University Lowbrow Astronomers
Ann Arbor, Michigan

REFLECTIONS AND REFRACTIONS

OF THE UNIVERSITY LOWBROW ASTRONOMERS

September 2003

Upcoming Events

September 2003

- **Saturday, September 20 (Starting at Sunset) Regular Scheduled Open House and Star Party at the Peach Mt. Observatory. Weather permitting.**
- **Saturday, September 27 (Starting at Sunset) Regular Scheduled Open House and Star Party at the Peach Mt. Observatory. Weather permitting.**
- **Friday, October 3 Cosmic Origins Public Lecture Series. 7:30 p.m. Angell Hall.**
- **Sunday, October 12 Great Space Adventures Day 12 noon to 5 p.m. EECS Building, North Campus.**
- **Friday, October 17 (Starting at 7:30) Monthly Club Meeting held in either room 130 or 807 in the Dennison Building.**
- **Saturday, October 18 (Starting at Sunset) Regular Scheduled Open House and Star Party at the Peach Mt. Observatory. Weather permitting**
- **Saturday, October 25 (Starting at Sunset) Regular Scheduled Open House and Star Party at the Peach Mt. Observatory. Weather Permitting.**

Mars Sketches by Doug Scobel

What Do Telescopes Do? Part II

by Doug Scobel

In my previous article I described some of the basic functions of telescopes. Now it's time to test your knowledge. You may be surprised to learn that there is a lot of "common wisdom" out there regarding telescope usage that is simply not true.

True or false? – Large telescopes are useless in light polluted areas because they make the sky background too bright

False. The truth is all telescopes of the same focal ratio will show about the same sky brightness through the same eyepiece. It has nothing to do with the aperture. To understand why, consider two approximately f/5 telescopes, one an 8 inch, the other a 16 inch. The focal length of the 8 inch will be around 1000 mm, and that of the 16 inch around 2000 mm. With a 25 mm eyepiece, the two scopes will give magnifications of around 40x and 80x, respectively. The 16", being double the diameter of the 8", will collect four times more light. Moreover, both combinations will produce about a 5 mm exit pupil.

Now you're thinking that since the 16" gathers four times more light than the 8", then the sky background should be four times brighter. What you're forgetting is that you're also at double the magnification, so you're only seeing one fourth the sky area as you're seeing through the 8". Four times more light, but you're only looking at one fourth the area, so the brightness per unit area is the same. If you could lower the power in the 16" to 40, by using a 50 mm eyepiece, then you would see a four fold increase in the background brightness. Unfortunately, such a combination will produce a too large (10 mm) exit pupil, and you're no longer using all 16 inches of the primary mirror, making the background dimmer.

So, the truth of the matter is that in a light polluted sky, all telescopes are more or less equally hindered, and it just might be that it seems worse in a larger scope because you expect more out of it.

True or False? – More aperture makes extended objects look brighter

Well, this is kind of true, but a more accurate statement is that more aperture lets you magnify faint, extended objects more, making them easier to see. But with more aperture, objects are not necessarily always brighter to your eye. The reason is similar to what I explained in the previous discussion. Suppose you are looking at M81 (a galaxy in Ursa Major) in the 8" f/5 scope with a 25 mm eyepiece. You are looking at the galaxy at 40x. Now switch to the 16" f/5 scope with the same eyepiece. You're now looking at it at 80x. You've got four times the light, but the galaxy is now covering four times the area in your eyepiece's field of view. So, to your eye, its brightness per unit area is the same in both scopes. Moreover, the sky background is the same brightness too, so contrast of the galaxy against the background is the same. So why does it look so much better? It's because the galaxy appears twice as large in the 16", covering four times the area, and you see much, much more detail.

Now if you switch to a 12.5 mm eyepiece in the 8", then you will be looking at it at 80x and it will appear as large as it does in the 16" with the 25 mm. But, you'll notice that it is much dimmer and less detailed, because it is only one fourth as bright. So, at equivalent magnifications, more aperture does indeed make extended objects appear brighter.

The bottom line is that the extra light provided by more aperture allows the observer to increase the magnification of an extended object to make it, and any details in it, easier to see. But its actual brightness per apparent unit area in the eyepiece remains the same at equivalent effective focal ratios.

Note that this applies to extended objects only. With stars, whose images are essentially points (not really, but close enough – see the next question below), more aperture does indeed make them look brighter in the eyepiece.

True or False? – Ability to resolve close double stars is a good indication of the quality of a telescope's optics

Mostly true, but sometimes false. Much of the time, slightly less than perfect optics can actually make it easier to split really close doubles, rather than make it more difficult. To understand why, you first need to understand what a star's image looks like in a telescope.

With reasonably good optics, the image of a star is not a point, but rather what is referred to as a diffraction pattern. The diffraction pattern consists of a central disk, called the Airy disk (named after Sir George Airy, a nineteenth century English scientist and astronomer, not because it is "airy"), and a series of surrounding rings. With perfect optics, 84% of the light goes into the Airy disk, and the rest is distributed into the surrounding rings. And most of that remaining 16% goes into the first ring. This pattern is the result of the wave nature of light, the rings being produced by alternating constructive and destructive interference of the light waves forming the image.

If you could look at a star through a hypothetically perfect telescope, with no central obstruction, one that is perfectly collimated, with an equally perfect eyepiece, with a perfectly steady atmosphere, at high power, then you would see a bright disk, a fainter first ring, and maybe a second ring if the star is bright enough. But, all sorts of "defects" in real telescopes perturb the wavefront, both laterally and longitudinally, so that less light ends up in the Airy disk, and more light goes into the surrounding rings. Atmospheric instability does it, the central obstruction in reflectors does it, and poor optical quality does it. So with real telescopes, under real conditions, when light is removed from the Airy disk, it looks ever so slightly smaller to your eye. In the case of a close double star, where the two diffraction patterns are nearly coincident, it can be easier to tell that there are two stars instead of one when the two Airy disks are smaller, rather than larger. And slightly inferior optics can do just that.

Of course, there's a limit. Once the optical quality gets bad enough, then the entire diffraction pattern breaks down, and you might not see an Airy disk at all. But for observing extremely close doubles under a steady atmosphere, ¼ wave optics just might work better than 1/10 wave optics!

Also note that this applies to splitting close double stars only. For viewing extended objects, especially those with low-contrast details like planets, good optics always out-perform poor optics, all other factors being equal (which of course never are!).

True or False? – You should not use high magnification on faint, extended objects

False. This is a common sense argument that simply does not hold up in practice. There are a great number of deep sky objects on which you actually need to use high magnification to be able to even see.

A good example is Stephan's Quintet, a small cluster of five faint galaxies in Pegasus. To find this little group, you need low power, but once you locate it, it's hard to tell what you're looking at. At low power, (around 50x in my 13" scope) it looks more like a little amorphous nebula than a cluster of galaxies. But increasing the magnification to around 200x makes a huge difference. Now it's easy to pick out all five galaxies, including their orientations.

Some think that it's because increasing the magnification darkens the sky background making the object easier to see. Not so, because the object itself is darkened by the same amount. The real reason is that it now appears big enough to "pick out" from the background. That's why for faint objects that already appear large in a low power eyepiece, like faint comets, adding magnification usually makes things worse, which is probably where this bad advice originated. But for small, faint objects, adding magnification often helps.

Adding magnification also lets you see details in the objects that you won't see at lower power. Many of the faint 11th and 12th magnitude galaxies in the so-called Herschel 400 list need to be viewed at relatively high power to see any structure in them, such as elongation, relative brightness of the core, etc. And for bright objects, say the Ring Nebula in Lyra, high power can provide stunningly spectacular views.

True or False? – Any red flashlight, regardless of its brightness, will preserve your night vision

False. Some think that as long as your flashlight has a red filter on it, that it will not harm your night vision. But a too bright flashlight, regardless of the color, will indeed harm it. Now red is probably the best color

About the University Lowbrow Astronomers

The University Lowbrow Astronomers is a club of Astronomy enthusiasts which meets on the third Friday of each month in the University of Michigan's Physics and Astronomy building (Dennison Hall, Room 130 or 807). Meetings begin at 7:30 PM and are open to the public. Public star parties are held twice a month at the University's Peach Mountain Observatory on North Territorial Road (1.1 miles west of Dexter-Pinckney Road; further directions at the end of the newsletter) on Saturdays before and after the new Moon. The party may be canceled if it's cloudy or very cold at sunset. For further information call (734) 480-4514.

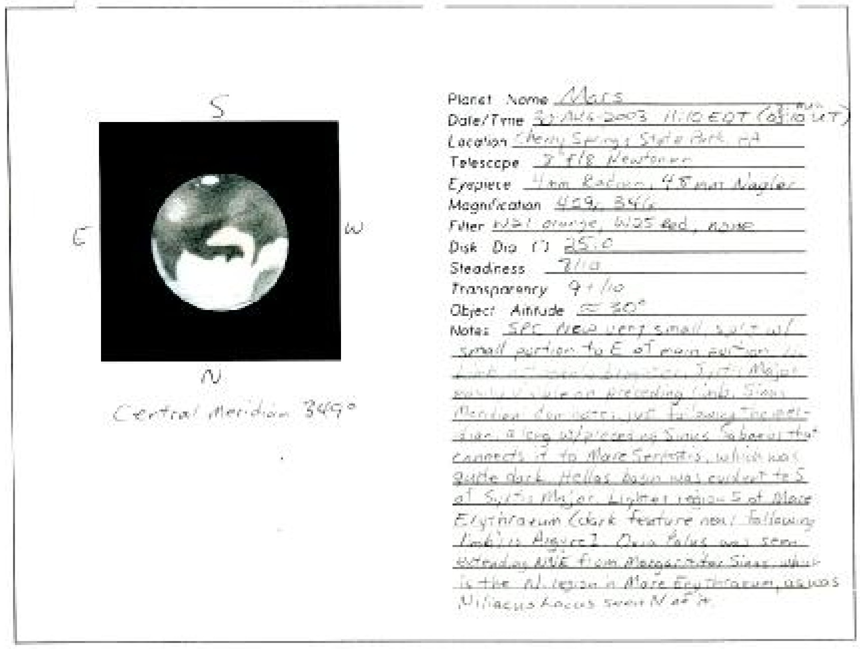
to use, although I don't know for sure, and some even claim that a dim green flashlight is actually better than a red one. But whatever its color, use as dim a light as possible. I see so many folks using such bright flashlights while reading charts, and I'm sure that their eyes never become fully dark adapted. Plus, be mindful of the background color of what you're looking at. If you can, use charts which have white stars on a black background (which will look more like the sky anyway), because the dark background will reflect little light back into your eyes. If you need to read charts with a white background, then use as dim a light as will just allow you to read them. If you are using a laptop computer, turn its monitor down as dim as it will go.

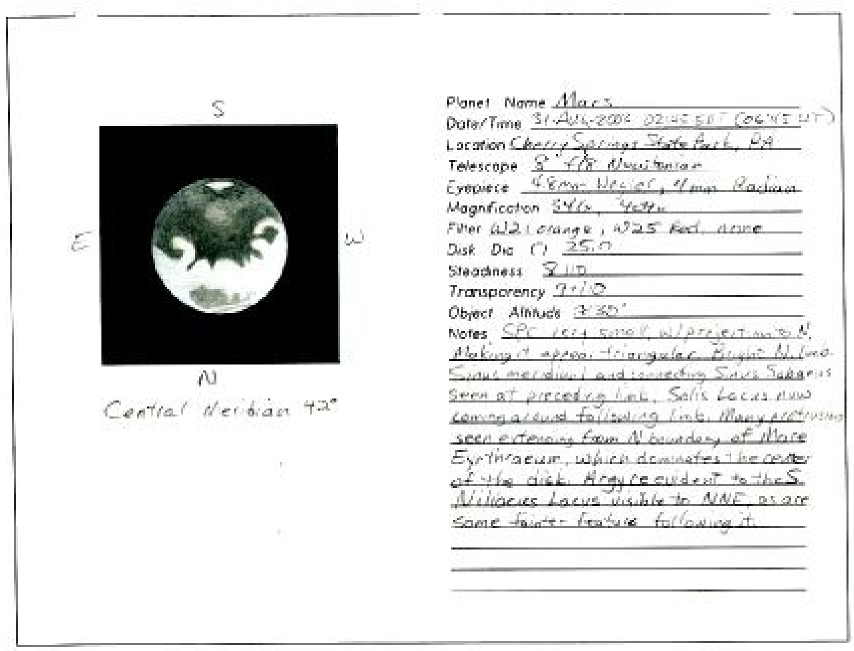
Personally, I use three flashlights while I'm observing. I have one bright one, a two C-cell Mag-Lite with its lens painted with Testor's red spray paint, that I use only for setting up and when putting everything away. A "medium" one, a two AA-cell mini Mag-Lite with the lens painted red, for general chart reading and fumbling around, and a dim, single red LED with built-in magnifier for close-up reading of star charts, writing notes, and any time I have to look at a page which is printed black on a white background. Even at that, I have noticed a slight, temporary loss of dark adaptation after I take a minute or two to jot down some notes on an object I've just observed.

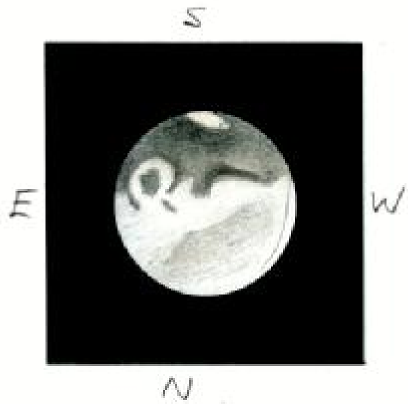
So there, now you have something new to think about the next time you're out with your scope. And don't believe everything you hear – or read. And that's the truth!

MARS II

Sketches from Lowbrow Members, Part II

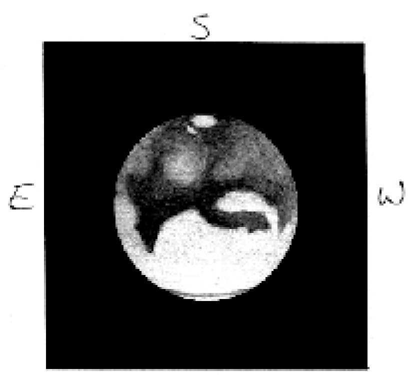






Central Meridian 124°

Planet Name: Mars
Date/Time: 20-AUG-2003 01:45 EDT (05:45 UT)
Location: Saline, MI
Telescope: 8" f/8 Newtonian
Eyepiece: 4.8 mm Nagler
Magnification: 341x
Filter: W21 orange, W25 red, none
Disk Dia ("): 24.8
Steadiness:
Transparency:
Object Altitude:
Notes:



Central Meridian 325°

Planet Name: Mars
Date/Time: 06-Sep-2003 01:10 EDT (05:10 UT)
Location: Saline, MI
Telescope: 8" f/8 Newtonian
Eyepiece: 4.8mm Nagler; 4mm Radian
Magnification: 341x; 409x
Filter: W21 orange, None
Disk Dia ("): 24.6
Steadiness: 8/10
Transparency: 9/10, gibbous moon
Object Altitude: ≈31°
Notes: SPC "split" - small bright spot in Novus Mons, Syrtis Major, Sinus Sabaeus, and Sinus Meridiani sharply outlined. Hellas basin easily seen. Also, dark "lane" heading SSW from Mare Serpentis following Hellas. Nothing seen to N other than NPH, which was not as obvious as it was on 30 Aug.

Telescope Topics

by Tom Ryan

<u>“Stray Light”</u>

Recently, I have been working on an optical system for medical use that is very interesting. Part of it consists of a microscope at the end of a long straight tube, and this part is used to examine internal organs, while the organs are still in the patient. Since the inside of a person is fairly (but not entirely) dark, a light is directed down the tube to light up the organs in question. The light has to be bright, of course, because not a whole lot of light gets reflected from most organs. About as much as comes from fresh steak, if you need a clearer picture.

The problem is that the light also lights up the lenses that return the image from the patient’s insides, and lights them up very efficiently. This makes looking into the tube very similar to looking through kitchen windows that have not been cleaned of cooking grease for a very long time. The view tends to wash out toward an even gray, and the image’s contrast suffers. Doctors hate this, and therefore, so do we.

The stray light has three components: a direct reflection from each lens surface, which returns more or less straight to the viewer; reflections which bounce off the inside of the tube and find their way back to the eye; and light which is scattered in all directions (which includes the viewer). Eliminating the stray light means addressing each one of these mechanisms.

On the face of things, eliminating the reflections from the lens surfaces would seem to be straightforward. Good anti-reflection coatings have been being applied to lenses for about sixty years now, and the people who apply these coatings are getting pretty good at it. Coatings are now available which will reduce the reflectance of a glass surface (depending on its index of refraction) from an uncoated 4% to a coated 0.5%, and that is over a fairly wide spectral range. Even more remarkable is the fact that some of these coatings work this well over fifteen or twenty degrees of incidence angle. (AR coatings work by interference between successive layers of high and low index materials of precise thickness, and that thickness varies, naturally, depending on the angle that light travels through the layers). So a good AR coating should take care of the first problem.

The second source of stray light is that which bounces off the lenses, hits the walls, and heads straight back to the viewer. This light can be reduced by intelligently designed baffles, and again, by proper coatings of the wall and the edges of the lenses. Technology marches on, and the Hubble telescope program has yielded a black coating that can be applied to almost any metal, and it is black. Not just mostly black. It is a black hole on earth, even at grazing angles. It is horrendously expensive, but hey, do you want that doctor to be able to see what he’s doing in there with a knife or not?

The edges of the lenses can be blackened by painting them with a black cellulose nitrate paint (airplane dope). This material has the fortunate property of having nearly the same index of refraction as BK7 glass, and light just disappears into it as a consequence. (Bet you didn’t know that black paint has an index of refraction. It does.) This paint doesn’t work as well with high index glasses, but I’m not going to tell you which paint does. You can never be sure about who’s reading this stuff.

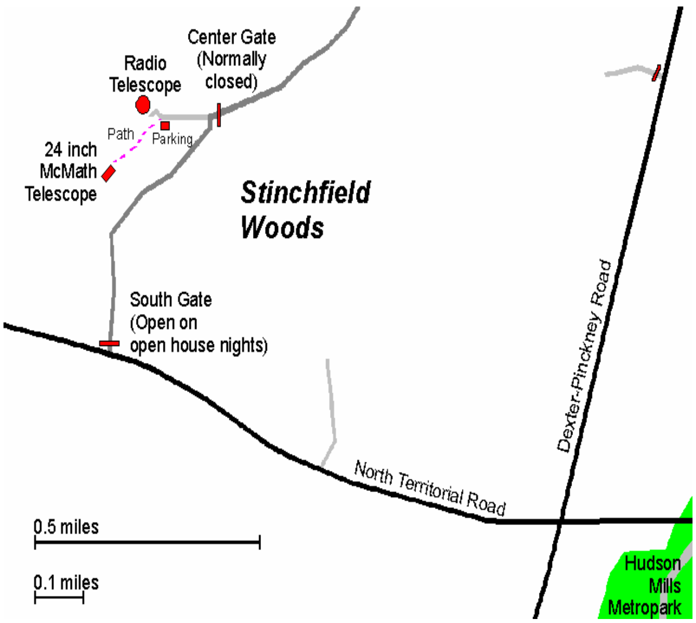
The third problem is that of scattered light. This light has basically two sources; dust particles, and those AR coatings we put on earlier. It is possible (and sometimes necessary) to assemble an optical system in a clean room to keep out the dust, but those AR coatings are there for a reason, and not much can be done about them. It seems strange that an uncoated, polished surface scatters less light than a coated one, but there you have it. Nothing is an unmitigated good, and engineering is the art of the compromise.

Just so you don’t think that this article was somehow misrouted from Medical Devices magazine, I would like to add that stray light is a problem in telescopes too. It has the same effects, and it has the same cures. I used to think that refractors produced better images than reflectors because the surfaces were usually spherical and thus lacked microripple, or because the aluminizing had some kind of sub-microscopic structure, but now I think it’s just better baffling and no diffraction from the secondary supports.

Eyepieces are also sources of stray light. When I was a teenager and Unitron refractors were the Astro-Physics of the day, I bought a few Brandon eyepieces because they had the reputation of giving the best images of planets available. The nicely overcoated lenses were hand-selected by Mr. Brandon, and were placed in beautifully machined, parfocalized, non-chromed barrels, but they really owed their success to the fact that there was simply not much glass in them. Their clarity was (and is) remarkable. I have since added a couple of wide angle Naglers to my collection, but I don’t use them for planetary observing. Too much glass.

Places and Times

Dennison Hall, also known as The University of Michigan's Physics and Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. It is found in Ann Arbor on Church Street about one block north of South University Avenue. The meeting is held in room 130. Monthly meetings of the Lowbrows are held on the 3rd Friday of each month at 7:30 PM. During the summer months, and when weather permits, a club observing session at Peach Mountain 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 inch telescope which is maintained by the Lowbrows. The observatory is located northwest of Dexter. The entrance is on North Territorial Road, 1.1 miles west of Dexter-Pinckney 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 between the two fenced in areas (about 300 feet) to reach the McMath telescope building.

Public Star Parties

Public Open House/Star Parties are held on the Saturday before and after each new Moon at the Peach Mountain Observatory. Star Parties are canceled if the sky is cloudy at sunset or the temperature is below 10 degrees F. Call 480-4514 for a recorded message on the afternoon of a scheduled Star Party to check on the status. Many members bring their telescopes and visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitoes - bring insect repellent, and it does get cold at night so dress warmly !
Amateur Telescope Making Group meets monthly, with the location rotating among member's houses. See the calendar on the front cover page for the time and location of next meeting.

Membership

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students and seniors (age 55/+). This entitles you to the monthly REFLECTIONS newsletter and the use of the 24" McMath telescope (after some training).
Dues can be paid to the club treasurer Charlie Nielsen at the monthly meeting or by mail at this address:
6655 Jackson Road #415
Ann Arbor, MI 48103

Magazines

Members of the University Lowbrow Astronomers can get a discount on these magazine subscriptions:
Sky and Telescope: $29.95 / year
Astronomy: $29.00 / year

For more information contact the club Treasurer. Members renewing subscriptions are reminded to send your renewal notice along with your check when applying through the club Treasurer. Make the check payable to "University Lowbrow Astronomers".

Newsletter Contributions

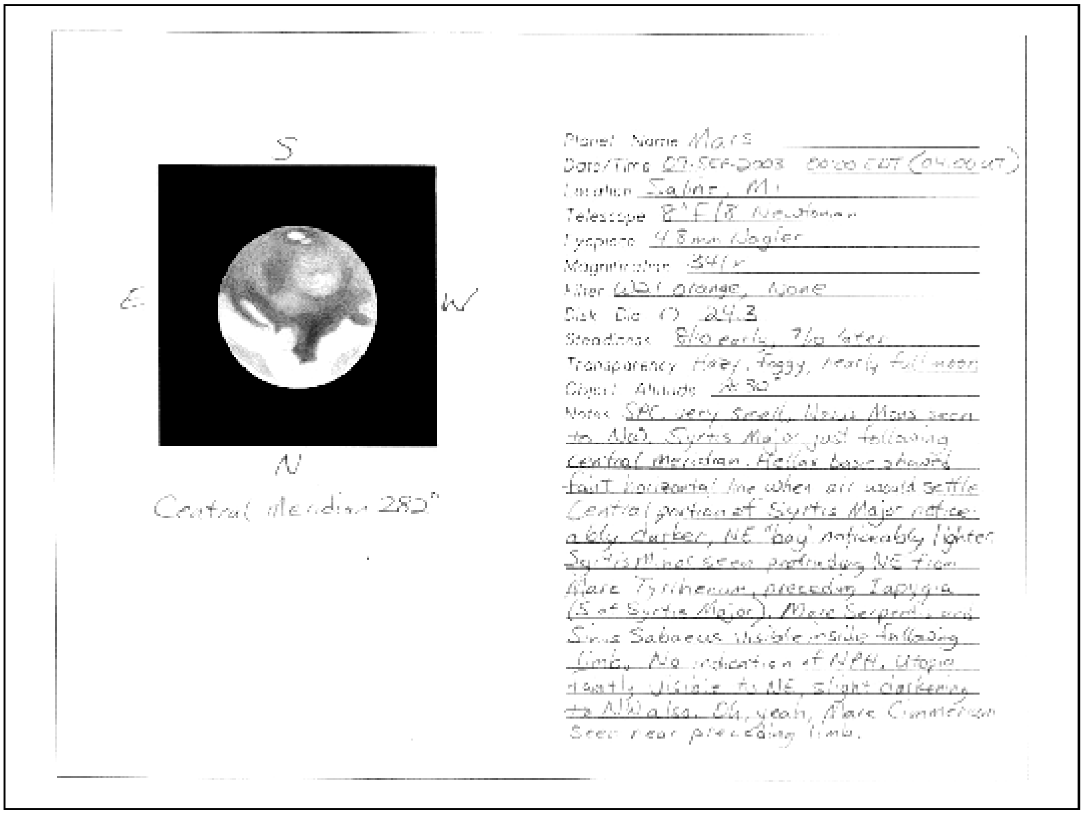
Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call or Email to Newsletter Editor at: John Ryan (734) 662-4188 john_edward_ryan@hotmail.com to discuss length and format. Announcements and articles are due by the first Friday of each month.

Telephone Numbers

President:	Charlie Nielsen	(734) 747-6585
Vice Presidents:	Jim Forrester	(734) 663-1638
	Bernard Friberg	(734) 761-1875
	Jim Wadsworth	
	Doug Warshow	(734) 998-1158
Treasurer:	Mike Garrahan	(734) 424-2874
Observatory Director:	Mike Radwick	(734) 453-3066
Newsletter Editor:	John Ryan	(734) 662-4188
Keyholders:	Bernard Friberg	(734) 761-1875
	Charlie Nielsen	(734) 747-6585
	Mike Radwick	(734) 453-3066
	Fred Schebor	(734) 426-2363

Lowbrow's Home Page

http://www.umich.edu/~lowbrows/
Dave Snyder, webmaster



Mars sketch made by Doug Scobel on September 9th from his backyard in Saline, Michigan.

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Check your membership expiration date on the mailing label.