broughton) at 11.2 magnitude was surprisingly bright, with a very noticeable curved fan shaped tail that extended 5 to 8 arc minutes. I let out a loud whistle to announce my success to the trio warming themselves in the comfort of John's kitchen and after a few minutes they all came down and verified my find! I personally can't think of a better way for me to experience "First-Light" in any scope than with a comet! I do so love my comets! We spent the next couple of hours exploring Auriga's clusters and ended the night with an incredible view of the Orion Nebula, just before mid-night.

John was cold and tired, Yasu and Yumi were also getting cold, so I began disassembling the PK-457 and packing up my frost covered gear, but all the while I kept a satisfied smile on my face. I am very pleased with my new scope, and the next time you see me at Peach Mt. it will be in the company of the "PK-457" I hope its very soon, I want to gather more star light in my eyes!

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 Astronomer c/o Yasuharu Inugi

2918 W Clark Rd #203
Ypsilanti, MI 48197

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.

Telephone Numbers

President:	Charlie Nielsen	(734) 747-6585
Vice Presidents:	Jim Forrester	(734) 663-1638
	Ken Cook	(734)769-7468
	Mike Kurylo	(517)223-7585
	Belinda Lee	(313)600-9210
Treasurer:	Yasuharu Inugi	(734)434-9544
Observatory Director:	D. C. Moons	(586) 254-9439
Newsletter Editor:	Mark S Deprest	(734) 223-0262
Key-holders:	Jim Forrester	(734) 663-1638
	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:

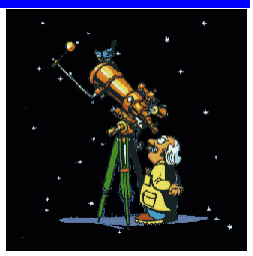
Lowbrow-members@umich.edu

University Lowbrow Astronomers

Yasuharu Inugi
2918 W Clark Rd #203
Ypsilanti, MI 48197

Phone: 734-434-9544
E-mail: yinugi@hotmail.com

Reflections & Refractions



Website
www.umich.edu/~lowbrows/

Comet C/2006 OF2 (Broughton) as seen on November 22, 2008 in the PK-457 by Mark Deprest, John Causland, and Yasu & Yumi Inugi!

Image by Francois Kugel from Observatorie de Dauban

University Lowbrow Astronomers
2918 W Clark Rd #203
Ypsilanti, MI 48197

Check your membership expiration date on the mailing label