Saguaro Astronomy Club

Metro Phoenix, Arizona

SACNEWS

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The Great Moon Race: The Tide Turns

by Andrew J. LePage

This article from the August, 1993 (Volume 5, Number 1) issue of the Electronic Journal of the Astronomical Society of the Atlantic (EJASA) of the Astronomical Society of the Atlantic (ASA).

By the late spring of 1966, the United States was ready to launch its second lunar lander series, named SURVEYOR. The ATLAS-CENTAUR rocket, despite its development problems, was deemed ready to hurl the new spacecraft to the Moon via a direct ascent trajectory. Even though the Soviets had beaten the Americans to the lunar surface with LUNA 9, it was hoped that SURVEYOR would ultimately surpass its Soviet competitor.

In private, the people involved with the SURVEYOR project hoped that it would just succeed at retrorocket ignition. While much testing had been done, certain aspects of the mission — such as how the lander would handle during retro fire and how the lander's radar would interact with the lunar surface — could only be determined by an actual flight. The chances for success on the first mission were considered low.

America's Fourth Lunar Landing Attempt

On May 30, 1966, ATLAS-CENTAUR 10 lifted off from Launch Pad 36A at Cape Kennedy (now Cape Canaveral) and placed the 2,194-pound (996-kilogram) SURVEYOR 1 on a direct ascent trajectory to the Moon. A landing site in Oceanus Procellarum was chosen to allow SURVEYOR 1 to make the easiest approach to the Moon: Virtually straight down. Sixteen hours after launch the spacecraft performed a 21-second course correction burn using its three vernier engines to correct the 250-mile (400-kilometer) aiming error. Except for indications that one of the two low-gain antennae (LGA) had not fully deployed, all was proceeding as planned. The lander was expected to touch down after a flight of 63.6 hours.

On June 2, SURVEYOR 1 obediently aligned its retrorocket along the flight path. At an altitude of 59.35 miles (95.49 kilometers), the marking radar mounted in the retrorocket nozzle locked onto the return signal from the lunar surface. Seven seconds later, the retrorocket ignited at a height of 46.75 miles (75.22 kilometers) as the lander reached a speed of 5,840 miles per hour (2,610 meters per second). After its 42-second burn, the speed was

Quick Calendar

SAC Star Party
Buckeye Hills Recreation Area
Saturday, October 9

All Arizona Star Party
EVAC's Arizona City Site
Friday & Saturday, October 15–16

Public Star Party
Thunderbird Park
North of Union Hills on 59th Ave.
Saturday, October 23

SAC Meeting
7:30, Friday, October 29

Magazine Renewals Are Due

See Member Services Form on the back page.

Officer Elections Are Coming

SAC Officers

President	Bob Dahl	582–5526
Vice President	Tom Polakis	966–2625
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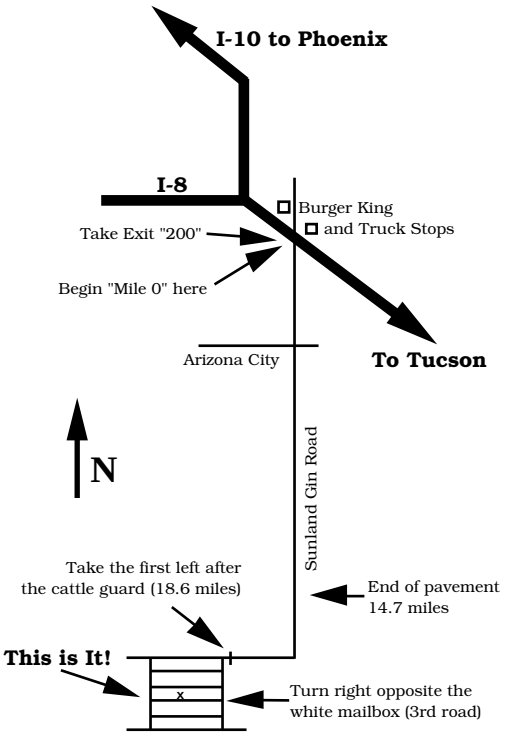
Secretary	Susan Morse	934–7496
Properties	Rich Walker	997–0711
SACNEWS Editor	Paul Dickson	862–4678
Public Events	Piet Burggraaf	995–1964

All-Arizona Star Party

The All-Arizona Star Party is at EVAC's Arizona City Deep Sky site. It's two nights, October 15, 16.

Friday night's session starts at sundown. Plenty of camping and set-up space, portable restrooms provided. On Saturday morning, tour of Silver Bell Mountain foothills. Swap Meet Saturday 2 – 5 PM.

For more information call: Ted Heckens, home (602) 827–1524, mobile: (602) 540–0395 or Dick Simmon (602) 949–1110.



cut to 250 miles per hour (110 meters per second) and the verniers were throttled up to full thrust. Ten seconds later the empty retrorocket was discarded.

By the time the altitude was cut to fourteen feet (4.3 meters), the robot's speed had fallen to three miles per hour (1.4 meters per second). The verniers were then shut down, allowing the lander to touch down at a speed of seven miles per hour (three meters per second). After a one-second, 2.6-inch (6.5-centimeter) high bounce, SURVEYOR 1 finally came to rest at 2.45 degrees south latitude, 43.22 degrees west longitude near the crater Flamsteed. SURVEYOR 1 had succeeded on the first try and landed only 8.7 miles (14 kilometers) off target!

After returning 36 minutes of engineering data to check on the lander's condition (which indicated that the previously stuck low-gain antenna snapped into place as a result of the landing impact), SURVEYOR 1 returned its first 200-line television image. This picture and the 10,731 others taken that first lunar day revealed that SURVEYOR 1 had landed on the inside of a 60-mile (100-kilometer) wide "ghost" crater that had been filled with molten rock eons ago. The landing site was littered with such boulders ranging up to one yard (one meter) across and craters of various sizes and states of preservation. The pictures and the engineering data from the landing indicated that the footpads had sunk only one inch (2.5 centimeters) into the granular lunar soil. The surface was more than firm enough to hold the weight of a manned lander and its human occupants.

As the Sun sank below the lunar horizon on June 14, SURVEYOR 1 was put into hibernation in hope that the probe would survive the minus 255 degree Fahrenheit (-160 degree Celsius), fourteen terran day-long lunar night. Although initial attempts at contact on June 28 failed, the lander responded to commands on July 6, returning another 618 images during its second lunar day of operations. On July 13, the battery voltage dropped dramatically as the Sun set once again.

While intermittent contact was maintained with the spacecraft until January 7, 1967, the mission was effec-

Such-A-Deal

SUCH-A-DEAL is a place to advertise equipment, supplies, and services related to amateur astronomy. This is a free service for SAC members and friends. SAC is not responsible for the quality of advertised items or services.

Telescope—Bausch & Lomb 4000 Telescope/Telephoto Tripod, Wedge Assy, Accessories. $500 OBO, G Hamilton, 895–7537.

tively over at the end of the second lunar day due to the worsening condition of the battery. All together, SURVEYOR 1 responded to 297 commands enroute to the Moon, 134,216 commands during its 219 terran days on the lunar surface, and returned 11,150 useful television images. The first SURVEYOR was an outstanding success. The tide had finally turned for the American lunar program.

LUNAR ORBITER

At the same time SURVEYOR 1 was performing its duties on the lunar surface, the first LUNAR ORBITER (LO) spacecraft was being prepared for launch on its ATLAS-AGENA D rocket. LUNAR ORBITER was designed for a single task: Orbit the Moon and take high-resolution images of the lunar surface in order to identify potential APOLLO landing sites. The 850-pound (385-kilogram) spacecraft was designed around an 147-pound (67-kilogram) photographic system built by Eastman-Kodak.

This system, based on Kodak's previously classified Department of Defense (DoD) work, was housed in an ellipsoidal aluminum alloy shell pressurized with dry nitrogen at 1.7 pounds per square inch (120 millibars). Viewing through a quartz window in the side of the shell were a wide-angle three-inch (eighty-millimeter) focal length, $f/4.5$ lens and a 24-inch (610-millimeter) focal length, $f/5.6$ narrow angle lens. These lenses simultaneously produced a pair of images on seventy-millimeter Kodak SO-243 high-contrast, fine grain aerial mapping film using exposures of 1/25th, 1/50th, or 1/100th of a second.

Some 260 feet (79 meters) of film were carried aboard LO, allowing as many as 212 image pairs to be taken. The 610-millimeter lens was also used by an electro-optic velocity/height sensor that slowly slewed the cameras during an exposure to compensate for the motion of the spacecraft as it orbited the Moon. During its fifteen to thirty day-long photography mission in a 29 by 1,150-mile (47 by 1,850-kilometer) mapping orbit, the best resolution for the narrow and wide-angle images was expected to be one and eight yards (one and eight meters), respectively.

This film was developed as the photographs were taken using Bimat Transfer Film, which employed spools of a webbing impregnated with the appropriate developing and fixing chemicals. Since the photographs could be taken faster than they could be processed, a set of takeup reels were included, allowing up to 21 image pairs to be stored. Once all the images were taken and the film was developed, the negatives were scanned by a 0.2 millimeter (5 micron) wide beam of high intensity light at a res-

Comet Comments

by Don Machholz

(916) 346-8963

September 7, 1993

One new comet has been discovered recently. We'll be able to observe it over the next few months. Meanwhile, Comet Mueller (1993a) remains in our northern sky where it is visible all night long.

Comet	Mueller				(1993a)
Date	RA-2000-Dec		Elong	Sky	Mag
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
10–15	13h12.7m	$+82^\circ 36'$	91°	M	9.5
10–20	15h28.5m	$+82^\circ 32'$	93°	E	9.3
10–25	17h19.4m	$+80^\circ 13'$	96°	E	9.2
10–30	18h25.9m	$+76^\circ 25'$	97°	E	9.1
11–04	19h06.2m	$+71^\circ 51'$	98°	E	9.0
11–09	19h33.1m	$+66^\circ 52'$	98°	E	8.9

Comet Mueller (1993p): Jean Mueller discovered this comet on Aug. 16 during the course of the second Palomar Sky Survey. It was at 14th magnitude in the morning sky. We now know that it has a highly inclined orbit and reaches perihelion at 0.98 AU early next April.

Found near the planetary nebula M 76, Comet 1993p will move slowly westward over the next few weeks, then turn southward, crossing the equator near Christmas. By then it will be in the evening sky, at about magnitude 10. At the end of February we lose it in the evening twilight (eighth magnitude). The Southern Hemisphere picks it up in the evening sky where it may be a binocular object at seventh magnitude. It then dims as it moves north, allowing Northern Hemisphere observes a chance to view it again in June and July. An ephemeris appears below, do not confuse this comet with the one found early this year by Mueller, 1993a.

Comet	Mueller				(1993p)
Date	RA-2000-Dec		Elong	Sky	Mag
10–05	00h30.3m	$+45^\circ 28'$	139°	M	12.1
10–10	00h18.5m	$+43^\circ 42'$	142°	M	11.9
10–15	00h06.8m	$+41^\circ 35'$	143°	M	11.8
10–20	23h55.5m	$+39^\circ 08'$	143°	E	11.6
10–25	23h44.8m	$+36^\circ 23'$	141°	E	11.5
10–30	23h35.0m	$+33^\circ 22'$	138°	E	11.3
11–04	23h26.3m	$+30^\circ 09'$	134°	E	11.2
11–09	23h28.7m	$+26^\circ 49'$	130°	E	11.1

olution equivalent of 7,300 lines per inch (287 lines per millimeter).

A photomultiplier tube detected the light beam, whose intensity was modulated by the film's density, and the appropriate electronics converted this signal into a form to be transmitted back to Earth. Each image pair could be transmitted in 43 minutes when both the Earth tracking station and the Sun were visible. The scanned photographs were the equivalent of a 8,360 by 9,880 pixel image for the wide-angle and a 8,360 by 33,288 pixels for the narrow-angle views. One of the primary reasons for choosing this photographic system over a scanned vidicon camera with magnetic tape storage was because of the incredible resolution and enormous data storage capabilities this technique offered, even by present standards.

This photographic system was mounted on the spacecraft's 4.6-foot (1.4-meter) diameter equipment deck at the base of the 6.6-foot (2.0-meter) tall, roughly conical-shaped spacecraft. Also mounted on this deck were a Canopus star sensor, five Sun sensors, and an inertial reference unit all used to determine LUNAR ORBITER's attitude to an accuracy of 0.2 degrees. A flight programmer possessed a 128-word memory that was able to control spacecraft activities for sixteen hours worth of photography. Under the control of this unit, the photographic system could be programmed to take groups of four, eight, or sixteen photographs of selected sites per orbital pass.

Data were returned via a boom-mounted, three-foot (92-centimeter) diameter high-gain dish antenna. A ten-watt transmitter would use this to transmit the images back to Earth. A low-gain antenna, dedicated to a one-half watt transmitter, was also mounted on the equipment deck opposite the high-gain antenna. It was used to return telemetry. Four solar panels, spanning a total of seventeen feet (5.2 meters), were also mounted here to provide the orbiter with 375 watts of electricity. When the spacecraft was in shadow, power was provided by nickel-cadmium batteries.

Mounted on an open truss frame above the equipment deck was the upper structural module. This unit housed the velocity control engine used to place LUNAR ORBITER in orbit as well as trim that orbit once there. This engine, based on the APOLLO attitude control thruster, produced 100 pounds (445 newtons) of thrust using the hypergolic propellants hydrazine and nitrogen tetraoxide. These propellants were stored in tanks also located in the upper structural module. Eight nitrogen gas jets mounted at the top of the spacecraft provided attitude control.

For thermal control, the entire spacecraft was shrouded in a blanket of aluminized mylar. The underside of the equipment deck, which would normally face the Sun, was covered with a white thermal paint. These measures were expected to maintain the orbiter's temperatures between 36 and 84 degrees Fahrenheit (2 and 29 degrees Celsius).

The only other instruments carried by LUNAR ORBITER were a ring of twenty pressurized meteoroid detectors and a pair of dosimeters to assess any radiation hazards to manned spacecraft in the near-lunar environment. By monitoring the orbital changes of the spacecraft, the mass distribution of the Moon could also be mapped. This knowledge would be essential for the pinpoint accuracy needed for the APOLLO landing missions. While the photographic portion of the mission was expected to last no more than one month, these other investigations would employ the spacecraft for up to one year.

America's Seventh Lunar Orbiter Attempt

America's seventh attempt to send a spacecraft into lunar orbit did not involve LUNAR ORBITER whatso-

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
Oct. 29
Nov. 19
Dec. 18 Party
— **1994** —
Jan. 28
Feb. 25
Mar. 25
Apr. 22
May 27
Jun. 24
Jul. 22
Aug. 19
Sep. 16

1993 SAC Star Parties

Date	Sunset	Moonrise
Oct. 9	6:03pm	1:04am
Nov. 6	5:33pm	11:57pm
Dec. 11	5:22pm	6:35am
— **1994** —		
Jan. 8	5:38pm	5:22am
Feb. 5	6:05pm	4:11am
Mar. 5	6:29pm	2:58am
Apr. 9	6:55pm	5:42am
May 7	7:16pm	4:17am
Jun. 4	7:34pm	2:52am
Jul. 2	7:42pm	1:27am
Aug. 6	7:24pm	6:09am
Sep. 3	6:51pm	4:56am

ever. That distinction falls to a little-known spacecraft built and operated by NASA's Goddard Space Flight Center (GSFC) called EXPLORER 33. This spacecraft was the fourth in their Interplanetary Monitoring Platform (IMP) series. Starting with the launch of EXPLORER 18 on November 26, 1963, this program's goal was to place satellites, loaded with particle and fields instrumentation, into highly eccentric orbits in order to study the planet Earth's magnetosphere and its interaction with the Sun-dominated interplanetary environment.

EXPLORER 33 was to be the first "Anchored" IMP. The anchor was to be the Moon. From this vantage point, EXPLORER 33 could continuously monitor the radiation and magnetic field environment from lunar distances, unlike the previous IMPs which would periodically swing back towards Earth in their elongated geocentric orbits. A secondary objective for this Anchored IMP was to study the Moon's effect on this environment as well as the lunar gravitational field.

The 205.7-pound (93.4-kilogram) spacecraft consisted of an eight-inch (twenty-centimeter) tall octagonal bus 28 inches (71 centimeters) across. It was topped by an 81-pound (37-kilogram) solid propellant retrorocket that would produce 916 pounds (4,080 newtons) of thrust for 20 to 22 seconds. Mounted on the bus were four solar panels producing 43 watts of electrical power and a pair of six-foot (1.8-meter) long magnetometer booms. A seven-watt transmitter inside the bus made use of four external whip antennae for communications. Also mounted inside were six particle and fields experiments and a data processor.

The probe spun at twenty revolutions per minute for attitude control but had no provisions for mid-course corrections. Instead, EXPLORER 33 would rely on the accuracy of its DELTA E — also known as the DSV-3E1 or THRUST AUGMENTED DELTA — launch vehicle to place it on the correct trajectory to enter a 810 by 4,000-mile (1,300 by 6,400-kilometer) lunar orbit inclined 175 degrees to the equator and having a period of about ten hours.

The DELTA E was the latest in NASA's ever-improving DELTA launch vehicle family that was originally based on the infamous THOR-ABLE booster that had failed so miserably in launching the early PIONEER lunar orbiters. Unlike its highly unreliable ancestor, the DELTA had proven to be NASA's most reliable rocket, with 35 successful launches in 38 attempts since its first flight on May 13, 1960.

The DSV-3E1 DELTA variant was vastly different from the THOR-ABLE. The engines in the enlarged first and second stages were up to seventeen percent more powerful and much more reliable and efficient than before. The more powerful Hercules X-258 solid rocket motor replaced the old ABL X-248 motor used previously in the third stage. Most importantly, three Thiokol built Castor 1 solid rocket boosters were strapped to the side of the first stage, giving the DELTA E a total liftoff thrust of 331,850 pounds (1,477 kilonewtons). Not as evident as these exterior changes, inside the launch vehicle was equipped with totally new guidance and control systems.

Despite all the upgrades and significant increase in reliability, it was recognized from the start that there was a fairly good chance that EXPLORER's launch vehicle could place the probe on a trajectory that could be off by just enough so that, without a mid-course correction capability, EXPLORER could not enter lunar orbit.

On July 1, 1966, EXPLORER 33 lifted off from Pad 17A at Cape Kennedy. As luck would have it, the DELTA's second and third stages worked slightly better than designed and imparted an excess velocity of 47.7 miles per hour (21.3 meters per second) to EXPLORER 33, resulting in a 9,880 by 270,560-mile (15,897 by 435,330-kilometer) geocentric orbit.

Although the second and third stages worked well within specifications, this excess velocity was just enough so that EXPLORER 33 could not enter lunar orbit. Instead, ground controllers fired the tiny EXPLORER's rocket motor to place the IMP into a 18,987 by 279,163-mile (30,550 by 449,174-kilometer) Earth orbit where EXPLORER 33 would conduct an alternate mission similar to previous IMPs. Another attempt to launch an Anchored IMP was scheduled for one year later.

America's First Lunar Orbiter

America's eighth attempt to send a probe to orbit the Moon, LUNAR ORBITER 1, was finally launched on August 19, 1966 from Pad 13 on Cape Kennedy using an ATLAS-AGENA D booster. The primary objective of this flight was to photograph nine potential APOLLO landing sites and seven secondary sites. Efforts would also be made to locate the SURVEYOR 1 lunar lander then completing its third lunar day on the surface.

After coasting in its 100-mile (160-kilometer) high Earth parking orbit for 28 minutes, the Bell 8096 engine of the AGENA D came to life again for a ten-minute burn that would send LUNAR ORBITER towards the Moon. After the spacecraft separated from its escape stage, LO unfolded its solar panels and antennae and proceeded to find its celestial attitude references. While the Sun was located without trouble, the Canopus star sensor failed to lock onto its target to provide the spacecraft with its needed roll reference. Apparently stray sunlight was being reflected from an unexpected location into the sensor. Instead, the brilliant Moon itself was used for a reference for the next two days until an alternate acquisition method could be devised.

Twenty-four point-seven hours after launch, LUNAR ORBITER 1 performed a course correction burn to place it within fifty miles (eighty kilometers) of its target point above the Moon. About 67 hours later, LUNAR ORBITER 1 fired its engine once again for 578.7 seconds to cut its approach speed by 1,766.8 miles per hour (789.65 meters per second). With this burn, LUNAR ORBITER entered a 119 by 1,152-mile (191 by 1,854-kilometer) orbit around the Moon inclined 12.2 degrees to the lunar equator and having a period of three hours and 37 minutes.

Tracking quickly revealed that the orbit was changing quite quickly because of the relatively large variations in the lunar gravitational field. The origin of these irregularities was unknown at the time. Later it was found these orbit changes were being caused by approximately one dozen near-surface mass concentrations, abbreviated "mascons".

Once in orbit, LUNAR ORBITER 1 took a series of twenty engineering images between August 18 and 20 of both sides of the Moon to check out the imaging system between. On August 21, the main engine was again fired to lower the periapsis of the orbit down to 31 miles (fifty kilometers) in preparation for actual mapping, which began the next day. The periapsis was lowered again on August 25 to an altitude of 25 miles (forty kilometers). While the initial wide angle images images had shown the system was working well, the high resolution images were hopelessly blurred because of a failure in the velocity/height sensor. Despite this failure, and some temperature control problems, 75 percent of the objectives were met and the mission was deemed a success. By August 30, LUNAR ORBITER used the last of its 211 exposures of film.

The images returned in the following days had shown that the lunar surface was capable of supporting a lander due to the presence of large boulders in various areas. The landing area of SURVEYOR 1 also seemed to have twenty percent fewer craters than other lunar maria, making it a good candidate of a manned landing. Low resolution images taken of the unseen farside of the Moon confirmed observations made by the Soviet LUNA 3 and ZOND 3 probes in 1959 and 1965, respectively, that this region of the Moon was almost completely devoid of large maria that dominate the familiar lunar near side.

During LUNAR ORBITER's eight weeks in orbit, not a single micrometeoroid impact was recorded, compared to the four that would be expected if the experiment were conducted in Earth orbit. The measured radiation dose was as predicted before the flight and would not prove to be a problem for a manned flight.

On October 29, LUNAR ORBITER 1, after completing 577 orbits, fired its main engine one last time for 97 seconds. This allowed the spacecraft to drop from lunar orbit and crash at 6.7 degrees north latitude, 162 east longitude. This was done so that transmissions from the probe would not interfere with the next LUNAR ORBITER, due for launch within the next week or so. After eight attempts in eight years, the Americans had their first successful lunar orbiter mission.

The Soviets Return

Two weeks after the launch of LUNAR ORBITER 1, the Soviet Union launched their third known orbiter attempt, LUNA 11. On August 27, the 3,611-pound (1,640-kilogram) spacecraft slipped into a 101.6 by 741.8-mile (163.5 by 1,193.6-kilometer) lunar orbit inclined 27 degrees to the equator. The exact configuration and payload of this orbiter have never been revealed by the Soviets. It does appear that the bus and payload did not separate once in lunar orbit as was the case with LUNA 10. Instead they remained together with the bus providing attitude control.

Fields and particle data were apparently returned. It was reported that image transmissions similar to those from LUNA 9 were intercepted at the radio observatory in Jodrell Bank in Great Britain. Since the Soviets never mentioned photography as a mission goal, it is possible that this experiment failed if indeed it was even carried at all. Whatever the mission of LUNA 11 was, the Soviet probe continued to function until October 1, when the batteries became exhausted. During its five weeks in orbit, LUNA 11 completed 277 revolutions around the Moon.

Before LUNA 11 fell silent, the American SURVEYOR 2 was prepared for launch. On September 20, ATLAS-CENTAUR 7 flawlessly lifted off from Cape Kennedy and placed the 2,204-pound (1,001-kilogram) lander on a trajectory to land in Sinus Medii near the center of the Moon's near side. Unlike SURVEYOR 1, which approached the lunar surface from a mere six degrees to the local vertical, SURVEYOR 2 would have to contend with a 23-degree approach angle in order to land.

Sixteen and one-half hours after launch, SURVEYOR 2 proceeded to align itself to make a 9.8-second course correction burn using its three vernier engines. Unfortunately, one of these engines failed to ignite, sending SURVEYOR 2 into a sixty-revolution per minute tumble. Attempts to halt this tumble using the nitrogen attitude jets failed; the rotation rate was far beyond their correction capability. After 39 unsuccessful attempts to start the malfunctioning vernier engine, the mission was declared a loss.

The mission planners decided to obtain as much engineering information as possible before impact. Commands were sent from the tracking station in Canberra, Australia, for SURVEYOR 2 to vent its helium propellant tank pressurant, erect its solar panel, and turn on its radar. The solid retrorocket was fired as the tumbling probe approached the surface. After firing for thirty seconds, contact with SURVEYOR 2 was lost as it slammed into the lunar surface at an estimated 6,000 miles per hour (2,700 meters per second) at 5.5 degrees north, 12.0 degrees west near the rayed crater Copernicus.

On October 22, the Soviets launched yet another lunar orbiting probe. LUNA 12 left its 123 by 132-mile (199 by 212-kilometer) parking orbit and performed a single course correction burn the following day. On October 25, LUNA 12 fired its KTDU-5A engine for 28 seconds to decrease its 4,665 mile per hour (2,085 meter per second) approach speed by 2,096 miles per hour (937 meters per second) and enter a 83 by 750 mile (133 by 1,200 kilometer) orbit inclined ten degrees to the lunar equator. Unlike the previous mission, this time there was no doubt as to the mission of LUNA 12: This was a mapping mission likely supporting the Soviet manned lunar landing program then secretly under development.

Like LUNA 11, the payload of LUNA 12 stayed at-

tached to the main bus. This payload was dominated by a large conical instrument compartment with its radiator mounted on top of the bus. Below this were extra spheres containing pressurized nitrogen for the attitude control system. Inside the instrument compartment above the radiator were experiments to detect gamma rays from the lunar surface, measure the magnetic and radiation near the Moon, an infrared radiometer, and meteoroid detectors.

Mounted on the side of the bus where the radar altimeter would be in a landing mission was a photographic package virtually identical in operation and capability to the one carried by ZOND 3 the previous year. In the few images released to the public, it appears that this system was capable of returning images with a maximum resolution of 50 to 65 feet (15 to 20 meters). Transmissions of these images began on October 29. Once its photography mission was completed, LUNA 12 was set spinning slowly about its roll axis in order to better perform its particle and fields measurements.

In addition to these scientific instruments, LUNA 12 also carried an engineering experiment. Unknown in the West at the time, a series of electric motors were carried into lunar orbit and tested. These motors were to be used by an unmanned lunar rover then under development as one part of the Soviets third generation of LUNA probes, to be launched in another two years.

This next series of lunar probes would make use of the PROTON launch vehicle then under development to support the Soviets' manned circum-lunar program and would weigh 3.5 times more than the current generation of lunar probes. Their mission was to act as precursors to a Soviet manned landing, expected around 1971, as well as work in conjunction with these missions once they started. In many ways the third generation LUNAs were similar in their mission and size to the proposed American PROSPECTOR project, canceled three years earlier due to budget constraints. In the meantime, LUNA 12 continued its mission until January 19, 1967, when its batteries were finally exhausted.

To be continued next month.

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`.

President's Column

by Robert Dahl, SAC President

Those of you who participated in our chartered bus trip to Flagstaff on August 28th know what an enjoyable trip it was. For the rest of you, make sure you sign up early next time! Unfortunately, this bus did not have the VCR hookup that the last one did, but we managed to rough it nevertheless. It just meant that we could not watch some of Steve Coe's old Star Trek reruns — so maybe it wasn't such a bad thing after all.

The light drizzle we had on the way to Flagstaff cleared up when we arrived at Lowell Observatory, and we had a wonderfully clear, cool mountain day. Brian Skiff gave us a personalized tour of the telescopes atop Anderson mesa, as well as some of the older instruments on Mars Hill. In many places, there was a juxtaposition of old and new — an ancient vacuum-tube drive circuit sitting next to a Sun workstation, for example. As Brian said, "We never get rid of anything, not even Percival!", while pointing at Percival Lowell's mausoleum on Mars Hill.

Changing the subject, we had one of the best star parties in recent memory on Saturday, September 11. The sky did not look very promising in the late afternoon, but the evening rated an absolute 10 for seeing! A slight haze and remnants of our summer monsoon humidity probably played a part to give us the extremely calm air. All of us dusted off those short-focus eyepieces and Barlows, testing how much magnification we could get before the image broke down.

With my 20-inch $f/5$ Obsession, everything was sharp at 900x, and nearly so at 1330x! We took turns viewing M 57 at high power, and all of us could easily see the central star. Neptune with Triton, and Uranus and one of its moons were easy, and we could see so much detail in Saturn's atmosphere that I'm sure I saw the face of Elvis!

Steve Coe was performing an eyepiece-comparison test using M 56 as his subject. Other star party attendees included AJ Crayon, James Van Dyke, Ethan Rausch, Rich and Tommy Walker, Steve Conner, Pierre Schwaar, and Tom Polakis.

The wind became very gusty around midnight as a cold front approached, and forced us to pack up. Moonrise was still two hours away, so Tom Polakis did not have an opportunity to take yet another batch of lunar photos to add to his already-too-large collection. Most of us then rendezvoused at Jerry's restaurant for late-night food and conversation.

In closing, let me remind you of some upcoming October events. Once again, the All-Arizona Star Party will be hosted at the EVAC Arizona City site on October 15th and 16th. EVAC deserves recognition for the fine job they did last year, and they evidently plan to make it an annual event. Be sure to bring your scope and barbecue grill!

The October SAC meeting is noteworthy for two reasons: first, it's your LAST CHANCE to pay your magazine subscription renewals (see Treasurer Carol Lee), and second, it's time to nominate officers for next year! So if you know someone who complains about the way things are run, nominate them!

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. For those setting up, please arrive by 5 PM (sunset is near 5:30).

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 Pisces. 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, November 4 at 7:30pm.

Minutes of the August Meeting

The August meeting of SAC was opened by President Bob Dahl at 7:40 PM. He welcomed all guests and new members and asked them to sign the guest book. He then asked all the members what they experienced for their observations on the Perseids meteor shower. Most members felt that the display was no better than normal. Bob reminded members to pick up their current newsletter from the box on the table.

Tom Polakis told all the members who were going on the bus trip to Lowell Observatory in Flagstaff, that the departure place was the parking lot at Smitty's store at Bell Road and I-17, and to be there before 0:00 AM. Members should pack their own picnic lunch, and after picking up Brian Skiff at Lowell, the tour would start at Anderson Mesa, then return to Lowell; the bus should be back in Phoenix by 10:00 PM.

Carol Lee gave the Treasurer's Report and mentioned that several nametags were available. Steve Coe said that the disks on the table represented the database of 10,000 objects and if members wanted a disk, the cost was $1.00. A.J. Crayon reminded members about the Deep Sky Group meeting on Sept. 2, at 7:30 at the McGrath's house. The constellation studied will be Aquarius.

For "Show'n'Tell", Stan Student displayed some slides on some recent computer nebulae that he observed.

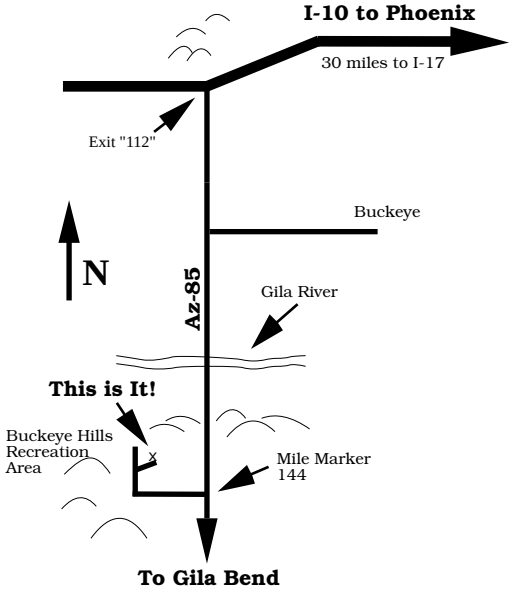
Following the break, Frank Zullo gave a wonderful slide presentation on astrophotography, showing his techniques on assembly composite slides.

Respectfully submitted, —*Susan V. Morse, SAC Secretary*

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.

October 1993

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
All Times are Mountain Standard Time					1	2
3	4	5	**EVAC Meeting** Directions: Joe Murray 482-2918 6	7	Last Quarter Moon 12:35 p.m. 8	**SAC Star Party** Buckeye Hills (members & guests) 9
10	11	Tomorrow Mercury at greatest elongation 25°E 12	Venus 7°N of Moon 6 p.m. 13	14	**All-Arizona Star Party** October 15 & 16 New Moon 4:36 a.m. 15	16
17	Jupiter in conjunction with Sun 18	19	20	Orionid meteor shower 21	First Quarter Moon 1:52 a.m. 22	**Public Star Party** Thunderbird Park 23
Saturn 7°S of Moon 24th 6 a.m. 24/31	25	26	27	28	**SAC Meeting** 29	Full Moon *Hunters' Moon* 5:38 a.m. 30

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 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. Mail the completed form to:

Carol Lee
SAC Treasurer
3314 N 68th Street, #205-W
Scottsdale AZ 85251

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

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