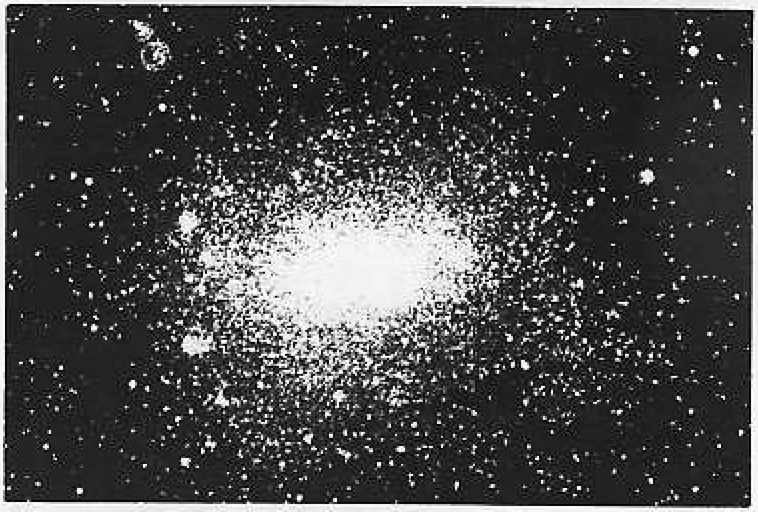
REFLECTIONS

REFLECTIONS



"Barnard's Galaxy", Irregular dwarf galaxy NGC 6822 in Sagittarius, RA 19h 45m, DEC -14d 48m, 9.2 mag (photographic). At 1.7 million light years away this galaxy is considered a member of the Local Group. The planetary nebular NGC 6818 is located 36' NNW of the galaxy and is approximately 3,000 light years away.

January 1996

Chris Sarnecki
Editor

Of the University Lowbrow Astronomers

The University Lowbrow Astronomers is a club of Astronomy enthusiasts which meets on the third Friday of each month in the University of Michigan's Physics and Astronomy building (Dennison Hall, Room 807). Meetings begin at 7:30 pm and are open to the public. Public star parties are held twice a month at the University's Peach Mountain Observatory on North Territorial Road (1.1 miles west of Dexter-Pinkney Road; further directions at the end of the newsletter) on Saturdays before and after the new Moon. The party is canceled if it's cloudy or very cold at sunset. For further information call club officers listed at the end of the newsletter.

This Month:

January 19 - Meeting at 807 Dennison - Tonight's talk is titled "Turbulence in the near Earth's Space Environment" and will be presented by Doug Drob.

January 20 - New Moon at 7:50 am EST and

January 20 - Public Star Party at Peach Mountain Observatory A good night to split some close binaries on the club's new 6" f10 refractor.

January 27 - Public Star Party at Peach Mountain Observatory Come on out tonight for some easy observing. Venus is closing in on Saturn. The Moon is at fist quarter.

Next Month:

February ? - Computer Subgroup Meeting. Subject, date, and time to be determined.

February 16 - Meeting at 807 Dennison Speaker/topic under investigation.

February 17 - Public Star Party at Peach Mountain Observatory The annual meeting of the Polar Bear Closet Astronomers Society out at the Peach. Bring your Woolies !

February 18 - New Moon at 11:30 pm EST

February 24 - Public Star Party at Peach Mountain Observatory The Winter sky is fast fading. Coma-Virgo is just around the corner.

January 22nd, 1:00 pm - NASA Ames will hold a live press conference over NASA Select TV to discuss the initial findings of the Galileo atmospheric probe.

January 26th, 4:00 pm Boeing Auditorium at the Francis Xavier Bagnold Building on North Campus- SPRL Colloquium Series presents "The GALILEO Mission to Jupiter's Magnetosphere" by Professor Frances Bagenal, Interdisciplinary Scientist on NASA's GALILEO Program and Professor at the University of Colorado. Dr. Bagenal will present and discuss what GALILEO scientists hope to learn about Jupiter in the next several years, including some of the early results from GALILEO. This talk is part of the Space Physics Research Laboratory Colloquium Series.

Galileo Status Report

PUBLIC INFORMATION OFFICE
JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GALILEO MISSION STATUS

December 7, 1995 - 6:10 p.m. NASA's Galileo spacecraft has successfully entered orbit around Jupiter after its six-year trip through the solar system. Project engineers report the spacecraft's rocket fired on time at 5:20 p.m. PST and stopped after 49 minutes as planned at 6:08 p.m. PST, enabling the spacecraft to enter orbit around the giant planet and begin its two-year mission of scientific studies. Launched October 18, 1989, Galileo has traveled 3.7 billion kilometers (2.3 billion miles) in a looping path through the solar system to reach Jupiter, which is 934 million kilometers (580 million miles) away from Earth.

December 15, 1995 - The Galileo spacecraft, now in orbit around Jupiter, finished delivering the first round of data from its atmospheric probe on Wednesday. Collected during the probe's one-hour plunge through Jupiter's clouds on Dec.7, the data represent the first direct measurement of an atmosphere of an outer planet. Galileo Project Scientist Dr. Torrence Johnson and Probe Scientist Dr. Rich Young confirmed that all the instruments seem to have worked properly and provided data during the probe's brief descent mission. The probe sent data to the Galileo orbiter for 57 minutes during its descent. Transmission of probe data to Earth has now been temporarily suspended as planned, because Jupiter is passing behind the Sun as seen from Earth and the communications link between the Galileo orbiter and Earth has, as expected, become very noisy. The spacecraft is currently more than 940 million kilometers (584 million miles) from Earth. Data transmission will resume in January, when Jupiter and the Earth move out of this alignment. Scientists are continuing to analyze the data in preparation for a briefing on the initial probe science results scheduled for 10 a.m. PST on Tuesday, Dec. 19, at NASA's Ames Research Center, Mountain View, CA.

December 18, 1995 - NOTE TO EDITORS: N95-83 BRIEFING TO ANNOUNCE EARLY GALILEO PROBE RESULTS POSTPONED. NASA's Galileo atmospheric probe briefing, scheduled for December 19, has been postponed due to the government wide furlough. The briefing will be rescheduled following return of NASA employees and an announcement will be immediately issued stating the briefing's new time and date.

January 22, 1996 - NASA Ames will hold a live press conference on January 22, 1996 at 1:00 PM EST over NASA Select TV to discuss the initial findings of the Galileo atmospheric probe. This one should be for real, folks. *[Thanks to Doug Warshow for submitting this last minute information - Ed]*

Comet Sample Return Mission Picked as next Discovery Flight

from the PUBLIC INFORMATION OFFICE,
JET PROPULSION LABORATORY, NASA

A spacecraft designed to gather samples of dust spewed from a comet and return the dust to Earth for detailed analysis has been selected to become the fourth flight mission in NASA's Discovery program. Known as Stardust, the mission also will gather and return samples of interstellar dust that the spacecraft encounters during its trip through the Solar System to fly by a comet called Wild-2 in January 2004. Stardust was one of three Discovery mission proposals selected for further study as part of a February 1995 announcement by NASA that a Moon-orbiting mission called Lunar Prospector had been selected as the third Discovery flight.

"Stardust was rated highest in terms of scientific content and, when combined with its low cost and high probability of success, this translates into the best return on investment for the nation," said Dr. Wesley T. Huntress Jr., NASA Associate Administrator for Space Science. "The Stardust team also did an excellent job of updating their plan to communicate the purpose and results of this exciting mission to educators and the public."

The Stardust mission team is led by Principal Investigator Dr. Donald Brownlee of the University of Washington in Seattle, with Lockheed-Martin Astronautics, Denver, as the contractor building the spacecraft. NASA's Jet Propulsion Laboratory will provide project management. Comet Wild-2 is known as a "fresh comet" because its orbit was deflected from much farther out in the Solar System by the gravitational attraction of Jupiter in 1974. Stardust will approach as close as 100 kilometers (62 miles) to the comet's nucleus.

"Space scientists are intensely interested in comets because we believe that most of them are well-preserved remnants from the earliest days of star and planetary formation," Huntress said. "Stardust should also give us some unique guidance about how to focus the science we plan to conduct a few years later with a surface lander on a different comet during the international Rosetta mission."

Stardust will be launched on an expendable launch vehicle in February 1999 for a total mission cost to NASA in real-year dollars of $199.6 million. The return capsule carrying the dust samples would parachute to Earth in a landing on a dry Utah lake bed in January 2006.

Stardust will use an unusual material called aerogel to capture the dust samples. This porous, extremely low density material is somewhat like glass in that it is made of silica - a pure form of sand - and it has about the same melting point. Although aerogel does not absorb moisture, the strangely fluorescent substance can absorb large amounts of gas or particle matter due to its remarkable internal surface area.

The spacecraft will also carry an optical camera that should return cometary images with 10 times the clarity of those taken of Halley's Comet by previous space missions, as well as a mass spectrometer provided by Germany to perform basic compositional analysis of the samples while in-flight.

Stardust was selected over a proposed mission to study the circulation of the atmosphere of Venus, known as the Venus Multiprobe, and a proposed mission to collect samples of particle matter from the Sun, called Suess-Urey. These three missions and Lunar Prospector were among 28 Discovery proposals submitted to NASA in October 1994 in response to an August 1994 announcement of opportunity.

The first two missions in the Discovery program will be launched in 1996, in February and December, respectively: the Near Earth Asteroid Rendezvous, a small spacecraft that will orbit and study the asteroid Eros beginning in January 1999; and the Mars Pathfinder, designed to place a small lander and robotic rover on the surface of Mars in July 1997.

Formally started in NASA's FY 1994 budget, the Discovery program features small planetary exploration spacecraft with focused science goals that can be built in 36 months or less, for less than $150 million (FY '92 dollars), not including the cost of the launch vehicle. The program grew out of a series of discussions and workshops that NASA has held with the space science community.

Voyager's Interstellar Mission

by Gary L. Spradlin, JPL, NASA

MISSION OBJECTIVE - The mission objective of the Voyager Interstellar Mission (VIM) is to extend the NASA exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond. This extended mission is expected to penetrate the heliopause boundary between the solar wind and the interstellar medium (heliopause), allowing measurements to be made of interstellar fields, particles, and waves unaffected by the solar plasma.

MISSION CHARACTERISTICS - The VIM is an extension of the Voyager primary mission that was completed in 1989 with the close flyby of Neptune by the Voyager 2 spacecraft. Neptune was the final outer planet visited by a Voyager spacecraft. Voyager 1 completed its planned close flybys of the Jupiter and Saturn planetary systems while Voyager 2, in addition to its own close flybys of Jupiter and Saturn, completed close flybys of the remaining two gas giants, Uranus and Neptune. At the start of the VIM, the two Voyager spacecraft had been in flight for over 12 years having been launched in August (Voyager 2) and September (Voyager 1), 1977. Voyager 1 was at a distance of approximately 40 AU (Astronomical Unit - mean distance of Earth from the Sun, 150 million kilometers) from the Sun, and Voyager 2 was at a distance of approximately 31 AU. Voyager 1 is escaping the solar system at a speed of about 3.5 AU, 35 degrees out of the ecliptic plan to the north, in the general direction of the Solar Apex (the direction of the Sun's motion relative to nearby stars). Voyager 2 is also escaping the solar system at a speed of about 3.1 AU per year, 48 degrees out of the ecliptic plane to the south.

It is appropriate to consider the VIM as three distinct phases: the termination shock, heliosheath exploration, and interstellar exploration phases. The two Voyager spacecraft began the VIM operating, and are still operating, in an environment controlled by the Suns magnetic field with the plasma particles being dominated by those contained in the expanding supersonic solar wind. This is the characteristic environment of the termination shock phase. At some distance from the Sun, the supersonic solar wind will be held back from further expansion by the interstellar wind. The first feature to be encountered by a spacecraft as a result of this interstellar wind/solar wind interaction will be the termination shock where the solar wind slows from supersonic to subsonic speed and large changes in plasma flow direction and magnetic field orientation occur. Passage through the termination shock ends the termination shock phase and begins the heliosheath exploration phase. While the exact location of the termination shock is not known, it is very possible that Voyager 1 will complete the termination shock phase of the mission about the year 2000 or 2001 when it will be about 80 AU from the Sun. After passage through the termination shock, the spacecraft will be operating in the heliosheath environment which is still dominated by the Suns magnetic field and particles contained in the solar wind. The heliosheath exploration phase ends with passage through the heliopause which is the outer extent of the Suns magnetic field and solar wind. The thickness of the heliosheath is uncertain and could be tens of AU thick taking several years to traverse. Passage through the heliopause begins the interstellar exploration phase with the spacecraft operating in an interstellar wind dominated environment. This interstellar exploration is the ultimate goal of the Voyager Interstellar Mission.

SCIENCE INVESTIGATIONS - There are currently six science investigations participating in the VIM.

- MAG - Magnetic field investigation
- LECP - Low energy charged particle investigation
- PLS - Plasma investigation
- CRS - Cosmic ray investigation
- PWS - Plasma wave investigation
- UVS - Ultraviolet investigation

The science teams for these investigations are currently collecting and evaluating data on the strength and orientation of the Sun's magnetic field; the composition, direction and energy spectra of the solar wind particles and interstellar cosmic rays; the strength of radio emissions that are thought to be originating at the heliopause, beyond which is interstellar space; and the distribution of hydrogen within the outer heliosphere.

SCIENCE DATA ACQUISITION STRATEGY - Science data are primarily returned to earth in real time at 160 bps, with selected periods of real time 600 bps data for UVS solar observations. Real time data capture uses 34 meter Deep Space Network (DSN) resources with the project goal to acquire at least 16 hours per day of real time data per spacecraft. This goal is not always achieved due to the competition for DSN resources with prime mission projects and other extended mission projects. Once a week per spacecraft, 48 seconds of high rate (115.2 kbps) PWS data are recorded onto the Digital Tape Recorder (DTR) for later playback. These data are played back to Earth once every 6 months per spacecraft and require 70 meter DSN support for data capture. After transmission of the data (either real time or recorded) to JPL, it is processed and made available in electronic files to the science teams located around the country for their processing and analysis.

SPACECRAFT LIFETIME - The two Voyager spacecraft continue to operate, with some loss in subsystem redundancy, but still capable of returning science data from a full complement of VIM science instruments. Both spacecraft also have adequate electrical power and attitude control propellant to continue operating until around 2020 when the available electrical power will no longer support science instrument operation. At this time science data return and spacecraft operations will end. Spacecraft electrical power is supplied by Radioisotope Thermoelectric Generators (RTGs) that provided approximately 470 w of 30 volt DC power at launch. Due to the natural radioactive decay of the Plutonium fuel source, the electrical energy provided by the RTGs is continually declining. At the beginning of 1995, the power generated by Voyager 1 had dropped to 345 w and to 349 w for Voyager 2. Both of these power levels represent better performance than the pre-launch predictions, which included a conservative degradation model for the bi-metallic thermocouples used to convert thermal energy into electrical energy. As the electrical power becomes less and less, power loads on the spacecraft must be turned off in order to avoid having demand exceed supply. As loads are turned off spacecraft capabilities are eliminated. The following table identifies the year when specific capabilities will end as a result of the available electrical power limitations.

VOYAGER 1 VOYAGER 2 - Terminate scan platform and UV observations 1998. Termination of gyro operations ~2007~2005. Termination of DTR operations~2006*~2012*. Initiate instrument power sharing ~2014~2016. Can no longer power any single instrument No earlier than 2020. * Limited by ability to capture 1.4 kbps data using a 70m/34m antenna array.

In order to maximize the duration of the fields and particles data acquisition capability, the first spacecraft loads to be turned off are instrument heaters on the scan platform. As these heaters are turned off the UV instrument, which is mounted on the scan platform, cools down until the point is reached when it can no longer function. Termination of gyro operations ends the capability to calibrate the magnetometer instrument with magnetometer roll maneuvers (MAGROLs). These maneuvers are performed 6 times a year, on each spacecraft, and consist of a spacecraft attitude maneuver of 10 successive 360 degree turns about the roll axis. Data from a MAGROL allow the spacecraft magnetic field to be determined and subtracted from the magnetometer science data. This is important since the spacecraft magnetic field is roughly the same magnitude as the solar magnetic field being measured. The termination of gyro operations also means an end to the attitude maneuvers used to check the combined calibration of the Sun Sensor and the High Gain Antenna pointing direction for maintaining communications with the ground. Instrument power sharing limits the number of science instruments that can be on at any given time. This instrument power sharing will continue until the available power will no longer support any instrument operation. At that time the Voyager Interstellar Mission will end.

GEE-WHIZ Stuff About The Voyager Project

The Voyager mission was officially approved in May 1972, has received the dedicated efforts of many skilled personnel for over two decades, and has returned more new knowledge about the outer planets than had existed in all of the preceding history of astronomy and planetary science. And the two Voyager machines are still performing like champs. It must come as no surprise that there are many remarkable, "gee-whiz" facts associated with the various aspects of the Voyager mission. These tidbits have been summarized below in appropriate categories. Several may seem difficult to believe, but they are all true and accurate.

OVERALL MISSION

•The total cost of the Voyager mission from May 1972 through the Neptune encounter (including launch vehicles, nuclear-power-source RTGs, and DSN tracking support) is 865 million dollars. At first, this may sound very expensive, but the fantastic returns are a bargain when we place the costs in the proper perspective. It is important to realize that:

1. on a per-capita basis, this is only 20 cents per U.S. resident per year, or roughly half the cost of one candy bar each year since project inception.

2. the daily interest on the U.S. national debt is a major fraction of the entire cost of Voyager.

•A total of 11,000 workhorse will have been devoted to the Voyager project through the Neptune encounter. This is equivalent to one-third the amount of effort estimated to complete the great pyramid at Giza to King Cheops.

•A total of five trillion bits of scientific data will have been returned to Earth by both Voyager spacecraft at the completion of the Neptune encounter. This represents enough bits to encode over 6000 complete sets of the Encyclopedia Britannica, and is equivalent to about 1000 bits of information provided to each person on Earth.

•The sensitivity of our deep-space tracking antennas located around the world is truly amazing. The antennas must capture Voyager information from a signal so weak that the power striking the antenna is only 10-16 watts (1 part in 10 quadrillion). A modern-day electronic digital watch operates at a power level 20 billion times greater than this feeble level.

VOYAGER SPACECRAFT

•Each Voyager spacecraft comprises 65,000 individual parts. Many of these parts have a large number of "equivalent" smaller parts such as transistors. One computer memory alone contains over one million equivalent electronic parts, with each spacecraft containing some five million equivalent parts. Since a color TV set contains about 2500 equivalent parts, each Voyager has the equivalent electronic circuit complexity of some 2000 color TV sets.

•Like the HAL computer aboard the ship Discovery from the famous science fiction story 2001: A Space Odyssey, each Voyager is equipped with computer programming for autonomous fault protection. The Voyager system is one of the most sophisticated ever designed for a deep-space probe. There are seven top-level fault protection routines, each capable of covering a multitude of possible failures. The spacecraft can place itself in a safe state in a matter of only seconds or minutes, an ability that is critical for its survival when round-trip communication times for Earth stretch to several hours as the spacecraft journeys to the remote outer solar system.

•Both Voyagers were specifically designed and protected to withstand the large radiation dosage during the Jupiter swing-by. This was accomplished by selecting radiation-hardened parts and by shielding very sensitive parts. An unprotected human passenger riding aboard Voyager 1 during its Jupiter encounter would have received a radiation dose equal to one thousand times the lethal level.

•The Voyager spacecraft can point its scientific instruments on the scan platform to an accuracy of better than one-tenth of a degree. This is comparable to bowling strike-after-strike ad infinitum, assuming that you must hit within one inch of the strike pocket every time. Such precision is necessary to properly center the narrow-angle picture whose square field-of-view would be equivalent to the width of a bowling pin.

•To avoid smearing in Voyager's television pictures, spacecraft angular rates must be extremely small to hold the cameras as steady as possible during the exposure time. Each spacecraft is so steady that angular rates are typically 15 times slower than the motion of a clock's hour hand. But even this will not be quite steady enough at Neptune, where light levels are 900 times fainter than those on Earth. Spacecraft engineers have already devised ways to make Voyager 30 times steadier than the hour hand on a clock.

•The electronics and heaters aboard each nearly one-ton Voyager spacecraft can operate on only 400 watts of power, or roughly one-fourth that used by an average residential home in the western United States.

•A set of small thrusters provides Voyager with the capability for attitude control and trajectory correction. Each of these tiny assemblies has a thrust of only three ounces. In the absence of friction, on a level road, it would take nearly six hours to accelerate a large car up to a speed of 48 km/h (30 mph) using one of the thrusters.

•The Voyager scan platform can be moved about two axes of rotation. A thumb-sized motor in the gear train drive assembly (which turns 9000 revolutions for each single revolution of the scan platform) will have rotated five million revolutions from launch through the Neptune encounter. This is equivalent to the number of automobile crankshaft revolutions during a trip of 2725 km (1700 mi).

•The Voyager gyroscopes can detect spacecraft angular motion as little as one ten-thousandth of a degree. The Sun's apparent motion in our sky moves over 40 times that amount in just one second.

•The tape recorder aboard each Voyager has been designed to record and playback a great deal of scientific data. The tape head should not begin to wear out until the tape has been moved back and forth through a distance comparable to that across the United States. Imagine playing a two-hour video cassette on your home VCR once a day for the next 22 years, without a failure.

•The Voyager magnetometers are mounted on a frail, spindly, fiberglass boom that was unfurled from a two-foot-long can shortly after the spacecraft left Earth. After the boom telescoped and rotated out of the can to an extension of nearly 13 meters (43 feet), the orientations of the magnetometer sensors were controlled to an accuracy better than two degrees.

NAVIGATION

•Each Voyager used the enormous gravity field of Jupiter to be hurled on to Saturn, experiencing a Sun-relative speed increase of roughly 35,700 mph. As total energy within the solar system must be conserved, Jupiter was initially slowed in its solar orbit---but by only one foot per trillion years. Additional gravity-assist swing-bys of Saturn and Uranus were necessary for Voyager 2 to complete its Grand Tour flight to Neptune, reducing the trip time by nearly twenty years when compared to the unassisted Earth-to-Neptune route.

•The Voyager delivery accuracy at Neptune of 100 km (62 mi), divided by the trip distance or arc length traveled of 7,128,603,456 km (4,429,508,700 mi), is equivalent to the feat of sinking a 3630 km (2260 mi) golf putt, assuming that the golfer can make a few illegal fine adjustments while the ball is rolling across this incredibly long green.

•Voyager's fuel efficiency (in terms of mpg) is quite impressive. Even though most of the launch vehicle's 700 ton weight is due to rocket fuel, Voyager 2's great travel distance of 7.1 billion km (4.4 billion mi) from launch to Neptune results in a fuel economy of about 13,000 km per liter (30,000 mi per gallon). As Voyager 2 streaks by Neptune and coasts out of the solar system, this economy will get better and better!

SCIENCE

•The resolution of the Voyager narrow-angle television cameras is sharp enough to read a newspaper headline at a distance of 1 km (0.62 mi).

•Pele, the largest of the volcanoes seen on Jupiter's moon Io, is throwing sulfur and sulfur-dioxide products to heights 30 times that of Mount Everest, and the fallout zone covers an area the size of France. The eruption of Mount St. Helens was but a tiny hiccup in comparison (admittedly, Io's surface-level gravity is some six times weaker than that of Earth).

•The smooth water-ice surface of Jupiter's moon Europa may hide an ocean beneath, but some scientists believe any past oceans have turned to slush or ice. In 2010: Odyssey Two, Arthur C. Clarke wraps his story around the possibility of life developing within the oceans of Europa.

•The rings of Saturn appeared to the Voyagers as a dazzling necklace of 10,000 strands. Trillions of ice particles and car-sized bergs race along each of the million-kilometer-long tracks, with the traffic flow orchestrated by the combined gravitational tugs of Saturn, a retinue of moons and moonlets, and even nearby ring particles. The rings of Saturn are so thin in proportion to their 171,000 km (106,000 mi) width that, if a full-scale model were to be built with the thickness of a phonograph record the model would have to measure four miles from its inner edge to its outer rim. An intricate tapestry of right-article patterns is created by man complex dynamic interactions that have spawned new theories of wave and particle motion.

•Saturn's largest moon Titan was seen as a strange world with its dense atmosphere and variety of hydrocarbons that slowly fall upon seas of ethane and methane. To some scientists, Titan, with its principally nitrogen atmosphere, seemed like a small Earth whose evolution had long ago been halted by the arrival of its ice age, perhaps deep-freezing a few organic relics beneath its present surface.

•The rings of Uranus are so dark that Voyager's challenge of taking their picture was comparable to the task of photographing a pile of charcoal briquettes at the foot of a Christmas tree, illuminated only by a 1 watt bulb at the top of the tree, using ASA-64 film. And Neptune light levels will be less than half those at Uranus.

THE FUTURE

•The solar system does not end at the orbit of Pluto, the ninth planet. Nor does it end at the heliopause boundary, where the solar wind can no longer continue to expand outward against the interstellar wind. It extends over a thousand times farther out where a swarm of small cometary nuclei, termed Oort's Cloud, is barely held in orbit by the Sun's gravity, feeble at such a great distance. Voyager 1 passed above the orbit of Pluto in May 1988, and Voyager 2 will pass beneath Pluto's orbit in august 1990. But even at speeds of over 35,000 mph, it will take nearly 20,000 years for the Voyagers to reach the middle of the comet swarm, and possibly twice this long for them to pass the outer boundaries of cometary space. By this time, they will have traveled a distance of two light-years, equivalent to half of the distance to Proxima Centauri, the nearest star.

•Barring any serious spacecraft subsystem failures, the Voyagers may survive until the early twenty-first century, when diminishing power and hydrazine levels will prevent further operation. Were it not for these dwindling consumables and the possibility of losing lock on the faint Sun, our tracking antennas could continue to "talk" with the Voyagers for another century or two!

FROM THE OBSERVATORY

by Bernard Friberg

The open house schedule at Peach Mountain for the next four months is as follows: Saturday Jan. 20 and the 27; February 17 and the 24; March 16 and the 23; April 13 and the 20. A Leslie Science Center open house is scheduled for Friday April 26. The MOON WALK / A NIGHT WALK ON PEACH MOUNTAIN is scheduled for the April 20 open house. We are looking for volunteers to staff special events, such as the talk on constellations (with telescopes in an open field), a talk on specific object types (galaxies, globular clusters etc.) , a talk on the radio telescope, a slide show. Volunteers are also needed for the welcome table, parking, signs etc. Suggestions for any of the above are also welcome.

HOW TO CLEAN MIRRORS AND LENSES

by Lenny Abbey

This file is an elaboration of a message sent in response to a request for help on ASTROFORUM in January, 1987. It is presented as an effort to assist those who have never had occasion to perform this delicate task.

The best advice on cleaning mirrors and lenses is.........<you guessed it> DON'T. But if things are so bad that you must, do it as follows:

FOR MIRRORS

1. Blow all loose dirt off with "Dust Off" or another canned clean air product. Take care not to shake the can while you are using it, and be sure to release a little air before using it on the optical surface. This will assure that no liquid is dispensed to make things worse! *[CAUTION - It is possible to blow the reflective coating off the mirror's surface if you hold the sprayer too close to the surface. Better yet don't use the canned air at all. Remove loose dirt with photographer's hand operated bulb sprayer. - Ed]*
2. Prepare a VERY dilute solution of mild liquid detergent (Dawn)
3. Rinse the mirror off under a moderate stream of lukewarm water.
4. Make a number of cotton balls from a newly opened package of Johnson & Johnson sterile surgical cotton, U.S.P. Soak 2 or 3 balls in the detergent solution. Wipe the surface of the wet mirror. The only pressure

on the cotton should be its own weight.
5. Throw cotton balls away.
6. Repeat process with new cotton balls, using a LITTLE more pressure.
7. Rinse mirror thoroughly under tap, which has been kept running for this step.
8. Rinse mirror with copious amounts of distilled water (do this no matter how clean your tap water is).
9. Set mirror on edge to dry, using paper towels to absorb the water which will all run to bottom of mirror. Keep replacing paper towels.
10. If any beads of water do not run to bottom, blow them off with Dust Off.
11. Replace mirror in cell, being careful to keep all clips and supports so loose that the mirror can rattle in the cell if it is shook. (Perhaps .5 to l mm clearance).
12. Spend the next month realigning your scope.
13. If you do anything more than this, you will damage the coating, and maybe the glass.

FOR OBJECTIVE LENSES

DO NOT UNDER ANY CIRCUMSTANCES REMOVE A LENS FROM ITS CELL, OR THE CELL FROM THE TELESCOPE. This restriction means that the above procedure must be modified. Only the front surface can be cleaned. If you remove the cell from the telescope, you will be in big trouble. There are probably not more than 25 people in this country who can effectively collimate a refractor!

1. Blow loose dirt off with Dust-Off, using the above precautions.
2. Soak the cotton balls in a 50:50 solution of Windex and water. Squeeze slightly so that the balls are not dripping wet.
3. Wipe front lens surfaces with the wet cotton. Follow immediately with dry cotton, using little or no pressure.
4. Repeat procedure, using slightly more pressure.
5. If some cotton lint remains on surface, blow off with Dust-Off.
6. Repeat procedure if lens is not clean, but if one repeat does not do it give up and leave it as is.
7. Inspect lens to make sure that no cleaning solution has found its way into the lens cell, or between the elements. If this has happened, leave the telescope with the lens uncovered in a warm room until it is dry.

FOR EYEPIECES AND BARLOWS

Follow the procedure given for objective lenses, but use Q-Tips (with plastic sticks) instead of cotton balls. You may, of course, clean both surfaces. The eyebrow juice on the eye lens of eyepieces may require repeated applications. I think that this is OK in this case.

SOME DONT'S

1. Do not use any aerosol spray product, no matter who sells it, or what their claims are.
2. Do not use lens tissue or paper. It DOES scratch.
3. Do not use prepackages cotton balls, they frequently are not cotton.
4. Do not use any kind of alcohol.
5. Do not use plain water.
6. Do not use any lens cleaning solution marked by funny companies, like Focal, Jason, Swift, or even Edmund's. Dawn and Windex are cheap and commonly available.

Treasurer's Report

by Doug Scobel

Congratulations! All Lowbrow shirts and 1996 calendars have been sold! Thanks for a job well done, and you won't have to listen to me whining about needing to get rid of them any more, until next winter, anyway. If you missed out on a calendar, you may still be able to get them locally at bookstores, or I can order them through Sky Publishing at "normal" prices (you can kiss the special eight dollar price goodbye!). Speaking of Sky, all ordered items (Observer's Handbooks, books, posters, etc.) are in, and I promise that this time I'll remember to bring them to the meeting. Give me a call if you need to make other arrangements for pick-up. As always, you can order Sky Publishing catalog items through me any time, at a 10% club discount.

Just a reminder, if you renew a *Sky & Telescope* or *Astronomy* magazine subscription through me, be sure to supply me your subscription renewal notice and envelope. It'll make things a little easier for me, and your renewal will probably be processed faster to boot. As with all money you submit to me, be sure to make your check payable to "University Lowbrow Astronomers".

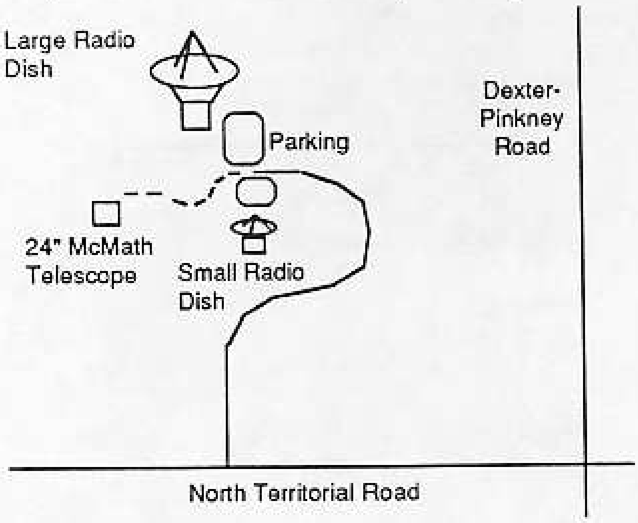
I'll bring an overview of the club's finances over the past year to the next meeting. If you want to know more about any details, just give me a call or find me at the meeting.

"Who were they, what lonely men,
Imposed on the fact of night,
The fiction of the constellations"
- Patric Dickinson

Places:

Dennison Hall, also known as The University of Michigan's Physics and Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. It is found in Ann Arbor on Church Street about one block north of South University Avenue. The meeting is held in room 807.

Peach Mountain Observatory is the home of The University of Michigan's 25 meter radio telescope as well as the University's McMath 24 inch telescope which is maintained by the Lowbrows. The observatory is located northwest of Dexter. The entrance is on North Territorial Road, 1.1 miles west of Dexter-Pickney Road. A small maize-and-blue sign marks the gate. Follow the gravel road one mile to a parking area near the radio telescopes. Walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.



Times:

Monthly meetings of the Lowbrows are held on the 3rd Friday of each month at 7:30 PM in 807 Dennison Hall. During the summer months, and when weather permits, a club observing session at Peach Mountain will follow the meeting.

Computer subgroup meetings are held on the first of each month, rotating among member's houses. See the calendar on the cover page for the location of next meeting.

Public Open House/Star Parties are held on the Saturday before and after each new Moon at the Peach Mountain Observatory. Star Parties are canceled if the sky is cloudy at sunset or the temperature is below 10 degrees F. Call 480-4514 for a recorded message on the afternoon of a scheduled Star Party to check on the status. Many members bring their telescopes and visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitos - bring insect repellent, and it does get cold at night so dress warmly !

Dues:

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students. This entitles you to the monthly REFLECTIONS newsletter and the use of the 24" McMath telescope (after some training). Dues can be paid to the club treasurer Doug Scobel either at the monthly meeting or by mail at:
Doug Scobel
1426 Wedgewood Drive
Saline, MI 48176

Magazines:

Members of the University Lowbrow Astronomers can get a discount on these magazine subscriptions:
Sky and Telescope: $24 / year
Astronomy: $20 / year
Odyssey: $16.95 / year
For more information contact the club Treasurer. Members renewing subscriptions are reminded to send your renewal notice along with your check when applying through the club Treasurer.

Newsletter Contributions:

Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call the Newsletter Editor Chris Sarnecki at 426-5772 or e-mail to chrisandi@aol.com to discuss length and format. Announcements and articles are due by the first Friday of each month. Articles should be mailed to:
Christopher Sarnecki
4835 Holly Way
Ann Arbor, MI 48103

Telephone Numbers

President:	Bill Razgunas	995-0934
Vice Pres:	Mark Cray	283-6311
	DC Moons	254-9439
	Tom Pettit	878-0438
	Tom Ryan	662-4188
	Randy Stevenson	429-5099
Treasurer:	Doug Scobel	429-4954
Observatory Director:	Bernard Friberg	761-1875
Newsletter:	Chris Sarnecki	426-5772
Peach Mtn Keyholder:	Fred Schebor	426-2363

MONTHLY MEETING:

TURBULENCE IN THE NEAR EARTH'S SPACE ENVIRONMENT

by Doug Drob

Find out all about the experiments near the Radio Telescope

January 19, 1996
at 7:30 pm in
Dennison Hall
Room 807

Eta Carinae,"Key-hole Nebula", NGC 3372 in Carina, RA 10h 44m, DEC -59d 52m, 7 mag. (-11 absolute mag. !) Approximately 3,700 light years distant.

University Lowbrow Astronomers
1740 David Ct.
Ann Arbor, MI 48105

Check your membership expiration date on the mailing label !