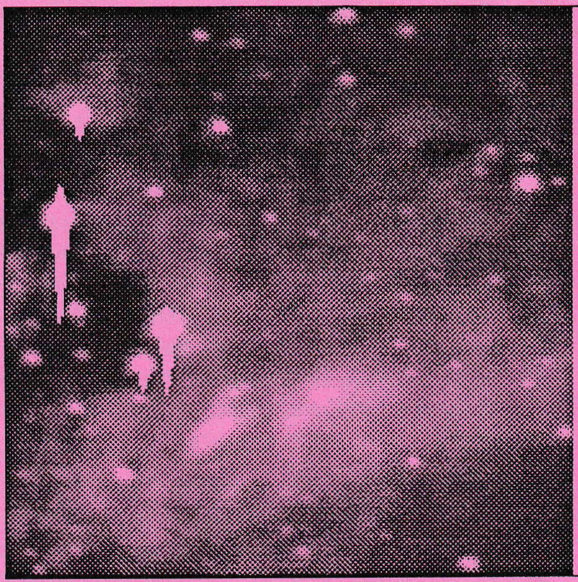
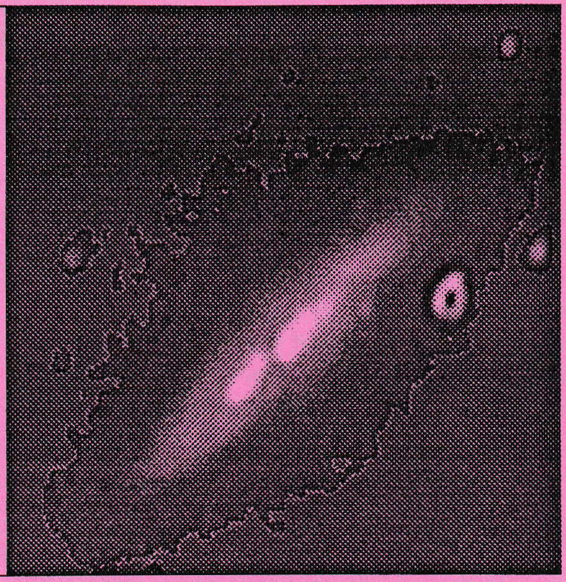
REFLECTIONS





REFLECTIONS

June 1992 Left - The Omega Nebula. Right - M82. CCD images by Roger Tanner at the Texas Star Party, May 1992. Image processing by George Semple and Kurt Hillig.

Kurt Hillig
Editor

University Lowbrow Astronomers

The University Lowbrow Astronomers is a club of astronomy entnusiasts which meets on the third Friday of each month in the University of Michigan's Detroit Observatory at the corner of Observatory and Ann Streets in Ann Arbor. Meetings begin at 7:30 PM and are open to the public. For further information, call Stuart Cohen at 665-0131.

This Month:

June 14/15 - Partial Lunar Eclipse starting at 11:27 PM maximum at 12:57 AM EDT

June 16/17 - Lunar Occultation of Neptune for all of you dedicated planetary observers. Neptune will disappear around dusk and reappear around midnight.

June 19 - Meeting at the **Detroit Observatory** in **Ann Arbor**. Our own Roger Tanner will report on the Texas Star Party, held last month in the Lone Star State. If the skies are clear, we'll adjourn to Peach Mountain for a club observing session. Bring your scopes!

June 27 - Public Open House at the **Peach Mountain Observatory** (on North Territorial Road, just west of Dexter-Pinkney Road). The last two were clouded out – let's try for clear skies this time!

Next Month:

July1 - Computer Subgroup Meeting at **Roger Tanner's** house in Canton (a Wednesday). We will continue working on telescope designs using the Zemax ray-tracing program. Call Roger at 981-0134 for directions.

July 4 - Public Open House at the **Peach Mountain Observatory** (on North Territorial Road, just west of Dexter-Pinkney Road). Will anybody be in town? With a little advertising and good weather, a star party on a holiday weekend could draw a respectable crowd.

July 14 - Lunar Occultation of Neptune at 5 AM EDT - the moon will be full, so hope for very clear skies...

July 17 - Meeting at the **Detroit Observatory** No scheduled speaker – we will follow our standard summer pattern of having informal talks by a few club members, followed by a club star party at Peach Mountain (if it's clear), or at the Brown Jug if it's cloudy.

July 25 - Public Open House at **Peach Mountain**

Announcements:

THIS WILL BE YOUR LAST NEWSLETTER

if you haven't paid your dues by July 4! If your mailing label says "4/92" in the upper right corner, then you aren't paid up yet (well, some of you are, but the treasurer didn't get the list to the membership chairman in time to get it to the newsletter editor...). Dues are $20 for one year ($12 for students). **Send your check NOW**! (Please make it payable to "University Lowbrow Astronomers") to:

Ron Avers, ULA Treasurer
9394 Anne Street
Pinckney MI 48169-8912

Mirror Blanks for Sale Fred Schebor has four Pyrex mirror blanks for sale (the last of a lot of16 picked up at the KMS auction). They are 16 inches in diameter by 3 inches thick and weigh about 50 lbs. Price is $175 each, plus shipping if necessary (retail price is about $850!). Call Fred at (313) 426-2363 for more information.

The Texas Star Party

by Roger Tanner

The Texas Star Party (April 26 to May 2, 1992) was a week of intensive dark sky observing during the nights, with talks during the days, at the Prude Ranch in southwest Texas. This year the weather was clear for 4-1/2 of the 7 nights. Several keen-eyed observers mentioned that the skies were not quite as transparent as usual because of the Mt. Pinatubo dust in the upper atmosphere. The TSP skies are noted for their transparency, but this year the dust seems to have noticeably obscured the near-horizon objects. Omega Centauri was not as clear or impressive as I remember it from years past, and Centaurus A was not very visible. Objects more than 45 degrees above the horizon were much less affected.

This year I set up in an RV spot in the middle field to avoid the dust of cars driving in and out during the day. The observing rules specify that only telescopes could be connected to the field power; people with computers must use an RV outlet, which means they were restricted in where they could set up. The organizers routed the traffic to the down-wind side of the field which also helped keep the dust down. While the large upper field was very crowded, the other fields were only partially filled. About 800 people had registered, but only 600 showed up.

Scopes, Scopes, and more Scopes The observing fields were covered with a wide variety of telescopes, including many large ones and several unusual ones. There were some 20" Dobsonains, two sets of binoculars – 17" and 20", a few 25's and one 32" scope. The 32" was a Dobsonian mounted on a rolling platform, which allowed it to track the sky for about an hour; it was heavy but could be moved fairly easily. This scope had an f4 primary (made by Star Instruments, if remembered correctly) and an 8" or 9" secondary. It also featured a multi-eyepiece focuser and a filter wheel. You could have three or four eyepieces in the holder at once, and just rotate the desired one into the beam to use it. Similarly, you could turn another knob to move several different types of filters into the light beam, allowing quick filter tryouts on any object. I looked at the Swan/Omega/Horseshoe Nebula (M17) with it, and the nebula showed a wider range of brightness compared to my 17", and even a hint of color.

There was a powered observing chair with a 6" f5 binocular on it, built by Pierre Schwar. It had a 12 volt car battery on board, with windshield washer motors driving some surplus gearboxes and a car starter ring gear as the final reduction drive. You could sit in the chair and use switches on the armrests to turn the whole assembly in altitude and azimuth and navigate around the sky. It really looked comfortable – but I would probably fall asleep observing. This design had the scopes on either side of the head with a finder just above the eyepieces.

Another scope that was interesting was Jim Lawrence's 17" binocular, which was almost completely rebuilt this year. The collimation adjustment between the two scopes worked much better than last year. I looked at several objects with it, and compared to my 17" 'monocular' scope the objects seemed brighter and it was easier to see faint stars embedded in a nebula. Jim saw a 15.9 magnitude supernova in a distant galaxy with it a few nights earlier. He likes to sketch deep sky objects; he compared his drawing of the galaxy and supernova with a photo another fellow had taken, and it was right on. Jim is a typical example of the super-friendly people at the star party. He hardly gets to look through his scope until late in the morning because he is always happy to let others use it. People were always showing up to look at some object or another to compare to the view in their own scopes.

The Sky I didn't fare so well in my own observing. One night I took photos but had some problems – all of the photos were slightly out of focus. The next night I used some old hypered Fuji 400, but found even less density on the film than when the film is unhypered. (One other problem – the nearest 1 hour photo shop is in Alpine, a half hour drive away.) I spent another night trying some CCD imaging on the 17" and experimenting with a 0.5 focal reducer, which gave it an 8 arc minute field at an f ratio of about 2.2. The focus was very soft, which leads me to believe the lens was not coping very well with the f4.5 light cone (which is not surprising since it was designed for a Schmidt–Cassegrain f10 system). I did get an image of M82 which shows either glare from the galaxy or the faint halo around it [shown at the top of page 1].

Without the focal reducer, the field in my 17" is only 4 arc minutes across, and it's hard to find deep sky objects which fit into a 4' field. This gave me a bad case of Pixel Envy (similar to Aperture Envy but much more expensive to treat). There were about 14 people with CCD systems there, but most seemed to use them only as autoguiders.

The Talks The talks were mostly pretty good. Richard Berry gave several talks. The first was on image processing for CCD images, with several useful ideas on how to squeeze the most out of low resolution cameras like the ST-4. He also talked about tricolor imaging with CCD cameras. Finally, he discussed the update of AstroIP which he is working on. This is a Visual Basic program for DOS/ Windows with the processing done in subroutines written in C. It is almost done and will be beta tested by Willmann-Bell for several months before being released in the third quarter this year – he hopes to have a demo at Astrofest this year.

Peter Ceravolo gave a lively talk about optics for amateur telescopes, and raved about the Max Optics program "ZEMAX" (which Tom Ryan has a copy of). He showed a 6" Maksutov-Newtonian which he built which gave nearly diffraction-limited images across a very wide field. He also had borrowed a flat from his employer (the National Research Council of Canada) and was testing telescopes for their optical figure – displaying the interference pattern on a TV for all to see – and visually guessing at the wave front rating of the scopes. I didn't get my scope in before the flat had to be loaded for its return trip. Peter is a very entertaining speaker – don't miss one of his presentations if you get a chance to hear him!

Before Richard Berry's talk on image processing, there was a demo of an impressive new sky charting program written by a programmer from Houston named Emil Bonanno. The program has no name yet, but he feels he will be selling it in a few months. The interesting thing about it is that he has compressed the entire Hubble Guide Star Catalog (which takes up two 600 MByte CD-Rom disks) into 46 MBytes, and has added about 20,000 deep sky objects. This gives it the ability to plot a field like you would see in a typical eyepiece (1/2 degree across) and show stars down to 15+ magnitude along with the deep sky objects. The other interesting thing it does is to show the deep sky objects at their actual size and orientation. This makes a great finder chart for those faint deep sky objects. The other neat thing he did was to add a table for all of your eyepiece and scope focal length data. This will allow you to click on the current eyepiece you are using and have the computer calculate the correct field diameter for the star chart. He wrote it to help him find some obscure objects like the globular cluster Pal 15. He looked for it at the star party, but though he knew he was looking at it he still couldn't see it. He is thinking about selling the program for $140. I got on his mailing list for info.

The feature talk was by Eugene Shoemaker, who gave the ideas and reasons why the mass extinctions at the K-T boundary (about 65 million years ago) and other extinctions are believed to have been caused by one or more comets hitting the Earth. Comets seem to be more numerous at the larger sizes necessary for the global effects. He also covered the evidence for the K-T event impact site being in the Yucatan Peninsula.

Dr. Shoemaker's wife and David Levy discussed their hunt for comets and earth crossing asteroids with the Palomar 18" Schmidt camera. They also talked about a new facility which they are seeking funding for. They propose installing a new, larger Schmidt camera in the dome of the Pluto scope at the Lowell Observatory in Arizona. This new camera would use four 2k x 2k CCD's hooked up to a powerful computer, to take hundreds of images per night. This will allow them to cover about 8 times more sky each year than they do now.

The Last Roundup The party ended with the Great Texas Giveaway, where probably a hundred door prizes were handed out. Since many people had left before Saturday because of the clouds, the odds were about 1 in 4 of winning something. The grand prize this year was a Home Dome, valued at about a thousand dollars. Some other interesting prizes were Nagler eyepieces, laminated desk editions of the Tirion atlas, and binocular observing stands. I won an Edmund Scientific binder with all sorts of introductory astronomy material and some useful observing note forms.

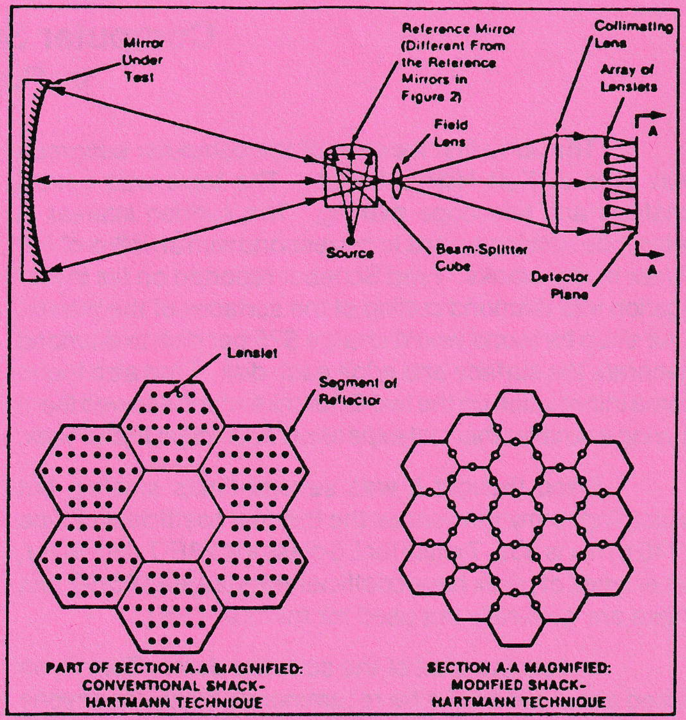
For those people who can't wait until next year, the Okie-Tex Star Party is being moved to the Prude Ranch this fall, October 19-24. The drive home took me two and a half days and I am already looking forward to the Astrofest and the Hidden Hollow star parties in the fall.

Aligning Segmented Mirrors
by Stuart Cohen

I've often wondered how the thin mirrors of active control telescopes, like the Keck, were aligned with each other and then collimated. During use, the mirrors are moved toward and away from the focal point with pistons, and are tilted and rotated by other actuators. How do you align up to 36 mirrors to within 1/10 wavelengthwhen they are several meters apart? I found a new method described in a paper entitled "FULL-SURFACE PHASING OF A SEGMENTED MIRROR", NASA Report NAS 7-918, carried out by the Jet Propulsion Laboratory, California Institute of Technology, for NASA. The following is excerpted, much of it verbatim, from that Report.

There are two kinds of errors which contribute to reduced performance: manufacturing errors and alignment errors. Ideally, one would like to achieve the smoothest possible surface over the entire array to minimize wavefront errors. Typically, monolithic surfaces with large optical errors are not measured using interferometry but rather with ray-based slope measurement techniques because of their extended dynamic range and more easily interpreted results. However, slope measurements are independent of surface height and are thus unsuitable for segmented arrays because relative piston errors between segments are not measured.

The conventional Shack-Hartmann test, which measures slope, is based on a ray-based, geometric optics approach to remove tilt (slope) errors from an individual panel. In this technique, collimated light is sent through a group of small lenses to focus light from each subaperture to a different location on each panel. By minimizing the rms deviation of the centroid location with respect to the original reference spots, one can use the conventional Shack-Hartmann camera to remove tilt from each panel surface.

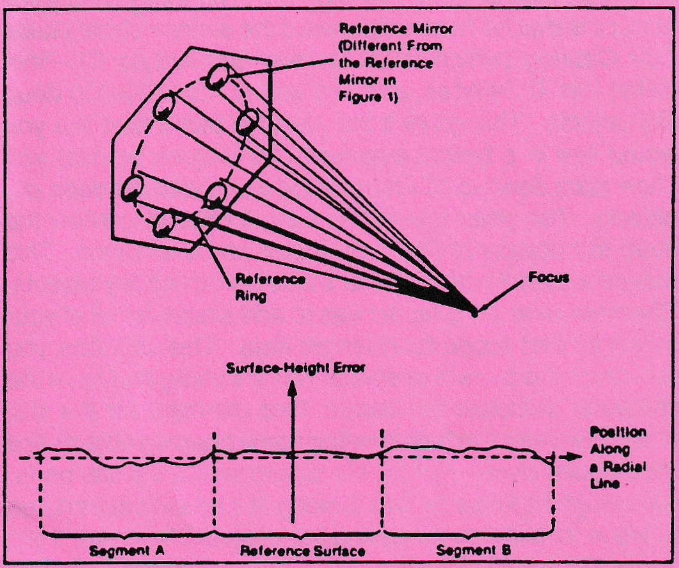


This test, however, is insensitive to piston (height) differences between panels. A method to measure the local relative piston errors of two adjacent segments is the modified Shack-Hartmann test. By straddling a lenslet across two adjacent segments, the local relative piston error between segments is obtained from that lenslet by measuring the character of the diffraction image of a far field source (star). This method is based purely on a wave-based, physical optics approach whereby the two wavefronts passing through the lenslet act as a white-light interferometer, which gives a characteristic signature when in phase. This edge-phasing technique is used to bring appropriate adjacent panel edges into phase throughout the array. This completes the alignment.

The new method can further reduce the effect of manufacturing errors by using computer programs that can phase the segmented mirror array by minimizing the rms surface-height variations with respect to some hypothetical reference parabola. Occupying the central panel position is a high-quality surface whose radius of curvature is the nominal radius of curvature of the segmented array. The reference surface is prealigned with the secondary mirror and object through conventional means. As before, using the modified Shack-Hartmann camera, the inside edges of the first ring are brought into phase with the reference surface. For a multiple ring system, one edge of the panels of each succeeding ring is phased in tilt and piston to a single edge of an inner panel which has already been adjusted.

A conventional Shack-Hartmann camera is then used to measures slope variation across the full array. Since the edges of the panels are phased and the slopes match, the surface is continuous from the reference surface to the panels. Next, the variation of surface-height error across the panel surface with respect to the inner panel is mapped out over the entire array.

For compensation of manufacturing errors, the additional amount of piston and tilt is found to minimize the surface-height variation over the entire panel. Piston compensation is accomplished by summing all the values in the sag error map and taking the average. This is a good approximation of how much the segment must move in piston to bring the average sag error value to zero.



For tilt compensation, a good approximation can be achieved by fitting a line to each row and column of data and weighing each line by the number of data points it contains. If the average slope is taken in each direction, one obtains tilts that can be used as compensators. The piston-and-tilt adjustments are then made for each panel. After adjustments are made, the surface is no longer continuous, so the technique cannot be used twice in iteration.

Computer Subgroup Report

by Roger Tanner

The June first meeting of the computer subgroup was held at Kurt Hillig's house. The topic was optical analysis and telescope making. The sudden interest in telescope making seems to correspond with an influx of 16" Pyrex mirror blanks. Fred Schebor reported on his investigation into diamond cutting of the surfaces of the blanks. One shop he found would charge $75 per disk to diamond generate the surface and edge each disk. Fred also found some information on the two E6 blanks which showed them having a smaller thermal expansion coefficient than Pyrex.

[Fred thought it was several times smaller, but according to my references the thermal coefficient of type 7740 pyrex is 33E-7 while for E6 glass it is 28E-7. However, other types of pyrex have coefficients as large as 95E-7, but these are generally not used for mirrors. - Ed.]

Before the start of the software demo, Tom Ryan talked about two books he recommends highly for anyone interested in telescope optics. The first is "Telescope Optics, Evaluation and Design" by Rutten and van Venrooij (published by Wilmann-Bell). This book has almost every possible optical system an amateur could ever imagine building. It gives the design information needed to make each system, and spot diagrams showing their optical performance. The other book is "Modern Optical Engineering" by Warren J. Smith (sorry, I forgot to note the publisher). This book is more technical and approaches optics more from the optical designer's point of view, but it is still very worthwhile as a reference book for its information on optical design and fabrication.

ZEMAX Zemax is a professional-caliber optical analysis program which allows you to ray-trace the path of light through an optical system and display the quality of the images in every possible way. Tom has the 32-bit version of the program, which means the program uses the 80386's 32-bit processor mode and not the 8086 (16-bit) emulation mode like 99.9% of other PC programs. This enables the processor to run about 2 times faster on small problems and many times faster for big problems. Tom related how he tried to write a ray-tracing program many years ago and found it very difficult. The program has several magnitudes more capability and flexibility than Tom's early attempts.

Tom began the demonstration by examining the optical aberrations of a typical 17" Newtonian. The system quickly calculated the spot diagram showing the large amounts of coma in the off axis images. The program can display the optical system graphically and allow you to rotate it in 3D space to view the light paths and surfaces from any angle. This is very handy to make sure you have entered the description correctly, as well as to view some of the system demo designs supplied with the program. The software comes with about a hundred optical systems pre-designed in demo files (all of the ones in Rutten and van Venrooij's book, mentioned above), including common ones such as the Newtonian, Cassegrain, Schmidt and Maksutov, various refractors, and even the Hubble space telescope (as it was designed, not as it was built!).

Tom described the coordinate system opticians use to define optics. The optical surfaces are defined by their curvature radius, the distance to the next surface, the surface type (reflecting or transmitting), the material (mirror, air or type of glass), and by the order of the conic section (0 for spheres, -1 for parabolas etc.). Glass tables are built in, so you can tell it a glass type and it will look up the index of refraction and dispersion for you. Additionally, apertures, stops and tilted components can be specified. The information is entered into a spreadsheet-like table. The program automatically recalculates the ray trace after each change is made.

Tom then showed the excellent resolution for the Rumak, which is a modified Cassegrain with a Maksutov-type corrector plate. The spot diagrams showed all of the light rays falling inside of the Airy disc even at large angles off-axis. This means the images would be diffraction-limited across the entire field. Furthermore, the field is nearly flat, making this an excellent photographic scope. This was the best spot diagram performance of any system that was analyzed. Tom also show the optical analysis of Brian Close's Tri-Shiefspiegler. This has different aberrations in each direction from the center because of its tilted optical design. The spot diagram was not as good as the Rumak but was very good compared to a Newtonian.

Tom also showed the MTF and PSF for these systems, two of the many other types of analysis the program will perform. The MTF is the Modulation Transfer Function, a very precise way of quantifying the resolution and contrast of the system. A good optical system will have a high MTF or contrast value for very small angular images. This is similar to the frequency response of a stereo system. A perfect system would roll off linearly with decreasing angular size, a system with a large obstruction or other aberration will roll off sooner. The Rumak has a fairly large central obstruction and showed a roll off of contrast sooner than a refractor or the Tri-Shiefspiegler .

The PSF, or Point Spread Function, shows the distribution of light falling on the image plane from a point source. This type of display looks like a 3D plot of a mountain showing the large central peak were the light is concentrated in the Airy disc and the surrounding rings caused by the wave nature of light. This type of display for the off axis image of the fast Newtonian looked more like a mountain range with a small central peak and several rows of mountains representing the coma. This display gives a much better feel for the intensity of the light thrown out of the Airy disc by optical aberrations.

The program will even perform a CCD simulation where it will calculate the amount of energy that will fall into each pixel of a CCD chip from the aberrations of the optical system (this is probably a cellular version of the PSF analysis). Among the many other things the program will calculate are the optical coefficients for the aberrations of the optical system at the image (focal) plane.

The feature which Tom was most impressed with was the optimization capability of Zemax. Any of the cells in the spread sheet table can be labeled a variable and the program will optimize these variables to maximize image quality. It can even select the glass with the best index of refraction and dispersion! Tom had the program start with a flat plate of glass 4" in diameter and had it determine the radius required to get the light to reach a focus 40' behind the plate. This only took a few seconds. This worked for one frequency of light but was poor at the other wavelengths. Tom attempted to add a second lens to improve the color correction, but several of the optimum points the computer found were pretty poor, and the lenses were unfeasible to make. Tom pointed out that the program found a local optimum point in the solution, not the global optimum point. This means that you need to start with a design that works to some extent. This also points out that the world's most sophisticated and powerful program will not make you an expert optical designer.

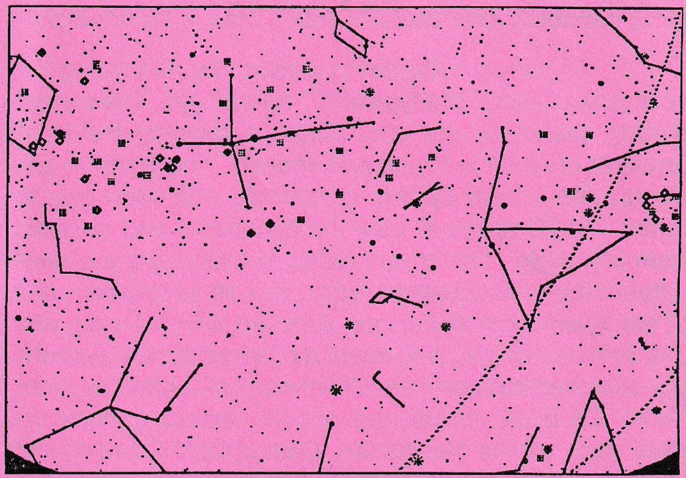
The price of all this wonderfulness is $900 for the 16 bit version and $1500 for the 32 bit version, plus the computer!!!. (It is much cheaper to con Tom into helping you analyze your optics by buying him lots of Diet Pepsi.) Seriously, Tom was happy (actually more like ecstatic) to use the program to help people get closer to the holy grail of optical perfection.

Next Meeting The next meeting will be at Roger Tanner's house in Canton on Wednesday, July 1 at 7:30. For directions call 981-0134. We will continue the ZEMAX analysis of the optical systems for various telescopes the club members are considering for their 16" mirrors. Also there will be a demo of Stargaze level 3, yet another PC star chart program. One of the interesting things about this program is that they have included Hubble Guide Star Catalog stars around the common deep sky objects. The Sky Globe shareware disc will be available also.

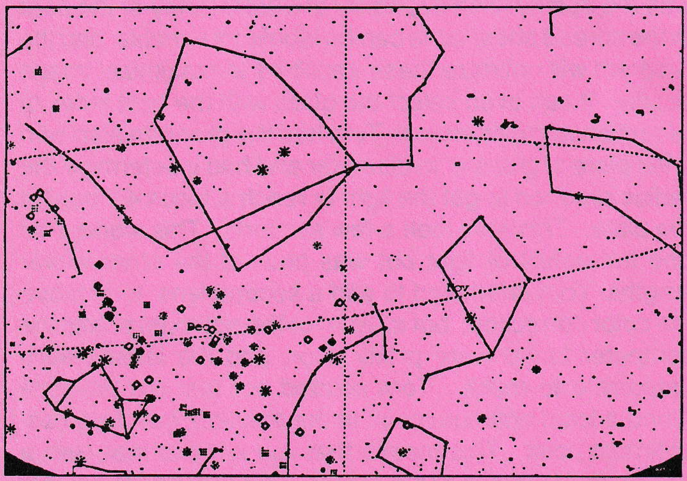
Sky Charts for June 19, 1992 at 11:00 PM EDT. As the Voyager program has limited resolution when printing full-sky star charts, I have divided the sky into North, South, East and West views, along with a Zenith view. Stars to 7th magnitude and deep-space objects to 11th magnitude are shown.

North

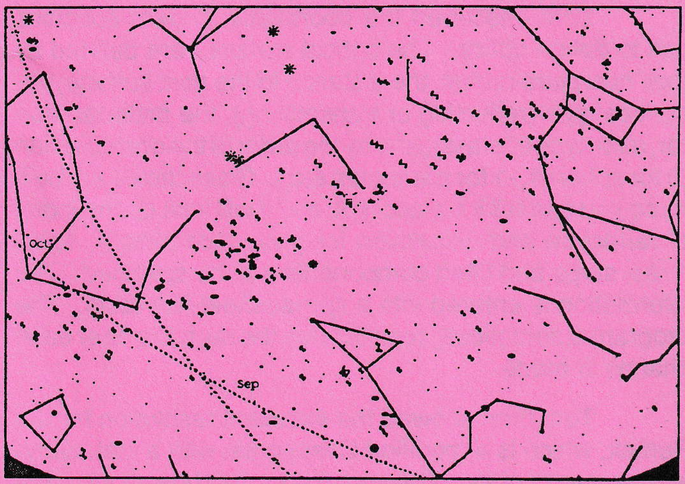
East



South



West



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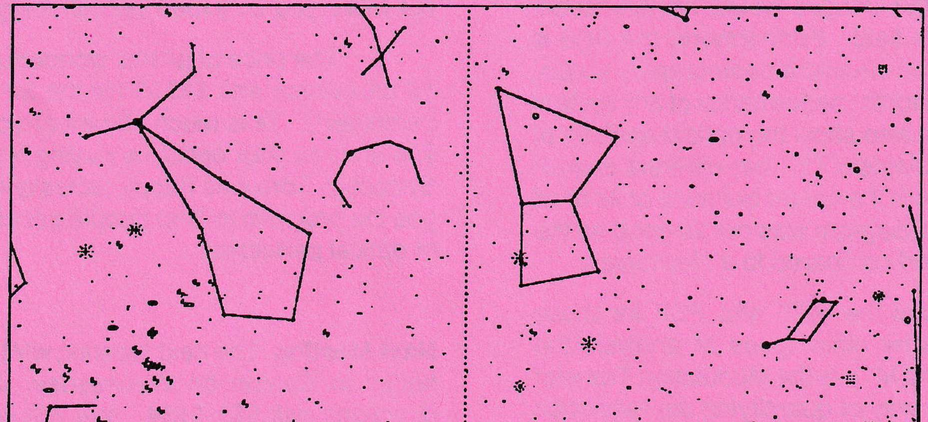

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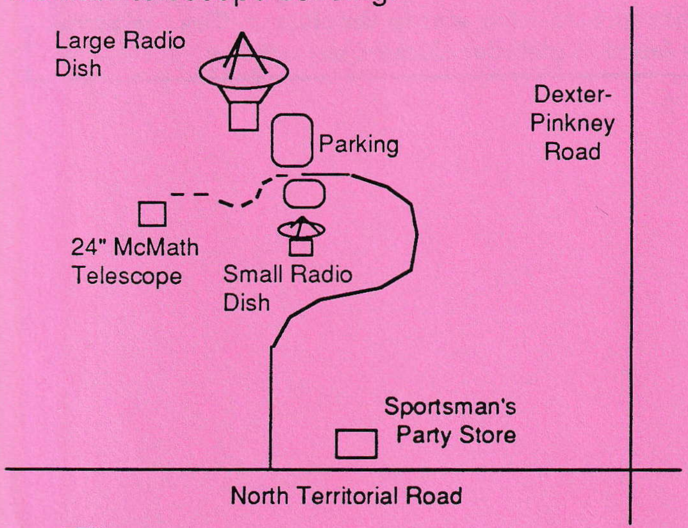
☞ Places:

The Detroit Observatory is in Ann Arbor, at the corner of Observatory and Ann Streets, across from the old University of Michigan hospital and between the Alice Lloyd and Couzens dormitories. The Detroit Observatory is an historic building which houses a 19th century 12-inch refractor and a 6-inch transit telescope.

The Peach Mountain Observatory is the home of the University of Michigan's 20-meter radio telescope, and the McMath 24-inch telescope maintained and used by the Lowbrows. The observatory is located northwest of Dexter; the entrance is on North Territorial Road, 1.1 miles west of Dexter-Pinkney Road. A small maize and blue sign marks the gate. Follow the gravel road one mile to a parking area near the radio telescopes. Walk along the path southwest (between the two fenced-in areas) about 300 feet to reach the McMath telescope building.



☞ Times:

The monthly meetings are held on the third Friday of each month at 7:30 PM at the Detroit Observatory. During the summer months, and when weather permits, a club observing session at Peach Mountain will follow the meeting.

Public Open House / Star Parties are held May through October on the Saturdays before and after each new moon at the Peach Mountain Observatory. Star Parties are cancelled if the sky is cloudy at sunset. Many members bring their own telescopes; visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitos – bring insect repellant, and wear warm clothes, as it gets cold at night!

☞ Dues:

Membership dues in the Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students. This entitles you to use the 24" McMath telescope (after some training). Dues can be paid to the club treasurer, Ron Avers, at a meeting or by mail at this address:

9394 Anne
Pinckney, MI 48169-8912

☞ Magazines:

Members of the Lowbrow Astronomers can get a discount on these magazine subscriptions:

Sky and Telescope: $18/yr
Astronomy: $16/yr
Odyssey: $10/yr

For more information, contact the treasurer.

❒ Sky Map:

The Sky Maps in this issue of *REFLECTIONS* were produced by Kurt Hillig, using the Voyager program on a Macintosh IIfx.

✎ Newsletter Contributions:

Members (and non-members) are encouraged to write about any astronomy-related area in which they are interested. Please call the newsletter editor (Kurt Hillig, 663-8699) to discuss length, format, etc. Announcements and articles are due 14 days before each monthly meeting. Contributions should be direced to Kurt Hillig, Reflections Editor, 1718 Longshore Dr., Ann Arbor, MI 48105.

☎ Telephone Numbers:

President:	Stuart Cohen	665-0131
Vice Pres:	Doug Nelle	996-8784
	Paul Etzler	426-2244
	Fred Schebor	426-2363
	Tom Ryan	662-4188
Treasurer:	Ron Avers	426-0375
Observatory:	D. C. Moons	254-9439
Newsletter:	Kurt Hillig	663-8699
Membership:	Steve Musko	426-4547

Peach Mountain Keyholder:

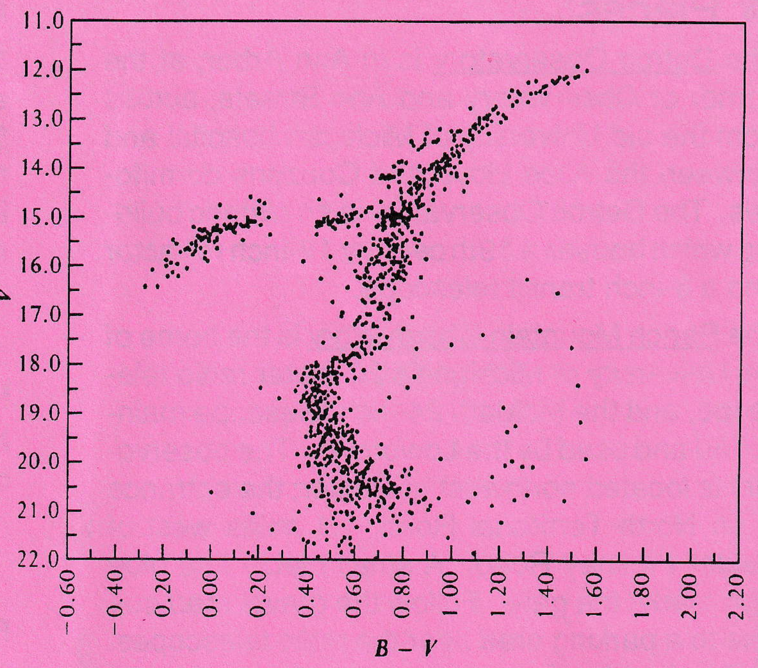
Fred Schebor 426-2363

Monthly Meeting:

A Report on the Texas Star Party by Roger Tanner

June 19, 1992 at 7:30 PM

At the
Detroit Observatory in
Ann Arbor



A Hertzsprung-Russel diagram for the globular cluster M5. The vertical axis is the absolute magnitude and the horizontal axis is the color index (blue magnitude – yellow magnitude). Each point represents one star in the cluster. The horizontal branch is found in globular clusters but not in open clusters.

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