REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers

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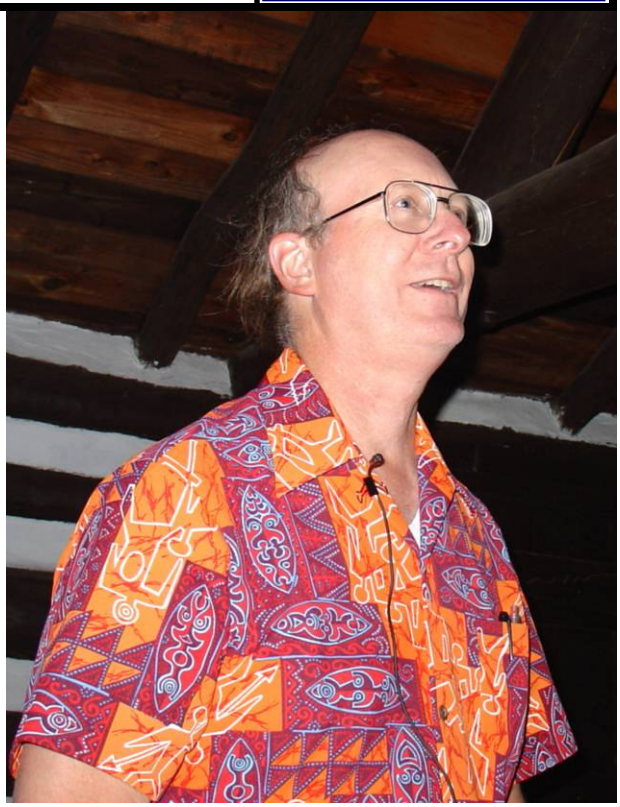
Greetings cometeers

Good subject. I've enjoyed reading the responses and would like to add my own.



My first recorded comet observation was of Comet Tago-Sato-Kosaka on January 27, 1970 from a park in Concord, California. With me that night was my 12th grade physics teacher and several friends and classmates. We used my 6" Dynascope Criterion reflector, the same telescope I used to visually discover my tenth comet in 2004.

My early impression was that comets were a bit of a disappointment. First, they were diffuse and did not appear as bright as the published magnitude would suggest. Secondly, they are always moving so you had to have up-to-date positions in order to find them, and the magazines I was receiving, especially "The Review of Popular Astronomy" was always arriving a month late. At that time I figured that comets were for the advanced amateur and that I would probably see very few comets in my life, and certainly that I would never, ever, discover one.

I missed seeing Comet Ikeya-Seki in October, 1965, the month I got my first telescope, a 2" reflector, because I did not know where to look.

I continued observing comets and began, in about 1975, making magnitude estimates of known comets. This was an important nitch in comet astronomy, and I felt that I was making valuable contributions by submitting those comet observations to the ICQ and the Comet News Service. For Comet Halley, for instance, I made 144 mag estimates on 101 nights. I made studies on different methods of estimating magnitude, these were published in the Comet News Service.

All this came to an abrupt end when a couple of comet "gurus" suggested that my use of the SAO Catalogues for comparison star magnitudes compromised my comet magnitude estimates because the SAO Catalog is a "secondary source". Having no money to purchase a "better" source of star magnitudes, I grew discouraged and stopped making comet magnitude estimates (except for the comets that I have discovered, and presently I'm noticing that P/96 had been dimming, and has now stalled at about mag 12).

My first comet hunting was on June 10, 1970, the week I graduated from high school. On and off I hunted for 25 hours over the next five years. On Jan 1, 1975 I began my systematic comet hunting program, not so much for a love of comets, but because I wanted a program that would give me a reason to look through the telescope, I love the view of the night sky through the telescope. I knew the possibility of finding a comet would be small, but at least I would see the sky, and learn my way around the sky better. It was a win-win situation. Since 1/1/1975 I've done 7330 hours of visual searching over 389 consecutive months.

Don Machholz

Colfax, California

This article is a result of a request by Gary Kronk to the members of the "Yahoo Group Comet-ml" for their first comets observed experiences. Don Machholz granted his permission to reprint this in our newsletter. Thank You Don!

Picture of Don Machholz, as a guest speaker at the Cherry Springs Star Party 2005 by Mark S Deprest.

Don did say that he doesn't ever wear that shirt when hunting comets!

How Eyepieces Are Designed

By Tom Ryan

In last month's Reflections, Doug Scobel gave a comprehensive and practical guide to eyepiece aberrations. It inspired me to write a vague and completely impractical description of how eyepieces are designed. (I also haven't had my weekly dose of optical design work, which seems to affect me in the same way that endless Michigan cloudy skies affect the Any Clear Night Observing Team, and this article is an excuse to get my head straightened out with some optical work.)

When I first started doing optical design, I read everything I could get my hands on about designing optical instruments, and that reading included eyepieces. Unfortunately, I had a hard time finding clear examples of good design practices. There were lots of books that talked about the virtues of the Ramsden vs. the Kellner, but most of the design methods described dated from the 1920's or earlier, were arcane, or seemed just plain weird. The best account that I remember was by the designers of the Pretoria eyepiece, Klee (yes, of Klee Barlow fame) and McDowell, which appeared in Telescope Making #29 in 1986. That article is still very much worth reading, if you can find a copy of it. Their description of how and why they designed the Pretoria eyepiece is a model of clarity and competence, and I learned more from reading their one article than I did from all other sources combined.

Ten years prior to 1986, I was working as the lead Toolmaker in a Die Shop. That year, my claim to fame was that I built the die that stamped out the speaker hole in the rear deck of the next year's Jeep. I did it by hand, turning the handles on a milling machine, cutting a female elliptical die and a male elliptical punch which fit together so well that they would shear a piece of paper like scissors when they were pressed together. It's hard to describe how good a guy has to be to manually make a die like that to someone who has never done it, but he has to be pretty good.

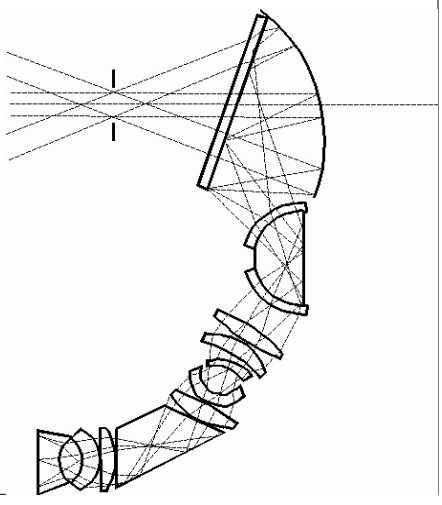
Ten years after 1986, that skill was completely irrelevant. Computers were now turning the handles on the mills, doing the job better (or at least not scrapping a very expensive block of tool steel) and doing the job faster (two hours vs. two weeks). As a consequence, I changed professions.

I mention this because optical design has also been transformed by computers. Today, optical design is no longer done the way it's described in the seminal books. All of the accounts I read of eyepiece design dated from the time before "personal" computers became ubiquitous. Rays were traced through an optical system by hand, one at a time, using slide rules and log tables. For obvious reasons, those designers didn't trace many rays. Instead, they relied on experience, tricks, and guesswork. They also didn't produce many new designs. A good example of the methods then in use appears in the 1978 book "Lens Design Fundamentals" by Rudolf Kingslake, a giant of optical designers. He shows the reader how to design a "military eyepiece" (which seems to be a 1921 Plossl), an Erfle eyepiece, and a Galilean viewfinder. Anybody got one of the latter? Raise your hands and tell us why.

Well, I'll say plainly that I'm not smart enough to design an eyepiece using those methods (and 99.999% of the guys running CNC machines today couldn't cut out a die by hand, but so what? They're daily making product that I couldn't make manually if my life depended on it). Fortunately, I don't have to design an eyepiece the old-fashioned way. I bought a computer and got on the winning side.

I recently designed a Heads-Up Display for some guys who want to put video game technology into armored vehicles, and I found that the design of a Heads-Up display is a lot like the design of an eyepiece, only somewhat more challenging if you are space-constrained. This shouldn't have been a surprise, because Al Nagler is rumored to have had a job designing Heads-Up displays before he started designing eyepieces.

Figure 1. HUD



Here's the deal on a Heads-Up display. Your head is inside the optical system, light is coming at you from a wide range of angles (up and down, left and right), and the light is collimated at infinity. That is, the rays from any particular direction are parallel to each other as they encounter your head (just like light from the stars in the night sky).

Here's a picture of a HUD (not mine), but before you look at it, you should know that standard optical convention is to have the light travel from left to right in optical layout diagrams:

That's not what is happening in the HUD diagram, though. The observer has his head at the point where the parallel lines cross, near the top, and is looking toward the right. If the curved image combiner on the extreme right is transparent, he can see through it, and the projected image is overlaid on the distant scene.

So a Heads-Up display lets you see the stars, but it also superimposes a created image over the stars. That created, superimposed image usually comes from a projector and starts out as a small, flat frame. What makes a Heads-Up display hard to design is the job of taking the

light that is radiating from a small, flat frame, expanding it until it surrounds your head, collimating it, and then redirecting it so that all of the collimated beams from all directions intersect at your head. And doing that without distorting the frame or introducing any color errors.

Before you start thinking that a HUD is some exotic piece of equipment that you'll never encounter unless you get a time machine, go back to when you were 18, join the Air Force and graduate to flying F-18's, you should know that a Telrad finder is a Head's Up Display. It just has a really small field. As I said, getting a large field is the trick.

Fortunately (as with almost everything else), there is a precedent. It's called an eyepiece.

In an eyepiece, the light coming out of it is collimated. It appears to be coming from infinity. It's coming from a bunch of different directions; up and down, left and right, out to as much as 80 degrees off axis. And all of the beams are converging toward one point, the pupil of your eye.Here's a picture of that.

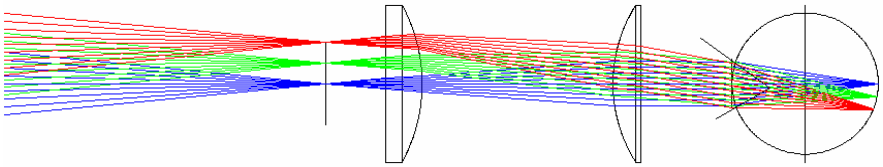


Figure 2. Eyepiece Pupil

Here, the light is coming from the left. That round thing on the right is the best I could do in my optics program to draw an eyeball. Notice that the light rays are parallel before they enter the eye.

The light through an eyepiece starts out from a small, more or less flat, frame. That frame is the image formed by your telescope's objective. If you don't think there's an image there, put a piece of waxed paper at the focal plane and check it out. To the optics which follow the image plane, that focal plane image looks very much like a slide in a slide projector.

Focal plane or slide, eyepiece or HUD, the principle is the same.

This article is titled "How Eyepieces are Designed", and the short answer is they are designed by intelligent use of the Merit Function of an optical program, but that's too big a subject to discuss in detail here. Instead of wading through the gory details of an arcane program, let's see how eyepiece design (and indeed, most optical design) progresses, using a modern computer program.

Many people don't know it, but eyepieces are designed backwards, with the light going from the pupil to the focal plane. Most optical design programs are set up to launch parallel light through an entrance aperture, which in our case is the pupil of the eye, so we'll just go with that. We need to add some eye relief, so we'll set the first lens back from the aperture, and we want the light to focus at the telescope's image plane. So far, it's sort of like a camera lens in reverse.

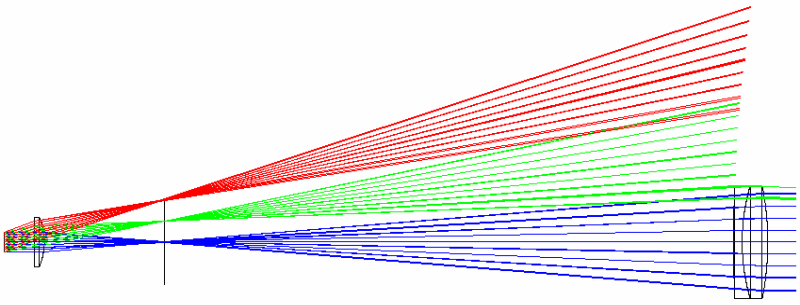


Figure 3. Camera lens.

However, the image formed by our eyepiece has to "match up" with the light formed at the focal plane by our telescope's objective. That is, the cones of light from our eyepiece which converge to the focal plane have to proceed on to intersect the telescope's objective. So, we need to add a second lens, usually called a field lens.

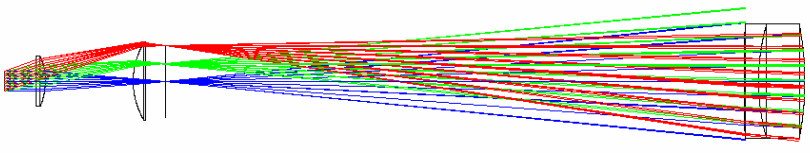


Figure 4. Lens and Objective.

When we do that, the light cones now point in the direction of the objective, and Bam! we've got a Ramsden. First designed in the late 1700's. The color correction is not too good off axis, but on axis, the green light is well focused, and the eye's sensitivity to red and blue light is not very high. In the above figure, you can tell that something bad is happening to the light as it gets closer to the objective, but that's because we haven't optimized the lenses we threw in there, and because the launch angles and f/ratio are far in excess of what the Ramsden design can support. (Incidentally, the rays are color-coded by field angle, not by wavelength in these layouts.) However, when we get the design's range (6" f/7, +/- 15 degree apparent FOV), it looks like this:

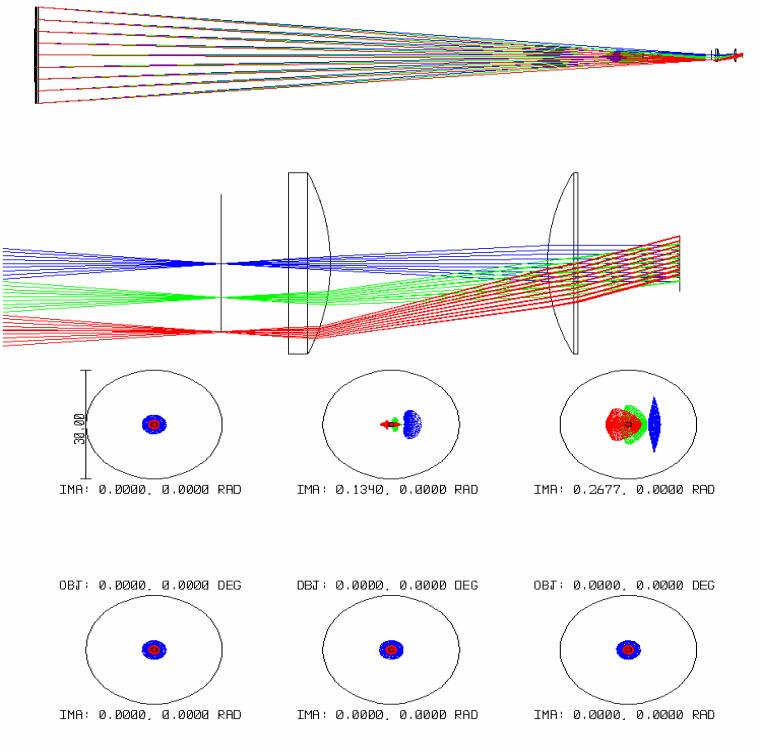


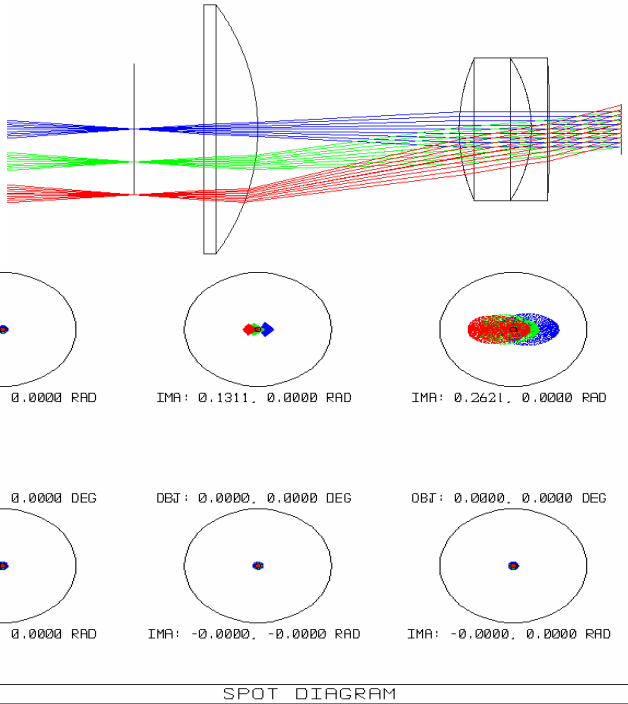
Figure 5. Ramsden 28 mm

Notice that the parallel rays don't all intersect the pupil of the eye at the same place. That's typical of eyepieces, but I'll bet you never noticed, unless you have a Nagler with the "kidney bean" effect.

The spot diagrams are what you would see if you looked into the eyepiece. The colors in the spot diagrams do represent the true spectral colors, and the big circle is the size of the full moon (30 minutes of arc). The left spot is on axis, the middle spot is at an apparent field angle of 7.5 degrees, and the right spot is at the edge of the field, at 15 degrees off axis. Back up until the circle is the size of the moon, and the spots are the apparent size (and color) of a star. Not so good.

However, we can do better. Let's achromatize the first element with a common, easily obtained flint glass. Now we have a Kellner, first designed in 1850.

Figure 6. Kellner 28 mm



(The apparent field angles are the same as for the Ramsden.)

Uh, what happens if we achromatize the second element? We get a Plossl, first designed in 1860.

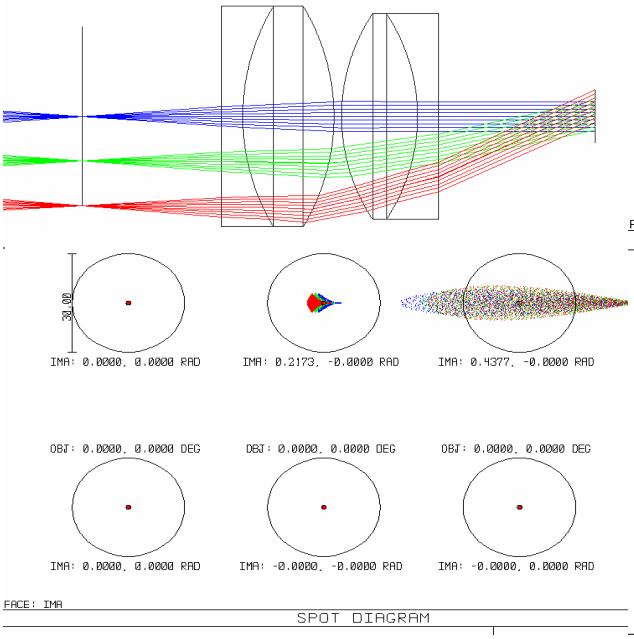
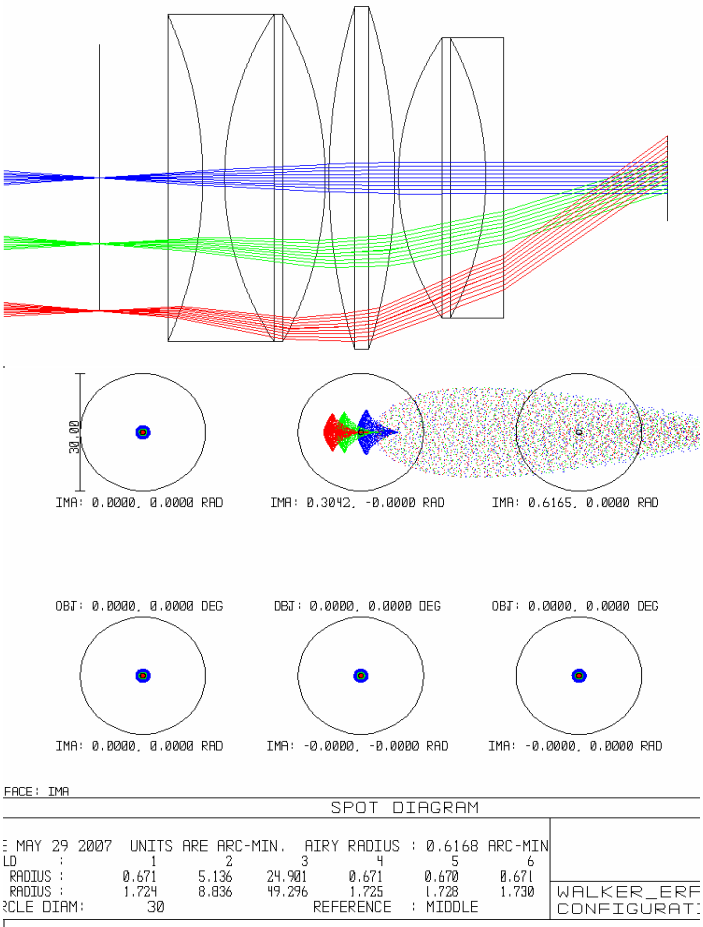


Figure 7. Plossl 28 mm

The apparent field angles are now 0, 12.5, and 25 degrees, for a 50 deg FOV. The image on the right doesn't look so good, but the image in the center almost as far off axis as the rightmost Ramsden and Kellner images were. I like Plossls.



We've had a lot of luck improving the design by adding lens elements. Let's throw in another lens between the two achromats and reoptimize. Now we have an Erfle, first patented in 1921.

Figure 8. Erfle 28 mm.

The apparent field angles are now 0, 18, and 35 degrees. I was never a fan of the Erfle, but it has an apparent FOV of 70 degrees, and the military likes it for that reason.

It is 1921, we now have five elements and the hard anti-reflection coating has yet to be invented. Internal ghost reflections and light losses in a five-element uncoated eyepiece are truly astounding.

An ideal, single layer AR coating has a thickness of ¼ wavelength of the light of interest, and an index of refraction that is the square root of that of the glass to which it is applied. Those requirements are very nearly met by the oils on human skin, and it is rumored that at least one astronomer improved the transmission of his uncoated objectives by rubbing his nose over them. While this works for uncoated glass, he may have had some explaining to do if someone saw him applying the coating to his refractors. ("Late Nights All Alone with His Instrument" picture omitted. –Ed.)

Hard AR coatings were perfected during WWII, and in 1979, Al Nagler patented his wide field Nagler eyepiece. (There's an ad for it in TM 29. It says "Patented 7-element design introduces a new dimension in observing. Dramatically more field, sharpness and eye relief than any commercial eyepiece. Multi-coated. Dynamite with Dobsonians.") Here is the first Nagler 13, according to the patent literature:

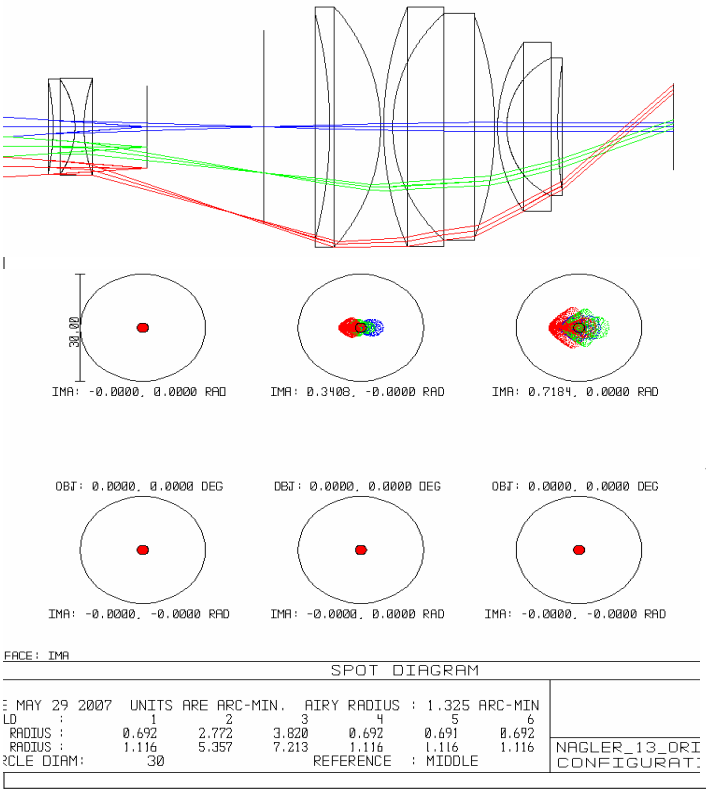
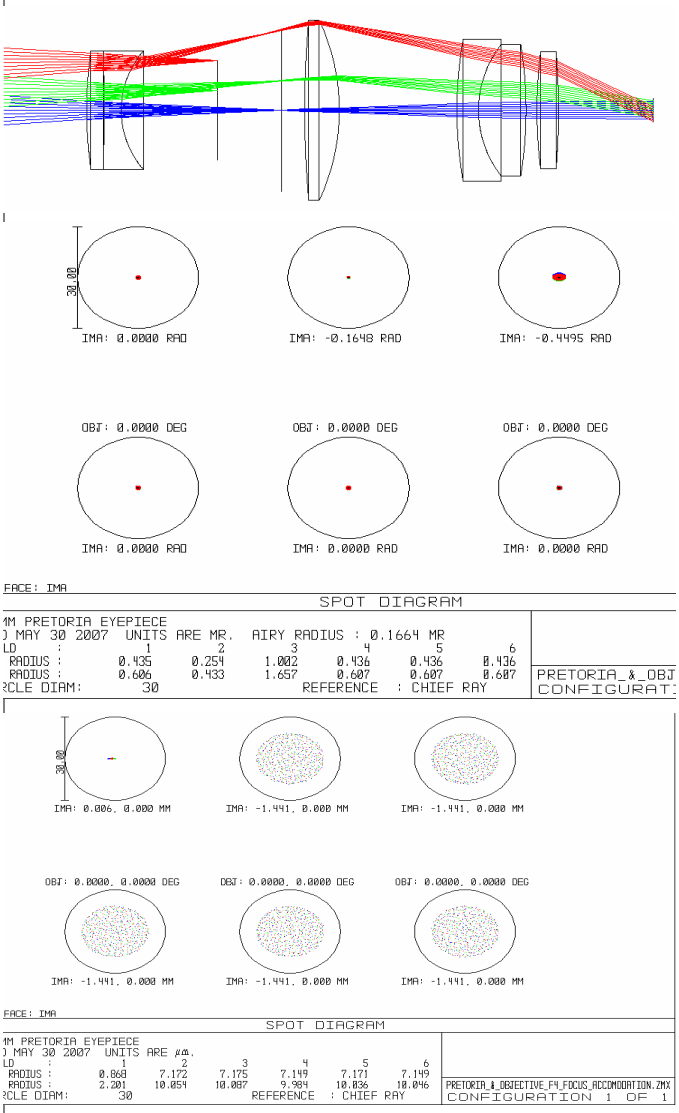


Figure 9. Nagler 13 mm

The apparent spot angles are 0, 20, and 41 degrees off axis, for an apparent FOV of 82 degrees.

Notice how the light is diverged by the first negative lens, and then brought back towards the pupil from very high angles. A great design. Scaled up, a great HUD, except for the pupil distortion, which was corrected in the Type II Naglers.

I said earlier that the eyepiece's light cones have to match the angle of the objective's cones. But while we're doing that, why not also correct the aberrations inherent in the objective? After all, the objective has aberrations. It probably has a curved field. We can correct for all of this stuff with enough lenses and glass types.



In 1985, the designers of the Pretoria designed an eyepiece to correct the inherent coma of a 150 mm diameter f/4 parabolic Newtonian telescope to under ¼ wave. The fact that it works on other instruments is a testament to the adaptability of the human eye and the abilities of the designers. Here is the Pretoria design:

Figure 10. Pretoria 28 mm.

The apparent field angles are 0, 13, and 26 degrees, for an apparent FOV of 52 degrees. The edge of the field doesn't look perfect, but the designers explained that the eyepiece has some field curvature, and the eye, when it looks at the edge of the field, can refocus by one diopter (which is about all that a 50 year old can muster). If the observer does that, a star at the edge looks like this:

And the spot diameter drops to about the limit of resolution of the human eye.

All of the eyepieces were evaluated in conjunction with a 6" f/7 Newtonian objective, except the Pretoria, which was evaluated using a 6" f/4 Newtonian.

Rutten and Van Venrooij pointed out that eyepieces and objectives could be matched for better performance in their raytrace-driven book "Telescope Optics, Evaluation and Design", and offered some examples of eyepieces matched to telescopes. I highly recommend that book if you need a spot diagram fix, or a better understanding of eyepieces than this article gave you. And if you have an f/4 reflector, I recommend buying a Pretoria from someone who wants a wider field of view. That's how I got mine.

Figure 11. Pretoria at the edge, with eye refocused.

So, you want to go to a "Big Star Party"

By Mark S Deprest

Well, I'm no expert, but I have been to my fair share of them and I've always had a great time at every one! That's right no matter what the weather conditions, including riding out hurricanes in a tent, I've always had great times, and the reasons are pretty simple. This article is not just for those of you thinking about going to one of these events, but also for those of you who go to them every year and those of you who have been to only a few but haven't seem to master how to have a good time at them yet. This article is filled with tips and my methods to successful "Star Partying."

First, and before you even choose a Star Party make sure you even go, most of these events are held some distance from where you live and many of them mean either camping in a tent or renting a "RV" at least one or two nights. Make sure you can actually handle that aspect of it. Most of the "bigger" Star Parties are held in either rural or remote areas, and hotels and cabins may be available off site but at some distance from the actual observing site. Make sure you can get the time off from work and if you are not taking your family with you, clear it with your spouse. If you are taking your family with you make sure you think about their entertainment too. In other words, put some real thought into this ahead of time.

Remember the 5 P's of any major undertaking: Proper Planning Prevents Poor Performance! That is the essence of this

article and probably the most important thing to remember.

Okay, you've actually decided that you can do this. Now you need to decide which one or ones you want to go to. There are many to choose from and each one has its own "personality" if you will. Riverside on the West Coast and Stellafane out East are big ATM (amateur telescope making) events, Astrofest is a "New Products and Vendor oriented event, Almost Heaven in WV, Black Forest in PA, Nebraska and Okie-Tex are all Dark Sky observing events, Green Bank in WV and The Texas Star Parties are a combination of Speaker, ATM, and Dark Sky oriented events. There are many other "big" star parties and lots little ones too and each of them have special things to offer, all of them have a few things in common. They are social events, they are astronomy related and they are all supposed to be FUN! Choose the one or ones that suit your interest and then do a little research on them, any Star Party that has been around for a while is doing something right, and there should be some info on the net or in the astronomy related publications about them. Find out the events' history and what other people have to say about them.

Sky Online has a nice list at: http://skytonight.com/news/3306276.html this is by no means the only ones to choose from but it's a good start.

As soon as possible you will want to register; all of the bigger star parties require advance registration. There are many reasons for this but mostly it's due to limited space at the venue's site. Some star parties have become so popular that they fill up months before the actual event, The Texas and Black Forest Star Parties are two that fill up fast. Most every star party requires a refundable registration fee and some allow registration at the "gate" but usually at a higher rate. Some of the week long events offer meal plans and unless you are on a special diet these are a great idea to register for. They are always cheaper than restaurants and generally better quality. They also mean you don't have to worry about packing and storing food in coolers or bringing a lot of cooking stuff like pots and pans, camp stoves, propane, etc. The food is prepared the menu is selected by people just like you and there is always enough for everyone who signs up for them.

I suppose I should talk a about the "bottom line" a little bit. I mean with gas prices headed to places unknown, the cost of getting to one of these events can be considerable, depending on how far away it is. Make sure you can afford to get there! It might be a good idea think in terms of a budget, whoops! That means doing some planning and we come back to the 5 P's. Plan out how you are going to get there (an actual route), you might want to see if any of your friends are planning on going and maybe carpool to offset some of the expenses. If you decide to carpool, make sure you consider your traveling partner when planning and discuss ahead of time **all** of the traveling plans. Remember some people like to take their time and site-see all the way and others like to hit and get it. There is no sense in traveling all that way together, just to get there and be pissed off at each other, especially since you'll probably be sharing the ride home!

Another thing that is worth mentioning right now is, keep in mind that part of the fun of any event is enjoying the trip there. I always plan at least one special stop or thing to see along the way to help break up the monotony of the road. Make sure that you remember to have fun along the way.

Okay, you've decided where & when, you've figured out how to afford it, you've planned out your trip and your accommodations while you're there. Now its time to think of all the gear you'll want to bring with you and the all the gear you actually have room for. I suggest that you take some time a week or two before you actually leave and lay everything out so that you can see it, make a list, add and subtract items from that list as you see fit. Remember to consider weather into your plans and pack for the most obvious possibilities. I'm not going to put an actual list of things in this article, but your list should be very comprehensive and should contain event the most obvious items, like if you are planning on tenting, the tent should be on the list. If you are bringing a telescope, the telescope should be on the list. I know this seems like over-kill but I know of some people who forgot to bring really obvious things, like eyepieces, telescope shrouds, flashlights, etc. Don't take anything for granted nothing is too obvious to include on your list. Now, with everything all laid out and your list made … try fitting it all in your car, truck, SUV, camper or trailer. If it doesn't all fit you are taking too much! If it all fits you're probably still taking too much but it all fits so who cares. Okay unload everything and put it somewhere you'll be able to find it when it comes time to actually pack.

If you are driving, make sure that your vehicle is in good working order, check and change the oil, check your brakes and tires make sure they are properly inflated, and check your lights, if it's an older vehicle have the transmission checked. There is nothing that can spoil a trip like a breakdown on the side of the road.

Now, the week before you leave, go through the list again, check the weather and road conditions, long range forecasts

are generally not much better than an educated guess but if they are predicting very cold or very hot weather and your list doesn't take this into consideration … revise your list! If your trip's route has a major construction project starting up on it you might want to consider revising it also or at the very least have an alternative route planned.

The day before you leave try and pack as much as you can, use your list. Check the weather again, but don't let the threat of inclement weather stop you from going. One of the best times I ever had at a star party was one of the worst for weather. Remember Star Parties are social events too, and every body there has something in common with you, a love of astronomy, and I don't know of any weatherman that is always right. Besides you did all that planning and prep-work, go and have fun!

The day has come finish packing and check your list, remember your planned route and follow it; there is no sense in getting lost. Take breaks when necessary, and enjoy the trip. Leaving means more than pulling out of the driveway, leave your troubles at home and at work there is no room in the car for them… they take up way to much space and time and they have no purpose at a star party. If you can't leave them then stay at home!

Once you get on the road and your head is clear of all the day-to-day stuff, you'll begin to understand how to have a great time. Treat yourself to something special you deserve it!

When you get to your chosen star party, the first thing you should unpack is a smile, put it on and don't take it off, and if you forgot yours look around everyone there has one for you! These are as much social events as they are observing venues, and remember everyone that is there shares the same interest as you! So, participate in the other activities that the event organizers have set up just for you. During the day walk around and talk to those around you, check out their equipment. I love showing off my scopes and telling people about them, guess what … lots of other people do too. This is a great way to meet new friends and make astronomy associations that can last a lifetime.

If the star party you choose has guest speakers lined up for talks, go to them you never know what you might learn. I have even gone so far as to be one of these guest speakers and I always have fun and I always learn something new when preparing for my talk, and this is about a subject I should know a lot about already. Imagine what you could learn as an audience member.

I said at the beginning of this article that no matter what the weather conditions or other problems that are going on during the star party, I have always had a great time at every one and I think its because I have learned how to enjoy myself and experience the moment for what it is. Remember if you aren't having fun, you are doing it wrong!

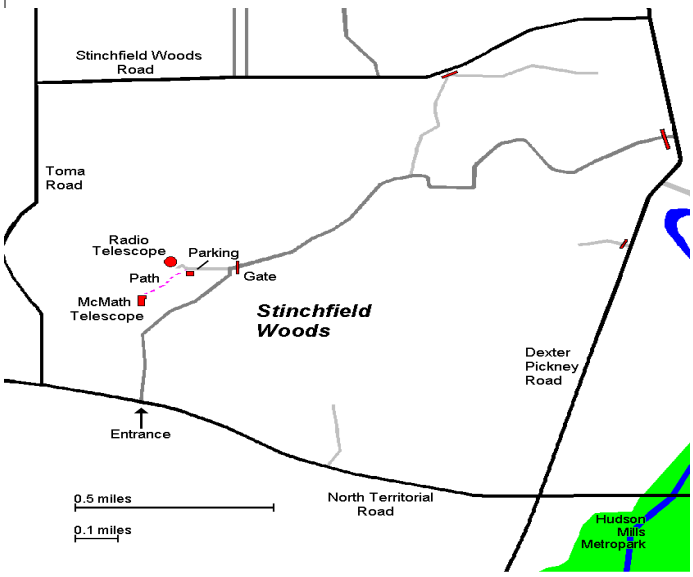
Newsletter Editor look for articles?

Picture by Chris Sarnecki at the 2006 Black Forest Star Party.

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

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** to discuss length and format. Announcements, articles and images are due by the 1st day of the month as publication is the 7th.

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	Ken Cook	(734)769-7468
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Lowbrow's Home Page

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

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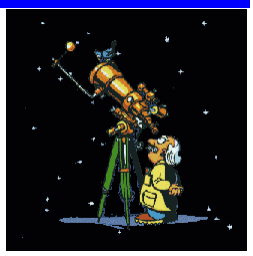
Reflections & Refractions



Website
www.umich.edu/~lowbrows/

Do you know the who, what and where of this image?

(answer below)

Who—Doug Scobel What—Observing Venus Where—Lake Hudson, MI

Image by Doug Scobel

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Check your membership expiration date on the mailing label