

Saguaro Astronomy Club

Metro Phoenix, Arizona

SACNEWS



August 1993 — Issue #199

v7.23

Recent Soviet Lunar and Planetary Program Revelations

by Andrew J. LePage

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As has happened so many times in the past couple of years, as soon as I write an article on the former Soviet space program, new and exciting information comes to light. In recent months, new information on the early days of the Soviet lunar and planetary exploration program has become available. One of the reasons I have not published the next part of my recent "The Great Moon Race" series in the EJASA is that I have been waiting for the dust to settle somewhat from the most recent flurry of revelations to come out of Russia and other parts of the former Soviet Union.

While the next installment in this series is still several months away, I have had enough time to digest the new information to summarize the Soviet attempts to explore the Moon, Venus, and Mars during the late 1950s and early 1960s.

Early LUNA Missions

Since writing the article, "The Great Moon Race: In the Beginning...", much new information on the early LUNA missions has become available. No information has come to light on the possible unsuccessful launches of May 1 and June 25, 1958, identified by Western intelligence sources. However, there is new information regarding the attempt made on September 23, 1958. This first acknowledged launch took place on the afternoon of that day, but failed when the VOSTOK launch vehicle broke up after ninety-two seconds of flight.

The second presently acknowledged LUNA launch attempt occurred on the morning of October 12, 1958, just

Quick Calendar

SAC Star Party
Buckeye Hills Recreation Area
Saturday, August 14

SAC Meeting
Speaker: Frank Zullo
7:30, Friday, August 27

Lowell Bus Tour
8:30 AM, Saturday, August 28

hours after the launch of the American lunar probe PIONEER 1. The Soviet Chief Designer, Sergei Korolov, determined that a probe launched at that time would just beat the American craft to the Moon. As it turned out, the VOSTOK booster for this mission broke up just one minute and forty seconds into the flight. An investigation of these two failures concluded that the addition of the Block E escape stage to the basic R-7 rocket shifted the launch vehicle's center of gravity in such a way that violent resonant vibrations would occur after 1.5 minutes of flight, literally shaking the ascending rocket to pieces.

No mention is made of a possible November 15, 1958 LUNA launch. The next admitted attempt took place on December 4, just two days before the launch of PIONEER 2. This LUNA failed due to a malfunction in the core's RD-108 engine at four minutes and five seconds into the flight.

The next attempt took place on January 2, 1959, with the launch of LUNA 1. There is as yet no mention of an alleged follow on attempt on January 9. The next launch attempt took place at some unspecified date that summer (possibly June 16). This probe failed because of a

SAC Officers

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malfunction in the second stage's navigation system. The next attempt was LUNA 2, launched on September 12.

After LUNA 2 successfully impacted the Moon, the Soviets turned their attention to LUNA 3-style missions. This program succeeded on the first try with the launch of LUNA 3 on October 4, 1959. Starting the day after LUNA's October 7 picture-taking session, attempts to transmit the images began. The first four transmissions were unsuccessful because of the large amounts of noise caused by LUNA 3's great distance from Earth. The first two images were finally returned on the fifth attempt when the probe was closer and after special measures were taken to minimize radio noise in the vicinity of the tracking station in the Crimea. In all, seventeen images of "rather satisfactory quality" were returned before LUNA 3 ceased to function.

After this mission, at least two additional LUNA 3-type probes were constructed. They were designed to take higher resolution images at closer range than LUNA 3 and were fitted with more powerful transmitters to help improve the quality of the returned photographs. The first attempt was made on April 15, 1960. This mission was cut short when the Block E escape stage shut down too early, leaving the probe in a short-lived, highly elliptical Earth orbit. This was a fate similar to the early United States PIONEER probes.

The last attempt was the most spectacular failure of all. This probe was rolled out onto the launch pad shortly after the failure of the April 15 LUNA probe. On the afternoon of April 16, the craft was launched and immediately ran into problems. The RD-107 engine of one of the four strap-on boosters failed to ignite. After struggling upwards 150 to 200 meters (500 to 650 feet), the VOSTOK launch vehicle finally started to tumble out of control with all four strap-on boosters breaking free of the core. Two of the boosters crashed and exploded near the launch pad. Another passed a mere 30 to 40 meters (100 to 130 feet) over the heads of some spectators located 1.5 kilometers (4,900 feet) from the pad. The rocket detonated on impact, shattering the windows of the MIK (Assembly and Test Building) for the VOSTOK. The core with the Block E escape stage and payload crashed into a small salt lake some 800 meters (0.5 mile) from the pad. This was the last Soviet LUNA mission until their landing program began.

Early VENERA and MARS Missions

The design work for the first Soviet interplanetary probes began just as the first unmanned flights to the Moon started in middle 1958. In August of 1959, the Applied Mathematics Division of the Mathematical Institute of the Academy of Sciences of the U.S.S.R. released a report detailing the requirements to reach Venus and Mars. It was concluded that, using the 8K78 launch vehicle (now known as the MOLNIYA) then under development, a 500-kilogram (1100-pound) payload could be sent to Mars during the September of 1960 launch window and an 800-kilogram (1760-pound) payload could be sent to Venus in January of 1961.

It has been recently revealed that only one launch attempt to Mars was made during the 1960 launch window. On October 14, 1960, a probe similar to VENERA 1 was launched with the intent of impacting on the Martian surface during the third week of May, 1961. Without a mid-course correction capability, however, the chances of an impact were slim. Only simple particle and fields instrumentation were carried and no camera was included in this payload. Unfortunately, this attempt reached a peak altitude of only 120 kilometers (74 miles) due to a failure of the turbopumps in the RD-461 engine in the new Block I stage.

While more than one probe was probably prepared for launch, according to some sources this was the only launch attempt actually made during that time. Another launch failure on October 10 that was previously identified by Western intelligence as a Mars probe apparently had nothing to do with the MARS program, just as an October 24 launch failure and deadly explosion of an R-16 ICBM development flight was thought to be a Mars probe mission until being revealed as otherwise in 1989.

Less than four months after their first attempt to launch a spacecraft to Mars, the Soviets were ready for the Venus launch window. The Type 1VA probes' mission was to, hopefully, impact on Venus. As with the first Mars probe, these probes carried no mid-course correction motor to negate any launch errors and fine-tune their aim, so an impact was unlikely. Still, just in case one of the probes chanced to be placed on a collision course with Venus, a small sphere designed to float in any Venusian ocean that might exist was carried containing a commemorative medal. This small sphere was placed behind a "thermal cover" to protect it during the descent through Venus' thick atmosphere.

These Venus-bound craft were hurriedly constructed. Due to the tight schedule, many factory tests were not performed to save time. The first probe was launched on February 4, 1961. Due to a timer malfunction, the escape stage never ignited and stranded the Venus-probe-to-be in a low Earth orbit. This new satellite was called Tyazhyolyi Sputnik, or simply "Heavy Satellite". A second probe was successfully launched on February 12 and eventually named VENERA 1. Contact with VENERA 1 is now known to have been lost enroute to Venus "on the second million kilometers of its trajectory".

The Next Round

In 1961, S. P. Korolov, the Soviet Chief Spacecraft Designer, decided to use a single spacecraft design to explore Venus and Mars, since the next launch windows for those planets (August/September and October/November of 1962, respectively) were so close to each other. This design was simply called Object MV. It was to serve as *the* spacecraft design for all Venus missions for the next eleven years and all Mars missions into the middle 1960s.

There were four variants of this design: The MV-1 had a launch mass of 948 kilograms (2,090 pounds) and was designed to land a probe on the surface of Venus.

The 935-kilogram (2,060-pound) MV-2 was designed to flyby Venus. MV-3 and MV-4 were designed to go to Mars. The 1,042 kilogram (2,294 pound) MV-3 would deliver a lander to Mars while the MV-4, weighing 1,037 kilograms (2,283 pounds), would conduct a photographic flyby. As with the American SURVEYOR lunar lander, these spacecraft proved to be too heavy for the launch vehicles then available. A great deal of weight was shaved off the original designs, especially the Mars probes.

Possibly as many as four of these new spacecraft were readied for the Venus window, but only three were actually launched. The first two, launched on August 25 and September 1, 1962, were Type 2MV-1 for landing on Venus, but they were stranded in Earth parking orbits due to failures in their escape stages. The third launch, on September 12, was for a Type 2MV-2 photographic flyby probe similar to MARS 1, but it too failed.

Before the sting from these failures could wear off, the Mars launch window opened. The first probe was launched on October 24, 1962, and was left stranded in its parking orbit. The second probe was successfully

launched on November 1 and became MARS 1. With a launch weight of 893.5 kilograms (1,967 pounds), this MV-4 type probe was about 144 kilograms (316 pounds) lighter than in its original design. The third probe, launched on November 4, failed to leave Earth orbit. No concrete information is available (yet!) on the mission of the two failed probes but it is quite likely one or both were of the MV-3 type designed to land on Mars.

The Early ZOND Flights

After this string of launch failures and with the early demise of MARS 1 before reaching its intended target, two new MV designs were developed. These probes, called ZOND, were stripped-down engineering test versions of the previous MV design. Two types of spacecraft were designed: ZOND A, with a launch mass of 800 kilograms (1,760 pounds) was equipped for a flyby of Venus. ZOND B weighed in at 996 kilograms (2,190 pounds) and would be targeted for a Mars flyby.

The first of the ZOND missions, using a Type 3MV-1A probe, was to be launched towards the Moon to pro-

Comet Comments

by Don Machholz

(916) 346-8963

July 7, 1993

Two faint returning comets have been recovered lately. Other than that, comet activity remains low. Don't forget the Perseid Meteor shower on the night of Aug. 11-12, this is the result of Periodic Comet Swift-Tuttle, observable late last year.

Periodic Comet Hartley 3 (1993m): Jim Scotti of Kitt Peak recovered this comet on June 23 at magnitude 20. It has a 6.8 year orbit, it will be closest to the sun next May at 2.5 AU, but is not expected to get much brighter.

Periodic Comet Whipple (1993n): Jim Scotti also recovered this comet. It is 18 months from a distant perihelion. It has a 8.5 year orbit and will not become visible in amateur scopes.

Periodic Comet Shoemaker-Levy 9 (1993e): This "string of pearls" comet, set to collide with Jupiter next July, is in a near-circular orbit. The positions given below

are from the latest orbit. The comet will pass behind the sun in October, we'll see it again in the morning sky in late December.

| Periodic Comet Shoemaker-Levy 9 (1993e) | | | | | |
|---|-------------|---------|-----|-----|------|
| Date | RA-2000-Dec | Elong | Sky | Mag | |
| 07-22 | 12h20.5m | -03°21' | 67° | E | 14.4 |
| 07-27 | 12h23.1m | -03°37' | 63° | E | 14.4 |
| 08-01 | 12h25.9m | -03°55' | 59° | E | 14.4 |
| 08-06 | 12h28.8m | -04°13' | 55° | E | 14.4 |
| 08-11 | 12h31.9m | -04°33' | 51° | E | 14.5 |
| 08-16 | 12h35.1m | -04°53' | 47° | E | 14.5 |
| 08-21 | 12h38.5m | -05°14' | 43° | E | 14.5 |
| 08-26 | 12h41.9m | -05°36' | 39° | E | 14.5 |
| 08-31 | 12h45.5m | -05°58' | 35° | E | 14.5 |
| 09-05 | 12h49.2m | -06°21' | 31° | E | 14.5 |

Seeking Comets

It has been more than seven months since an amateur has discovered a comet. This is not unusual, as a look at other amateur comet discovery "droughts" since 1975 shows absences of comet finds.

With 63 visual finds during this time period, on the average a new comet would be visually discovered every 3.3 months.

| | | | |
|-------------|---------------|----|---------------|
| 18.0 months | Mar. 3, 1976 | to | Sept. 4, 1977 |
| 17.8 months | Dec. 26, 1980 | to | Jun. 18, 1982 |
| 11.5 months | May 27, 1985 | to | May 12, 1986 |
| 10.5 months | Jun. 18, 1982 | to | May 4, 1983 |
| 8.5 months | Oct. 10, 1978 | to | Jun. 24, 1979 |
| 7.7 months | May 12, 1986 | to | Jan. 5, 1987 |
| 7.5 months | Jan. 6, 1989 | to | Aug. 24, 1989 |
| 7.2 months | Dec. 25, 1979 | to | Jul. 31, 1980 |

vide a test of vital flyby systems close to home. Launched on November 11, 1963, this first engineering test became the victim of an all too common experience of previous probes. The escape stage failed to operate and the probe, now called KOSMOS 21, was stranded in Earth orbit.

The next batch of four Type 3MV-1A ZOND probes were meant for exploring Venus. The probes launched on February 19 and March 1, 1964, never even made it to Earth orbit. A third craft, launched on March 27, got stranded in its parking orbit and was named KOSMOS 27. The last, ZOND 1, weighing 825 kilograms (1,827 pounds), finally made it into a Venus-bound trajectory only to fail enroute. These are the only known flights of either original ZOND design.

The next ZOND missions apparently made use of improved versions of the original MV design. The details of the late 1966 Mars window payloads are still hazy. While only ZOND 2 was actually launched towards Mars on November 30, 1964, at least one MV-4 flyby spacecraft carrying a photo-television and spectrometer package was scheduled to be launched to “complement” the payload of ZOND 2. While this is not quite yet proof, it strengthens the belief I have supported that ZOND 2 was a MV-3 type probe meant to land a package on the surface of Mars. The MV-4 type spacecraft that missed this launch window was eventually launched on July 18, 1965, as ZOND 3. This vehicle conducted a photographic flyby test of the Moon.

During the next Venus launch window, four probes, two of each type, were prepared for launch. The first launched was a 3MV-2 spacecraft on November 12, 1965, named VENERA 2. The second, VENERA 3, was launched on November 16 and was a Type 3MV-1 lander. A third probe, also a Type 3MV-1 lander, was launched on November 23, but due to an escape stage failure, it was stranded in an Earth parking orbit and became KOSMOS

96. The fourth and last probe, a 3MV-2 flyby probe like VENERA 2, was launched on November 26 but failed to achieve Earth orbit.

Later Mars and Venus Missions

After five unsuccessful Mars and thirteen unsuccessful Venus missions, along with the death of Korolov in January of 1966, the Soviets changed their direction. All work on the planetary probes was transferred from the Korolov Design Bureau (then deeply involved in the Soviets’ manned lunar landing mission development) to the Babakin Design Bureau. No more photographic missions to Venus would be attempted. Instead, all work in this area was directed towards preparing two highly modified MV-1 payloads, known as V-67, to land on Venus.

Not much is still known about the direction of the MARS program at this time, but all further flights of MV-3 and MV-4 payloads were suspended. The American Mars probe, MARINER 4, probably dealt the Soviets a double blow: First, data returned from MARINER 4 in July of 1965 indicated that the Martian atmosphere was at least a factor of ten thinner than previously believed, making the MV-3 lander design useless. Second, the Soviets at the time had the mindset of “do it first or, if someone does it before you, do not do it at all”. The fact that MARINER 4 succeeded in its photographic mission made flights of the MV-4 design politically unnecessary.

Instead it appears that the Soviets began design work on a new and heavier spacecraft to be launched towards Mars using the new 8K82K or PROTON rocket vehicle. It has recently been revealed that the first pair of these spacecraft were launched towards Mars on March 27 and April 14, 1969. These probes were similar to MARS 2 and 3, launched in 1971, but did not carry landers like the failed KOSMOS 419, also launched in 1971. The 1969

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 same week of the month. The same is true of the club’s star parties. Star parties at Buckeye Hills are mostly held on the Saturday of the third quarter moon.

1993 SAC Meetings

- Jan. 8
- Feb. 5
- Mar. 5
- Apr. 2
- May 7
- Jun. 4
- Jul. 2
- Aug. 27
- Sep. 24
- Oct. 29
- Nov. 19
- Dec. 18 Party

1993 SAC Star Parties

| Date | Sunset | Moonrise |
|---------|--------|----------|
| Jan. 16 | 5:46pm | 3:11am |
| Feb. 13 | 6:12pm | 2:05am |
| Mar. 20 | 6:41pm | 5:24am |
| Apr. 17 | 7:01pm | 3:55am |
| May 15 | 7:22pm | 2:25am |
| Jun. 12 | 7:38pm | 12:55am |
| Jul. 17 | 7:38pm | 4:44am |
| Aug. 14 | 7:15pm | 3:39am |
| Sep. 11 | 6:40pm | 2:15am |
| Oct. 9 | 6:03pm | 1:04am |
| Nov. 6 | 5:33pm | 11:57pm |
| Dec. 11 | 5:22pm | 6:35am |

probes were meant to be orbiters and would have beat the Americans to Martian orbit by two years. The Soviet craft would have also made the mission of MARINER 6 and 7 — scheduled for a late July and early August, 1969 flyby of Mars — look second-rate.

Unfortunately, while the MOLNIYA had matured to the point where launch failures were relatively uncommon, the PROTON was still plagued with failures. Both new Mars probes failed to reach their Earth parking orbits due to the relatively new Soviet booster.

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About the Author

Andrew J. LePage is a scientist at a small R&D company in the Boston, Massachusetts area involved in space science image and data analysis. He has written many articles on the history of spaceflight and astronomy over the past few years that have been published in many magazines throughout North America and Europe. Andrew has been a serious observer of the Soviet space program for over one dozen years. Andrew’s Internet address is: lepage@bur.visidyne.com.

Newsletter Deadline

Mail items at least two weeks before the end of the month. Items arriving too late for an issue will be included in the next newsletter.

Bits and Pieces

Coming Events

The Lowell Observatory Tour is planned for Saturday, August 28. For those of you who have paid, see the details on page 6 in this newsletters for when and where to meet.

This Fall, there will only be one public Star Party. It is scheduled for October 23 at Thunderbird Park in Glendale.

Deep Sky Meeting

The Deep Sky Group is made up of people that like to observe celestial bodies out past the far reaches of our Solar System. These bodies include stars, nebula and galaxies. If you are interested in sharing your observations, or knowing what they look like in telescopes — then by all means come join us at the next meeting. We will discuss Deep Sky objects in Aquarius. The meeting will be held at John McGrath’s house; directions are here in the newsletter.

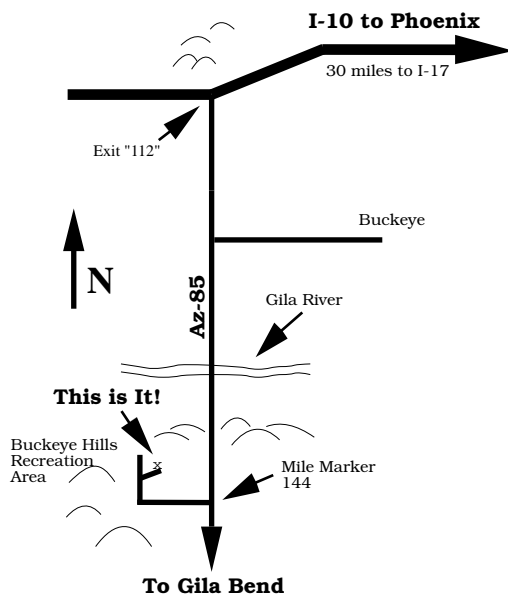
You don’t need to RSVP, we don’t extend special invitations to anyone — ourselves included. If you are interested show up, we’d love to have you.

The Deep Sky meeting will take place on Thursday, September 2 at 7:30pm.

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 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.

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.

Lowell Observatory Tour

Saturday, August 28

Those of you going on the Lowell Observatory tour, need to meet the bus at 9:00 AM Saturday, August 29. The bus will be leaving Phoenix at 9:00 AM and will arrive back in town around 10:00 PM.

Bring a sack lunch for a picnic in Flagstaff. Remember to bring your camera. But most of all, remember to bring yourself.

SAC Board Meeting Minutes

June 15, 1993

Present: Bob Dahl, Rich Walker, Tom Polakis, Carol Lee, Piet Burggraaf, Paul Dickson, Susan Morse

President Bob Dahl opened the meeting at 7:15 PM.

Tom made the suggestion that SAC rejoin the International Dark-Sky Association. After some discussion, the Board voted to send the \$100 membership registration fee to the organization.

One of the SAC members had made the a suggestion that at each meeting, an announcement would be made about the next program's speaker or program. For one of the Fall meetings, Gene Shoemaker is being considered as a possible speaker. SAC may open this particular meeting to other groups or the public for this October or November program. A larger meeting room may be a necessity and several possibilities are available. All information should be checked with Tom. The Lowell Observatory trip for August 28, 1993 is almost full (with 33 sign-ups) and an announcement will be made at the next meeting for any remaining spots.

Bob reported that a group from ASU wanted the SAC mailing list for distribution of free copies of an ASU research magazine. Paul mentioned that **Internet Direct** is interested in paying for advertising in the newsletter and the Board decided that we would accept the ad.

A discussion arose concerning some type of publicity brochure for the club being printed. This could be available for the public star parties and other events where people want information about the club. Carol said that some radio stations will give free public service announcements and it would be a way to introduce the club to prospective new members. Bob noted that he received several calls of interest after the **Sunset** magazine article appeared. Paul said that he could print a one page information brochure.

The next meeting in August on the 27th comes the day before the Lowell bus trip to Flagstaff, but the dates could not be changed. Piet said that he is busy working on arranging new public star parties for the Fall. Paul reported that our newsletter is currently our biggest ex-

pense and the complimentary copies now number 26. Tom said that he received good feedback from the members about the May meeting in which the club members gave short presentations and it was suggested that the club have more similar programs in the future.

With no other business, the meeting concluded at 9:00 PM.

Respectfully submitted, Susan V. Morse, SAC Secretary

Minutes of the July Meeting

President Bob Dahl opened the meeting at 7:32 PM and told the members that SAC had received honorable mention about National Astronomy Day. Tom Polakis reminded members about the Lowell Observatory bus trip and this meeting is the last chance to sign up. The speaker next month will be Frank Zullo, who specializes in night landscape photography. A.J. Crayon announced the meeting of the Deep Sky group for July 8, with the constellation Ophiuchus featured. Stan Student listed the new books and software available in the library.

For "Show'n'Tell", Paul Lind shared his humorous adventure in the darkroom in copying film; Tom Polakis showed slides of the last lunar eclipse; and Pierre Schwaar had slides and videotape of the latest sunrise solar eclipse. Following the break, the main speaker, Chris Schur discussed darkroom procedures for astrophotos.

Respectfully submitted from notes taken by Tim Lee at the meeting.

Correction to the June minutes. Rich Walker was the recipient of the Herschel 400 award and Stan Student received the Messier award. My apologies to both members.

—Susan V. Morse, SAC Secretary

Next Month...

Next month is issue 200 of SACNEWS. It will contain a look back at SAC as seen from past issues of this newsletter.

August 1993

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|--------|--|---|--|--|----------------------------------|--|
| | Full Moon Moon 5:10 a.m. | Mercury at greatest elongation W (19°) | EVAC Meeting Directions: Joe Murray 482-2918 | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | | Last Quarter Moon 8:19 a.m. | | Perseid meteor shower Max = 8 a.m. | | SAC Star Party Buckeye Hills (members & guests) |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | | New Moon 12:28 p.m. | | Saturn at opposition | Jupiter 6°N of Moon 9 p.m. | |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| | Mars Observer Mars Orbit Insertion Tomorrow | First Quarter Moon 2:57 a.m. | | | SAC Meeting | SAC Lowell Tour Galileo at Asteroid Ida |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| | Saturn 7°S of Moon 11 p.m. | | All Times are Mountain Standard Time | | | |
| 29 | 30 | 31 | | | | |

SAC Deep-Sky Database Version 6.0 Ready by Steve Coe

Thanks to the diligent efforts of the Deep Sky group and the very informal Computer group in the Saguaro Astronomy Club, version 6.0 of the SAC deep sky database is ready for release. The database contains information on over 10,000 objects and contains the entire NGC catalog with additions from the P-K planetary catalog, Barnard dark nebulae, Sharpless nebulae and many other sources.

Information on the position, brightness, size, Uranometria chart, surface brightness and notes are contained within the database. All the data is in ASCII format delimited with the standard quote comma quote. This allows the information to be imported into almost any database manager program. If you do not have a database manager there is a search program included which will allow the user to make observing lists by several criteria.

The cost of our labor will be amazing. Club members will have to pay one dollar at the next meeting to receive a diskette with the database. All the distribution will be in IBM format on 720K disks. If you would like to distribute the data on a different format, we would be happy to have someone support Mac, Amiga or other formats.

Saguaro Astronomy Club Member Services Form

Membership

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

- \$20.....Individual Membership
- \$30.....Family Membership (one newsletter)
- \$100.....Business Membership (includes advertising)
- \$4.....Nametag for members
- \$10.....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 treasurer to renew your subscription.

- Sky & Telescope.....\$20.00 for one year
- Astronomy.....\$16.00 for one year

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

Make checks payable to SAC.
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