Saguaro Astronomy Club

Metro Phoenix, Arizona

SACNEWS

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The Great Moon Race: The Red Moon

by Andrew J. LePage

This article from the July, 1993 (Volume 4, Number 12) issue of the Electronic Journal of the Astronomical Society of the Atlantic (EJASA) of the Astronomical Society of the Atlantic (ASA).

As the year 1965 was drawing to a close, Soviet lunar probes were being launched from the Baikonur Cosmodrome as if from a celestial machine gun. In typical Soviet aerospace engineering style, a lunar spacecraft would be launched, failures were analyzed, modifications would be made, and a new probe would be launched. After a half decade of this cycle, the Soviets were very close to success. LUNA 7 and 8 both performed flawlessly until the ignition of their retrorockets: LUNA 7 fired its engines seconds too early while LUNA 8 fired its engines seconds too late.

While the Soviets emphasized in-flight testing of their spacecraft, partly on the off-chance that one of the early flights might actually succeed— thus ensuring another space first— the United States emphasized ground testing. As a result of the adverse American public reaction to the failures of the early lunar PIONEERs and the Block II RANGERs, NASA literally could not afford any more strings of in-flight failures. The American people and Congress would not foot the bill for even more expensive lunar programs without an excellent chance for success. Despite the differing political climates and engineering philosophies, by the beginning of 1966 both the Soviet Union and the United States were very close to landing their first unmanned spacecraft on the Moon.

SURVEYOR is Readied

As one Soviet lunar lander after another was launched during 1965, the United States continued development of SURVEYOR and its launch vehicle, the ATLAS-CENTAUR. Following the failure of ATLAS-CENTAUR 5 on March 2, 1965, ATLAS-CENTAUR 6 was a success. Launched on August 11, this test flight placed a 2,084-pound (946-kilogram) dynamic model of SURVEYOR directly into a 105 by 509,829-mile (169 by 820,315-kilometer) orbit that simulated the direct ascent trajectory the first SURVEYORs would use to reach the Moon. With this successful mission, the first phase of CENTAUR development was completed and the ATLAS-CENTAUR was deemed ready for service. Future test flights would be used to develop CENTAUR's in-orbit restart capability.

Development of SURVEYOR itself was nearly completed at the same time. The last balloon-borne drop test to verify the landing sequence was a success. The first flight article, SURVEYOR A, had completed an extensive series of functional and environmental tests. The launch of this first spacecraft was expected in the early spring of 1966.

Meanwhile, plans for future SURVEYOR missions were being restructured. After a thorough review, NASA decided to make use of the lighter 2,200-pound (1,000-kilogram) stripped-down "engineering" model of SUR-

Quick Calendar

SAC Star Party
Buckeye Hills Recreation Area
Saturday, September 11

SAC Meeting
7:30, Friday, September 24

SAC Officers

President	Bob Dahl	582–5526
Vice President	Tom Polakis	966–2625
Treasurer	Carol Lee	946–9206
Secretary	Susan Morse	934–7496
Properties	Rich Walker	997–0711
SACNEWS Editor	Paul Dickson	841–7044
Public Events	Piet Burggraaf	995–1964

VEYOR for all seven scheduled flights, instead of just for the first four missions as previously planned. It was felt that the lightly instrumented (and cheaper) lander was adequate to fulfill its primary objective of gathering information needed to verify the manned APOLLO Lunar Module (LM) design. A decision to launch three follow-on missions using the more heavily instrumented SURVEYOR model was deferred pending further study.

In its final form, SURVEYOR was the most advanced lunar spacecraft of its day. The basic eight-foot (2.4-meter) tall structure consisted of a simple 59-pound (27-kilogram) tetrahedral frame made of tubular aluminum alloy members. In each of the three lower corners was a landing leg equipped with an aircraft-style shock absorber and a footpad of crushable honeycomb aluminum. The total span of the legs, once deployed, was 14 feet (4.3 meters). Rising from the apex of the frame was a mast upon which was mounted a gimballed planar high-gain antenna (HGA) and a solar panel supplying an average of sixty watts of power to the lander's silver-zinc batteries. From the footpads to the top of its mast, SURVEYOR stood ten feet (three meters) tall.

Buried inside the spacecraft's frame was a Morton Thiokol-built 36-inch (91-centimeter) diameter TE-M-364 solid propellant rocket motor that would provide between 8,000 and 10,000 pounds (36 to 45 kilonewtons) of thrust. This 1,444-pound (656-kilogram) motor would be used to negate most of SURVEYOR's motion towards the Moon as the lander approached the barren surface.

SURVEYOR also carried a second propulsion system for midcourse corrections and attitude control during the main retrorocket burn for the final descent. This system consisted of three vernier engines fueled by monoethylhydrazine hydrate with a mixture of ninety percent nitrogen tetraoxide and ten percent nitric acid serving as the oxidizer. These engines were throttable, producing between 30 and 104 pounds (130 and 460 newtons) of thrust each. Yaw, pitch, and descent rate were controlled by selective throttling of the engines. Roll was controlled by a single gimballed vernier. During the trans-lunar coast, SURVEYOR's attitude was controlled by a set of six nitrogen gas jets, each providing one ounce (0.27 newtons) of thrust.

All the temperature sensitive electronics were carried in two thermal boxes. These compartments were covered with 75 layers of aluminized mylar insulation and the tops were covered by mirrored glass thermal regulators. Compartment A, which maintained the temperature between 40 and 125 degrees Fahrenheit (4 and 52 degrees Celsius), carried a redundant set of receivers and ten-watt radio transmitters, the batteries, their charge regulators, and some auxiliary equipment.

The second box, Compartment B, was designed to maintain the temperature between 0 and 125 degrees Fahrenheit (-15 and 52 degrees Celsius). This compartment carried the computer "brains" of the spacecraft, which controlled all aspects of the lander's operation using a total of 256 commands. Mounted elsewhere on the frame were star sensors, a pair of radar antennae, low-gain antennae (LGA), propellant, and helium pressurization tanks.

A total of 65 pounds (30 kilograms) of instrumentation were carried by the first SURVEYORs. Most were engineering sensors such as strain gauges, accelerometers, rate gyros, temperature sensors, and so on to be used to make more than two hundred measurements of the spacecraft's performance and condition. While not specifically designed for investigating the lunar environment, many of these measurements could be used to determine some of its basic properties.

The only true scientific instruments were a pair of slow-scan television cameras. One was pointed down to provide a RANGER-style view of the lunar surface and a footpad during landing. These images would be transmitted during SURVEYOR's final approach to allow the landing site to be pinpointed, along with providing information on the surrounding terrain. As it turned out, however, this camera was never used on the first two flights and was deleted altogether afterwards. It was felt that the upcoming LUNAR ORBITER missions would provide the needed detailed images to help interpret the SURVEYOR findings and put them in a geologic context.

The second camera was mounted in a 65-inch (1.65-meter) tall mast on the spacecraft's framework. The camera pointed up into a movable mirror that allowed the camera to view 360 degrees of azimuth and from sixty degrees below to fifty degrees above the normal plane of the camera. This device was canted at a sixteen-degree angle to offer a clear view of the surface between two of the footpads out to the lunar horizon 1.5 miles (2.5 kilometers) away.

The camera was fitted with a 25 to 100 millimeter (mm) zoom lens that offered a field of view of between 25.3 and 6.4 degrees. The aperture could be set between $f/4$ and $f/22$ and the lens could be focused from four feet (1.2 meters) to infinity. A shutter was also included so that various integration times could be used to obtain the ideal exposure. The nominal exposure time was 150 milliseconds, but exposures as long as about thirty minutes could be accommodated. The typical resolution of the camera was one millimeter at a distance of thirteen feet (four meters).

The camera was also fitted with a filter wheel containing clear, colored, and polarizing filters. With the aid of color calibration targets mounted at various points of the spacecraft, pictures taken through red, green, and blue filters could be reconstructed back on Earth to yield full-color views of the lunar surface. Images taken with the polarization filters, when combined with information of the viewing geometry, could be used to determine the scattering characteristics of the lunar surface.

The camera could only operate through remote control from Earth using a total of 25 commands. The primary means of transmitting images was through the high-

gain antenna. Using this powerful antenna, an image would be broken up into six hundred scan lines and transmitted to the home planet in 3.6 seconds. The less powerful low-gain antennae, which served as a backup, would permit an image to be broken up into only two hundred lines and would require 61.8 seconds to transmit.

Like RANGER, SURVEYOR was designed to make a direct descent to the lunar surface. SURVEYOR was much more flexible than the Block II RANGER lander, however, since SURVEYOR could approach the lunar surface at a substantial angle off the local vertical. This made most of the lunar hemisphere facing Earth accessible to this new lander. Early flights, however, would be limited to the equatorial mare regions which, as a result of RANGER photography, appeared to be the safest landing sites for the early APOLLO missions.

The typical SURVEYOR mission started with its launch from Cape Kennedy on the east coast of Florida. Once the ATLAS-CENTAUR sent the lander on its way, SURVEYOR would deploy its landing gear and low-gain antennae, lock its solar panel onto the Sun, and then acquire its second celestial reference, the star Canopus. During its over sixty-hour coast to the Moon, the probe would make as many as two mid-course burns of its vernier engines to fine tune its aim towards the Moon.

Once within one thousand miles (1,600 kilometers) of the lunar surface, the lander would align its retrorocket along the flight path. The descent camera, if it was used, would start relaying images. At a height of 200 miles (320 kilometers), an altitude-marking radar mounted inside the molybdenum nozzle of the retrorocket would be activated. At a slant range of 60 miles (100 kilometers), the flight programmer would start a predetermined countdown and then ignite the three vernier engines, followed by the main retrorocket. During the forty-second burn, attitude was maintained by the verniers and the speed was cut from over 5,800 miles per hour (2,600 meters per second) to only 250 miles per hour (110 meters per second) at an altitude of 25 miles (40 kilometers).

About eleven seconds after burnout, the high-

Comet Comments

by Don Machholz

(916) 346-8963 May 9, 1993

One faint comet has been recovered. This month we'll begin watching Comet Mueller. It was discovered early this year during the Second Palomar Survey. It remains circumpolar until mid-November and will be visible to Northern Hemisphere observers through early next year.

Periodic Comet West-Kohoutek-Ikemura (1993o): Jim Scotti of Kitt Peak recovered this comet on July 20 at magnitude 20. It has an orbital period of 6.4 years and a perihelion distance of 1.6 AU. It may reach magnitude 12 late this year.

Comet	**Mueller**				**(1993a)**
Date	RA-2000-Dec		Elong	Sky	Mag
08–22	08h11.0m	$+61^\circ 58'$	54°	M	11.1
08–27	08h18.9m	$+63^\circ 07'$	57°	M	11.0
08–01	08h27.5m	$+64^\circ 26'$	60°	M	10.8
09–05	08h37.0m	$+65^\circ 50'$	64°	M	10.7
09–10	08h47.6m	$+67^\circ 27'$	67°	M	10.5
09–15	08h59.9m	$+69^\circ 15'$	71°	M	10.4
09–20	09h14.6m	$+71^\circ 16'$	74°	M	10.2
09–25	09h33.1m	$+73^\circ 28'$	78°	M	10.1
09–30	09h57.9m	$+75^\circ 53'$	82°	M	9.9
10–05	10h34.3m	$+78^\circ 24'$	85°	M	9.8
10–10	11h33.1m	$+80^\circ 51'$	88°	M	9.6

Seeking Comets

by Don Machholz

Do comet hunters commute to their comet hunting sites, or do they search from their own back yards? The deciding factor seems to be the level of light pollution that can be tolerated, although occasionally a comet hunter must go elsewhere to seek better horizons.

Australian's William Bradfield visits several sites for his comet hunting. He is considering a short move which will result in, among other things, darker skies. Rodney Austin commutes to various sites, depending upon the horizon he needs to sweep and the fishing lights off his coast in New Zealand. Both Rolf Meier and Doug George used the 16″ telescope belonging to an astronomy club in Ottawa, Canada, and housed in its observatory. Many of the Japanese comet hunters must commute to find darker and cleaner skies.

Others sweep from their homes. David Levy visually discovered his comets from his backyard in Tucson, Arizona. Michael Rudenko swept from his backyard in Amherst, MA., using a light pollution filter. Howard Brewington commuted while living is South Carolina, he has since moved to a mountaintop in New Mexico which provides low horizons and dark skies. George Alcock of England and Leo Boethin of the Philippines both discovered comets from their porches.

For fifteen years I commuted to comet hunt, often for 40 minutes each way up to 200 times a year. Three years ago we moved to a more rural location for several non-astronomical reasons, one of the fringe benefits being the darker skies.

strength steel retrorocket case was jettisoned and the Radar Altimeter and Doppler Velocity Sensor (RADVS) was activated. Using data from RADVS, the onboard computer controlled the thrust of the vernier engines to further reduce the speed of the lander to only three miles per hour (1.3 meters per second) at an altitude of 14 feet (4.3 meters). At this point, the verniers were shutdown and SURVEYOR dropped to the surface at a speed of 15 miles per hour (6.6 meters per second).

Once on the lunar surface, the lander's onboard systems would be checked and the first two hundred line image showing the footpad would be taken and relayed back to Earth. Over the course of the lunar day (equivalent to fourteen Earth days), several panoramas made of six hundred line images would be returned and observations of the surrounding terrain under various lighting conditions would be made. Shortly after local sunset, the lander would be shut down. Operations would begin following sunrise if the spacecraft survived the bitterly cold lunar night.

The First Lunar Landing!

Before SURVEYOR ever made it to the launch pad, the Soviets' luck finally turned. After a successful launch into a 104 by 136-mile (167 by 219-kilometer) Earth parking orbit, LUNA 9 headed towards the Moon on January 31, 1966. The 3,387-pound (1,538-kilogram) spacecraft was of a totally different design than the American SURVEYOR. The 8.9-foot (2.7-meter) tall spacecraft consisted of a two-part multi-mission bus and the payload.

The bottom half of the main bus consisted of a propulsion module incorporating an Isayev Design Bureau-built KTDU-5A retrorocket. It was topped with a torroidal aluminum alloy tank filled with an amine-based fuel and a 35-inch (90-centimeter) diameter spherical tank filled with the nitric acid oxidizer. The total propellant load for a landing mission was about 1,800 pounds (800 kilograms). Four outrigger vernier thrust chambers provided attitude control and thrust trimming during retrorocket fire as well as perform mid-course corrections. In total, this propulsion system could provide 10,200 pounds (45.5 kilonewtons) of thrust for a single 43-second burn.

On top of the propulsion module was a cylindrical equipment module, which was pressurized to 1.2 Earth atmospheres. This section contained communications equipment, power supplies, batteries, and spacecraft control systems. This section also supported the Sun and Moon sensors needed for attitude reference. Strapped to either side of this section were 660 pounds (300 kilograms) of lightly constructed, jettisonable packages containing radar equipment to initiate retrorocket fire and the in-flight attitude control system. This consisted of sets of nitrogen gas jets mounted on three arms and feeding off of three gas bottles. Once the engines ignited, these items were no longer needed and were discarded to save weight for the descent.

Mounted on top of this bus was the lander, which would be thrown from the stack upon contact with the lunar surface. The lander was a sphere about 23 inches (58 centimeters) in diameter and weighing 220 pounds (100 kilograms). After the bottom-heavy lander rolled to a stop, four petals would open to stabilize it. Inside were the lander's transmitter, batteries, and other equipment. Like the American Block II RANGER lander, the interior temperature was maintained between 66 and 86 degrees Fahrenheit (19 and 30 degrees Celsius) by a capsule of water.

Two instruments were carried by the lander: A simple SBM-10 radiation detector and a facsimile-style panoramic camera similar to the cameras carried by the American VIKING Mars landers one decade later. A mirror mounted in a three-inch (eight-centimeter) turret at the top of the lander some two feet (sixty centimeters) above the surface was used so that the camera could scan through 360 degrees of azimuth and from eighteen degrees below to eleven degrees above the horizon. A full six thousand line panorama could be transmitted back to Earth in one hundred minutes. The camera could focus on objects from as close as five feet (1.5 meters) to infinity with a maximum resolution of 0.06 to 0.08 inches (1.5 to 2 millimeters). Small targets dangled from the four antennae to calibrate the camera and three thin mirrors provided stereoscopic views of small areas near the lander.

After LUNA 9 separated from its escape stage, the nitrogen jets were fired to orient the spacecraft and start it rolling at one revolution every 1.5 minutes to even out the heat radiating from the Sun. After being tracked for 31 hours and 47 minutes, the nitrogen jets were fired again

Summary of Lunar Probe Launches, First Quarter 1966

Name	Launch Date	Country	Weight lbs (kg)	Launch Vehicle	Comments
LUNA 9	Jan 31, 1966	USSR	3387 (1538)	MOLNIYA	Lunar hard landing
KOSMOS 111	Mar 1, 1966	USSR	3480 (1580)?	MOLNIYA	Possible failed lunar orbiter
LUNA 10	Mar 31, 1966	USSR	3484 (1582)	MOLNIYA	Lunar orbiter

NOTES: Probe names given in *italics* are used if no official name exists.
Weights given are the launch weights of the probes and do not include any additional equipment that may have been carried by the escape stage.

to align the probe with the Moon and Sun. A 48-second course correction burn was performed, after which LUNA 9 resumed its slow roll.

Unlike the American lunar probes that could be oriented in any direction for their mid-course correction, the second generation LUNAs could only perform course correction burns perpendicular to its flight path, thus greatly simplifying the astro-orientation system. Another simplification incorporated into the design was that the LUNA landers could only approach the lunar surface from near the local vertical, much like the Block II RANGER. Also like the American lander, this constraint limited landings to equatorial sites near 64 degrees west longitude in the eastern part of Oceanus Procellarum.

On February 3— about one hour before landing— at an altitude of 5,200 miles (8,300 kilometers), the nitrogen jets again fired to stop the descending craft's roll and orient it along the local vertical. The on-board radar triggered the terminal descent sequence at an altitude of 47 miles (75 kilometers) as the spacecraft speed increased to 5,800 miles per hour (2,600 meters per second). The four outrigger engines fired, attitude reference was taken over by the onboard gyros, and the now useless side compartments were jettisoned. At that moment the main retrorocket burst to life. Sixteen feet (five meters) above the surface, a deployed sensor made contact with the surface and cast off the lunar lander as the main bus hit the surface at a speed of about fourteen miles per hour (six meters per second).

The spherical lander bounced along the ground several times and finally came to rest at 18:45:30 Greenwich Mean Time (GMT) west of the crater Reiner at 7.13 degrees north latitude, 64.37 degrees west longitude. Some 250 seconds after touchdown, the artificial petals opened and the spacecraft started transmitting back to Earth. While this landing was not as elegant as SURVEYOR's, the Soviets did beat the Americans once again in the conquest of space.

About seven hours after landing, the long process of returning the first panorama to Earth was begun. The pictures showed that LUNA 9 came to rest on a smooth area inside an 82-foot (25-meter) crater tilted at a 16.5 degree angle. While the images had rather limited resolution, they did put to rest once and for all the notion that the Moon's surface was covered by a deep dust layer that would swallow any visiting spacecraft.

Almost thirteen hours after taking its first panorama, LUNA 9 was commanded to take a second one. During the intervening time, the lander's position shifted slightly, allowing stereoscopic study of large portions of the landing site. Three more panoramas were transmitted on February 5 and images of smaller areas were taken the following day. Data from the radiation detector indicated that the radiation level at the surface was about thirty millirads per day.

At 22:55 GMT on February 6, the lander's batteries were exhausted and the mission ended. During LUNA 9's 76 hours and 10 minutes on the lunar surface, it transmitted for a total of eight hours and five minutes during six communication sessions, returning nine images from the surface and radiation data. The mission was a resounding success. At best, the Americans would be the second nation to land on the Moon.

The First in Orbit

Being first to land on the surface of the Moon was not the Soviets' only goal. On March 1, 1966, another lunar spacecraft was launched into a 119 by 140-mile (191 by 226-kilometer) Earth parking orbit. Unfortunately, the escape stage failed to operate, stranding its payload— now designated KOSMOS 111— in a quickly decaying

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

orbit. On March 31, a second lunar payload was successfully launched towards the Moon and subsequently named LUNA 10.

Unlike the previous second generation LUNA missions, this probe was not meant to land. Instead of a lander, the multi-mission bus carried a 539-pound (245-kilogram) lunar orbiter. On April 3, LUNA 10 fired its main propulsion system to cut 1,900 miles per hour (850 meters per second) off of its approach velocity. This act allowed the probe to enter a 218 by 632-mile (350 by 1,017-kilometer) orbit inclined 71.9 degrees and having a period two minutes short of three hours. Twenty minutes into its first orbit, the spacecraft's payload was spun up to two revolutions per minute and ejected from the now useless bus.

The LUNA 10 orbiter was similar to many of the small KOSMOS-class Earth orbiting science satellites launched at that time. Basically, the probe was a pressurized 2.5-foot (75-centimeter) wide, 4.9-foot (1.5-meter) long chambered cylinder, deriving all of its power from internal batteries. Unlike the American LUNAR ORBITER, only field and particle instrumentation were carried to study the near-lunar environment. These included a piezoelectric micrometeoroid detector with a collecting area of 13 square feet (1.2 square meters), capable of detecting particles as light as 2.5 trillionths of an ounce (0.07 micrograms). Two 0.6 by 1.2-inch (15 by 30-millimeter) plates served as infrared detectors to measure the temperature of the lunar surface.

Various radiation detectors were carried, including a gamma-ray sensor sensitive to energies between 0.3 and 4 MeV (Mega-electron Volt) that could be used to assess the composition of the lunar surface. A sensitive magnetometer mounted on a 4.9-foot (1.5-meter) boom was used to measure lunar magnetic fields. Changes in radio transmission properties could be used to determine the characteristics of any thin gaseous medium near the surface. Finally, the orbiter could be tracked to determine the mass distribution of the Moon.

The mission of LUNA 10 was as much political as it was scientific. One of the probe's first tasks upon reaching orbit was to broadcast the Soviet anthem "Internationale" to the Twenty-Third Congress of the Communist Party then meeting in Russia. The Soviets were first again and wanted the whole world to know it. After 56 days in orbit and 219 communication sessions, LUNA's batteries were exhausted. The first lunar satellite was last known to be in a 235 by 612-mile (378 by 985-kilometer) orbit, perturbed by the highly irregular lunar gravitational field.

This would prove to be the high water mark of Soviet lunar exploration in the Nineteen Sixties. The Soviets achieved all the major firsts in the race to the Moon: The first flyby, first impact, first farside photographs, first landing, and now the first lunar satellite. After almost one decade of failures, delays, and, at best, coming in second, the United States was now poised to seize control of the Great Moon Race.

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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/CIS 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

There will be a public Star Party at Thunderbird Park in Glendale on October 23.

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.

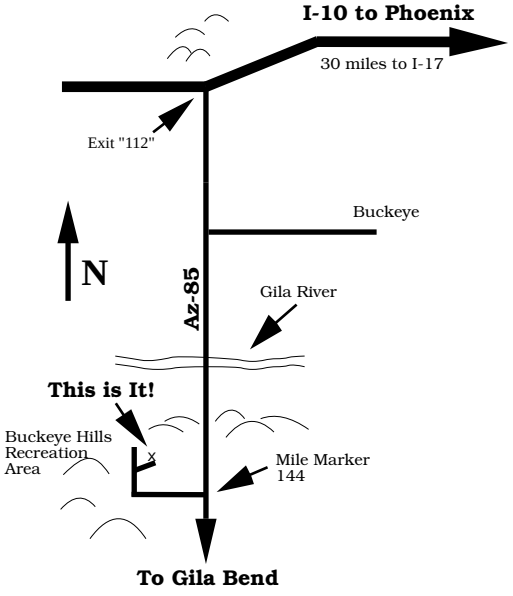
You don't need to RSVP, we don't extend special invitations to anyone — ourselves included. If you are interested show up, we'd love to have you.

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.

Perseids: 1993

by Paul Dickson

The 1993 Perseid meteor took place on Wednesday night, August 11. But this story begins a week earlier, the preceding Thursday. I happened to be at home that evening when a reporter from the *Arizona Republic* called and ask me what the astronomy clubs were planning for the up-coming meteor shower. Since the Saguaro Astronomy Club (SAC) didn't have anything organized, I told him about my tentative plans and the plans of the East Valley Astronomy Club (EVAC). The article appeared in the Sunday paper that quoted several of my comments.

My plans were to head southwest, to a know dark-sky observing site at Sentinel (30 miles west of Gila Bend). It is a 100 mile trip, one-way. Members from EVAC were planning on going to their site near Tortilla Flat (35 miles northeast of Mesa), a 75 mile trip. I was planning on going to Sentinel, since it was most likely to be outside the Monsoon weather flow.

The Monsoon storms were late starting this year. The Midwest states ended up getting most of our moisture. Only when the storms stopped there did the storms start here. Last year's meteor shower was clouded out by a thunderstorm and clouds that lingered until dawn.

On Friday night, I attended the Tucson Amateur Astronomy Association's (TAAA) meeting. This was something I was planning on doing for the past couple of months, but couldn't due to scheduling conflicts. Their plans were to drive half-way to Los Angles since western Arizona is usually outside of the monsoon flow. My plan to go to Sentinel would put me on the edge of the monsoon flow.

On Monday night Phoenix had one of its monsoon storms, with lots of lightning and locally heavy rain. The TV weather radar put Sentinel right on the edge of that night's storm.

Miraculously, on Tuesday evening there were almost no clouds around Phoenix. A high pressure system had moved into Arizona, and it was expected to last several days!

On Wednesday, the weather was still holding, although thin high clouds covered the sky above and to the west. The eastern sky is mostly clear. It wasn't until I got on the freeway that I decided where I was going to observe. My original plans were to go to Sentinel, but I knew of only one other person who might be going there — observing is more fun with more people. Sentinel's advantage was that it's far enough west to be outside of the monsoon storms, but since there weren't any thunderstorms (only high thin clouds that appeared to thicken to the west), Sentinel wasn't an advantage. So when I reached I-10, I decided to go east rather than west. I was going to Tortilla Flat, where I knew several people would be there.

I must admit, that the route to this site was one of the most scenic of any that I've taken to an observing site. After leaving Apache Junction at the east end of the valley, Arizona route 88 heads northeast through the Superstition Mountains. Climbing mountains and dropping into valleys, the highway eventually reaches Canyon Lake. Parts of the highway are narrow and twisting, with a 25 MPH speed limit. There are several one-lane bridges over inlets of the lake. Seeing the lake, it brought back memories of then I'd last been there as child. Until now, I did not remember exactly where this lake was. Seven miles beyond the lake I arrived at EVAC's observing site at 7:40, just at it was really becoming necessary to have the head-lights on while driving.

I didn't need to worry about arriving late though, a TV news crew (channel 3) was there with their bright lights recording interviews for the 10 PM news. I arrived too late to be interviewed, but got to watch some reaction shots being recorded.

When Rick Blakley saw a meteor — it wasn't even a Perseid — on went the camera's spot light and at the

distance of three feet, Rick was questioned about what he saw. Someone standing to the side, one of those who had seen the meteor and kept their mouths closed, said "He won't be seeing any more for the next half-hour." A few minutes later, Rich and Leon Knott were discussing where in the sky the meteor shower's radiant would be, physically pointing to the sky, when out popped the camera again. Shining the camera's spot light first on their backs, looking over their shoulders, and then in their faces as the looked to the sky. Naturally, they couldn't see anything that they were pointing at. Finally, the crew got enough shots, packed up and left for Phoenix by 8:30, without seeing a single meteor. Shortly after that the first Perseids were seen, possibly one of the most spectacular ones of the evening.

Three meteors came from the northern horizon heading south, crossing the sky to the east of us before ending in the southeast. For the duration of this article, north will be the direction of the radiant and not true north. This will make is easier to describe the sky.

These meteors crossed the sky surprisingly slowly as we would discover as the night progressed. They occurred at the same time and had nearly identical behavior. They left a short duration train that was white with the possible hint of green. The meteor itself was orange, with multiple orange pieces disappearing behind the leading piece. Talking to Leon a few minutes later, he said that meteor made the entire trip out to the site worth while, even if nothing else happens. I had to agree with him. I went and got my chaise lounge from the car and set it up by everyone else, to settle in for several hours observing.

During the hour after midnight, we counted 223 meteors.

The high clouds were moving eastward. I wasn't too worried, it was common for the clouds to disappear after night fall and tonight wasn't the exception. As the clouds moved out of the Phoenix sky-glow, becoming more overhead, they became thinner. During the late evening we would watch the clouds almost reach the Milky Way before disappearing completely. The clouds over Phoenix continued to drift eastward, but never really interfered with out view of the sky.

The sky-glow of Phoenix was to the west. It covered 60 degrees of the western horizon and rose maybe 30 degrees. At 2 AM, the southern end of the Milky Way would disappear into this glow while the northern end was disappearing in the Moon's glow. During the night I didn't watch the western sky, but it was frustrating to hear about all the meteors that occurred behind me. From 8 to 9 PM, we saw only 14 meteors.

We saw numerous satellites shortly after sunset. They were almost as common as the mosquitoes that braved the insect repellent.

When 9 PM MST rolled around, a group of 15 of us started counting out meteors spotted. The count for this first hour was about 62 meteors. Leon was complaining that the meteors only appeared while he was looking through his large binoculars, which meant he had to put his glasses back on in order to view the sky. So he didn't see many this first hour.

During the 10 o'clock hour, we saw 20 more than the previous hour, putting that hour's count at 82. The most common and most useless statement heard that night was in reply to "There's one." It was "Where?" By the time an answer could be formed, the event was over.

It was during this hour we had our first large flash. I just happened to move my head just as it became most brilliant. I did not see its trail, all I saw was it flash. Others saw either the whole event, which they said it only had a short trail, while others saw shadows cast on the ground by the meteor. The next really bright on would be several hours later, but it would leave a train.

For the hour starting at 11 PM, we counted 118 meteors. EVAC's site is unfortunately on a turnout along side a dirt road. Even though the road is off of route 88, there was a surprisingly large amount of traffic on it until midnight. We would get a vehicle driving by maybe every 30–40 minutes. After midnight, the only traffic was people leaving the site. All of this irritated those, like Mike Janes, who were trying to photograph the sky. Very few exposures went their full 10 minute durations without interruption.

The sky was showing signs of being very dark, even with Phoenix to the west. The Milky Way stretched from north to south. Leon even remarked on how pronounced the large dark lane was near the North American nebula.

During the hour after midnight, we counted 223 meteors. During the last 20 minutes, we watched the Pleiades rise in a white glow with black clouds above it. At first, it was thought to be a brush fire, but after about 10 minutes it was realized that the black clouds were the high, thin clouds we had seen during the day. The clouds were still white over the Phoenix sky-glow, but were blocking the moon's glow to appear black. Sure enough around 1 AM, the moon rose above the mountain ridge. Watching from Leon's 25x100 binoculars, it was a beautiful view watching the moon's dark face — glowing from Earth-shine — rise over some rocks and brush between two Saguaro cacti, about a mile away. It would have been a stunning picture.

When the moon was completely above the ridge, I could see things on both sides of the moon's terminator. And where the Saguaro cactus still touched the moon, it was black, but the part of the cactus that didn't touch had a ghostly white silhouette caused by the moon light on the spines. Too bad no one with a camera had the equipment to take a picture, although the brightest differences would have surely made such a photo difficult, if not impossible.

The hour after the moon rose we only counted 182 meteors. There was some discussion as to whether the moon really affected our observing the meteors. I believe

September 1993

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
All Times are Mountain Standard Time			**EVAC Meeting** Directions: Joe Murray 482-2918 **1**	**2**	**3**	**4**
5	Mars 0.9°S of Jupiter 5 p.m. **6**	**7**	Last Quarter Moon 11:26 p.m. **8**	**9**	**10**	**SAC Star Party** Buckeye Hills (members & guests) **11**
12	Venus 6°N of Moon 8 p.m. **13**	**14**	New Moon 8:10 p.m. **15**	**16**	**17**	**18**
19	**20**	**21**	First Quarter Moon 12:32 p.m. **22**	**23**	**SAC Meeting** **24**	**25**
26	Saturn 7°S of Moon 2 a.m. **27**	**28**	**29**	Full Moon *Harvest Moon* 11:54 a.m. **30**		

it did, but Leon felt it didn't as we could still see the dark lane through the Milky Way near the North American nebula. Before the moon rose, I could actually see the Andromeda Galaxy as a half degree smudge, which was the first time I had really seen it with a size. After the moon rose, I didn't notice it being smaller. So it was very difficult to tell.

For the next hour a serious count wasn't taken. Some people started packing and going home. The total count was 112, but could have been very easily have been greater than 150 if we had kept a count. After 3 AM, the decision of whether to sleep there or to packup and head for home was being considered by all. I left around 3:30.

Frank Kraljic was the recorder for the night. He tallied each meteor that was called out. This meant he missed more than a few, but he was still able to see most of them.

While driving home, I saw two more meteors. One as I was driving past downtown Phoenix, just before the I-10 tunnel, and another as I arrived at home. I had left to go observing at 6 PM and returned at 5 AM.

The next few years will definitely be worth the effort to go sky-watching. Some think that the Perseids might even be better than this year's for the next few years. As to the weather, we might not get this lucky again, with a break in the monsoon system when we wanted it. Even if we don't get this lucky, there's always western Arizona.

Saguaro Astronomy Club Member Services Form

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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)
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- ❑ $4.....Nametag for members
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Write your name, address, and phone number in the space below.

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