Smoky Mountain Astronomical Society

Volume 28, Number 4
April 2005

S.C.R.A.P.S.

Society's **C**h**R**onological **A**stronomical **P**aper**S**

Note: ***This could be your last issue of SCRAPS! Please renew today.***

SMAS, P.O. Box 53265
Knoxville, TN 37950

April 8th SMAS MEETING

PSTCC, Main Campus, Hardin Valley Road
7 pm, Alexander Bldg, Room 223

From The President—Mike Littleton

You have been an amateur astronomer since you were a child. Your parents gave you your first telescope, a department store 60 mm refractor. You were lucky enough to lose the welding glass solar filter that came with the telescope before it cracked while observing the Sun and burning a spot on your retina. You have spent all these years observing the heavens by yourself unless you could coax a friend or family member into the cold night to look at faint fuzzies. So, why should you join an astronomy club like SMAS?

Promote Appreciation of Astronomy in the Community This is a mission in the Constitution of SMAS. SMAS has done a very good job of promoting astronomy through public star parties and demonstrations. The viewing of Mars in its favorable opposition in the summer of 2003 was a rousing success with SMAS members and telescopes at PSCC and Maryville College. More than one thousand people were able to see Mars during our weeklong observing sessions. Last year we had public observing star parties during the warm months and an Astronomy Day at PSCC.

(Contintued)

Learn More about Astronomy from Other Members SMAS has a wide diversity of interests and astronomy experience levels. We range from beginner observers to accomplished CCD imagers. There is a great amount of accumulated astronomy knowledge to draw on. During the SMAS meetings, we have had presentations ranging from practical astronomy to the forefront of theoretical aspects of the field by professional astronomers. During our monthly meetings and special events in 2005/2006, SMAS will continue member educational activities. I would appreciate any ideas and assistance from the members in furthering this effort.

Our newsletter, SCRAPS, our website, and our Yahoo Group has been invaluable tools in disseminating SMAS-related information and a vehicle to share astronomy information and experience. I encourage any contribution in these areas.

Use of Loaned Equipment SMAS has a few small to medium-sized telescopes available for use by the members. These telescopes have been acquired primarily by donations. Bill Burgess contributed our latest acquisition, a 125 mm achromatic refractor, which is fine instrument for planetary observing. The comments from some former SMAS officers were that this equipment has not been used much because most members already have their own equipment. This program could use a "makeover" to better use of this equipment. I would appreciate any suggestions.

Use of Equipment Beyond My Means SMAS has one major asset beyond the price range of most of the members, the 20 inch dobsonian telescope. Using this behemoth should be a real advantage of being a SMAS member. It gets little use. It also needs upgrading and repair. It could use a trailer. This takes funds that we do not have in SMAS's treasury. The officers have discussed ideas in raising funds such as raffles, which are legal now in Tennessee for not for profit organizations with prior authorization. This year, we will look at establishing our organization's legal status as well as possible ways to raise funds for the 20 inch dob and other activities.

2005-2006 SMAS Officers

Michael Littleton	*President*	Erik Iverson	*Vice President*
Ron Dinkins	*Treasurer*	Lee Erickson	*Secretary*
Mike Fleenor	*Webmaster*	Peter Bush	*Editor*

Minuets SMAS March 18 Meeting 2005—Lee Erickson

The meeting came to order at 7:15 with new president Mike Littleton presiding.
There were 14 members present, including our newest member Joe Baldwin. Welcome Joe!

There were announcements:
TAO is having a work party on Saturday the 19th. Special projects are: the Trail of the Planets and the big star-clock project.

Treasurer's reported balance as of meeting was $814.19. Projected 2005 expenses are slightly greater, at $860 so we need to raise additional funds to maintain existing programs.

Mike Littleton presented a plaque to outgoing president Michael McCulloch. The plaque bears an engraving of M42 from a photograph that Mike Fleenor took. Thanks Michael for leading, entertaining, and educating us in 2004.

Our principal program was a presentation by Bill and Tammy Burgess on their new optical instruments. Burgess optical will have five lines of eyepieces. Bill says, "that everybody's eyepieces are getting better and costing less". He passed around some 1-1/4 and 2 inch eyepieces that, to this author, were marvelous to look at.

Bill described how production in China of asperhical glass lenses is world class and bringing down the cost for all telescope manufacturers. There is tremendous production capability and China has high quality glass that is inexpensive.

Bill showed us small telescopes suitable for backpacking and a large telescope that will be inexpensive because of the use of spherical optics. Bill also demonstrated mind reading abilities, as Bob Arr tried to ask what the central obstruction was on the large telescope, and Bill had the answer while Bob was still pointing and grunting.

Bill also showed a large custom designed binocular that

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is the prototype for his latest line.

Bill is working on a source of telescope mounts but currently says that they are a dream not a reality.

Our technical program was a presentation by Mike Littleton of Celestial Coordinate Systems. We learned about the coordinate system called "equatorial", also know as Declination and Right Ascension. It is used for convenient astronomy here on the surface of the earth. We learned about "ecliptic" coordinate system, useful if you are calculating interplanetary space probe trajectories. And we learned about "galactic" coordinates that are based upon the plane of our galaxy. It was pointed out that perpendicular to this plane, in the northern hemisphere, is where we easily see nearby galaxy clusters in Coma Berenices and Virgo.

Eric Iverson presented a discussion of the brainteaser posed in his email "So - on what date was Clay's Kochab Clock exactly correct? (That is, when was the NCP 55' from Polaris in the direction of Kochab.) How far off is the Kochab Clock today? "

The secretary was too confused by most of the discussion and hopes that Eric will write up something himself for the newsletter. (see below -editor)

SMAS Brainteaser
18 March 2005

Clay's Kochab Clock, a description of which can be found at the website http://www.weasner.com/etx/ref_guides/polar_align.html, claims that Polar Alignment is easiest to do when you set your telescope up such that its polar axis points at a spot exactly 55' (that's fifty-five arc-minutes) from Polaris in the direction of Kochab, the last (and brightest) star in the Little Dipper's Bowl.

That's just a simpler way of saying that the North Celestial Pole is 55' from Polaris, in the direction of Kochab. Obviously, this isn't always the case; we know that PRECESSION makes the NCP move through the sky, completing a huge circle through Polaris, Vega, and Thuban over the course of 26,000 years. So – on what date was/is Clay's Kochab Clock exactly correct? (That is, when was the NCP 55' from Polaris in the direction of Kochab.) How far off is the Kochab Clock today?

(For Answer—see page 8)

Trails and Tribulations of Building a Dobsonian Telescope Part II
-Mike Littleton

In the November 2004 Issue of SCRAPS, I wrote Part I. If you recall, I purchased an AstroSystems kit* for a 13.1" f/4.5 truss-tube dobsonian. The optics for the telescope were pirated from one of the Coulter Red Tube telescopes. In November, I was still waiting for a few missing parts for the kit. These parts arrived shortly after writing the article and the kit was finished in February. The two guys that are the owners/workers at AstroSystems were helpful in completing the kit and offering advice.

The telescope could not be completed until I verified the tube length with an object at infinity focus. As expected, the truss-tubes were a little long and had to be cut for the focal plane to reach eyepieces. After cutting the tubes, the telescope focuser was mechanically adjusted to place the optical centerline perpendicular to the upper cage assembly. Then the telescope was collimated using a laser collimator.

OK, now its time for first light, but when will the infamous East Tennessee Weather and my schedule cooperate? First light came on 3/4/05 at Tamke-Allan Observatory. The night was completely overcast at sunset, but the sky clock promised better conditions. While we waited for improving conditions, we ate snacks and listened to John Mannone talk on black holes. About 10 PM, the skies cleared enough to use the telescope and the views were fantastic. The star images were round out to the edge of field. Its resolution was superior to an identical optical system in D. R. Fudge's old Coulter Red Tube. No doubt, this is due to the nine-point mirror suspension in the AstroSystem's design vice taping the mirror to plywood sheet in the Red Tube.

The AstroSystems telescope has some nice features. Movement in azimuth and elevation is smooth. The telescope uses three ball bearing-loaded bearing for azimuthal movement and one teflon/formica and one ball bearing-loaded bearing on each altitude bearing. The mir-

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ror cell has a fan run by internal deep-discharge batteries to equalize the telescope temperature with the surroundings. A filter holder in the secondary cage allows selection of up to four filters without removing the eyepiece.

Happy with the telescope's performance, I tried to install the Sky Commander computer system on the telescope the next day. I was not successful. The mirror box has insufficient clearance above the azimuthal encoder to allow rotation in elevation. I wrote the guys at AstroSystems about the problem. They reported that the design of their kits allowed sufficient clearance. Unfortunately, there was an error in the CAD drawing for my kit. They promised to send a couple of gears coupled with a chain to move the encoder away from the azmuthal pivot to get the required clearance.

After the trails and tribulations, would I purchase another AstroSystems kit? Yes, there is high quality of materials and manufacture in the kit. Parts fit together as designed. The telescope looks good and performs well. I have only two notes of caution. You need to enjoy woodworking and have some basic skill level in it. You should not be in a hurry to get the kit after placing your order.

* There was a typo in the first article. AstroSystems makes kits for mirrors from 12.5" to 32" vice 21.5" to 32" in the text.

The Wiz

Dear Wiz,

I keep hearing that I shouldn't use eyepieces that deliver an exit pupil greater than my eye's pupil. Why? What are they gonna do, put me in jail?

J. I.

Dear Juan,

There are a couple good reasons not to use them, but there are occasionally good reasons to use them anyway. Here's one of the best explanations I've ever come across (this is a copy of a recent post on Talking Telescopes, between Tony Rome and Geoff Gaherty, reprinted with permission—-Thanks, Geoff.)

[Quote]
Question, Geoff:

How can I determine what my exit pupil really is? I am 62 now, I don't wear glasses but for reading.

Continued

Hi Tony,

Technically, exit pupil is a property of the telescope and eyepiece, not the eye. The equivalent property of the eye is pupil diameter, the inner diameter of the eye's iris. This varies constantly as the eye is exposed to varying levels of light; it acts like the iris diaphragm in a camera lens, opening up in dim light and closing down in bright light, under the control of the autonomic nervous system.

What is of interest in astronomy is the **maximum pupil size, which is achieved after 20 minutes or so in darkness**. This varies from one person to another, and also depends on the person's age: typically it is about 8mm at age 10, and decreases over time to about 5mm at age 80. These are just averages, and everyone must measure their own eyes.

There are various ways to measure your actual maximum pupil size. The one I used a few years ago was to hold various metric Allen key wrenches in front of my dark adapted eye to see at what point the light from a star was completely blocked. My pupil measured 5mm, which is a bit on the small size for my age at the time, about 60.

When the doctor is examining your eyes, they dilate the eye artificially with belladonna. I had my ophthalmologist measure my dilated eye around the same time, and it was over 8mm. However, the resolution is poor with an artificially dilated eye, because you're using the outer reaches of the eye's lens, where aberrations are maximum.

Many books will tell you that you must never use a telescope with an exit pupil larger than your eye's pupil because you will "waste" light. This is questioned by Roy Bishop in his excellent article on exit pupils which is reprinted each year on the RASC Observer's Handbook, which is where most of my information comes from. What actually happens when the exit pupil exceeds the eye's pupil is that your eye's pupil acts as a mask, effectively reducing the aperture of your telescope. Another disadvantage is that, because you're using your eye's lens out to its maximum aperture, any aberrations such as astigmatism will be at their maximum.

Let's take a practical example, a 35mm Panoptic in a 20" f/4 Newtonian. This produces 58x and an exit pupil of 8.75mm. If someone with a 7mm pupil uses this scope and eyepiece, their eye will mask its aperture down to about 16" rather than 20". If I were to use it with my 5mm pupil, it would be masked down to 11"! This seems to many people to be a terrible "waste" of aperture. The positive side is that it gives you the maximum aperture possible for that particular magnification, and hence the widest possible field of view. Sometimes it's worth sacrificing aperture to get that wide field of view.

What are the down sides of exceeding the eye's pupil, other than losing the use of the outer

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parts of your telescope's objective? As I mentioned, you'll be using the worst parts of your eye. If your telescope has a central obstruction (such as a Newtonian's secondary mirror) it will be larger in proportion to the effective aperture, and may become visible (a black blob, right in the center of the FOV). I used to use a 40mm eyepiece in my 10" f/4.5 Newtonian all the time. I normally couldn't see the central obstruction at night when my eyes were dark adapted (fully open to 5mm), but it was really obvious in twilight, when my eyes were closed down to about 2mm. With a refractor, this isn't a problem because there is no central obstruction. A final problem is that such low magnifications tend to exaggerate the sky background. Unless you're under a really dark sky, you may get an unpleasantly bright sky background.

You can use the measurement of your actual pupil to optimize aperture use and image contrast. Dividing your scope's aperture (mm) by your maximum pupil size will tell you the lowest magnification you should use on that scope. For example, with a 20" aperture, I wouldn't use anything below 102x (508mm aperture divided by 5mm pupil diameter). There's nothing to prevent you from using a lower magnification, but you need to know what you are sacrificing when you do so: aperture, contrast, and clarity.
[Unquote]

Da Wiz

SMAS Brainteaser
18 March 2005
Solution

Clay's Kochab Clock, in theory, isn't a bad idea. As the North Celestial Pole (NCP) precesses through the centuries, it traces out a circle. Right now, the NCP is very close to the star we call Polaris, or α Ursa Minor. A line from Polaris to Kochab, also in Ursa Minor, comes even closer to the NCP. This led Clay Sherrod, the author of Clay's Kochab Clock, to suggest that the easiest way to align an equatorially-mounted telescope to the NCP is to point the telescope at Polaris at a time when the star Kochab is directly right, left, above or below Polaris, and then move a specified distance in one axis only toward Kochab. As I said – in theory, this isn't a bad idea. Using such a method, one can get pretty darn close to the true NCP, at least for this century or so. But how close is pretty darn close in this case?

There's one other problem with Clay's Kochab Clock, and it's a bigger one. You can see what this problem is by comparing two websites discussing Clay's Kochab Clock:
http://www.weasner.com/etx/ref_guides/polar_align.html and
http://www.arksky.org/Kochab.htm.

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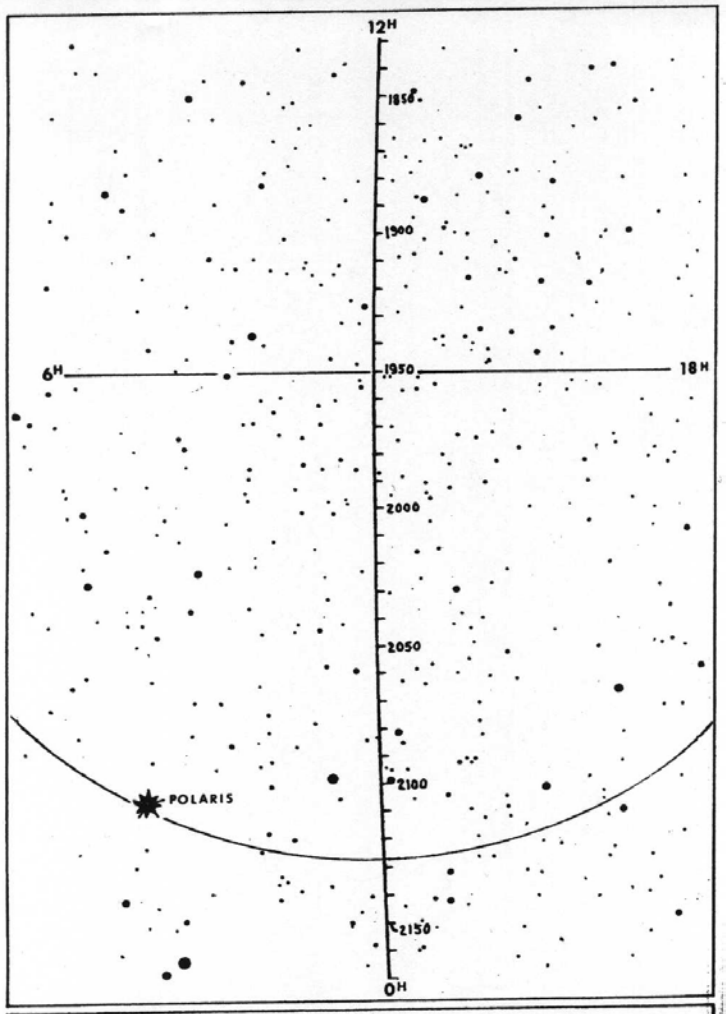

PATH OF THE NORTH POLE from 1850 to 2150 AD. The portion of the circle is 1° in radius, centered on the position for 1950.

Both sites claim the same process will yield perfect polar alignment. But one says you need to go 55', the other says 43'. How can this be? The answer, of course, is that the NCP moves (precesses), and thus the distance changes. But none of the places that mention Clay's Kochab Clock tells you when to use which number – the closest they come is the date when the individual webpage was last updated, and that's not very reliable.

Thus the two parts of our brainteaser: when was/is the clock "right," and how far off is it today? Our brainteaser made it more explicit, and asked "when was the NCP 55' from Polaris in the direction of Kochab?"

Robert Burnham, in his classic "Burnham's Celestial Handbook," gives a great diagram showing how the NCP moves past Polaris, from about the year 1950 to 2150, at the rate of about 20 arc-seconds per year. Note that this is different than the precession rate of the equinoxes, which is about 50 arc-seconds per year. This figure is reproduced to the left. Burnham also gives the proper motion of both Polaris and Kochab; 0.046 and 0.03 arc-seconds per year, respectively, almost one thousand times slower than the precession of the NCP. Over the course of the two hundred years covered in this figure, Polaris moves 9.2 arc-seconds, and Kochab moves 6 arc-seconds. This amount is significantly less than the size of the "dot" that marks Polaris here, so we can pretty much ignore proper motion for this discussion. In this figure, Kochab is way off the page to the upper right.

Any ephemeris program can give you positions of the stars at a given date. Most ephemeris programs will let you specify the "Epoch," that is, the date at which the coordinate system is

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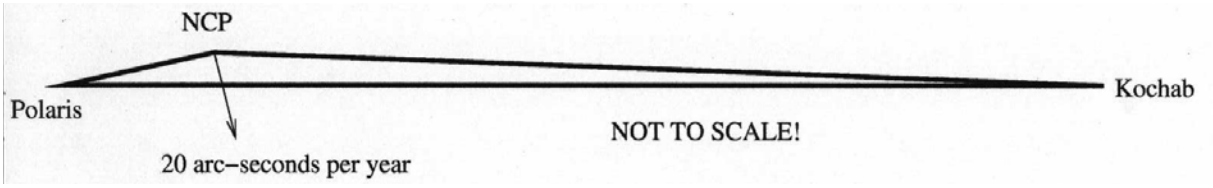
defined by the NCP and Celestial Equator on that date. For example, my Sky Atlas, by Wil Tirion, is Sky Atlas 2000.0, for Epoch 2000.0, and the NCP, Celestial Equator, and lines of Declination and Right Ascension are shown in the positions they were at the moment of 1 January 2000. For this particular problem, though, you want the Epoch of the Date – that is, the NCP position, etc., should be exact for the given date, not referenced to a specific year. Then just change the date on the ephemeris program to give you the coordinates (Epoch of the Date) for Polaris and Kochab. I used XEphemeris, but Guide, etc., will work as well. The coordinates I got are listed in the table below for this date (the date of the SMAS meeting) for several different years.

Epoch of Date and Date	Polaris RA	**Polaris Dec**	**Kochab RA**	**Kochab Dec**
Epoch 1950.21, 1950/03/18	1:47:17.20	89:02:00.8	14:50:54.54	74:21:11.50
Epoch 1960.21, 1960/03/18	1:55:14.93	89:04:49.4	14:50:49.69	74:18:56.80
Epoch 1970.21, 1970/03/18	2:01:52.14	89:07:55.1	14:50:51.18	74:16:15.20
Epoch 1980.21, 1980/03/18	2:11:06.85	89:10:31.9	14:50:46.94	74:14:03.60
Epoch 1990.21, 1990/03/18	2:20:02.63	89:13:33.1	14:50:47.91	74:11:20.50
Epoch 2000.21, 2000/03/18	2:30:48.95	89:15:59.2	14:50:44.82	74:09:08.60
Epoch 2005.21, 2005/03/18	2:35:05.16	89:17:28.0	14:50:46.43	74:07:44.00
Epoch 2010.21, 2010/03/18	2:42:56.57	89:18:48.6	14:50:44.83	74:06:27.20
Epoch 2020.21, 2020/03/18	2:55:44.07	89:21:04.4	14:50:43.21	74:04:12.10
Epoch 2030.21, 2030/03/18	3:11:58.56	89:23:32.6	14:50:42.00	74:01:35.20

I think of Polaris, Kochab, and the NCP making a long, skinny triangle. The length of the line from the NCP to Polaris is just 90 degrees minus the declination of Polaris, 89:23:32.6 on 18 March 2030 for example, or just about 0.5 arc-degrees. The length of the line from the NCP to Kochab is 90 degrees minus the declination of Kochab, about 26 arc-degrees on the same date. The angle made by those two lines is the difference in their Right Ascension, converted to degrees (remember that 1 hour RA is 15 degrees RA, and that 1 degree RA is NOT 1 arc-degree), in this case about 11 hours and 40 minutes RA, or 175 degrees.



Clay's Kochab Clock will be exactly right when that angle is exactly 180 degrees, and the triangle turns into a straight line. It's easy, if a little slow, to interpolate between the numbers in the table above to find out just when that is. Since the relationships aren't linear, you might have to look up a few more points to get closer to the exact date before you do the interpolation.

When I do that, I find that that the Kochab Clock is correct in October 2015, when the NCP is 40 arc-minutes from Polaris, on a line going from Polaris to Kochab. But that's not really

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the complete answer to the brainteaser, which asked, "When is the NCP 55 arc-minutes from Polaris…" Again, we can interpolate, and find that Polaris was 55 arc-minutes from the NCP in October of 1960, but the NCP wasn't exactly on the line, just close to it. To make the best Kochab Clock using the number 55 arc-minutes, the date would be in September of 1953, and you would still be 15 arc-minutes away from the NCP! So what can we say? We can say that the idea behind Clay's Kochab Clock is pretty good, and the Clock is exact in October 2015, but the particular version quoting 55 arc-minutes was not that close. You might get slightly different numbers, because different catalogs give different positions for the stars.

So how close is Clay's Kochab Clock? Well, if you use the right distance for the date, it can be quite good. In September of 1953, that distance was 55 arc-minutes, and the point you would find if you followed the instructions perfectly would be about 15 arc-minutes of the true NCP, about four times closer than if you'd just lined up on Polaris itself. This is probably close enough for visual work, or for aligning a go-to telescope. Today that distance is 42.75 arc-minutes, and you'll be within 3 arc-minutes of the NCP.

But how much mis-alignment is a problem for doing long-exposure astro-photography? Michael Covington, in his book "Astrophotography for the Amateur," gives a great mathematical analysis of the effects of polar mis-alignment. Warning – while the book generally doesn't require much math at all, the appendix talking about polar mis-alignment is some serious trigonometry! Anyway, using his equations, I find that an alignment error of 3 arc-minutes results in a declination drift as large as 45 arc-seconds per hour of exposure, and a field rotation as large as 0.03 degrees per hour of exposure. While the declination drift can be corrected with guiding, the field rotation can't. But Covington says that for a guide star within your photograph's field of view, field rotation of as much as 0.1 degrees is acceptable. This means that Clay's Kochab Clock is good enough for astrophotography (even if it's not exactly right) for about the next 70 years, as long as you use the correct distance for the date!

To summarize, the specific version of Clay's Kochab Clock given in the brainteaser (the 55 arc-minute version) is never exactly right. But if you use the right distance offset for the date, you'll be close enough for the next 70 years even to do long-exposure astrophotography. Using the correct distance, 42.43 arc-minutes, for today's date, 18 March 2005, gets you within 3 arc-minutes. Using the 55 arc-minute distance today, on the other hand, gets you with about 12 arc-minutes.

You can find a copy of the spreadsheet I used to calculate the numbers I give on the SMAS Yahoo Group Website, in the files section. If you have any questions, feel free to ask them on the Yahoo Group! We had two solutions submitted for the SMAS March 2005 brainteaser. Thanks to all who gave it a shot, whether you put a solution in or not, and thanks to everyone who participated in the discussion that took place regarding the brainteaser!

Amateur Observing Package

10", f4.5 DOB signed by Mr. Dobson, himself.
It's a truss style made using Meade components.
It has a Telrad that's heated and the secondary mirror is heated as well.

Eye Pieces include:
Meade (not the new less desirable ones) Series 4000 Super Plossl
9.7 mm, 13.8 mm, 26 wide, Bill Burgess plossl 30 mm
$650
Add a Pentax XL21 ($250 if sold alone).
All the eyepieces are housed in an aluminum carrying case.

Sky Vector II Digital Setting Circles $150-$200

Roll up table and adjustable scope chair $100

Starry Night Pro software $100.00

BOOKS as follows:

- Burnhams Celestial Hand Book Hard cover -- $20
- NGC 2000.0 -- Depending on the edition, $15 or $85
- Observing the Constellations -- $8 to $10
- The Observer's Sky Atlas -- $15
- Norton's Sky Atlas -- $10
- Advanced Sky Watching . $15
- Messier Marathon Field Guide -- $25 (hardcover)
- Your Guide to the Sky -- $5
- Orion's Deep Sky Map 600 -- $8
- The Hatfield Photographic Moon Atlas -- $25 to $30
- Wil Tirion's Sky Atlas 2000 -- spiral bound, $40
- Star Gazing with Binoc. & Telescope $8
- (About a dozen editions.)
- Finder Charts of The Messier Objects 2 vol. Plastic-coated. $30.00

The whole package is about $1500.
I'd like to sell the whole thing at once, if possible, and will entertain all offers.

Stephen Rothschild
bowbender2@earthlink.net

SMAS Brainteaser
April 2005

This photo was taken on the Apollo 8 mission, and captured the attention and imagination of a generation of space enthusiasts. Entitled "Earthrise," it shows the partially sunlit Earth rising over the lunar horizon as the spacecraft comes around. The sunset terminator crosses Africa near the upper center, and clouds swirl over most of the rest of globe. Our brainteaser for this month concerns the orbital mechanics of the Earth-Moon system.

What was the phase of the moon when this picture was taken?

- New
- Waxing crescent
- First quarter
- Waxing gibbous
- Full
- Waning gibbous
- Third quarter
- Waning crescent

For extra credit, which way was the orbiter orbiting the moon as viewed from the North Ecliptic Pole, clockwise or counter clockwise? Come to the SMAS meeting in April and we'll discuss the answer as part of the meeting. Your answer should be written down, along with an explanation of how you solved the problem, and will be collected at the beginning of the meeting. Correct answers will be rewarded!

Remember, don't send your answer to the Yahoo Group – this is a meeting topic!

April 2005

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3 Daylight Savings Time Clocks forward one hour 	4	5	6	7	8 **SMAS Meeting PSTCC Rm 223 7 pm**  Annular Total Eclipse of Sun *New Moon*	9 Star Party Unicoi Crest
10	11	12	13	14	15	16 Astronomy Day @ Tamke-Allan Star Party Look Rock #4
17	18	19	20	21	22	23
24 *Full Moon*	25	26	27	28	29	30

UTK—roof of Neilson Physics Building
on The Hill at UT
1st & 3rd Fridays
TAO —Tamke-Allan Observatory
Public Stargaze
Watts Bar Lake, Roane County
1st & 3rd Saturdays