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NAAPO (North American AstroPhysical Observatory)

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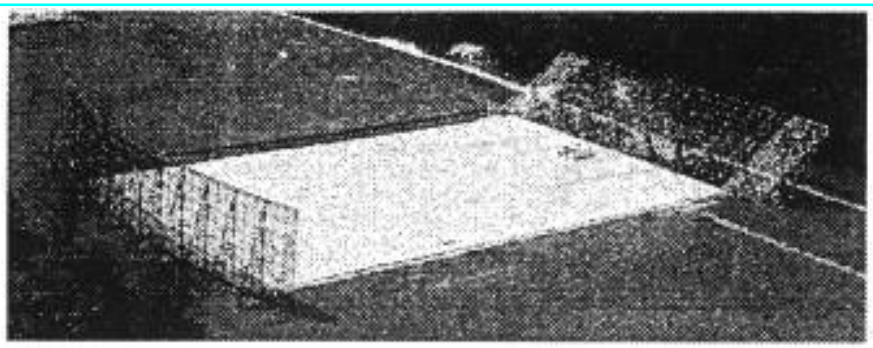
SIGNALS



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COORDINATOR'S CORNER
By: Phil Barnhart

We are just a year from the end of the trail at the site of the 110-meter radio telescope affectionately dubbed 'Big Ear'. Unwillingness to continue to service the site at minimal cost and the opportunity to cash in on a lease break for the owners and developers of the land has meant the university washes its hands of the site. We must seek a new home.

Not that it is all bad. Those of us who have moved at some time in our life know that part of the process involves purging and rearranging priorities. There is growth potential in the nomadic life.

Our big opportunity now lies in developing a new radio astronomy technology that separates itself from the long standing tradition begun by Galileo when he directed his 'optik tube' at the sky. That tradition evolved in the nearly four centuries since that time to greater and greater aperture with ever decreasing angular coverage of the sky. With the exception of the 20th Century development of the wide field Schmidt Camera, which even in the largest models still only covered about 0.4% of the entire sky at a time, telescopes at all wavelengths have driven toward smaller and smaller portions of the sky at any one time. With conventional telescopes to observe one hemisphere of the sky at one time would require about 500,000 Arecibo dishes or 680,000 5-meter Palomar telescopes.

For the cost of a quality, automated 1.5-meter visible reflector we are proposing to build a radio telescope that will catch everything that happens over nearly a hemisphere of the sky in real time Our prototype will not be as sensitive as the present Big Ear, but it can be expanded to that capability for the cost of a good 5-meter optical telescope. To accomplish the same job with an array of large 100 meter radio dishes would cost 500,000 times the cost of the new Green Bank dish antenna ($175,000,000?)! We offer a bargain.

Negotiations are on for a new home for the Big Ear project. We have hardware in development. Software is in the planning stage. There is already a home page on the Internet. Drop in for further developments at WWW.BIGEAR.ORG.

VOLUNTEER PROFILE: Cindy Brooman

0ne of our more recent volunteers, Cindy has had a long time interest in Astronomy. She is a charter subscriber to Cosmic Search magazine and took a course in introductory astronomy at Ohio Wesleyan University. She has a degree with majors in Biology and Chemistry, a minor in German Literature and advanced coursework in Biochemistry. Cindy came to one of the open house sessions a couple of years ago and learned that volunteers were welcome. Since joining the cause she has worked on the punch card project, engaged in the Muirfield Green painting project (*the purpose of which was NOT to end up with green volunteers, but the*

result was green volunteers) and has assisted with vigor the open house routine. Her major contribution has been a project to try to get Cosmic Search on a CD-ROM and to provide a World Wide Web Page for the Radio Observatory. She is maintaining the Web Site and reports a large number of contacts from all over the world.

Her professional background includes Programming/Analysis for a State Agency, technical illustration (*textbook*), and combining the two into a home based company doing graphics, content and programming for the World Wide Web.

When asked what satisfaction she gains from affiliation with NAAPO she commented, "Although all of the volunteers are somewhat different in their background, we all have at least one thing in common, and that is our interest in Astronomy and SETI. It's nice to get together with people who have similar interests, whether for serious discussion or just plain fun."

Cindy sparks up the Saturday meetings and recognizes the weakness for chocolate most of us have. Her wit, charm and general ability make her a definite asset to the cause.

GALILEO MISSION STATUS
December 10, 1996

The Galileo spacecraft is operating properly, with data playback from the recent flyby of the Jovian satellite Callisto continuing as engineers prepare the spacecraft for its upcoming first encounter with the intriguing moon Europa on December 19th.

Some images from the Callisto encounter are taking longer to return because the targets contain more variation in their scenes and therefore contain more data per frame. The Galileo flight team hopes to be able to complete most of the planned data return including Europa images, recorded during the Callisto encounter before the Europa encounter begins next week.

Last week, new software commands were successfully radioed to the spacecraft to further improve certain recording operations. In addition, Galileo's attitude control system received a parameter adjustment, and new flight software was installed in the spacecraft's dust instrument.

Recent results from Galileo's fields and particles experiments from studies of the moon Ganymede will be published in the science journal Nature this week. A NASA press briefing, televised live on NASA Television, is scheduled for Thursday, Dec. 12, at 11 a.

m. Pacific time (*2 p.m. Eastern time*) to discuss the results and preview the upcoming Europa flyby. NASA Television is available through the Spacenet 2 satellite on transponder 5, channel 9, 69 degrees west longitude, frequency 3880 MHz, audio subcarrier 6.8 MHz, horizontal polarization.

PIONEER 10 GETS THE AX

Found on the Internet

Due to budget cuts, NASA will be terminating the Pioneer 10 mission on March 31, 1997, despite the fact that it is NASA's most distant spacecraft, and is still sending back important data with its Geiger Tube Telescope (GTT), and is exploring a region of space not explored by the Voyagers or the now-defunct Pioneer 11, the tail of the heliosphere. It could have continued the GTT data into late 1997, and continued transmitting into 1998. However, the $500,000 dollars needed to continue operations apparently could not be found.

11/16/96 MEETING NOTES
By: Earl Phillips

Attending today's meeting were: Brooman, Barnhart, Dixon, Phillips, James, Ehman, Campanella, and Brown.

Dr. Barnhart brings aerial photos of the grounds recently taken with the assistance of pilot Ang Campanella. It was also reported that the east gate to the ground plane is wrecked, and another way must be found to secure the area.

Don James reports that the crane is operational, but it's battery must be recharged. The truck's battery is not in such good shape, though he feels as though the truck could be convinced to run, given enough work.

Dr. Dixon brings more photos of his recent trip to Belgium. He received a request from a scout group for a tour during our next meeting (12/7/96), and Cindy Brooman eagerly volunteered to lead the tour. He has been surfing the web looking for antenna design software, and feels he has found several good packages. Jerry Ehman volunteered to download some of them and test them. It is felt that this will save a lot of work in building and testing various designs if some of it can be done electronically. He has begun writing a proposal to the *SETI Institute* for **ARGUS**.

Steve Brown reports that he has suffered a lot of test equipment failure recently, and is

attempting to make repairs.

Jerry Ehman reports that he has done some research on helical antennae. He brings a *Dispatch* article on one of our donors, George Foster, and an article from the *Delaware Gazette* on seismology at Perkins Observatory.

Cindy Brooman reports that she was contacted by someone asking what the "6EQUJ5" meant on the "WOW" printout. She has requested that someone write an explanation that she can include on the Big Ear web site. The meeting broke at roughly 11:15am.

MARS PROBE ON ITS WAY

NASA's new Mars probe is wobbling its way through space, but NASA officials said the spacecraft was having a minor problem they expected to resolve soon.

The Mars Global Surveyor, which blasted off from Cape Canaveral, picked up the slight wobble because one of its two solar panels was askew, the officials said.

The balky wing-like solar array was angled about 20 degrees from its intended position, upsetting the spacecraft's balance as it headed into deep space.

Engineers had suspected that part of the panel's hinge mechanism may have become too cold, causing it to stick, but Friday that was seen as a less-likely explanation.

"Our original supposition that a cold damper was involved is fading with time, so we continue to look for the real answer," mission director Glenn Cunningham said in a statement.

Despite the problem, the 18-feet-square panel was generating more than enough electricity to power the one-ton probe.

Space agency officials said they expected to resolve the difficulty before a crucial engine firing later this month to place the craft on course for Mars.

"We are not overly concerned about this because, if necessary, we can use motor-driven gimbals to place the panel at the desired angle," said Cunningham.

Mars Global Surveyor is the first in a trio of spacecraft destined for the Red Planet this year. It is due to arrive in September 1997 and will begin a two-year survey of Mars six

months later.

NASA's next Mars mission, which will land a six-wheeled rover on the planet's surface, is due for launch Dec. 2.

WATER DISCOVERED ON MOON

Scientists, authors, and dreamers have for decades propounded on the possibility of building human colonies on the moon. Their visions may have taken a huge step toward reality with the discovery of frozen water on a body thought to have been more arid than a desert. A lake-like mass of ice the size of four football fields has been detected at the bottom of a 10 mile-deep crater on the moon's dark south pole by Clementine, a US satellite built to test technology for a space-based antiballistic missile defense system.

The discovery of the lake, first made in 1995 and revealed this week, holds profound implications for the future of lunar exploration. The ice it contains, thought to be "tens of feet deep," could potentially be used to sustain a human colony by providing it with a source of drinking water, irrigation for crops, and oxygen for breathing.

"The fact that there is a potential resource there increases clearly the moon's desirability as a way station in space," says Wes Huntress, who heads the National Aeronautics and Space Administration's office of space science. "If it can't be used as a way station, it could be used for humans to live and train for life for planetary bodies."

There is a further possibility that the hydrogen and oxygen from the water could be processed into rocket fuel for return trips to Earth. "This would eliminate the need to carry a round-trip supply (of fuel)," says Rick Lehner, a spokesman for the Pentagon's Ballistic Missile Defense Organization, popularly known as star wars. "It could end up that you might be able to harvest this water."

The discovery comes only months after NASA announced that scientists had found evidence life may have existed more than 3.6 billion years ago on Mars, where there are huge amounts of frozen water, a basic necessity for life. Strong evidence of liquid water on Jupiter's moon Europa has fueled speculation about the existence of primitive life below that satellite's icy surface. But there's no speculation now that the presence of water on the moon holds a similar potential. "Scientists ... don't seem to have looked at the possibility of life within the water, but mainly at its (future) application," says Mr. Lehner.

The discovery comes at a time of renewed interest in lunar exploration, not just by US

scientists, but by Europe and Japan, which has what Boston University astrophysicist Michael Mendillo calls "a very aggressive program" to explore the moon and exploit its resources. Next September, NASA will launch Lunar Prospector, a $63 million mission to map 80 percent of the moon, as well as record its mineral distribution. It will also look for signs of water.

Clementine's discovery involved some serendipity. The $75-million spacecraft was using the moon as a target for a research radar, and scientists were intrigued by readings from the crater's depths. During lengthy analysis, the signals were compared with those from frozen water masses detected on other planets and found to be similar. Although there was a lot of debate at first, now "there seems to be a consensus ... that it is water ice," says Lehner.

The ice could be 3.6 billion years old. The moon's age is estimated at about 4 billion years. "The theory is that the ice came as a result of the tail of a comet or the collision of an asteroid or meteor with the surface of the moon," Lehner says. An early theory that water could exist on the moon was dispelled by the geological specimens brought back by the six Apollo missions.

Now, the prospect of using the moon's water as a basis for human colonies depends on where it is and how easily it can be recovered. Researchers still may find that importing water from Earth would be cheaper than taking chips of the moon's blocks. Yet the discovery is significant, Dr. Mendillo says, if for no other reason "than it reminds us once again that the early solar system was a very violent place."

HUBBLE SPIES SUPERSONIC "COMET-CLOUDS" IN HEART OF GALAXY

Analyses of dramatic images by NASA's Hubble Space Telescope reveal immense comet-shaped knots of gas in the heart of the Cartwheel galaxy, a peculiar looking wagon-wheel shaped galaxy which collided with another galaxy.

Their discovery may eventually help explain why the center of the Cartwheel galaxy has little star formation, and what causes the unusual spoke pattern between the bright outer ring of young stars and the mysterious, dusty galactic nucleus.

A team of astronomers used Hubble's Wide Field Planetary Camera 2 to probe the nucleus of the Cartwheel galaxy, which has an unusual network of dust lanes but lacks giant starbirth regions found in our own Milky Way. They were surprised to find comet-like features crossing a dust lane. The objects uncovered by Hubble really aren't comets

because they are far too huge. The "heads" are a few hundred light-years across and the tails are more than 1,000 light-years long, the longest being nearly 5,000 light-years long.

The "comet heads" are most likely vast clouds of molecular hydrogen, similar to those found in our own Milky Way galaxy. The "tails" are an incandescent wake of hot glowing gasses and possible newborn stars, as suggested by their bluish color in the Hubble images. The structures look like comets because they probably result from a collision between high speed and slower moving material. This creates an arrowhead-shaped pattern called a bow-shock, similar to the wake of a boat speeding across a lake. Researchers conclude the maelstrom was kicked up by a nearly head-on collision between the Cartwheel galaxy and a smaller galaxy 200 million years ago. This makes the Cartwheel galaxy a unique laboratory for studying supersonic collisions between massive clouds and large scale "ripples" of gas created by the collision.

One possible explanation for the features results from the fact that during the collision gas clouds are pulled inward, but afterwards they are released to oscillate around their original position like a plucked guitar string. (*These oscillations are around the balance point between centrifugal and gravitational forces*). Comets may result when large clouds plowing through space at nearly 700,000 miles per hour, smash into a ring of gas and dust pushing outwards as part of the next oscillation. A second explanation is that the spokes and "comets" may represent a later stage where material begins falling back into the galaxy — a phenomena not seen in most other ring-shaped galaxies younger than the Cartwheel. In this scenario, the molecular cloud "comet heads" were first splashed out from the galaxy's plane, and, like a baseball tossed into the air, the clouds slowed and then fell back into the galaxy. As they plummet, they locally heat interstellar gas to more than a million degrees Fahrenheit.

The new findings were made by Curt Struck, Philip Appleton (*Iowa State University*), Kirk Borne (*Hughes STX Corporation*), and Ray Lucas (*Space Telescope Science Institute*). Their results appear in the November issue of the Astronomical Journal.

The puzzling findings call for a variety of follow-on observations, including spectroscopy of the "comets" and X-ray observations to search for shocked gas in the nucleus.

The Cartwheel galaxy is located 500 million light-years away in the constellation Sculptor.

LIBRARY RESEARCHER NEEDED!
From: Bob Dixon

We badly need a volunteer to get articles relevant to the **Argus** project for us. I have all the exact references, but someone needs to get the actual articles and xerox them so we can study them. Some of them are in obscure references and require some detective work. Some of the articles can be ordered by computer thru OSU, and others require in-person visits to the OSU libraries.

A side benefit is that this volunteer will learn a great deal about how to use libraries. Can someone do this for us?

Saturday, December 7, 1996 Meeting Notes
By: Tom Hanson

Attending: Russ Childers, Cindy Brooman, Jerry Ehman, Bob Tournoux, Guest of Bob, John Ayotte, Ken Ayotte, Dr. Barnhart, Dr. Dixon, Ron Leeseberg, Ang Campanella , Steve Brown

As I arrived, Dr. Dixon's opening monolog was in progress.

Correspondence was discussed and circulated, and an Argus Proposal is under development.

Dr. Barnhart — There appears to be a new box on stilts on ground plane, which might suggest the ElectroScience Lab folks are active in experiments again. Russ Childers said he had not noticed anything new.

Ron Leeseberg — Ron is building a radio observatory at home. He reported that his 'new' 386 system is operating. A sound card is working. Ron still needs to build an adapter card to complete the system.

Ang Campanella — Ang went through his archives recently. He found notes on work he had done on helixes in 1954. John Ayotte asked to see these, and said he would make copies. Dr. Dixon asked to see the work as well. In addition, Ang found some NASA publications which seem pertinent to the Argus project.

Tom Hanson — old 286's (*IBM PS/2 Model 50's*) are available for donation. In the absence of strong objection from the members in attendence, Tom will bring some of

these systems to the next meeting.

Earl Phillips — asking for contributions to *Signals*. Earl was present in spirit, thanks to Dr. Barnhart, who made this appeal on Earl's behalf.

Russ Childers — Declination is -22 degrees even — moving 1/3 a degree per week. RFI and data collection are going on two days a week. Made numerous CDs recently, due to attending a class at OSU. Russ took advantage of equipment and staff in the multimedia lab on campus. The equipment works very well. The staff at the multimedia lab are pretty good. The time consuming part of the job is transferring data from zip drive to Macintosh.

Dr. Dixon — have we any plans to copy data from 8 inch PDP floppy disks? Russ said that a volunteer would be needed. The data would have to be transferred from floppy to serial line to a PC.

Ken Ayotte — CD Rom writer at school died. There is talk of repair, but nothing has happened yet.

Dr. Barnhart inquired about how many 8 inch floppies we have.

Bob Tournoux is still looking for more 8 inch floppies at work.

Russ — we now have 9 sets of CDs of LOBES data. We had data on zip disks from April. The class Russ is taking is C++ Object Oriented Programming course - 1 Credit Hour (*Pass/Fail*).

Cindy Brooman — Big Ear has received over 3000 hits (*document requests*). Estimate of over 1,000 visitors.

Jody McKean — sent membership list to Cindy. Cindy will be contacting Jody to confirm accuracy of the data file, after installation on her server. Apparently translation of the data from Jody's Macintosh to Cindy's Intel system resulted in minor alterations of the text.

Discussion of comets — Dr. Dixon — comets naturally give off radio signals.

Cindy made Herb Johnson slides into prints, but the company did not do a good job. John Ayotte volunteered to try to scan the 43 slides. He will try a slide, and if it works, then John will try more.

Discussion — comparison of Herb's collection to collections held by Drs. Dixon and Barnhart. Apparently some of Herb's slides are also included in Dixon/Barnhart presentations.

Cindy has a 486 66MHz 16 MB RAM, 1 gig HD, stealth video modem, sound card, which she is offering for use by Radobs. What operating system should be loaded? Russ — DOS 5.0 is on LOBES. Note: NT 4.0 is a memory hog.

Jerry Ehman — Dr. Dixon provided URL for getting information on antenna design — Evaluation version of antenna modelling program does not save data, so the operator has to reenter the data each time the program is run. Jerry downloaded a Windows 3.1 version. The program only handles straight line segments, so the operator has to enter multiple line segments for the helix problem. Jerry circulated an article about 'Dornoch' Golf Club. Jerry circulated an article about issues relating to planning for new optical observatory, in which OSU will be a participant.

Dr. Barnhart — discussion of negotiations for use of Kitt Peak 20 years ago. Comparison of negotiations with Apaches. Discussion of issue of red squirrels. Their population has increased after hunting stopped.

Steve Brown arrived.

Bob Tournoux — still looking for eight inch disks. The people who have them have been on vacation. Bob has access to a CD writer. Bob changed his Internet address.

Dr. Dixon offered to help Bob change the distribution of the Radobs mailing list to reflect Bob's new address. Bob offered a CDROM reader for the system Cindy is donating. Such a capability would be helpful, considering the volume of data which Russ Childers and supporters have written to CDROM.

Mininec is the name of the program which Jerry is evaluating. Bob Tournoux may have access to the program.

Dr. Dixon — article in Delaware Gazette — there is some opposition to the Dornoch plan to annex property on which Big Ear stands.

David Tournoux — Hilliard school district-6th grade; David was Bob's guest today — He described a school activity called Future Problem Solvers — students are supposed to find

problems, and then find possible solutions. David's group is now studying extraterrestrial intelligence.

Vocabulary sheet — didn't have Big Ear. Dr. Barnhart inquired if the vocabulary sheet would be updated to include the name of this important installation.

15 people are in David's 'fuzzy' project group. The group was invited to visit Big Ear.

Gerschbacher(?), Mrs. — teacher

John Ayotte — show and tell time — Argus antenna design work. Large roll of paper and actual cone on table. Discussion of what helixes might look like. Paper helix on table — about a foot high, with base diameter of about 10 inches, and top diameter of about 5 inches. Russ Childers pointed out that the model looks a great deal like a party hat. Red and blue tapes circle the cone. Each rising element circles the cone once exactly. Clarification — what I took to be red and blue tapes were in fact printed on a color printing plotter. John will confirm the model makes sense, and if it does he will move to construction of a model with actual conductors.

Article: Electronics Magazine May 30, 1966. Latest Word in Space Talk: It can come from anywhere. William Korvin, NASA. George G. Chadwick, Radiation Systems. Phased array antenna provides satellites with coverage in all directions, with high gain transmitting or receiving during communication with ground stations or other satellites.

Continuing discussion of John Ayotte's paper antenna model. Dr. Dixon, Ang Campanella, Steve Brown, Jerry Ehman, John Ayotte all participated in the discussion. Dr. Dixon — do we want antenna to be dual polarized from the beginning or not? If we do, then we need dual receivers. An alternative might be to provide a switch. John is thinking ahead to how antenna's such as his model might be mass produced. Dr. Dixon — conference — French company — antenna: unrolled foil and there was the entire phased array.

Discussion — should we make the antenna more wideband from the beginning? The model is optimized for 400 MHz. Dr. Barnhart asked if it might be possible to tap into the antenna elements wherever they cross. Dr. Dixon responded that the signal must be withdrawn at the ends of the elements. Steve Brown said that it is common practice to test the performance of an antenna design by transmitting from it. The desired gain for this antenna design is 2, according to Jerry Ehman. Dr. Dixon said the desired gain would be

as low as possible. Jerry Ehman optimized without a ground plane, energy would be received from the ground. Dr. Dixon said that if the antenna is tapped properly, there would not be a ground facing lobe. Ron Leeseberg inquired if there is a simple way to measure antenna performance. John Ayotte replied that the network analyzer which Dan Fleisch has available at work can perform analysis and recording very rapidly. Steve Brown optimized it is very difficult to collect all the energy radiated by an antenna, without altering the pattern of radiation. Discussion of mounting method. Comparison of pole mounting and ground mounting. Frost heaving. 12 foot poles swaying in the wind. Question: could traffic cones by used for initial testing of this design? There seems to be some agreement that this might be a useful idea. Dr. Dixon cautioned that the physical characteristics of the plastic used for the cones may be important. Plastic traffic cones are an unknown quantity, and there would be no particular quality control in manufacture, with regard to factors effecting use as an antenna.

Ken Ayotte has started using his radio telescope. He has entered a Westinghouse talent contest. Ken is working at 612 MHz. Receiver components outside by the antenna are being effected by temperature changes. Ang suggesting putting the equipment box in a picnic cooler. Russ suggested adding a heater to the system, to try to maintain a constant temperature. Ang suggested that heat mass is important, in a heat control system. Steve Brown suggested using techniques developed for sourdough bread making, which needs constant temperature in the range of 90 degrees. Chicken incubators use lamps to maintain temperature. Ron Leeseberg suggested using a glow bar, which is used to maintain temperature in pianos, and to keep humidity down. There was some discussion of the benefit of locating the receiver equipment underground, in a suitable water-proof container.

PIONEER 10 & 11 STATUS
STATUS UPDATED: 2 December 1996

Pioneer 10
(*Launched 2 March 1972*)

* Distance from Sun (*1 November 1996*): 66.26 AU
* Speed relative to the Sun: 12.5 km/sec (*27,962 mph*)
* Distance from Earth: 9.76 billion kilometers (*6.06 billion miles*)
* Roundtrip Light Time: 18 hours 6 minutes
* Active Instruments:
    - o Charged Particle Instrument (*CPI*), Powered on for 3 weeks per month
    - o Geiger Tube Telescope (*GTT*), Powered on for 1 week per month

o Ultraviolet Photometer (*UV*), Powered on for 1 week per month

The spacecraft is healthy and continues to send back valuable scientific observations from the outer regions of our Solar System. The spacecraft is still supporting the Charged Particle Instrument (*CPI*). The battery has been absorbing some of the electrical load. The instrument will be turned off sometime in December.

Pioneer 11
(*Launched 5 April 1973*)

The Mission of Pioneer 11 has ended. Its RTG power source is exhausted. The last communication from Pioneer 11 was received in November 1995, shortly before the Earth's motion carried it out of view of the spacecraft antenna.

The spacecraft is headed toward the constellation of Aquila (*The Eagle*), northwest of the constellation of Sagittarius. Pioneer 11 may pass near one of the stars in the constellation in about 4 million years.

VOYAGER MISSION OPERATIONS STATUS REPORT #943
NOVEMBER 16 THROUGH NOVEMBER 22, 1996

COMMAND TRANSMISSION & VERIFICATION OPERATIONS

Voyager 1 command operations consisted of a command loss timer reset on 11/19 [DOY 324/1645z]. The command was received by the spacecraft.

Voyager 2 command operations consisted of seven bracketed command loss timer resets on 11/19 [DOY 324/1238z]. Elements two through seven of the seven sent were received by the spacecraft.

SEQUENCE GENERATION OPERATIONS

Review of the Preliminary AACS/SRF was supported per the Level 5 Schedule.

DATA RETURN OPERATIONS

Voyager 1 Data Processing and Operations: There were 111.3 hours of DSN scheduled support for Voyager 1 of which 8.0 hours were large aperture coverage. There were no real-time or schedule support changes during the period.

There were five significant outages; 1.3 hours on 11/19 [DOY 324] due to loss of interface with the APC at DSS-24 [DR G01412], 0.5 hours on 11/22 [DOY 327] due to a

SCP failure at SPC-60 [DR L00722], 1.3 hours on 11/22 [DOY 327] due to loss of interface with the APC at DSS-25 [DR G01425], 1.8 hours on 11/22 [DOY 327] due to subreflector problems at DSS-25 [DR G01426], and 0.8 hours on 11/22 [DOY 327] due to a power failure at SPC-10 [DR G01427].

Science instrument performance was nominal for all activities during this period. One frame of GS-4 data was recorded this week with the PLS modulator switched off. The EDR backlog is 1 days.

Voyager 2 Data Processing and Operations: There were 60.0 hours of DSN scheduled support for Voyager 2 of which 1.0 hours were large aperture coverage. There were two real-time changes; 0.6 hours and 0.5 hours of DSS-45 support were added on 11/17 [DOY 322] and 11/19 [DOY 324] respectively to enable the viewing of SSB commands from CCS Processor A. The total actual support for the period was 61.1 hours of which 1.0 hours were large aperture coverage.

There were two significant outages; 0.5 hours on 11/16 [DOY 321] due to rain at DSS-45 [DR A00762] and 1.3 hours on 11/21 [DOY 326] due to rain at DSS-15.

Science instrument performance was nominal for all activities during this period. One frame of GS-4 data was recorded this week. The EDR backlog is 2 days.

FLIGHT SYSTEM PERFORMANCE

Voyager 1 performance was nominal during this report period.

Voyager 2 performance was nominal during this report period. However, on DOY 96-321/07:39:06 ERT, CCS telemetry indicated that CCS Processor 'A' had gone to 'internal error' as indicated by status measurements C-1815 and C-2815 (ISA 8290). All subsequent CCS executions have been nominal which would indicate that no 'internal error' condition exist. Full CCS MRO is planned for DOY 96-331.

PROPELLANT/POWER CONSUMABLES
STATUS AS OF 11/22/96

Consumption Propellant Output Margin Spacecraft One Week
(Gm) Remaining (Kg) (Watts) (Watts)
31 6.59 33.76 336.59 42 32 6.46 35.61
338.04 41

[Note from webpage editor: The above data was not properly formatted in the printed

newsletter and has not been reformatted here because of the ambiguities inherent in trying to reformat.]

RANGE, VELOCITY AND ROUND TRIP LIGHT TIME AS OF 11/22/96

Parameter	Voyager 1	Voyager 2
Distance from the Sun (Km)	9,715,000,000	7,534,000,000
Distance from the Sun (Mi)	6,037,000,000	4,681,000,000
Distance from the Earth (Km)	9,837,000,000	7,632,000,000
Distance from the Earth (Mi)	6,112,000,000	4,742,000,000
Total Distance Traveled Since Launch (Km)	11,501,000,000	10,859,000,000
Total Distance Traveled Since Launch (Mi)	7,146,000,000	6,748,000,000
Velocity Relative to Sun (Km/sec)	17.400	15.995
Velocity Relative to Sun (Mi/hr)	38,923	35,780
Velocity Relative to Earth (Km/sec)	38.786	41.108
Velocity Relative to Earth (Mi/hr)	86,762	91,956
Round Trip light Time (Hours: Minutes: Seconds)	18:13:39	14:08:35

A GLIMPSE INTO THE TIME BEFORE QUASARS WERE BORN

According to the widely accepted Big Bang theory, the first galaxies formed by gravitational accretion from slight irregularities in a primordial sea of matter, a process that required considerable time. Hence it would be expected that there would be a delay between the Big Bang and the appearance of the first galaxies. Or, looking back in time from the present, we would expect to find an epoch in the distant past when galaxies had not yet come into being.

An international group of astronomers has now performed observations that seem to offer a glimpse into this very early period. They show that, when looking further and further into space and therefore successively farther back in time, the space density of quasars, after first increasing towards a maximum, then declines rapidly towards zero.

Quasars are thought to be the nuclei of active galaxies, that is galaxies in the process of formation or undergoing violent interactions with other galaxies. Such objects are extremely bright and they can be seen across the Universe. That is the reason why quasars, rather than the much fainter normal galaxies, have been used to study the distant

Universe.

The possible existence of a rapid decline in the number of quasars as we look into the very distant Universe has been suspected for many years. Recent searches for distant quasars by means of optical telescopes observing their visible light have provided the strongest evidence. However, it has also been suggested that this decline could be merely due to obscuration caused by material in intervening galaxies — the distant Universe may be hidden from view.

Radio waves are unaffected by dust, however, and many quasars are strong radio sources. Therefore, the group of astronomers from Germany, Great Britain, and the United States recently undertook a search for very distant quasars based on their radio emission.

This involved measuring accurate positions of hundreds of radio sources using two large radio telescopes, the Australia Telescope in New South Wales and the Very Large Array in New Mexico, and identifying them with visible counterparts using the European Southern Observatory's 3.6-metre telescope on La Silla, Chile.

The blue light from objects in the early Universe is known to be absorbed by atomic hydrogen in intervening gas clouds, and this provides a signature for very distant objects. Thus, the astronomers sought optical identifications of the radio sources which are visible only at the red end of the optical spectrum, and which are point-like in appearance (*from this originates the term quasi-stellar objects, or quasars*), in contrast to the fuzzy appearance of galaxies.

One of the identified objects had these characteristics, and indeed it was found to be the most distant radio quasar known. But no other radio quasars were found at greater distances, although they could easily have been detected by these observations if they were there. Because all of the other radio sources were identified with more nearby quasars and galaxies, by a process of elimination there were simply none left that could be quasars at very large distances.

It was therefore possible to confirm that, beyond a distance corresponding to the time when the Universe was less than 10 percent of its present age (*i.e. less than about 1-2 billion years old*), the number of quasars decreases dramatically — a conclusion which is independent of any possible complications due to dust obscuration. It thus appears that astronomers may now be seeing beyond the most distant quasars, and possibly galaxies, into the so-called Dark Ages when the first galaxies had not yet formed.

This provides further support for the Big Bang evolutionary cosmologies, according to which there should be a significant delay between the Big Bang and the appearance of the first galaxies. Detection of the pre-existing gas clouds out of which the galaxies formed at this early epoch will be one of the major challenges for astronomy in the years to come.

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