April, May, June 2004 Volume 24, Issue 2

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Web Site Changes

Web Site Member Area

We now have an area of the web site that is specifically just for our members. This area was set up to provide a benefit to our members that only they can access. In this area of the web site you can get a copy of the latest issue of the newsletter and order W.A.S. merchandise. Other goodies will be coming soon, so stay tuned for further developments. Also, if you have forgotten the password to access the member area, please contact Tim Grunewald.

Item	Cost
Fitted T-shirt	$15.99
White T-Shirt	$13.99
Ash Grey T-Shirt	$14.99
Golf Shirt	$16.99
Long Sleeve T-Shirt	$18.99
Women's T-Shirt	$13.99
Hooded Sweatshirt	$24.99
Sweatshirt	$20.99
Baseball Cap	$12.99
Large Mug	$11.99
Mug	$10.99
Stainless Steel Travel Mug	$14.99
Tile Coaster	$4.50
Mousepad	$10.99
Wall Clock	$10.99
Flying Disc	$6.49
Journal	$7.49
Sticker (Oval)	$2.49
Sticker (Rectangular)	$2.49
Tote Bag	$12.99
Messenger Bag	$18.99

All items have the color logo (black background with yellow title).

W.A.S. Merchandise Now Available Online

We have converted our merchandise sales to an on-line store. The advantage of using an online store is that we have no overhead. Cafepress.com provides the service to our members and shipments go directly to their home.

You can get to the store through the member area of the web site. If you do not have Internet access you can contact the merchandise coordinator or one of the board members for a print out of the web page and one of them can place the order for you.

-Tim Grunewald

W.A.S. News and Information

At the Observatory - 2003

Date	Weather	Attendance
Friday, January 10	19°, clear	20 people
Friday, January 24	15°, overcast	0 people
Friday, February 7	13°, clear	16 people
Friday, February 21	37°, clear then hazy	20 people
Friday, March 7	34°, overcast	0 people
Friday, March 21	40°, overcast/light rain	0 people
Friday, April 7	30°, overcast/flurries	0 people
Friday, April 25	45°, clear	22 people
Friday, May 2	43°, clear	27 people
Friday, May 9	75°, clear	27 people
Friday, June 6	55°, light rain	0 people
Friday, June 20	61°, clear	20 people
Friday, July 11	68°, partly cloudy	15 people
Friday, July 25	77°, overcast	0 people
Friday, August 8	66°, clear	35 people
Friday, August 22	71°, clear	100 people *
Tuesday, August 26	75°, hazy	50 people *
Wednesday, August 27	66°, mostly clear	125 people *
Friday, September 5	64°, clear	100 people *
Friday, September 19	57°, clear	27 people
Friday, October 3	57°, overcast	0 people
Friday, October 17	52°, overcast with small holes	3 peop le
Friday, November 7	28°, clear	18 people
Friday, November 21	39°, overcast	0 people
Friday, December 5	38°, clear	22 people
Friday, December 19	20°, clear	15 people

* Advertised sessions for Mars closest approach to Earth

2004 W.A.S Volunteer Positions

Board of Directors

★ **President:** Joe Carlone
★ **Vice President:** Mike Nugent
★ **Secretary:** Jackie Mau
★ **Treasurer:** Sandy Dombeck
★ **Observatory Director:** ***Tim Grunewald

Milwaukee County Parks Liaison: Karen Kerans
Public Program Planning Committee Chairperson:
Sandy Dombeck
Froemming Park Observing Helpers:
Joe Carlone
Sandy Dombeck
Gene & Charlotte DuPree
Adam Machajewski
Todd Weiler
Phil Schumacher
Pauline Beck
Membership Coordinator: Sandy Dombeck
Merchandise Administrator: Jackie Mau
Magazine Subscription Coordinator: Sandy Dombeck
Webmaster: Tim Grunewald

Newsletter Editor: Adam Machajewski
Newsletter Proofreader: Donna Grunewald
Newsletter Duplicator: Tim Grunewald
Newsletter Mailer: Tim Grunewald
Newsletter Article Writers:
Tim Grunewald
Jay Wichmann
Adam Machajewski
Phil Schumacher
Pauline Beck
(Any members are welcome and encouraged to send in articles for the Newsletter. Edited and published at the discretion of the editor.)
Librarian: Adel Roy
Historian: Greg Gonia
Public Outreach Coordinator: Karen Kerans
Book/Magazine/Slide Loanout Administrator: Karen Kerans
Telescope Loanout Administrator: (Observatory Director) ***Tim Grunewald
Auditors: (by appointment of the Board of Directors)
Picnic Coordinator: Gene & Charlotte DuPree
5 Year banquet coordinator: **Open**

Note: *** signifies a position available

Using Auto-guiding to Produce Sharp CCD Images

Introduction

When I first attempted to take a picture of a galaxy or nebula I was happy to see anything, even a vague resemblance to the object. My first photo of the Horsehead Nebula proved that it could be done from my light-polluted backyard in Greenfield. But, it was fuzzy and indistinct. As I progressed, it was apparent that I could not get images like I was seeing from more experienced astrophotographers without getting much more picky about the results. I needed to learn something new. This article describes a technique that resulted in a great improvement in my images.

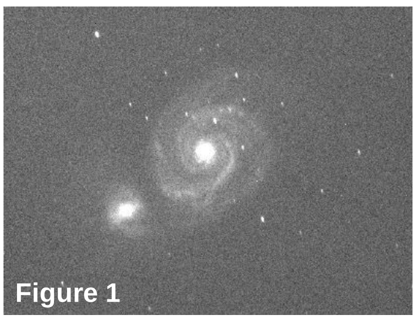


Figure 1

An important part of deep-sky photography is getting a sharp long exposure image. After getting good focus, the next important aspect is to have the telescope track the object through the sky to great precision. The accuracy required is on the order of one arc-second of pointing variation throughout the exposure. One arc-second is 1/3,600 degree, or the width of a penny at 2.5 miles! Even a very expensive mount cannot maintain this kind of accuracy for more than 1 or 2 minutes. The raw 60-second image in Figure 1 illustrates the problem.

Notice that in this photo of Galaxy M51 the stars are not round points, but are elongated. Even though the mis-tracking is still small, it is quite noticeable. This will cause the final galaxy image to be lacking in sharpness and detail.

In order to get accurately tracked exposures, some means of guiding the telescope is required. The low tech traditional method is to look at a star through another attached telescope (guide scope) with a cross-hair eyepiece, and manually correct the telescope's position with the hand controller. This is very tedious and error prone, but has resulted in some exceptional results. I definitely do not have the patience for this!

A better solution to this problem is to use a digital imager and a computer to automatically correct the telescope's pointing. This works exceptionally well, and allows a long exposure, or even a sequence of long exposures to run completely unattended with excellent results. See Figure 2 for a final image made of five 10-minute exposures of M51 using auto-guiding. Without auto-guiding, I can track for a maximum of 60 seconds. Even that short exposure requires me to throw away more than half of the images, and even the best ones are marginally well tracked. With auto-guiding, I can take 600-second exposures or longer, and usually every one of them is nearly perfectly tracked.

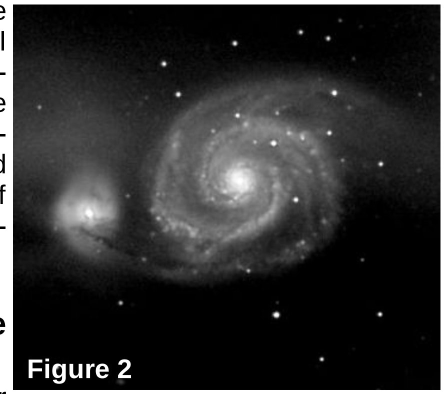


Figure 2

Causes of the problem

The problem of poor tracking has a number of causes. Some are under the control of the operator, some are not. For example, the mount needs to be accurately polar aligned. Any inaccuracy will cause a slow drift in declination. Poor adjustment of the mount can result in excessive backlash or play in the gears. These things may not have been noticeable when using the telescope for visual observations, but long-exposure astrophotography is much more demanding.

Inherent unevenness in the drive gears causes a predictable inaccuracy called periodic error. This is a small back-and-forth motion in the right ascension drive. On a very good (and expensive) mount this can be as small as +/- 2 arc-seconds. On my Losmandy GM-8 mount it is about +/-10 arc-seconds, and repeats every 8 minutes. Auto-guiding will not help much if the mount can't track well for at least a few seconds, or can't be commanded to smoothly adjust its position.

There are also random errors due to sky turbulence, wind, and vibration. The goal of auto-guiding is to correct for as many of these problems as possible.

How does auto-guiding work?

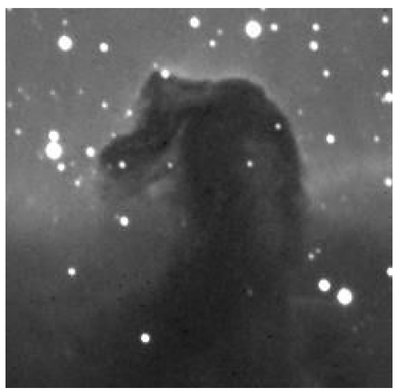
My SBIG ST-7XME camera has two CCD sensor chips, a large one used for imaging, and a nearby smaller one normally used for the auto-guiding operation. A cable runs from the camera to the

The auto-guiding software performs the following steps:

1. Take a picture of the guide star (about a 1.5 second exposure).
2. Wait several seconds.
3. Take another picture of the guide star area.
4. Determine how much the guide star has moved in the field in both RA and DEC directions.
5. Command the mount to move to put the guide star back where it started.
6. Repeat steps 2-5 for the duration of the exposure.

mount's hand control input. When auto-guiding, I set my mount's correction speed to 0.5 sidereal rate. This results in the drive motor either being slowed or sped up by ½ of the tracking rate when the guide corrections are made. This is for the tracking Right Ascension (RA) motor which never reverses direction. The Declination (DEC) motor is normally off, and is turned on either in one direction or the other to make guide corrections. Since it needs to reverse direction, gear backlash can be a problem in DEC.

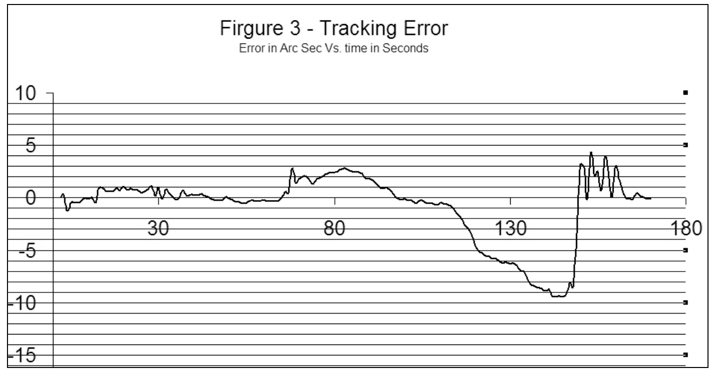
A calibration procedure is run to let the software controlling the camera know how the mount operates. This procedure commands the mount to move in each of the four directions while the camera is observing the position of the guide star. In this way the software learns how fast the mount moves, and in what directions.



This procedure is run automatically by the camera control software for as long as necessary to obtain all of the requested exposures. The guide star needs to be bright enough to be detected in a one or two second exposure. With my setup this allows a guide star as dim as 12^{th} magnitude. So far, it's been fairly easy to find one near my object of interest. In visual guiding, finding a bright enough guide star can be a real challenge.

The software can determine the location of the center of the star accurate to 0.1 pixels or better. It seems a bit odd to be able to measure this to better that 1 pixel, but the star image lights up a number of surrounding pixels and they are all used to determine the center accurately.

Figure 3 is a graph of the tracking error of my telescope with and without auto-guiding running. The first minute or so, the CCD camera is sending corrections to the mount to keep the tracking



accurate to about 1 arc-second. I then disconnected the cable to the mount to prevent guide corrections. At this point we can see that the star's relative movement has increased greatly, approaching 10 arc-seconds of error after another minute or so. This would cause unacceptable trailing of the stars and smearing of the image. At about 150 seconds, I reconnected the cable and the guide star is corrected back near zero after a period of oscillation.

Even with auto-guiding, getting excellent tracking requires some fussiness. The mount needs to be correctly balanced, with the drive motor pushing against a small amount of weight, and the camera software has several parameters which need to be set correctly to get the best performance.

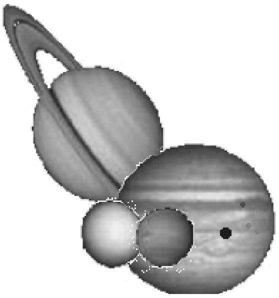
Auto-guiding is also used for film photography, by using a separate guide scope and a CCD camera to lock the telescope on the target while the film camera takes the image.

Conclusions

Using the technique of auto-guiding has allowed me to greatly increase the exposure time and quality of CCD images of deep-sky objects. The longer exposures collect more of the elusive photons from very dim objects resulting in more detail with less background noise. This picture of the Horsehead Nebula would not have been possible without the ability to take sufficiently long exposures.

For more of my images see my web page at:
http://www.cloudtrap.com

-Phil Schumacher



Solar System News Roundup

PLUTO (and KBOs)

Astronomers acquired some of the valuable Hubble time remaining to see if Pluto and Charon had any additional moonlets; however none were found. What was an additional surprise to the searchers was that there were even fewer than expected Kuiper Belt Objects (KBOs) found in the narrow sector arc beyond Pluto. They had expected to find at least 60, but only 3 more were discovered. Both of these revelations are puzzling, since the latest theories of the formation of the Kuiper Belt postulate that Neptune's gravity has "piled up" great masses of KBOs, and that the immediate area of Pluto's gravitational attraction would have brought them to its vicinity.

The same team from CalTech that discovered Quaoar, the largest KBO found so far, has now found another KBO. It is temporarily named 2004 DW and might supplant Quaoar in size.

NEPTUNE

The outermost gas giant's effect on bodies in the Kuiper Belt is becoming more apparent. In addition to creating Plutinos (KBO's in a 2:3 orbital time resonance with Neptune, such as their namesake Pluto is) it seems also to be creating Centaurs. These are KBOs plucked out of the Belt by Neptune's gravity and sent down into the lower Solar System to wander in changing orbits amongst the gas giants. They get no farther down than past Saturn before being reined in by Jupiter's massive hold. To add to the speculations, Neptune's own position in the solar system is constantly debated. Astronomers still can't reconcile its being at the end of the giant-planet range, given a mass and density greater than Uranus, which is further inside.

URANUS

Up to now, the bizarre surface of Uranus' moon Miranda, with its mile-high cliffs, saw tooth ridges and chevron rings, has been attributed to a collision with another moon. The resulting jumbled surfaces are apparently the action of heavier elements slowly sinking down into the merged mass. However, new studies (see Europa below) cast doubt that Miranda has enough radioactive elements in its small 300-mile-diameter mass to cause such heated sinking. Rather, they suggest that it is an upwelling, not a sinking, of materials that caused the strange surface formations. This is somewhat akin to a super-cold lava lamp, as one scientist put it.

The only problem with this theory is that these actions are usually only caused by tidal friction from the parent planet on an elliptical orbit or moons passing each other in resonance, neither of which exist in the Uranian system. One explanation remaining is that Miranda passed "through" a period of resonance with one of its nearby sisters in the past, and when the resonance period ceased, (maybe by Neptune passing nearby on its journey outwards?) so did the restructuring of the tidal-stressed surface.

SATURN

Only three months remain till the Cassini spacecraft completes its seven-year journey and enters the Saturnian system in June. Already the first "mystery" has popped up to be solved: the absence of the spoke-like dark markings on the rings that were discovered during the approach of the Voyager probe 23 years ago.

The first moon to be viewed close-up will be Phoebe, which was dimly viewed by Voyager 2 back in the '80's from 1.4 million miles out. What is fascinating about 130-mile-wide Phoebe is that with its retrograde, 30º-inclined, 18-month elliptical orbit around Saturn, it is most probably a captured Centaur. Its very darkness (only 6% reflectivity) indicates a surface made up of primordial material from the early days of the Solar System. So astronomers will get a close-up view in a few months of this hitherto unknown type of KBO a whole decade before the Kuiper Express is scheduled to arrive at the Kuiper Belt in 2014.

JUPITER

An interesting idea has been put forth as to what kind of exploration might next be tried on Jupiter's moon Europa. On Europa's surface, the Galileo probe photographed intriguing domes that might have been formed by globs of ice from inside the frozen surface that were pushed upward by thermal uplifts from the warmer ices and water underneath. If any life exists in a European ocean, it could only be accessed if it were brought to the surface from dozens of miles beneath. Thus any domes forced up might carry such evidence, and would be an ideal target for any future Europa landers to zero in on.

ASTEROIDS

After a year's delay, compounded by further delays in February due to weather damage, the European Space Agency (ESA) finally launched the comet orbiter/lander Rosetta on March 2. It is aimed at Comet 67P/Churyumov-Gerasimenko, a 2.5-mile-diameter, six-year-period body. It will arrive in 2014 at the time when 67P/C-G will be back in the vicinity of the Asteroid Belt and, being in aphelion to the Sun, will be at its lowest level of outgassing. Rosetta consists of an orbiter and a small lander to touch down on the icy-dirt surface.

MARS

The Rover probes' successful landings are already the highlight of the year for NASA. With the exciting confirmation by the Opportunity Rover that the Meridiani Plane was the site of an "ocean" in times past, bigger and more startling discoveries are in the offing. These include the possibility that the tiny "rotini" shapes found embedded in the crater rock bank just might turn out to be fossils!

What the Rover operators now have to be concerned about is the local weather. Mars has dust storms, -100-degree temperature drops every night, and dust devils which really should be called "monsters" instead of devils. These huge tornadoes hundreds of yards in diameter rip across the Martian plains, gouging the surface, scraping up barrages of rocks and sand and flinging them outwards in their wakes. Mars Global Surveyor (MGS) and MOS orbiters have revealed that the 100-mile-wide Gusev Crater site (where the Spirit Rover is now roaming) has a tenfold greater incidence of dust devil tornadoes than did the Pathfinder site of 1997 in the Ares Valley. The Gusev dust devil tracks in fact are so pervasive from just one season, that an overhead photo of the trails in the crater has the appearance of a plate of spaghetti.

EARTH

With the announced halt to Hubble-servicing shuttle flights, it is doubtful it will survive until 2011 when it is to be replaced by the James Webb Space Telescope. However, that in turn depends on having an entirely new type of delivery vehicle and servicing craft by that time.

Overlooked in the public's despair at losing Hubble's visual-wave-length photos is the existence of two other orbiting observatories: the short wave-length Chandra X-Ray Observatory and the long wave-length Space Infrared Telescope Facility (SIRTF) which was launched into orbit last August. The latter, with a 34-inch mirror, will be able to peer through the dusty nebular clouds that obstruct Hubble, plus being able to find objects that barely emit any heat, such as any nearby Brown Dwarfs and low-reflectivity KBOs.

LUNA

Propelled by its tiny impulse-ion engine, SMART-1, the ESA probe to the Moon launched in September after months of delay, reached the Moon's orbit by the end of the year. However, it will still take SMART-1 all of 2004 to maneuver to achieve a permanent orbit around the Moon, and then several more months after that to stabilize into the programmed lunar orbit. It will begin investigations for water ice sometime in 2005.

VENUS

Snow on +700º Venus? That depends on what is considered snow. Recent evaluations of data sent back from the 90's Magellan orbiter revealed a mysterious brightening effect on some mountains in the radar imaging. Scientists speculated it was due to a metal-containing "snow" only a few millimeters in thickness "frosting" the mountains' rugged surfaces. Now it has been determined that the "snow" is composed of both lead and bismuth sulfides which precipitated out of the boiling hot clouds of the Cytherea atmosphere when the temperatures at the heights of those mountains fell below the boiling point of their compounds. Everything is relative.

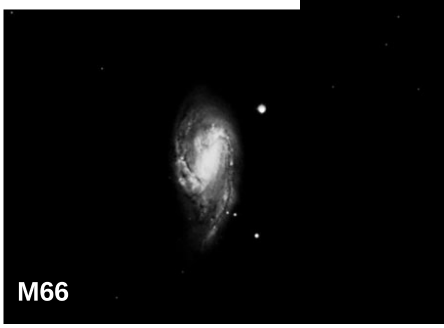
MERCURY

NASA's orbiting probe to the innermost planet, called Messenger, is still on track to be launched in May of this year. It will arrive at Mercury in January of 2008. Messenger is NASA's anagram for "Mercury Surface, Space Environment, Geochemistry and Ranging." The spacecraft will conduct two flybys each of Venus and Mercury in the intervening years that will adjust its speed before it begins orbiting Mercury in 2009.

-Jay Wichmann

Observer's Corner
– M65 and M66

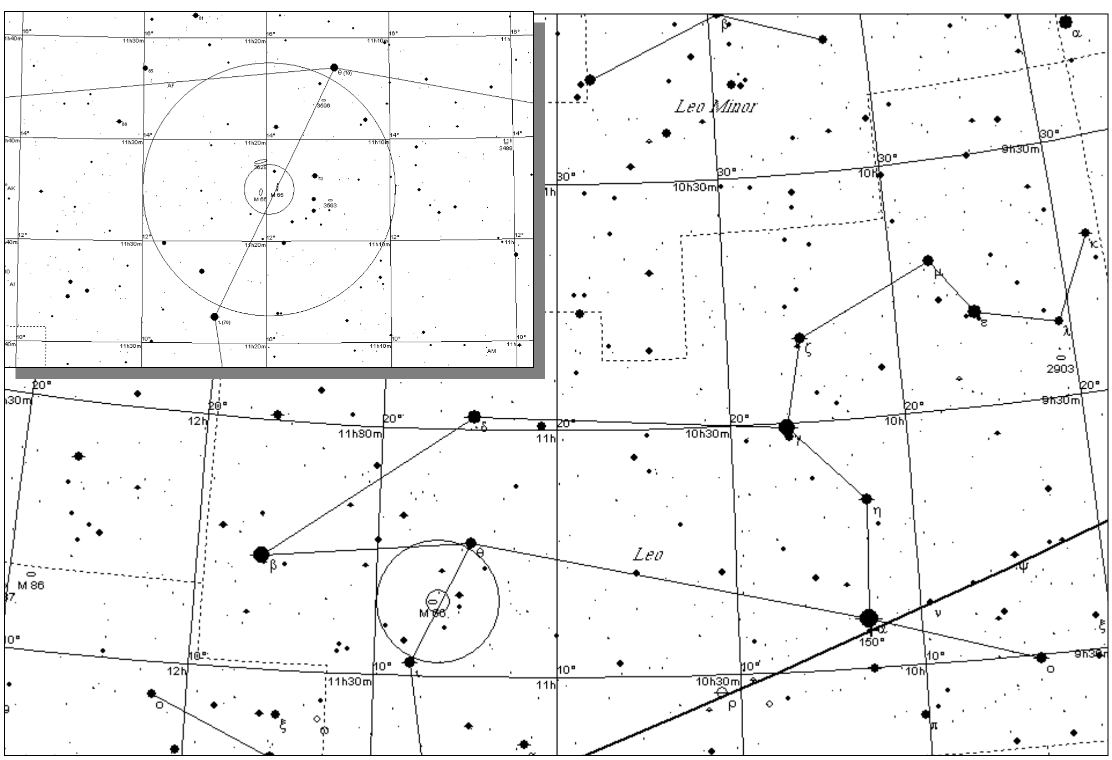
This quarter we will be looking at two close galaxies in the constellation Leo, the Lion. These galaxies are close enough in the sky that you can see both of them in the same field of view using a low power eyepiece. Their location is easy to find, which is in the back leg of the lion. The galaxies themselves are a little difficult to see in smaller scopes since these galaxies are somewhat dim at magnitude 9.3 and 8.9 for M65 and M66 respectively. This pair is similar to M81 and M82 in Ursa Major, which are brighter at magnitude 6.9 and 8.4 respectively.



To locate these galaxies, put your finderscope in the middle of the line between θ Leonis and ι Leonis. You should see in the finderscope a line of three stars to the left with two fainter stars next to them that form an upside down and backward letter "L". The galaxies M65 and M66 are inside this "L" as shown in the inset.

They are about 35 million light years away from us. Also in the area is NGC 3628, which can be viewed from dark skies in the same field of view as M65 and M66.

-Tim Grunewald



Lunar Phases

○	**April 5**	**Full**
◑	**April 11**	**Last Quarter**
●	**April 19**	**New**
◐	**April 27**	**First Quarter**
○	**May 4**	**Full**
◑	**May 11**	**Last Quarter**
●	**May 19**	**New**
◐	**May 27**	**First Quarter**
○	**June 3**	**Full**
◑	**June 9**	**Last Quarter**
●	**June 17**	**New**
◐	**June 25**	**First Quarter**

SCHEDULED ACTIVITIES

FOR

The Wehr Astronomical Society

http://www.wehrastro.org

Regular Meetings

(Free and Open to the Public)

April 13, 2004
Wehr Nature Center
Michael Bakich, Associate Editor for Astronomy Magazine, will be giving a program on "Star Death."

May 11, 2004
Wehr Nature Center
Rob Sparks will be speaking on "Swift: Catching Gamma Ray Bursts." The Swift satellite mission is scheduled to launch this summer.

June 8, 2004
Wehr Nature Center
Adam Machajewski will be presenting his updated study on "Analyzing Solar Motions and Phenomena."

Observatory Activities

(Free and Open to the Public)

April 9	8:30	Deep Sky Observing. Locate Leo, the Lion. See Venus, Mars, Saturn and Jupiter. (GRS transit 2:24am)
April 23	8:30	Observing the Moon and Deep Sky objects. **Celebrate Astronomy Day.** See a crescent moon and the brighter deep sky objects. See Venus, Mars, Saturn and Jupiter. (Europa shadow transit 7:40pm)
May 14	9:00	Deep Sky Observing. See comet C/2001 Q4 NEAT next to the Beehive cluster. See Venus, Mars, Saturn and Jupiter. (GRS Transit 8:24pm, Io shadow transit 7:40pm)
May 21	9:00	Observing the Moon and Deep Sky objects. See a crescent moon and the brighter deep sky objects. See Mars, Saturn and Jupiter. (GRS transit 9:11pm, Io shadow transit 12:16am)
June 11	9:00	Deep Sky Observing. Locate Hercules and the Great Gobular Cluster. See Jupiter (GRS transit 11:36pm).
June 25	9:00	Observing the Moon and deep sky objects. See a 1st quarter moon and the brighter deep sky objects. See Jupiter (GRS transit 1:14am)

Note: All observatory dates fall on a Friday, and are held at Froemming Park.
GRS transit: When Jupiter's Great Red Spot is in the middle of the planet. The GRS is visible 1 hour before and after this time.