Saguaro Astronomy Club

Metro Phoenix, Arizona

SACNEWS

November 1997 — Issue #250

v10.28

Discovering Asteroids

by Paul G. Comba

E-mail: comba@northlink.com

Geometric Background

The asteroids (also known as minor planets) are, together with comets and meteoroids, the small denizens of the solar system. Like the other planets, they revolve around the Sun. Most of their orbits lie between those of Mars and Jupiter and constitute the so-called main belt.

Main belt asteroids have orbits with semi-major axes between 2.1 and 3.2 astronomical units, periods of 3 to 6 years, and eccentricities of 0 to 0.35. Most of their orbital planes are fairly close to the ecliptic (the orbital plane of Earth), but a few have inclinations of 20 degrees or more. A few unusual asteroids have elongated orbits that cross the orbit of Mars or, in a few cases, the orbit of the Earth.

A fairly typical asteroid orbit is that of 6 Hebe, which happens to be the first asteroid that I observed, back in 1976. Hebe has a semi-major axis a=2.42 astronomical units, period p=3.78 years, and eccentricity e=0.20. The motion of Hebe around the Sun, like that of the other planets, goes in the counter-clockwise direction as seen from the North pole. To an observer placed on the Sun, the planets would appear to move from West to East against the background of the stars.

The Earth, however, moves faster that Hebe. In the span of 4 years Hebe will have completed just over one revolution to the Earth's 4. So the Earth catches up with Hebe 3 times in 4 years, i.e. about every 16 months. At such times, the Sun, the Earth and Hebe will be approximately in a straight line (more precisely, the plane perpendicular to the ecliptic that contains the Sun and the Earth will also contains Hebe); Hebe is then said to be at opposition.

An asteroid is at its brightest near opposition, where it also appears to move in retrograde motion (East to West) against the background of the stars. The retrograde motion slows down gradually and after about 40 or 50 days the asteroid reaches a stationary point, after which it resumes its direct (West to East) motion.

Not all oppositions, however, are equally good. This is where the eccentricity comes into play, as one can see in the case of Hebe. The apparent brightness of an asteroid is inversely proportional to the square of its distance from the Sun and the square of its distance from the Earth. At perihelion, the distance of Hebe to the Sun is $a(1 - e) = 1.936$ A. U. If it is then at opposition, the distance to the Earth is 0.936 (neglecting the eccentricity of the Earth, which is very small). At aphelion the distances from the Sun and the Earth are respectively $a(1 + e)$

Quick Calendar

SAC Meeting
Speaker: Paul Scowen: *HST Observations*
7:30 PM, Friday, November 14

SAC Deep-Sky Meeting
7:30 PM, Thursday, November 20

SAC Star Party
Buckeye Hills Recreation Area
Novice Session
Saturday, November 22

Magazine & Membership Renewals Due

See Note on Page 12

Officer Elections

SAC Officers

Area Code (602)

President	Adam Sunshine	780–1386
		asunshine@netzone.com
Vice President	Gerry Rattley	892–5698
Treasurer	Regina Lawless	
Secretary	David Fredericksen	979–0513
Properties	Jack Jones	944-5488
		jack.jones@mcione.com
Public Events	Rich Walker	997–0711
Deep-Sky Group	A.J. Crayon	938–3277
		acrayon@primenet.com
SACNEWS Editor	Paul Dickson	862–4678
		FAX: 841–0509
		dickson@primenet.com

= 2.904 and 1.904. If we take the product of the two farthest distances, divide by the product of the two nearest distances, and square the result, we get 9.3. So at its most favorable opposition Hebe is over 9 times brighter than at its most unfavorable. This works out to a difference of 2.4 magnitudes.

This phenomenon can have unpleasant consequences. Several months ago I discovered a rather fast moving object, designated 1996 UJ, at magnitude 18. I was able to observe it over an arc of 52 days, so that a fairly good orbit could be computed, showing an eccentricity of 0.35. Unfortunately at the next two oppositions it will not get brighter than 21, so I will not be able to observe it.

How big? How many? How bright?

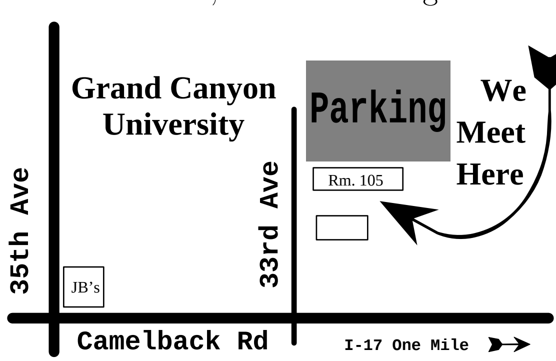
The first asteroid discovered, 1 Ceres, is also the largest, with a diameter of 900 kilometers. There are about 200 with diameters greater than 100 km, 7000 greater than 10 km, and an estimated 5 million greater than 1 km.

The asteroids that have been discovered so far can be grouped into three classes:

- The numbered asteroids, of which there were 7367 at the end of 1996. These have usually been observed at 4 of more oppositions, and their orbits are known with great precision so they can easily be recovered even after an interval of many years.
- The multi-opposition or long-arc asteroids (the latter having been observed many times near a single opposition over an arc of some 70 days or more). These have orbits that are known with moderately high precision, and they can usually be recovered at later oppositions. As more observations accumulate, their orbits become better known and they get numbered. There are some 6000 of these.

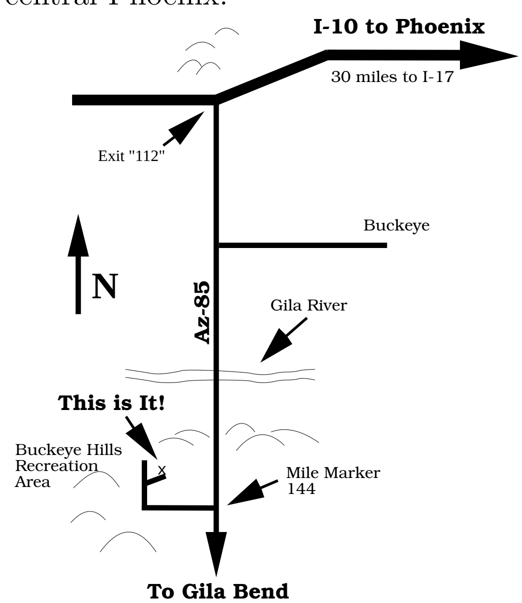
Directions to SAC Events

SAC General Meetings 7:30 PM at Grand Canyon University, Fleming Building, Room 105 — 1 mile west of Interstate 17 on Camelback Rd., north on 33rd Ave., second building on the right.



SAC Deep Sky Subgroup Meeting at John & Tom McGrath's, 11239 N. 75th St., Scottsdale, 998–4661 — Scottsdale Rd. north, Cholla St. east to 75th St., southeast corner.

SAC Star Parties at Buckeye Hills Recreation Area Interstate 10 west to Exit 112 (30 miles west of Interstate 17), then south for 10.5 miles, right at entrance to recreation area, one-half mile, on the right. No water and only pit toilets. Please arrive before sunset; allow one hour from central Phoenix.



• The single opposition asteroids. There are perhaps 20,000 of these and their number is increasing by several thousand a year, especially since several observatories have established programs for the specific purpose of discovering asteroids. Some of these objects have been observed over a span of just 2 or 3 days; an orbit calculated from such observations has very low accuracy: it is useful for reobserving the object for the next few weeks, but after that it becomes quite useless. On the other hand, if the asteroid is observed repeatedly for several weeks or months, the orbital calculation may be good enough to recover it at the next opposition. After I discovered 1995 ON photographically in July 1995, I made a total of 25 astrometric observations over a span of 35 days. Based on those observations, the Minor Planet Center calculated an orbit, and based on that orbit I was able to recover 1995 ON without difficulty in August 1996.

At favorable oppositions 4 Vesta gets brighter than magnitude 5.5 and can be glimpsed with the naked eye if one has good eyesight and a dark sky and knows where to look. About 100 asteroids get brighter than 10 at favorable oppositions, and 2000 get brighter than 15. Almost all the asteroids that ever get brighter than 16 are believed to have been discovered. Between 16 and 18 there are still quite a few to be discovered, and beyond 18 it's a hunter's paradise.

From Collecting to Astrometry to Discovery

Like other asteroid aficionados, I spent many years visually observing a large number of minor planets with a series of increasingly large telescopes. The hope of discovering a new asteroid was often in the back of my mind, but the likelihood seemed very remote.

The next step was to take up astrophotography, which increased the limiting magnitude by about 2.5 and also opened the door to astrometry. An astrometric observation means that the position of a moving object is measured, at a given time, with an accuracy of a fraction of an arc second. I used a method to measure photographs with the aid of a flat bed scanner and a computer; the measurements were then fed into a program, together with the positions of the nearby "reference stars" extracted from the Guide Star Catalog; and the program computed the position of the the asteroid.

This method worked quite well, and with it I was able to reduce about 16 astrometric observations each month. This went on for a year and a half, and in that period of time I made my first discovery, 1995 ON, at V magnitude 16.5, which was close to the photographic limit. Unfortunately the method was very slow, and it became clear that much better results could be obtained with a CCD camera. Also, by 1995 excellent astrometric software was available that interfaced directly with both the CCD image files and the Guide Star Catalog.

The very first pair of CCD images that I blinked, using the Astrometrica program, showed two objects jumping back and forth side by side, where I had expected just one. I had just discovered a new asteroid, as I was able to confirm the next night. This event made me realize that with a CCD camera, and with my mastery of astrometry, discovery would be relatively easy.

Comet Comments

by Don Machholz

(916) 346–8963 CC231.TXT October 8, 1997
http://members.aol.com/cometcom/index.html
DonM353259@aol.com

1995 O1 (Hale-Bopp)

Date	RA-2000-Dec		Elong	Sky	Mag
10–24	08h09.3m	−47°08′	79°	M	6.5
10–29	08h07.6m	−49°09′	81°	M	6.6
11–03	08h04.9m	−51°07′	83°	M	6.7
11–08	08h01.2m	−53°00′	84°	M	6.8
11–13	07h56.4m	−54°48′	86°	M	6.9
11–18	07h50.5m	−56°29′	87°	M	7.0
11–23	07h43.4m	−58°04′	89°	M	7.1
11–28	07h35.0m	−59°30′	90°	M	7.2
12–03	07h25.5m	−60°46′	91°	M	7.3
12–08	07h14.9m	−61°52′	91°	M	7.4
12–13	07h03.3m	−62°47′	92°	M	7.5

A new comet has been visually discovered. It can be seen in most telescopes for the next few months. Meanwhile, **Comet Hale-Bopp** dims as it moves south in the morning sky. **Comet Meunier-Dupouy**, up to a magnitude fainter than suggested in the ephemeris below, remains in our northern evening sky. **Periodic Comet Hartley 2** has returned on its 6.4-year orbit. Finally, our monthly report on daylight comet discoveries shows five more short-lived faint comets being found on images obtained by the SOHO satellite, bringing its total to 30.

The newly-discovered comet is **C/1997 T1 (Utsunomiya)**. It was found on Oct. 4 by Syogo Utsunomiya of Japan who was using 6″ binoculars at 25 power. The comet was quite far north (+72 degrees declination) and showed a short tail. An early orbit indicates that the comet reaches perihelion in early December when it will be outside our orbit and a bit behind us.

Continued on next page...

C/1997 J2 (Meunier-Dupouy)

Date	RA-2000-Dec		Elong	Sky	Mag
10–24	16h10.9m	+56°33′	74°	E	10.9
10–29	16h26.5m	+55°30′	74°	E	10.9
11–03	16h42.0m	+54°25′	75°	E	10.8
11–08	16h57.2m	+53°17′	75°	E	10.8
11–13	17h12.3m	+52°08′	75°	E	10.8
11–18	17h27.0m	+50°57′	74°	E	10.7
11–23	17h41.5m	+49°45′	74°	E	10.7
11–28	17h55.6m	+48°33′	73°	E	10.7
12–03	18h09.4m	+47°21′	73°	E	10.7
12–08	18h22.9m	+46°10′	71°	E	10.7
12–13	18h35.9m	+45°00′	70°	E	10.6

In one year since that day, 1996 March 26, I have discovered 210 minor planets that were given provisional designations by the Minor Planet Center. In the same span of time I have submitted over 2500 astrometric observations that were published in the Minor Planet Circulars. These results far exceed anything I might have envisioned at the outset. But I must admit that I have several advantages not enjoyed be every amateur. Being retired, I can devote most of my energies to the pursuit of minor planets. The weather in Prescott, Arizona produces many clear nights and very few unbearably cold ones. And my ST-8 CCD camera is very large by amateur standards.

Some statistics on my discoveries are presented below, following a discussion of the discovery process.

What's a discovery?

The Minor Planet Center (MPC) in Cambridge, MA is the clearing- house for all astrometric observations of asteroids and all discoveries. With rare exceptions, the MPC does not welcome reports of discoveries based on a single night's observations.

Before you attempt to discover asteroids you should master astrometry. The Astrometrica program makes the whole process quite easy and rapid, from blinking images to detect a moving object, to selecting reference stars from the Guide Star Catalog, to measuring the coordinates of the object and the stars. With a little practice on the numbered asteroids you can find out how good your measurements are and how to improve them.

Suppose now that you have taken two CCD images of the same area and you find a moving object that you cannot identify. The next step is to try to find out if it is a known object. This can be done by subscribing to the MPC Computer Service, which is accessed through the Internet. From the Computer Service you can get a listing of all known asteroids which at a specified time lie within a circle of one degree radius centered at a given point in the sky. If the position of your find (which you should have determined at least approximately) does not match with any of the objects on the listing, you have passed the first hurdle.

The positions of the new found object should now be determined with astrometric precision (if this has not already been done). From two good observations one can

---

Continued from previous page...

103P/Hartley 2

Date	RA-2000	Dec	Elong	Sky	Mag
10–24	19h19.8m	−07°04′	80°	E	10.9
10–29	19h30.6m	−07°36′	78°	E	10.7
11–03	19h42.5m	−08°04′	76°	E	10.4
11–08	19h55.5m	−08°29′	74°	E	10.1
11–13	20h09.7m	−08°51′	72°	E	9.8
11–18	20h25.0m	−09°08′	71°	E	9.5
11–23	20h41.5m	−09°20′	70°	E	9.3
11–28	20h59.2m	−09°27′	69°	E	9.1
12–03	21h18.1m	−09°29′	68°	E	8.9
12–08	21h38.2m	−09°25′	68°	E	8.7
12–13	21h59.4m	−09°14′	68°	E	8.5

A second and much fainter comet was discovered on Oct. 5 by a team of professional observers using a CCD attached to a telescope at the European Southern Observatory. Found at magnitude 19 it appeared as an asteroid: a single slow-moving point of light. But closer examination has showed a tiny tail. It is possibly a short-period comet staying at least 3 astronomical units from the sun. It is known as **P/1997 T3** and will remain faint.

COMET HUNTING NOTES: Since the first day of 1975, 76 comets have been visually discovered. Some have been discovered by more than one person: ten by two visual discoverers and seven by three. This amounts to 100 visual discovery events. Thirty-two of those 76 comets were found in the evening sky with 44 found in the morning sky. Additionally, 42 were found in the north of the celestial equator with 34 found south. All of the 23 comets found by observers living south of the equator were found in the southern celestial sky. Northern Hemisphere observers found comets both north and south of the equator.

C/1997 T1 (Utsunomiya)

Date	RA-2000	Dec	Elong	Sky	Mag
10–24	19h23.4m	+47°07′	93°	E	9.8
10–29	19h09.9m	+40°20′	87°	E	9.9
11–03	19h01.2m	+34°24′	81°	E	9.9
11–08	18h55.5m	+29°19′	74°	E	10.0
11–13	18h51.7m	+25°00′	68°	E	10.1
11–18	18h49.2m	+21°19′	63°	E	10.2
11–23	18h47.7m	+18°09′	57°	E	10.3
11–28	18h46.7m	+15°26′	52°	E	10.3
12–03	18h46.3m	+13°05′	47°	E	10.4
12–08	18h46.2m	+11°01′	43°	E	10.5
12–13	18h46.3m	+09°11′	39°	E	10.6

Orbital Elements

Object:	Hale-Bopp	Meunier-Dupouy	Hartley 2	Utsunomiya
Peri Date:	1997 04 01.13800	1998 03 10.4346	1997 12 22.02418	1997 12 10.836
Peri Dist:	0.9141405 AU	3.050393 AU	1.0317245 AU	1.34933 AU
Arg/Peri (2000)	130.58915°	122.6927°	180.72400°	096.950°
Asc Node (2000)	282.47069°	148.8384°	219.95471°	053.942°
Incl (2000):	089.42943°	091.2715°	013.61908°	128.182°
Eccentricity:	0.9951172	1.001491	0.7003913	1.0
Orbital Period:	~2500 years	Long Period	6.39 years	Long Period(?)
Reference:	MPC 29568	MPC 30429	MPC 29880	IAU 6753
Epoch:	1997 06 01	1998 03 08	1997 12 18	1997 10 06
Absol Mag/"n":	−1.0/4.0	3.0/4.0	8.5/8.0	7.8/4.0

predict the position of the object for the next several days by linear extrapolation, possibly making slight corrections to take into account the fact that an asteroid appears to accelerate before reaching opposition and to slow down thereafter; or, by interacting with the Computer Service, one can get an approximate ephemeris. In any case, it is best to try to confirm the discovery as soon as possible, preferably the next night.

You should now send the two nights' observations the to MPC by e-mail. They will again check them against the positions of known objects and notify you of the results. If your object appears to be new, you will also be told its provisional designation.

At this point you may want to keep observing your object every few days or weeks, submitting your observations to the MPC, so that its orbit may be computed with increasing accuracy. This will lead to one of several possibilities:

(1) It may happen that, after further checking on the part of the MPC staff or some other orbit computer, it is found that the same object has already been discovered; and that the other discoverer's observations were used to prove the identity of the two discoveries. In that case, the other discoverer's provisional designation is retained as the principal designation, and when the asteroid is ultimately numbered he/she will be listed as the discoverer. At this point you may understandably lose interest in further observing the object.

(2) Conversely, it may happen that the identity between your object and a previously observed one is established on the basis of your observations, and your designation then becomes the principal one. This is the most desirable outcome, in that the earlier observations make it possible to compute a more accurate orbit, which makes it easier to recover the asteroid at the next opposition.

(3) No earlier observations of your object can be found. This is the most challenging situation: it is now up to you to accumulate enough observations to make the recovery possible.

After a minor planet has been observed at a second opposition, it is unlikely to become lost. However, the MPC requires that it be observed on at least four oppositions before it can be numbered, so one must be prepared to make additional observations over the next few years. After the planet is numbered, the discoverer's name becomes part of the public record and he/she has the privilege of proposing a name for the planet.

One Year's Experience

The tables below summarize the characteristics of my discoveries. Table 1 indicates the magnitudes at the time of discovery. These are visual magnitudes, which are 0.4 fainter than the R magnitudes measured directly with CCD equipment. Although the individual magnitude measurements may have errors of a few tenths, especially for the fainter objects, the averages are close to the correct values.

Magnitude	Number
16.0 – 16.9	4
17.0 – 17.9	25
18.0 – 18.9	64
19.0 – 19.9	112
20.0 –	5

Table 1 — Magnitudes at time of discovery

In Table 2 the asteroids are grouped according to the length of time they were observed and whether they were linked to observations made by earlier observers.

Group		Num.	Avg. Mag.
1	Linked, credited to author	18	17.7
2	Arc of 60 days or more	9	17.8
3	Arc of 40 to 59 days	15	17.9
4	Arc of 20 to 39 days	20	18.6
5	Arc of less than 20 days	143	19.2
6	Linked, credited to other observers	5	17.8

Table 2 — Length of observation and linkages

Group 1 objects have been observed at between one and three earlier oppositions and they should be the easiest to recover at the next opposition (except for a few that will be beyond magnitude 20).

Groups 2 and 3 have moderately accurate orbits and most of them should be recoverable.

Group 4 is more problematic, but a few attempts will be made at recovering the brighter ones with the longer arcs.

No further observations are planned on groups 5 and 6.

A night's observing run

A night's observing starts and ends in my study. After I decide what objects to observe, I use the MegaStar software on my computer to print out finder charts (about one square degree) for each object; then I plot their positions. The finder charts have coordinate grids and show all the objects in the Guide Star Catalog.

Since the ST-8 CCD camera has both an imaging and a guiding chip, I have made a cardboard template with a larger rectangular hole corresponding to the imaging chip, and a smaller square hole for the guiding chip. Using the template I can outline on a finder chart the exact area that I want to image, making sure it contains enough reference stars to do the astrometry, and also pick out the guide star to be used.

It's now time to put on heavy clothes, head for the observatory, open it, turn on the computer, initialize the CCD camera and align the telescope. Then, using the digital setting circles, the telescope is pointed to the vicinity of the first area to be observed. I then take one or more 3-second exposures and, using the paddle, center the area exactly in the field of the camera. These short exposures will display on the computer screen all objects to magnitude 15+, including all the GSC objects.

The self-guiding feature of the camera is now turned on, the cross-hair is placed on the guide star, and the main exposure is started. Its length might typically be 4 minutes, which would show stars up to magnitude 20.

Fuzzy Spot

by Ken Reeves

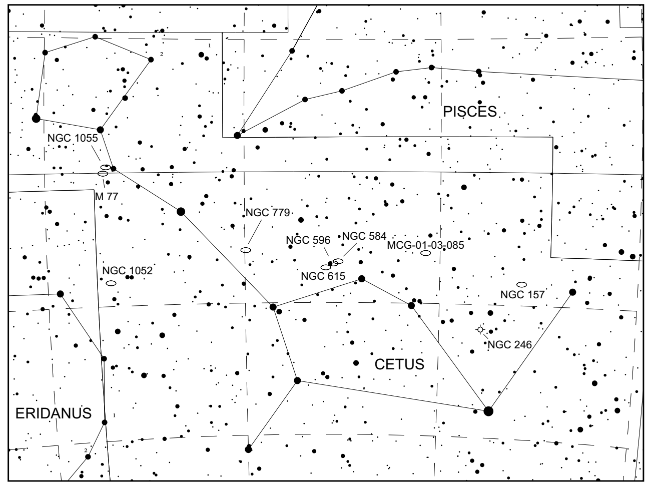
Cetus **November 1997**

Cetus, the whale, spans a large section of the Fall equatorial sky. Ranging in RA from about 0 hours to 3.5 hours and in declination from about −25 degrees to +10 degrees, it is the 4th largest constellation in area. I have always had a hard time drawing any stick figure for this constellation, with the possible exception of the head. However, the stars are sufficiently bright enough to easily find you way around.

Though not as rich as the spring skies, Cetus contains many interesting galaxies, a fairly easily observable non-NGC/IC galaxy, and a nice planetary. M 77 gets the distinction as being either the first or second object usually hunted down in the Messier Marathon. Cetus is also famous for Mira, the first discovered long period variable star.

Now that the weather is (hopefully) cooling off here in the desert, drive out to Buckeye Hills, White Tanks West, or Sentinel and enjoy the many objects in Cetus. Most of these observation were taken from Sentinel on a night I rated 9 out of 10 for both seeing and transparency, I night I will cherish for a long time.

NGC 157 (00h34.9 $-08^\circ24$) At 100X, this galaxy is pretty bright, pretty large, elongated ENE/WSW, and a little brighter in middle. Using averted vision makes it grow somewhat and shows a little mottling. The galaxy is situated nicely between 2 stars N and S, and on the ENE end is a faint star.



NGC 246 (00h47.1 $-11^\circ53$) This is a nice planetary situated in galaxy country. At 70X, it is very large, somewhat bright, and irregularly round. 3 bright stars are involved in the nebula, with 2 just outside, and 3 or 4 fainter ones inside. I was unable to see any color in this planetary. Use averted vision to help make it stand out, or better yet, use a UHC filter. It emphasizes the roundness of planetary, and shows the middle as a little darker. I consider this as one of the nicer planetaries.

Continued on next page...

While the exposure goes on there is nothing for me to do except sit in an easy chair and listen to the whirring of the camera's cooling fan and the clicking of the relays activated by the guiding program. After the exposure is completed it gets stored on the computer hard disk, where it takes about 400K bytes. I usually take 2 or 3 images of the same area: 2 images taken 6 minutes apart are sufficient to show the motion of an average speed asteroid. On a typical evening I may take 16 to 20 images over a period of 3 hours. Then I download the images to a ZIP drive, close the observatory, and head back to my study.

Now for each pair or triplet of images the same procedure is followed: the images are blinked in pairs on the computer screen to pick out all moving objects; the positions (RA/Dec) of these objects are measured, using the Astrometrica program, to an accuracy of about 0.2 arcseconds; then the objects must be identified. Astrometrica produces a listing of all observations, and each position is compared carefully against an ephemeris of a known asteroid or against a listing (obtained by e-mail from the MPC Computer Service) of all known asteroids in the vicinity. If an object does not match and appears to be new, a second night's observations, consistent with the first, must be made before it is reported. When all relevant observations are assembled, they are e-mailed to the MPC. If new unidentified objects are reported, a response is usually received within a few hours giving their designations.

Conclusion

The astrometry and discovery of minor planets are well within the reach of amateurs with CCD equipment. A large telescope is not needed: a 10″ to 12″ instrument with short focal length is fully adequate. These activities are widely and successfully practiced by many Italian and Japanese amateurs. So far, relatively few American amateurs have taken up these challenging endeavors that bridge the gap between the amateur and the professional.

In my view, the main reward derived from measuring and discovering asteroids is the feeling that one is doing professional level scientific work. And if you live in Arizona you may have the additional pleasure of seeing your contribution published next to those of Lowell or Kitt Peak.

Newsletter Deadline

Mail items for Such-a-Deal at least two weeks before the end of the month. Articles that need to be published in a timely fashion must be submitted or the newsletter editor notified of the article at least 6 weeks before month they are published. Items arriving too late for an issue will be included in the next newsletter.

Continued from previous page...

NGC 584 (01h31.3 −06∘51) Cetus contains a nice string of 3 Herschel-400 galaxies, 584, 596, and 615. At 100X, 584 is bright, pretty small, very much brighter in the middle, and contains a non-stellar nucleus. No elongation was seen, but I did note some mottling around the core. Bright stars are seen to the NNE and SSW, not quite forming a straight line with this galaxy. To the south is a nice double star. Look closely between the 2 bright stars, almost exactly in the middle is NGC 586 faintly glowing.

NGC 596 (01h32.8 −07∘01) The middle of the string of galaxies, this object is pretty small, pretty bright, with a very much brighter middle and a non-stellar nucleus. It is quite similar to 584 without the mottling. To the E is a very bright star which does disrupts viewing this object.

NGC 615 (01h35.1 −07∘19) Of the 3 galaxies in a row, this is the faintest. I considered it as somewhat bright, somewhat small, much brighter middle and containing a non-stellar nucleus. It is very elongated N/S. No other detail was seen, but averted vision helped the halo a little. It sits in a nice grouping of 3 stars.

NGC 779 (01h59.7 −05∘58) At 100X, this galaxy is somewhat faint, somewhat small, and very elongated NNW/SSE. The middle is a little brighter, but no nucleus was seen. Those of you that have observed with me know that I record my observation on a pocket tape recorder. This can provide some interesting notes when I go to transcribe them later. At the end of this observation, I noted that no dark lanes or elongation was seen?

NGC 1052 (02h41.0 −08∘15) Yet another galaxy, 1052 is pretty bright, somewhat small, brighter in the middle, no nucleus seen, and no elongation seen. To the SW is galaxy NGC 1042, which is large and really needs averted vision to see it, slightly brighter in the middle. Some graininess was noted almost like a faint globular cluster, a few field stars pop out over it with averted vision. Nice to see small bright and large faint galaxies close together. If you are having a hard time seeing 1042, try moving or wiggling the scope.

NGC 1055 (02h41.8 +00∘26) For those of you looking to observe past the Messier list, this is a good object to start with. It is real close to M 77 and has two 7th magnitude stars right next to it to help direct you. At 100X, I noted that it forms an equilateral triangle with the 2 bright stars, is somewhat bright, fairly large, and a little brighter in the middle. Using averted vision makes it grow somewhat, and shows some possible elongation E/W. The glare from the stars does makes it kind of hard to observe. The surrounding star field is nice with a star NE and a trio to the SW.

NEW 1 (01h05.1 −06∘13) Also known as **MCG-01-03-085**, this galaxy is accessible for people with moderate aperture scopes. In the 10″, I observed it as very faint, pretty large, slightly brighter in the middle, and no elongation detected. To really see it, use averted vision or jiggle the scope. This one is fun just to capture something in an obscure catalog.

Herschel 400 Objects

157, 246, 247, 584, 596, 615, 720, 779, 908, 936
1022, 1052, 1055

SAC's 110 Best of the NGC Objects

246, 939

Getting Started

Selection and Breeding of Equatorial Mounts

by Wil Milan

Sooner or later every astronomer longs for a good equatorial mount. Most of us started with simple alt-azimuth mounts, often a glorified photo tripod or perhaps a simple, sturdy Dobsonian mount. Others may have started with a small department-store telescope on a cheap equatorial mount, the kind of equatorial mount which drive many to swear off equatorials forever. But not all equatorial mounts are bad; a good one is a joy to use and can do things which no alt-az mount can ever do. In this first part of a two-part series we'll discuss how to select an equatorial mount and how to expand its uses; in the second part ("The Care and Feeding of Equatorial Mounts," next month) we'll talk about how to live with and use an equatorial mount.

The basics

The first thing that comes to my mind when I think of equatorial mounts is that I would never have called them that. They have nothing to do with equators; they have everything to do with north and south poles, so I would have called them "polar mounts." But no one asked me, so we're stuck with the name.

The reason I would have called them "polar" mounts is this: The key feature of an equatorial mount is that its main axis of rotation (called the "polar axis" — I told you that was a better name) can be aligned with the Earth's axis of rotation. When the polar axis of the mount is aligned parallel with the Earth's axis of rotation the telescope can track the motion of the sky by simply turning on the polar axis. Whereas with an alt-az mount you have to be continually moving the scope both up and down and sideways to keep an object in the field of view, with the equatorial a periodic nudge along the polar axis will keep an object in the field of view all night long.

And you don't even have to supply the nudge. Almost all equatorial mounts have what is known as a "clock drive," a tiny motor which keeps nudging the polar axis even if you fall asleep at the eyepiece (not an infrequent occurrence for some of us). The tiny motor is geared to turn very slowly, so slowly that the motion is undetectable by looking at the scope, but still fast enough to keep up with the stars as they move across the sky from hour to hour. The result is that when the clock drive is running you can point the scope at an object, walk away, and the scope will still be pointed at that object when you come back (or wake up) an hour later. Very nice.

Or at least that's the theory. In fact no equatorial mount tracks perfectly, and some are much easier to align and use than others. But before we can talk about those differences we need to consider the types of equatorial mounts and which kind might be best for your scope.

Types of equatorial mounts

Because astronomers are clever folks (and because some of them have too much time on their hands) over the last 300 years there have arisen many ways to align a mount with the axis of the Earth. There's the English mount, the split-ring mount, the Poncet platform, and many more. For our purposes, however, we will concentrate on the two types which are by far the most common types of equatorials: fork mounts and German equatorial mounts. They do the same things, but they do them in very different ways.

The fork mount

The fork mount is the simpler of the two, both to understand and to use. In a fork mount a massive metal fork is bolted to the end of the polar axis, thereby looking like a giant pickle fork pointed at the North Star. The scope is mounted on a pivot across the tines of the fork, allowing the scope to swing down (to point south) and up (to point north). There's not much else to it except the clock drive, which is usually built into the base of the fork assembly.

Fork mounts are intuitively easy to use: Swivel the scope on both axes until it points to the object you want, engage the clock drive, and you're done. If the forks are properly sized for the scope the fork mount can see any part of the sky from horizon to zenith, and track any object all the way across the sky. Because of this ease of use fork mounts are the prime choice of big scope makers such as Meade and Celestron for their popular Schmidt-Cassegrain scopes. These are the most popular scopes in the world, and the great majority of them are on fork mounts.

German equatorial mounts

So-called "German" (no, I don't know why) equatorial mounts operate in a very different manner. In a German equatorial mount (sometimes called by the acronym "GEM") there is no fork. Instead the side of the scope is bolted to a small platform which in turn is attached directly to the polar axis and revolves around it. The platform can swivel about its own axis, thereby allowing the scope to swing north and south.

The chief distinguishing feature of a GEM comes about because the scope attached to one side of the polar axis makes that axis unbalanced. For that reason on the opposite side of the polar shaft from the scope a GEM has a long shaft which points away from the scope, and on that shaft is attached a large counterweight. With the counterweight on one side and the scope on the other, the weight is balanced about the polar axis and the scope doesn't flop down to the bottom. The counterweight can usually be moved up and down the counterweight shaft to balance accessories on the scope, a piggyback camera, etc.

No matter how one looks at it, counterweights are a significant inconvenience. They add to the weight of the whole assembly, so that in addition to the scope and mount you also have to tote around one or two heavy weights. (Heavy weights which in the dark of night always try to slide off the shaft and land on your foot.) The counterweights add to the assembly time, because to set up a GEM usually requires assembling the counterweight shaft into the mount, then the counterweights on the shaft, and only then can you put the scope on the mount. On a fork mount, by contrast, the forks and scope usually stay together, so all that is required for setup is to put the fork-and-scope assembly on the tripod — very quick to do.

German equatorials have other drawbacks too: Because the scope is only inches from the hub of the mount, in certain positions the scope can be swung so it whacks into its own mount. Avoiding that requires care in swinging and pointing the scope, and the wise GEM user never lets go of the scope until everything is locked in place. Also, because the scope hangs on one side of the mount, as the clock drive tracks the motion of the sky the scope will reach a point near the meridian where it will bump into the base of the mount. The only solution at that point is to disengage the clock drive, swing the scope away from the object, flip the polar axis around so the scope is now hanging on the other side of the mount, find the object again, and re-engage the clock drive. That's a nuisance, both for visual use and for astrophotographers who have to plan exposures so they will end before the scope bumps into the mount.

The upshot is that German equatorial mounts are more complicated, take longer to set up, are harder to use, and often are heavier than equivalent fork mounts. So why would anyone use them: Aha, because they have one great shining advantage: Because the weight of the scope is attached very close to the polar axis itself, German equatorials are less prone to the vibration and shimmy which often plague fork mounts. On a fork mount the weight of the scope is far from the hub of the mount, and thus the whole fork can become like a giant tuning fork, shaking and wiggling each time the scope is touched or the slightest breezes blow. The only way to overcome this is with very beefy forks, but that also adds weight, which negates some of the advantages of fork mounts.

German equatorials also excel in another respect: Because the scope does not have to fit within a fork, GEMs can handle much longer scopes. A scope five feet long would require an awkwardly large fork, but a relatively small GEM can handle it with ease because on the GEM the scope length is not restricted by the mount. For that reason short, compact Schmidt-Cassegrain scopes are generally mounted on fork mounts, while long refractors and Newtonians are almost always mounted on German equatorials.

What you should choose

Whether you're shopping for a stand-alone mount for your existing scope or a complete scope-and-mount assembly, there are some things you should consider and check for when evaluating equatorial mounts. Fortunately most of them are very easy to check:

Consideration #1 is stability — how well the mount resists shimmy and vibration. If you're buying a complete scope and mount this is very easy to check: Put in an eyepiece which will provide at least 200x magnification, then try to focus it on a distant object. If just trying to focus the scope causes the image to vibrate so much that it's hard to see, move on to another mount. A mount so prone to vibration is very frustrating to use; it can take minutes just to re-focus the scope each time you change eyepieces. Such a mount is typically also prone to vibrate at the slightest wind, which can keep you from observing on what otherwise would be good observing nights.

If you end up with such a shimmy-prone mount anyway, there are several things you can do to help it. One of them is to get an electric focuser (sold by many third-party vendors) so you can focus the scope without touching it. Another help is to buy vibration-suppression pads (sold by Celestron) which help dampen vibrations of the whole mount. But the best solution, if you have a choice, is a better-built mount.

If the scope passes the focusing test, once the object is focused with a high-power eyepiece try giving the scope a little thump near the eyepiece end. It will shake and vibrate a bit, but it should stop quickly. Four seconds is typical; a very solid mount will stop shaking within a second or two, while a bad one may take eight seconds or more to settle down again.

If you're buying a bare mount (i.e., without a scope) all this is hard to evaluate because you can't look through the scope on the mount. If you evaluate the mount with a different scope the results may not be valid; a mount which is solid and stable with a small, short scope may wiggle like jelly with a longer and/or heavier scope on it. Your best solution may be to ask around (perhaps on the Internet) and talk with others who are using scopes like yours on the same type of mount.

Consideration #2 is how well the mount tracks and moves. Swinging the mount on both axes should feel buttery-smooth and free of side play or backlash. There should be no hard spots, grinding sounds or feel, and no end play on the shafts. When the axes are locked (ask the owner or vendor to show you how; it varies from mount to mount) the whole mount should feel rigid and solid with no wiggling or free play anywhere.

Consideration #3 is the clock drive, and this starts to get hard to evaluate. If the mount is used you should make sure the clock drive operates and drives the polar shaft smoothly. At night this is easy to check: point it a bright star, put in a high-power eyepiece, and see if the drive keeps the star centered indefinitely (well, at least a half-hour or so). If the mount is new this should be assumed, presuming you can take it back if it doesn't track properly.

The tricky aspect of checking a clock drive is something called "periodic error." Clock drives operate through a complex set of gears which match the speed of the motor to the speed required to track the sky. But it is impossible to cut gears perfectly, so every gear in the gear train introduces a tiny bit of error. The main culprit is the gear which drives the final drive gear, often known as a "worm gear." Any unevenness in the worm gear will result in the scope slightly speeding up when on one side of the gear and slowing down on the other side. Because the worm gear typically revolves once every few minutes (driving the main gear which moves much slower), the unevenness of the worm gear will result in a slow east-west wobble in the scope as it tracks the sky.

If you're only going to use the scope for visual use this probably won't matter. The wobble is usually so small and so slow that you won't notice it. But for astrophotographers the slow wobble every few minutes means that the scope will require continual corrections to keep it tracking properly. This becomes a major nuisance during long exposures.

If you're planning to do some astrophotography with your new mount you should therefore try to find one with a small periodic error. (No mount is perfect in this respect, some are just better than others.) Unfortunately a low periodic error usually comes hand-in-hand with a high price, but some mounts represent better values in this respect than others. You should also try to get a mount which has "periodic error correction" ("PEC" for short), an electronic feature which reduces the effects of periodic error by automatically adjusting the speed of the clock drive to compensate for the gear-induced error.

Consideration #4 is what other features the mount has. If you're planning to use the mount for astrophotography you should definitely get one which has a drive corrector. This is a hand-held control which allows you to make tiny east-west corrections to the tracking while you're guiding for astrophotography. For astrophotography you should also make sure the mount has a declination motor, which allows you to make tiny north-south corrections while photographing.

For visual use you don't need any kind of drive corrector or hand controller, but you may want one anyway because the corrector and hand control allow you to make tiny corrections to center objects in the field of view or to see a different part of an object (such as roving the scope about the face of the moon at high power). In addition to making tiny corrections many better mounts also offer several "slew" rates, faster rates of motion selectable from the hand controller specifically for sweeping the scope across the sky. It's very nice to be able to sweep the sky very slowly, taking in the views without having to touch the scope. This is more than just convenience; at high power it's hard to move the scope smoothly by hand, but the drive controller can do it easily.

The last major consideration when evaluating a mount is convenience. How hard is it to assemble and disassemble? How heavy and awkward is it to transport? Does it take two people to assemble the scope and mount, or can one person do it easily? Go through a complete breakdown and re-assembly of the mount and decide these things for yourself.

One convenience consideration often overlooked is the power requirements of the mount. Some mounts have motors which require AC house current, which is OK at home but a pain to provide in the field. (There are small converters just for this use, but they are not as convenient as a mount which runs on batteries.) For battery-powered scopes, find out what kind of batteries they take and how much power they consume. Some "battery powered" scopes actually require a car battery or something similar to power them, while others will happily run for many hours on small AA batteries or a 9-volt transistor battery. Find out what the mount in question requires, and if it needs to be plugged into a cigarette lighter socket plan to get a portable storage battery instead of running it off your car. It's a terrible thing to spend a long night observing at a remote spot, then discover that you're stuck in the middle of nowhere because your car won't start.

If you're buying a mount by itself there's one more consideration which really supersedes all the others: Make sure the mount will really work with your scope. Know exactly how your scope will go on the mount before you buy the mount. With enough ingenuity and machining skills almost any scope can be adapted to any mount, but you may not want to go through that much grief. Know what you're getting into.

Stay tuned...

In the second installment of this two-part series we'll discuss how to use your new mount, some tricks for getting the most out of it, and a few tips on living with equatorial mounts.

Paid Advertising

The postage for this oversized newsletter was paid by the advertising.

Novice Group Meeting

At November Star Party: Nov. 22

The Buckeye Hills Star Party in November will also be the next Novice Group meeting. Several folks in the club expressed an interest in having a Novice Group get together under the stars, so let's plan for the November SAC Star Party at Buckeye Hills Recreation Area as the time and place to do that. Please show up a little early so that we can get setup and answer some questions while there is still twilight. Be there by 5:30, which means leave town about 4:30 and we can have a sandwich and get started. Please be sure to bring warm clothing.

If you need some help with setup, alignment to the Pole, collimation or any other questions, bring them to the Star Party. A demo will be given on finding your way around in the sky and another on using binoculars to observe the Universe.

Bits and Pieces

Minutes from the September Meeting

The meeting was called to order at 7:30 by Adam Sunshine. Adam asked our guests to introduce themselves. We had 2 guests present.

Paul Dickson discussed the books that are for sale. The new Herschel book is not in print yet. On Oct. 3 and 4 there is the All Arizona Star party in Arizona City.

Regina Lawless gave the treasurers report. Regina reported that David Levy has just found out he has cancer. Please drop David a line to let him know that we are thinking of him.

A.J. Crayon talked about the Messier Marathon. He will be helped by Rick Rotramel.

Gene Lucas discussed that the town of Buckeye will not be bringing bright lights to the park, so we can continue to use the site for the time being. Gene thinks that we should contact the Parks department and keep in touch so that we know what is going on.

Steve Coe talked about the eclipse cruise. There are still rooms left. A novice meeting is being organized for the November club meeting at Buckeye.

There will be a board meeting 1/2 hour before the next club meeting.

Chris Schur brought in some slides for us to see. Very nice shots, Chris.

There was 38 people present at the break.

After the break, Gerry introduced Warren Kutok from Photon Limited. His talk was about telescope restoration. They have restored mainly large refractors. He talked about the many observatories that they have gone into to restore their telescopes. Very interesting talk.

After the meeting, 11 of us adjourned to JB's to continue our talks.

—David Fredericksen, SAC Secretary

November Club Meeting

The speaker for the November club meeting will be Dr. Paul Scowen from A.S.U. He will talk about his observations with the Hubble Space Telescope that he's done with Dr. Jeff Hester.

Minutes from the October Meeting

The October meeting was called to order by Adam Sunshine at 7:30.

We had 2 guests stand up and introduce themselves. Welcome.

Regina Lawless gave the treasurers report.

Paul Dickson talked about the SAC Best 110 and the Messier book that are for sale through the club. He also had the prototype of the Herschel book. He has order forms if you want one.

A.J. Crayon talked about the the Deep Sky Group meeting that will be next month. The objects come from Ken Reeves Fuzzy Spots articles. The Messier Marathon announcements are going out the weekend of Oct. 17. It will be March 28, 1998. On the evening of November 10 at 8:34 PM there will be a triple shadow transit on Jupiter. A.J. discussed buying a wonderful SAC T-shirt as a Christmas gift for your significant other.

Adam showed the *Astronomy and Space* weekly calendar that he recieved. The books retail for $12.95, but we can get it for $8.95 if we order 10 or more. We would like to ask $10 and have the extra money go to the club.

We opened the nominations for club officers. Nominations were:

President: Adam Sunshine, Paul Dickson
Vice President: Gerry Rattley
Treasurer: Jack Jones
Properties Director: Adam Sunshine
Secretary: *no nominations yet*

Note: Steve Coe said we should talk to him next year about being Properties Director.

Steve Coe donated a laser pointer for our Show and Tell segment. Steve was the first to present during Show and Tell. He showed us pictures with regular film and the same shots with some infrared film. He said it is difficult to use, so... He had some nice shots with the Fuji film of the Milky Way. Nice shots, Steve. Pierre Schwar and Steve Redman showed us some video of the occultation of Saturn by the Moon. Excellent shots of the occultation. Pierre then showed moonrise over the Four Peaks. Will Milan showed some slides using slower speed films and then copying onto high contrast slide film.

Tony Ortega from the New Times discussed how he wrote his story about Robert Burnham, Jr. He gathered much of his information from Burnham's sister. Tony showed us the handbook in Japanese, Burnham's lengthy high school report on the 7 wonders of the World, and other memorabilia from Burnham. Thanks Tony for an enlightening tale of Robert Burnham, Jr.

We had about 45 people in attendance. After the meeting, 17 people went to JB's to continue discussions.

—David Fredericksen, SAC Secretary

Minutes from the October 17th Board Meeting

October board meeting was attended by Gerry Rattley, Regina Lawless, A.J. Crayon, Jack Jones, Adam Sunshine, Paul Dickson and David Fredericksen.

A.J. said that the Messier marathon notices will go out to 18 different clubs the weekend of the 18th of Oct.

Gerry discussed that he was contacted about a stain-glass window memorial fund for Clyde Tombaugh.

Right now nothing is happening with regard to finding a replacement for Buckeye Hills. We need to be looking for a new sight that is fairly close for newcomers that is easily accessible. A.J. thinks that Buckeye will be usable for maybe 2 more years. Yet to be explored, is the site that Pierre Schwaar located more than a year ago.

On the subject of locating better meeting facilites, Jack Jones said that the Arizona Science Center is interested in having astronomy clubs coming but only for a one time event, not monthly. This was mainly due to the center being closed during the evenings. We will contact them after the year to see if we can plan an event with them.

Regina said that due to all of the honorariums we may need to raise the dues in the near future.

Adam had the Space and Astronomy calendar and wanted to know if we should offer it to the club. If we have 10 orders, we would get a discount from the $12.95 price. It was decided to put out a sign up list and see if anyone wanted to order it. The board meeting was adjourned at 7:25 PM.

—David Fredericksen, SAC Secretary

Deep-Sky Group Meeting

The Deep-Sky Group is a Special Interest Group made up of people who like to discuss observing and observing techniques. They particularly like to observe objects out past the Orrt Cloud that's why they're called the Deep-Sky Group. The type of objects include stars, nebulae, and galaxies.

If you are interested in sharing your observations, or are interested in observing techniques, then by all means come join in. The meetings are held at John McGrath's house every other month on the Thursday after the SAC meeting; directions are found on page 2 of this newsletter.

Consider this to be an invitation to this meeting. This meeting is OPEN to all SAC members. All you have to bring is an interest in what objects look like when view through a telescope.

For the November Deep-Sky Meeting we will discuss the objects in Ken Reeves' September and October *Fuzzy Spot* columns (Lacerta and Cepheus), which total 13 objects.

If you have new or old observations, bring them along. Even if you have no observations, come anyway. This is a good way to improve your observing skills.

Magazine & Membership Renewals Due

The end of the year is fast approaching and it is time to renew your magazine subscriptions and your memberships. The club gets a discounted rate for astronomy magazine subscriptions because members subscribe in a block. Subscriptions at other times of the year must be held until the minimum number of subscribers is reached. So it's best to renew early, so no issues are lost. *Sky & Telescope* is $27 for a year and *Astronomy* is $20.

The SAC membership is based on the calendar year. Membership is from January through December. Please make an effort to renew your membership at the October or November SAC meetings. In 1998, SAC will have a new treasurer, not having to keep track of a large number of late subscribers will make the job a lot easier. Dues are $28 for individuals and $42 for families (one newsletter).

Your last newsletter will be the December issue unless you renew before January.

The form to fill-out is at the top of the back page.

Also coming up is the ordering of Royal Astronomical Society of Canada's *Observer's Handbook.* A final count of the number of books needed will be taken at the October club meeting. If you want one, be sure to attend one of these meetings to be counted.

—*Regina Lawless, SAC Treasurer*

Arizona Science Center Presents

Looking Back to the Big Bang

Tod R. Lauer, NOAO
Wednesday, November 5, at 7:00 P.M.
Dorrance Planetarium
$5.00 ASC members; $7.00 non-members

As a special offer to Saguaro Astronomy Club Members, we will be giving a discount of $3.00 off each ticket.

Tod R. Lauer, an astronomer at the National Optical Astronomy Observatories, will speak on "Looking Back to the Big Bang." Lauer will summarize the current understanding of the Big Bang and how astronomers are using their powerful telescopes to actually look back in time to when the universe was younger.

Lauer was a member of the Hubble Space Telescope Imaging team and has been using the Hubble since its launch to study nearby galaxies and to search for massive black holes. Lauer also works on trying to understand the present structure of the universe.

To reserve your tickets, call 602/716–2028 and follow the voice mail directions to reserve tickets for "lectures." Be sure to mention you are a member of the Saguaro Astronomy Club in order to receive your discount.

Arizona Science Center
600 E. Washington
Phoenix, AZ 85004

Where's Waldo?

This image is part of a stereo image pair taken on the afternoon of Sol 74 (September 17) shows the Sojourner rover behind the rock "Chimp" is the top/center of the image. Sojourner was a record 12.3 meters from the lander.

November 1997

All Times are Mountain Standard Time

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4	Venus at greatest elongation 47° (evening) 5	**PAS Meeting** Brophy Prep. Physics Lab 6	**TAAA Meeting** (Tucson) 7	Yesterday First Quarter Moon 2:43 P.M. 8
9	Triple Transit of Jupiter 8:34 PM 10	11	**EVAC Meeting** (SCC: Rm. PS172) 12	Tomorrow Full Moon 7:41 A.M. 13	**SAC Meeting** Grand Canyon University, Fleming Rm. 105 14	15
16	Leonid Meteors Peak: 4 A.M. Z.H.R.: High ! 17	18	19	**SAC Deep-Sky Meeting** 7:30 P.M. 20	Last Quarter Moon 4:59 P.M. 21	**SAC Star Party** Buckeye Hills (members&guests) 22
Nov. 22 Sun enters Scorpio 8 P.M. 23/30	24	25	26	Thanksgiving Pluto at conjunction 27	Mercury at greatest elongation 22° (evening) 28	New Moon 7:14 P.M. 29

Magazines & Discounts

Club members may subscribe to astronomical magazines at reduced rates through the club Treasurer. See the Member Services Form on the back page of this newsletter. Furthermore, club members are encouraged to align their subscriptions with the Jan.–Dec. calendar year. This eases the burden both on the Treasurer and the Publisher by permitting a single Group Renewal to be placed in the autumn for the upcoming calendar year.

Those members who experience problems with their subscriptions to *Astronomy* magazine may call Kalmbach Publishing Customer Service at (800) 446–5489.

Those members who experience problems with their subscriptions to *Sky & Telescope* magazine may call Sky Publishing at (800) 253–0245.

Besides the club discount on *Sky & Telescope* magazine, Sky Publishing offers club members a 10% discount on all other Sky publications. This means books, star atlases, observing aids, Spotlight prints, videos, globes, computer software, and more.

Club members who subscribe to *Sky & Telescope* through the Club Discount Plan may order Sky publications directly, at the above toll-free number, without going through the club Treasurer. Simply mention the Club Discount Plan and give the Saguaro Astronomy Club name to receive the discount. Sky Publishing will check their records to verify that you are eligible to receive the discount.

Saguaro Astronomy Club Member Services Form

Membership

Memberships are for the calendar year and are prorated as follows: Jan - Mar 100%, Apr - Jun 75%, Jul - Sep 50%, Oct - Dec 25%.

- ❑ $28......Individual Membership
- ❑ $42......Family Membership (one newsletter)
- ❑ $100......Business Membership (includes advertising)
- ❑ $4......Nametag for members
- ❑ $14......Newsletter Only

Subscriptions

The following magazines are available to members. Subscribe or renew by paying the club treasurer. You will receive the discounted club rate only by allowing the club treasurer to renew your subscription.

Sky & Telescope................$27.00 for one year ❑

Astronomy............................$20.00 for one year ❑

Write your name, address, phone number, and E-mail address in the space below.

Make checks payable to SAC.
Mail the completed form to:

David Fredericksen
SAC Secretary
6222 W Desert Hills Dr
Glendale AZ 85304

SAC and SAC Meetings

Saguaro Astronomy Club (**SAC**) was formed in 1977 to promote fellowship and the exchange of scientific information among its members — amateur astronomers. **SAC** meets monthly for both general meetings and star parties, and regularly conducts and supports public programs on astronomy.

SAC meetings are usually held on the Friday nearest the full moon. This means that over the course of the year, meetings are not held on the same week of the month. The same is true of the club's star parties. Star parties at Buckeye Hills Recreation Area are mostly held on the Saturday of the third quarter moon.

SAC General Meetings: 7:30 PM at Grand Canyon University, Fleming Building, room 105 — one mile west of Interstate 17 on Camelback Rd, north on 33rd Ave., second building on the right. See inside for a map to the meeting location.

1997 SAC Meetings
Jan. 24
Feb. 21
Mar. 21
Apr. 25
May 16
Jun. 20
Jul. 18
Aug. 22
Sep. 19
Oct. 17
Nov. 14
Dec. 13 Party

1997 SAC Star Parties

Date	Sunset	Moonrise
Jan. 4	5:37PM	3:50AM
Feb. 1	6:03PM	2:35AM
Mar. 1	6:28PM	1:23AM
May 31	7:34PM	3:01AM
Jun. 28	7:44PM	1:43AM
Jul. 26	7:34PM	12:25AM
Aug. 30	6:58PM	4:56AM
Sep. 27	6:20PM	3:46AM
Oct. 25	5:46PM	3:33AM
Nov. 22	5:25PM	1:18AM
Dec. 27	5:31PM	6:22AM

SACNEWS
c/o Paul Dickson
7714 N 36th Avenue
Phoenix AZ 85051

Stamp

First Class Mail

Inside:

SAC Meeting — November 14
Deep-Sky Meeting — November 20
SAC Star Party — November 22