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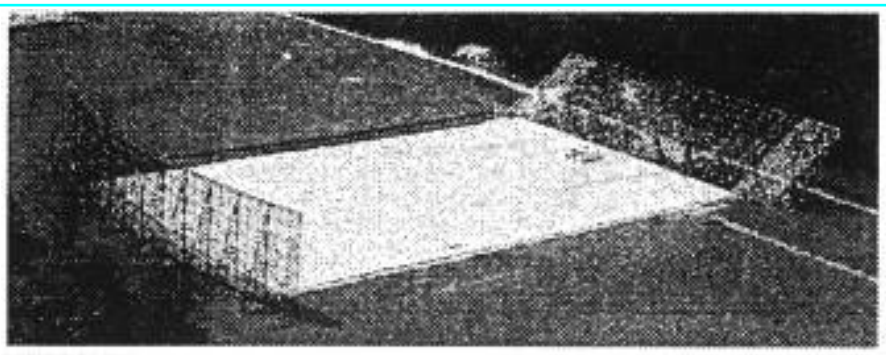
SIGNALS



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IN THIS ISSUE:

COORDINATOR'S CORNER
Phil Barnhart

After frustrating weeks (months!) of silence enforced by 'sensitive negotiations' regarding the fate of the radio telescope, we now learn the 'new' landlords indeed plan to convert the second largest aperture radio telescope in America into golf fairways. A news conference held by the purchasers of the land on which the instrument rests indicates they have negotiated the design of nine more holes by a professional golfer.

Ohio State University, the party of the second part in the lease arrangement for the use of Big Ear, is still negotiating disposition of a lease buy-out that hopefully includes provision for a three year extension of occupancy for the facility. Since these negotiations are continuing we are still not free to reveal details of the pending agreement.

Considerable irony accompanies the discussions and policies adopted over the past two years. Many of the top level decisions seem to have been made without consultation with the parties most aquainted with the status and effectiveness of the radio observatory. Briefly, the stand taken by the University rests strongly on information gleaned from the former landlord (Green Highlands Development Corporation) — hardly a disinterested party to the continued operation and use of the telescope. This stand seems based upon two major contentions propounded by the landlord and unexamined throughout most of the negotiations for renewal of the

lease agreement. These are:

1. The telescope is not being used and no one is interested in using it. The telescope is a financial liability.

2. The installation is obsolete and poorly equipped to perform meaningful research.

Thoughout the period of negotiations information to the contrary has been fed up the lines of communication, but for some reason never seems to have reached the top echelons of the decision making process. In fact, both assumptions — regularly propounded by representatives of the landlord — are patently incorrect.

First, over the past ten years NASA contracts for the SETI program plus Air Force contracts to the Electro-Sciences Laboratory have netted the University over $800,000 in INDIRECT (i. e., overhead) costs. The University has sustained operating costs of approximately $15,000 per year (lease and utilities) for the same ten year period. The telescope has essentially been in continuous operation during that time. That the representatives of the landlord should perceive this as a time of inactivity is best understood when it is realized most of the operation of the telescope has been automated and requires little in the way of on-sight human intervention. Occasional visits to the site reveal minimal activity and apparent lack of use.

As to the second assumption — that of obsolescence — simple inquiry of the users of the instrument (NAAPO and ESL) would reveal that not only state-of-the-art equipment is employed, but some truly innovative techniques and apparatus is being employed. The facility has unique features (constituting as it does the world's largest compact range for radar experimentation) and is an ideal instrument to commit to long-term survey type observations. No other instrument of comparable aperture ANYWHERE IN THE WORLD can be dedicated to a continuous availability for routine survey purposes. The former landlords viewed the telescope only as an inconvenient eyesore!

One bone of contention has been the inclusion in the original lease agreement of a commitment on the part of the University to maintain and paint the telescope. As the time of lease renewal approached the decision to not invest ANY more money into the telescope facility meant the University refused to contract the painting of the telescope. The bid for painting both reflectors is just over $160,000 (approximately 1/5 the amount of overhead received by the University over the past ten years). The

repainting discussion has been stonewalled for well over the past year, finally being resolved with a firm "Never" by the University administration. Yet, within the past month the University contracted with an environmental 'clean-up' group to remove a number of truckloads of soil from the old dump site because tests indicated "...the presence of arsenic..." in levels exceeding EPA standards. This was done without checking to see if indeed the arsenic was deposited in the dump before or after the observatory personnel stopped using the dump site. The golf course maintenance crews continued to use the site for a variety of dumping of waste material long after the radio observatory personnel cleaned up the dump from the decades of dumping prior to the sale of the land.

Estimated cost to the University — $180K for the clean-up and additional expense to repair the road damaged by the heavy equipment brought in to do the job.

We have become resigned to the fact that the University will no longer support the radio telescope. We have not, however, given up the quest for an answer to one of the most important questions facing humanity. "Are we the sole possessors of intelligence sufficient to gain a measure of control of our universe to be able to detect a comparable civilization anywhere in the Milky Way Galaxy?" The volunteers at the radio observatory and NAAPO remain committed to carry out the search and will forge ahead in the development of the next generation of radio telescope to make use of an all-sky instrument at a site less pressured by the demands of golfers and up-scale home buyers.

ONWARD ARGUS!!!

FROM "THE LANTERN" — OSU STUDENT NEWSPAPER — August 24 1995
By T.K. Brown
Lantern staff writer

Say good bye to "Big Ear".

Ohio State negotiators, land owners and land developers "...have pretty much agreed in principle" on a deal that would lead to the dismantling of OSU's "Big Ear" radio teleecope by Jan. 1, 1998, said Leslie Winters, OSU senior real estate coordinator.

Gary Bachinski, New Green Highlands president, said in a news release that his group plans to add nine new golf holes to the Delaware Golf Club course expanding

it to an 18-hole course. The golf holes will be designed by Fuzzy Zoeller, a PGA Tour pro.

The New Green Highlands plans also call for single-family homes situated along the golf course.

So what about Big Ear?

Dixon said volunteers are in the midst of a second all-sky survey of natural radio signals. The first all-sky survey completed by Big Ear in the 1970s was the largest survey of natural radio signals conducted at that time. The first survey revealed about 20,000 various celestial objects in space.

"It (the current survey) has to be done with the same telescope or you have no basis for comparison," Dixon said.

It is unclear whether the second survey will be completed prior to the proposed January 1998 date to dismantle Big Ear, Dixon said.

SATURDAY 7/15/95 MEETING NOTES
By: Tom Hanson

In attendence on this pleasant summer day were: Dr. Dixon, Ang Campanella, Joe Mitchell, Jerry Ehman, Mark Sundstrom, Dan Fleisch, Ron Leeseberg and Steve Brown.

Cindy Brooman arrived after the meeting, and introduced us to her impressive pet cock-a-too.

ULYSSES CLIMBS TO HIGHEST LATITUDE OVER SUN'S NORTHERN POLE

The **European Space Agency's** (*ESA*) Ulysses spacecraft, the first probe ever to fly over the poles of the Sun, will climb to its maximum latitude of 80.2 degrees north of the Sun's equator on Monday, July 31, and survey the solar forces at work from this unique vantage point in space.

The spacecraft will have traveled about 1.86 billion miles when it reaches the summit of its trajectory over the Sun at 11 a.m. EDT, according to mission operations team

members at **NASA's Jet Propulsion Laboratory**, Pasadena, CA.

All Ulysses operations and science experiments continue to go well in this unique, five-year journey out of the ecliptic plane. NASA's tracking facilities near Madrid, Spain and at Goldstone, CA, are monitoring the spacecraft 24 hours a day as maneuvers are performed to keep Ulysses' radio antenna pointed to Earth.

Launched on October 6, 1990, aboard the **Space Shuttle Discovery**, the 810-pound **ESA** probe was designed to study the heliosphere — that region of space dominated by the solar wind — at all latitudes above and below the Sun's equatorial plane. These high latitude regions have never been explored before.

Named for the legendary Greek adventurer who journeyed to the hidden side of the Sun, Ulysses carries nine scientific instruments provided by European countries and the United States to make detailed studies of solar wind, magnetic fields and particles, interplanetary dust and gas, and cosmic rays entering the solar system from the Milky Way galaxy. In addition, Ulysses' radio data have been used for other experiments to study the Sun's outer atmosphere, or corona, and to search for gravitational waves in interplanetary space, and the gamma ray burst detector helps triangulate the brightest cosmic gamma ray bursts.

Today the spacecraft is traveling at about 55,300 miles per hour with respect to the Sun. Ulysses will begin to descend in latitude as it loops over the northern solar polar region.

On September 29, the spacecraft will complete the northern polar pass and begin to journey back out to the orbit of Jupiter, reaching Jupiter's distance of 5.4 astronomical units (*about 500 million miles*) on April 17, 1998. Ulysses will then head back on its high latitude trajectory toward the Sun, returning again to its vicinity in September 2000.

Ulysses is managed jointly by **NASA** and **ESA** to study the regions above the Sun's poles. The **Jet Propulsion Laboratory** manages the U.S. portion of the mission for NASA's Office of Space Science, Washington, DC.

HUBBLE FINDS SURPRISINGLY COMPLEX STRUCTURES IN RADIO GALAXIES

Probing some of the most distant and energetic galaxies in the universe, **NASA's Hubble Space Telescope** has uncovered surprisingly varied and intricate structures of stars and gas that suggest the processes powering these so-called radio galaxies are more complex than previously thought.

The Hubble observations, made by a team of astronomers at *Cambridge University*, England, should shed light on the nature of active galaxies that might be powered by immense b1ack holes at their cores, and more generally, on galactic evolution. The radio galaxies observed are so far away they existed when the universe was half its present age, and the light is only now reaching us.

The bizarre, never-before-seen details may be a combination of light from massive star forming regions, small satellite dwarf galaxies, and bow shocks caused by jets of hot gas blasted out of the galaxy's core by a suspected black hole.

The observations were made by **Professor Malcolm Longair** and **Philip Best** of the *Cavendish Laboratory*, Cambridge University, and **Huub Rottgering** of *Leiden Observatory*, The Netherlands, who have published images of three radio galaxies (*3C368, 3C324 and 3C265*) in the August 1 issue of the *Monthly Notices of the Royal Astronomical Society*.

The team is analyzing a sample of 28 radio galaxies that have been imaged by Hubble in visible light, by the **Very Large Array Radio Interferometer** (*an array of 27 separate radioantennas*) at radio wavelengths, and by the **UK Infrared Telescope**.

A radio galaxy emits powerful radio waves along two opposite directions pointing out from the galaxy's core. The radio lobes usually extend far beyond the host galaxy. The suspected powerhouse behind the radio emission is a one-billion solar mass black hole in a galaxy's core. Gaseous jets, traveling at nearly the speed of light, blast out along the rotation axis of the spinning black hole. These jets bore through space like a narrow stream of water from a garden hose nozzle plowing through sand. When they are finally stopped by the intergalactic medium, a huge amount of energy is released in the form of radio waves.

Previous ground-based observations since 1987 have shown that, in visible light, radio galaxies have an unusual elongated structure — unlike the classic spiral and elliptical shapes in normal galaxies — that align to the twin lobe of radio emissions that are the trademark of such active galaxies. In the Hubble views, these shapes break up into a string of bright knots that might be regions where new stars are forming, or could be glowing clouds of gas. In one galaxy, the knots align to the axis of the jet, while in another case they do not, and instead cluster around the galaxy like smaller "satellite" galaxies.

One explanation for the alignment between the invisible jets and optical structures is that the jets trigger the formation of stars along their paths. However, some of the galaxies emit highly polarized light. Since this type of light is not produced by stars, other processes must be at work. A possible explanation is that the light from the galaxy's hidden active nucleus is scattered in our direction by dust or electrons.

Longair, Best and Rottgering propose that the remarkable structures seen in the Hubble images are different manifestations of activity associated with radio galaxies. They conclude at least two mechanisms responsible for the alignment effect. They also note that the period during which there is strong radio emission is quite short relative to the total lifetime of a galaxy, so different processes may dominate as the radio source ages. They are planning further observations to determine the relative importance of the different effects.

The **Space Telescope Science Institute** is operated by the **Association of Universities for Research in Astronomy, Inc.**, for **NASA**, under contract with the **Goddard Space Flight Center**, Greenbelt, MD. The **Hubble Space Telescope** is a project of international cooperation between **NASA** and the **European Space Agency**.

WATER DETECTED IN JUPITER'S ATMOSPHERE

Italian scientists have detected water in the upper atmosphere of Jupiter after a fragment of a giant comet smashed into the planet last year, Italy's **National Research Council** said Monday.

The state body said the discovery would interest researchers pursuing theories that a similar cometary collision created the conditions for life on Earth.

"*What might have happened here four billion years ago, following a bombardment by swarms of comets, could have occurred and may be occurring in millions of planetary systems of the galaxy,*" the council said in a statement.

More than 20 fragments of the icy comet **Shoemaker-Levy 9**, each with the power of millions of nuclear warheads, struck Jupiter in July 1994 in an event followed by observatories around the world and monitored by satellite probes in space.

Italy followed the impacts using a giant radiotelescope equipped with a high-speed spectrometer run by the National Research Council near the central city of Bologna. The spectrometer detects and identifies substances by the frequencies of electro-magnetic waves they emit.

The council said spectroscopic analysis of a weak band of emissions in Jupiter's upper atmosphere following the impact of a fragment of the comet on July 18, 1994 clearly showed that water molecules were present. It said the discovery was "of exceptional scientific value."

"*Researchers believe that the water discovered is of certain cometary origin since it was not present in Jupiter's atmosphere before the impact,*" it said. It said the findings demonstrated that comets were capable of introducing water and organic material — the building blocks of life — into planetary atmospheres.

"*Various theories affirm that without such an introduction...biological evolution on our planet would not have been possible,*" the council said.

LUNAR PROSPECTOR SPACECRAFT TO RETURN TO THE MOON IN 1997

The **Lunar Prospector** program, headed by **Principal Investigator Dr. Alan Binder** of *Lockheed Martin Missiles & Space*, will build on the science of the **Apollo** program and return America to the Moon in June 1997.

It is the first peer reviewed, competitively selected mission in **NASA's** new Discovery series of "Faster, Better, Cheaper" solar system exploration missions, and the Missiles & Space and Ames team was selected on February 28, 1995. G. Scott Hubbard of the **NASA Ames Research Center** at Moffett Field, is the **NASA** mission manager for Lunar Prospector.

The overall management of the Lunar Prospector program is the responsibility of Dr. Binder. The spacecraft and launch vehicle, a Lockheed Launch Vehicle 2, are being built at the Sunnyvale facility and are being readied for launch in June 1997. Dr. Dominick Tenerelli of Lockheed Martin in Sunnyvale is the project manager.

During a one-year polar orbiting mission Lunar Prospector will map the Moon's surface composition, gravity and magnetic fields, and volatile release activity. These data are needed for expanding the lunar science legacy of Apollo, and for planning future exploration missions. Lunar Prospector will demonstrate that high quality science missions can be accomplished economically and within short time scales.

SCIENCE PAYLOAD

The Lunar Prospector science payload was chosen from a list of experiments proposed by **NASA** scientists for lunar mapping missions. The spacecraft carries six of the highest priority experiments, chosen for their scientific value, their ability to be flown on a simple, spin-stabilized spacecraft, and for their low mass, power and data rate requirements. The experiments are:

Gamma-Ray Spectrometer — The gamma-ray spectrometer is a more advanced system than was flown on the Apollo missions and will provide global maps of the elemental composition of the surface layer of the Moon. The main elements mapped are uranium, thorium, potassium, iron, titanium, oxygen, silicon, aluminum, magnesium and calcium. Knowledge of the concentrations of these elements over the entire lunar surface will aid in understanding the composition and evolution of the

lunar crust.

Though uranium, thorium and potassium are only trace elements, they are found concentrated in a material called **KREEP** (*potassium [K], rare earth elements [REE] and phosphorus [P]*). KREEP is not only the main source of these elements, but many other important trace elements such as zirconium, fluorine and chlorine. Mapping the locations and concentrations of KREEP deposits is important to lunar science as it is believed that the material developed late in the formation of the lunar crust and upper mantle, and thus can help define how the crust and mantle formed and evolved.

Neutron Spectrometer — While the Moon does not have any water of its own, theoretical calculations suggest that water brought to the Moon by comets and water-rich meteoroids may be frozen in the bottom of small craters in the polar regions. The floors of some small craters located within 30 degrees of the north and south poles never see sunlight and have continuous temperatures below -190 degrees centigrade. At such temperatures, water ice would be stable over the lifetime of the solar system. The neutron spectrometer on Lunar Prospector has a water ice detectability limit of better than 0.01%, which means it can locate 200 grams of water (*a cup of water*) in a cubic meter (*about a cubic yard*) of regolith (*lunar soil*). The discovery of lunar polar ice would have a profound effect on the economics and logistics of the exploration and colonization of the Moon and the inner solar system. It would mean that water, necessary for life support and as a source of both oxygen and hydrogen needed to produce rocket propellant, would be available in situ to future lunar explorers.

Alpha Particle Spectrometer — The alpha particle experiment is an advanced version of an experiment flown on Apollo 15 and 16. It will determine the locations and frequency of radon gas release events by detecting alpha particles from both radioactive radon gas and its decay product, polonium. This is the only orbital instrument which provides information on the current level of tectonic and volcanic out-gassing activity of the Moon. Thus, it provides unique information about the Moon which, until Apollo, was thought to be tectonically and volcanically dead. As a result of the Apollo surface seismometers and mass spectrometer and the orbiting alpha particle experiment, scientists now know that the Moon is active, though much less so than Earth or Mars.

Magnetometer and Electron Reflectometer — These two experiments map the

lunar magnetic fields. While the Moon does not have a global magnetic field like the Earth, it does have weak fields of local extent. Mapping the strengths and distributions of these local fields over the Moon will determine if they were caused by an earlier global magnetic field like the Earth's, if they were caused by meteoroid impacts, or if they have some other origin. The data should also provide information on the size and composition of the lunar core and, coupled with Neutron Spectrometer data, could reveal correlations between magnetic fields and solar wind implanted hydrogen and helium concentrations.

On Earth, magnetic mapping is an important tool for locating economically important ore bodies. Similarly, the magnetic experiments will provide information to help understand the economic potential of the Moon.

Doppler Gravity Experiment — The experiment provides the first complete gravity map of the Moon. Because no earlier mission was in a low polar orbit, **NASA** does not have an adequate lunar gravity model for planning follow-on unmanned and manned lunar missions. Lunar Prospector will define the lunar gravity field that affects the altitude, and thus the fuel quantity required for orbit maintenance, of all orbiting spacecraft. It will also provide data on density differences in the crust, the internal density of the Moon, and the nature of the core.

THE SPACECRAFT

The Lunar Prospector spacecraft is a small, simple, reliable, spin stabilized spacecraft with a fully fueled mass of 233 kg (*513 lb.*). It is 1.42 m (*4.6 ft*) in diameter, 1.22 m (*4.1 ft*) in axial length drum with solar cells mounted on its outer surface which provide 202 watts of power. The scientific instruments are mounted on three booms to isolate them from the bus and simplify the spacecraft-instrument interfaces.

THE MISSION

The mission begins with launch in June of 1997. The flight to the Moon will take five days, during which two midcourse maneuvers occur, booms are deployed, and science instruments begin to collect calibration data. Once the spacecraft reaches the Moon, it will perform three separate Lunar Orbit Insertion burns. The first burn will put the spacecraft into a 24-hour, elliptical orbit. One day later, the second burn will put the spacecraft into a four-hour elliptical orbit. Finally, 24-hours later, the third burn will insert the spacecraft into a circular, 118-minute, 100 km altitude, polar

mapping orbit. At that point, the spacecraft will begin its nominal one-year mapping mission. During this phase, periodic orbital maintenance maneuvers will be made to keep the spacecraft in its proper orbit.

If, as expected, fuel is available at the end of the one-year nominal mission, the mapping may be extended, first during a six-week phase in a circular, 50 km altitude orbit to obtain much more sensitive magnetic and gravity data and then from elliptical orbits as low at 10 km above the surface over a few areas of special interest. The mission will end when the fuel needed for orbital maintenance is depleted and the spacecraft impacts on the lunar surface. ***[Courtesy of Lockheed Martin Astronautics.]***

PALOMAR SURVEY REVEALS PEAK IN QUASAR FORMATION

Astronomers have discovered direct evidence that most quasars came into existence during the same era, when the universe was still in its infancy. This discovery will help scientists use quasars, the most luminous objects in the sky, as tools for studying the universe back to a time when it was less than a billion years old.

"This survey allows scientists to investigate for the first time the era of quasar formation," said **Maarten Schmidt**, a *Caltech* astronomer and a coauthor of the study.

Using data from the recently completed quasar search known as the **Palomar Transit Grism Survey**, Schmidt, **Donald P. Schneider** of *Penn State*, and **James Gunn** of *Princeton University* published their discovery in the July 1995 issue of the *Astronomical Journal*. (*A grism, from the combination of grating and prism, is a transmission grating mounted on a clear, wedge-shaped piece of glass.*)

The survey shows that the space density of quasars — the number of quasars in a given volume of space — reaches a maximum for those with redshifts between 1.7 and 2.7, and declines steeply for quasars with higher redshifts.

"*This maximum means there was a peak in the rate of quasar formation between 1.9 and 3.0 billion years after the Big Bang,*" Gunn said, "and a much lower rate earlier in the history of the universe."

A typical quasar emits 100 times more energy than our home galaxy, the Milky Way. This makes them the most luminous and also some of the most distant known objects

in the universe. Because light from quasars takes billions of years to reach the earth, scientists see them as they were billions of years ago. Therefore quasars are important to astronomers as one of the best probes available for studying the conditions present in the early universe.

Astronomers first identified quasars in 1960 as starlike counterparts to strong sources of radio waves, but were initially unable to determine the nature of the objects. In February 1963, Maarten Schmidt made a breakthrough.

"*I recognized that the pattern of spectral lines in one particularly bright quasar was due to hydrogen, but that the location of the lines was redshifted,*" Schmidt said. "*This indicated that the object was moving away from the earth at a very high velocity.*"

Redshifting is an effect seen in rapidly receding sources of light, where the spectral lines of such sources move toward longer wavelengths, or toward the red end of the visible spectrum. The larger the redshift, the more the light is shifted toward red, and the greater the distance to the source.

The small size of quasars is as astonishing as their luminosity. Studies of the variability of quasars have shown that their brightness can change on time scales of days, or sometimes just a few hours, which implies that their physical size is not much larger than our solar system. Because of quasars' extraordinary brightness and small size, astronomers suspect that they are probably powered by matter spiraling into a supermassive black hole. But just how quasars form and whether black holes really power them remain a puzzle, one which studies such as the one reported here will help scientists solve.

The Palomar Transit Grism Survey was undertaken with the goal of finding a large number of high-redshift quasars so that scientists could study the evolution of these objects back to a time when the universe was less than a billion years old. The survey began in 1985 using a special electronic camera designed by James Gunn that was mounted on the 200-inch **Hale Telescope** at **Palomar Observatory**.

Finding a large number of quasars was like looking for needles in a haystack and required special software to separate the quasars from superficially similar foreground objects. "*For every high-redshift quasar that we found, we recorded and sorted through thousands of nearby objects,*" Schneider said.

The Palomar Transit Grism Survey succeeded in identifying 90 quasars with redshifts between 2.75 and 4.75, with a typical luminosity more than a trillion times that of our sun. Analysis of the survey data has revealed that between redshifts of 2.7 and 4.7, the space density of luminous quasars declines by a factor of seven. That is, for quasars with redshifts greater than 2.7, the higher the redshift, the fewer quasars there are in a given volume of space.

Previous studies by other groups have shown that the space density of quasars increases dramatically — by a factor of 100 or more — in the range of redshifts between 0 and 2.0. These results, combined with other studies of quasars with intermediate redshifts, show that the space density of quasars exhibits a sharp peak at a redshift between 1.7 and 2.7, indicating that the bulk of quasar formation must have occurred around 2.5 billion years after the Big Bang. This result will help astronomers refine their theories by placing important constraints both on models of galaxy and quasar formation, and on ideas about the mechanism that supplies quasars with their tremendous energy.

This is a joint release by **Caltech** and the **Pennsylvania State University**.

BILLBOARDS IN SPACE: REVISITED

ed. note: *Signals volume 9, # 8 (Sept. 93) carried an article on "**Billboards In Space**", an especially atrocious form of light pollution. That attempt was aborted after an outpouring of opposition from the astronomical community, professional and amateur. Another company is now trying to breathe life back into this idea. The following article was posted to the electronic newsgroups available on the Internet. If you would like to help halt this attempt before it flies, please write to the **ESA** and let 'em know how you feel!*

For sale: the first advertising billboard in space. Cost: $1 million.

The **Maxus** experimental space probe, financed by the **European Space Agency** and to be launched from Sweden in November, Friday offered what was billed as the most expensive — and fastest — billboard ever. Companies have until the end of August to bid for the 280 square foot site on the side of the probe. It was heralded by the advertising industry as its "final frontier."

Project Fenix is being masterminded by the Swedish advertising agency **Gazolin&S**

on behalf of the **Swedish Space Corporation**.

"*It is extremely rare that the opportunity presents itself for a genuinely ground-breaking advertising medium,*" spokesman Robert Bryhn said in a statement.

"*Its potential in terms of marketing spinoffs is enormous. The winning bidder will be moving advertising into a new dimension for the next millenium,*" he added.

Funds from the sale will be ploughed back into the space project.

"*Operating costs in this field are high and commercial opportunities such as this are to be welcomed,*" Sven Grahn of the Swedish Space Corporation said in a statement.

HUBBLE SHEDS LIGHT ON THE "FAINT BLUE GALAXY" MYSTERY

International teams of astronomers using **NASA's Hubble Space Telescope** have solved a 20-year-old mystery by showing that a class of galaxy once thought to be rare is actually the most common in the universe.

Analyzing some of the deepest images ever taken of the heavens, the astronomers conclude that small irregular objects called "blue dwarfs" were more numerous several billion years ago, outnumbering the spiral galaxies like our Milky Way, and giant elliptical galaxies as well. This means the blue dwarfs are a more important constituent of the universe and figure more prominently in the evolution of galaxies than previously thought, researchers say.

The discovery was made by the international **Medium Deep Survey** team, led by **Richard Griffiths** of the *Johns Hopkins University*, Baltimore, MD, and extended by a deeper survey with Hubble Space Telescope by a team led by **Rogier Windhorst** of *Arizona State University*, Tempe.

"*The new results have overturned the conventional picture of a universe dominated by giant grand design spiral systems and elliptical galaxies,*" said Griffiths. "*Instead, we're going to have to come up with a new way of understanding the distorted galaxies we see in huge numbers, which seem to have formed later than the giant galaxies.*"

However, they say it is not clear whether these small irregular systems are indeed the building blocks of galaxies like the Milky Way, or have simply faded into obscurity.

"*Most of these faint objects are visibly blue in color, a strong indication that they are undergoing a brief, rapid burst of star formation. At larger distances, such systems may well have been the building blocks of today's giant spiral and elliptical galaxies,*" said Windhorst, who along with **William Keel** of the *University of Alabama*, conducted a separate survey of remote galaxies.

These faint galaxies were randomly imaged as part of a key Hubble Telescope project, called the "Medium Deep Survey." The survey uses Hubble's Wide Field/ Planetary Camera-2 (*WFPC-2*) to search for unexpected objects in uncharted areas of the sky. This highly efficient and cost-effective survey is conducted in "parallel mode" where the WFPC-2 takes detailed pictures while a "primary" instrument, such as a spectrograph, collects data from a predetermined celestial target.

For the past 17 months, Griffiths and co-investigators from the United States, (*Richard Green, John Huchra, Garth Illingworth, David Koo, Kavan Ratnatunga, Tony Tyson, Rogier Windhorst*) and the United Kingdom (*Richard Ellis, Gerry Gilmore*), have studied more than 50 random snapshots containing high resolution information for a total of tens of thousands of galaxies.

"*We were immediately struck by the large numbers of irregular and peculiar galaxies in these HST random images,*" Griffiths said.

An additional, deeper Hubble image obtained by Windhorst and Keel, and analyzed by Driver, Windhorst, and associates, has further extended these results.

"*At last Hubble has allowed crystal clear images of these extremely faint objects, and we find that our universe is dominated by distorted systems of stars,*" said Simon Driver of Arizona State University. At the faintest limits more than half the galaxies seen are such systems.

"*We all know that the (clear) sky during the day is blue — due to scattered sunlight — but if your eyes had much more sensitivity, they would also see a very dim blue glow in the sky at night caused by myriads of faint blue galaxies, the mysterious nature of which was unknown until we imaged them in detail with Hubble,*" said Windhorst. The researchers are now measuring the distances to these galaxies using the world's new generation of giant ground-based telescopes.

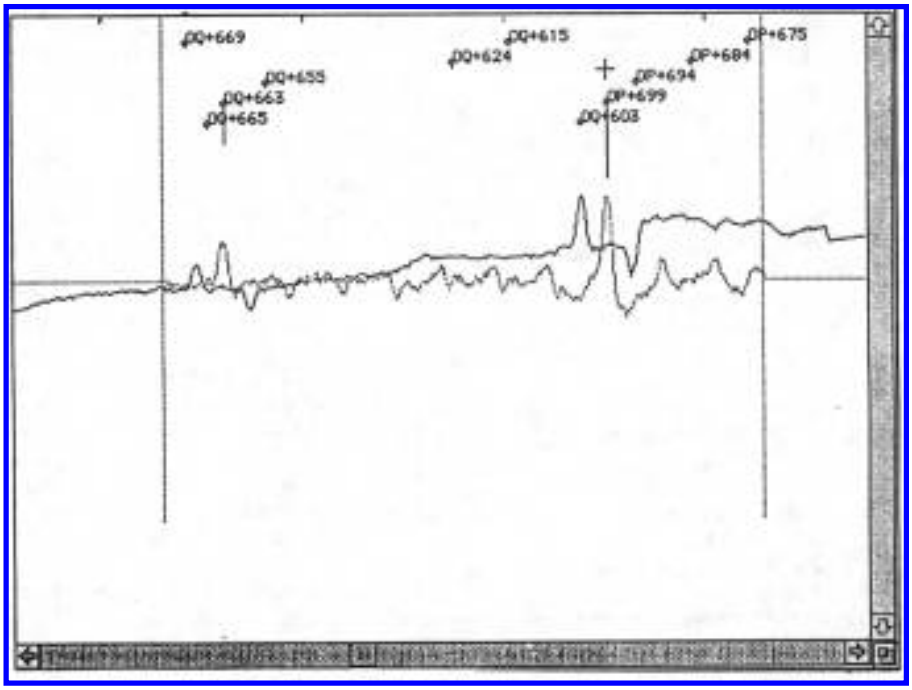
The **Space Telescope Science Institute** is operated by the **Association of Universities for Research in Astronomy, Inc.**(*AURA*) for **NASA**, under contract with the **Goddard Space Flight Center**, Greenbelt, MD. The **Hubble Space Telescope** is a project of international cooperation between **NASA** and the **European Space Agency** (*ESA*).

NEWS OF THE VOLUNTEERS

Dr. Philip E. Barnhart announced his retirement from Otterbein College beginning 1 September 1995. After 36 years of teaching he feels it is time to devote energy and acquired relaxation skills to other activities.

Dr. Barnhart will continue to offer coordinative assistance to the Radio Observatory and try to see the ARGUS Project into the 21st Century.

MARK SUNDSTROM ADAPTS PATTERN RECTIFICATION ALGORITHM



Using the technique developed originally by Russ Childers to remove the double horn signature of celestial sources and produce a single horn 'response', Mark Sundstrom has produced an illustration of the process with the continuum data obtained on 03 October 1993. The relatively strong sources OQ+663 and OP+699 are noted. OQ+663 is a 2.4 jansky source.

[Click on plot to obtain a larger version.]

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Designed by Jerry Ehman
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