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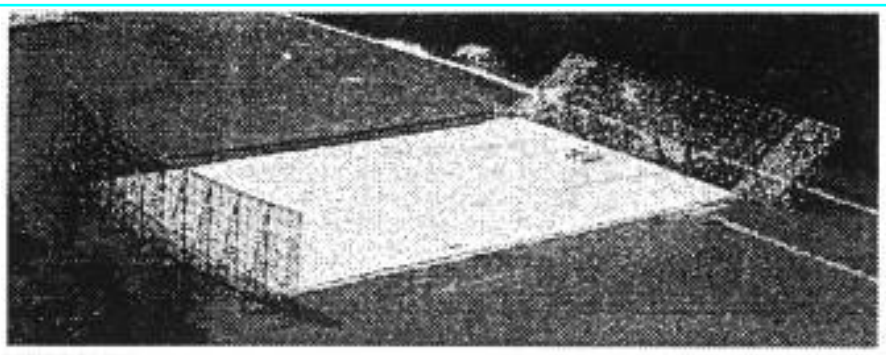

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IN THIS ISSUE:

Big Ear Website Goes Online
By Cindy Brooman

Big Ear now has a Website with its own domain name on the Internet. The site may be reached at www.bigear.org, and features a rich selection of historical and current information collected from a variety of sources. Additional pages will be added as the site "develops". I am providing the server and the Internet line, and also serving in the role of Webmaster.

My design objective in putting the site together was to make it interesting to the public, yet provide additional features for members of the organization. Although the

articles may be read with any browser, users of *Netscape 2.0* or above and *MSIE 3.0* will find some added "bells and whistles" buried in the content.

A password-protected "Members Only" directory has also been developed which will eventually contain an online copy of the most recent issue of *SIGNALS*. Any *SIGNALS* readers who have Internet access and would like to receive the username and password for this special section should visit the site and fill out the feedback form, or send email to cindy@point-and-click.com.

Many thanks to the original writers of the source materials I used to put the site together (who have been cited in the content). A special thank you goes to Herb Johnson for his informative additions to the materials, and for helping me round up the information I was looking for. Many thanks also to Jerry Ehman for reading through the content and providing me with corrections. Thanks are also in order to Tom Hanson for suggesting that we register the domain name, and for providing the funds to pay for the registration.

COORDINATOR'S CORNER
By: Phil Barnhart

After some months of finding nothing but negative reactions to astronomical development at the Ohio State University, a glimmer of hope has filtered out of the darkness. On October 11 the university announced it is seeking to buy shares in two large aperture telescope projects. The first is the Large Binocular Telescope (LBT), the program from which the University withdrew unceremoneously a few years back. The hope is to buy back a 1/8 share in the project.

The second is the Michigan-Dartmouth-MIT observatory located on Kitt Peak. Total cost to the University will be of the order of $7.7 Million spread over a five year period.

I am extremely pleased to see such a commitment on the part of the institution even though it comes at the expense of abandoning ALL local astronomical facilities as well as the 72-inch Ohio Wesleyan/Lowell Observatory telescope at Flagstaff, Arizona. I have a soft spot in my heart and career for these instruments.

I wish to extend my best wishes to the OSU Astronomy Department on the successful completion of these negotiations. These are very important additions to the facilities of that department.

VOLUNTEER PROFILE: Mark Sundstrom

Volunteers come to the Radio Observatory from a wide range of backgrounds. One very fortunate Encounter of the Third Kind (check out Hynek and Hollywood) occured some months back when Mark Sundstrom appeared like magic out of the environs of Silicon Valley.

Mark sought us out because he was a long time amateur optical astronomer who knew little about radio astronomy. He felt it would be a great opportunity to learn about the subject on a world class telescope for the investment of a contribution via his computer programming experience. He is, incidentally, the creator and developer of the Aldus 'Pagemaker' software. (*ed. note: this is the software I use to put together Signals!*)

One of his first tasks was to become involved in the infamous project to paint the telescope Muirfield Green. This project was conceived to demonstrate to the developers of the land the commitment of the RO operators to continue operation and maintenance of the instrument by beginning the requested painting of the structure to the specifications of the landscape consultants looking to the future development around the site. This project, carried out by a sizable contingent of the volunteer staff to paint all the cement foundations, produced a large number of 'little green persons' moving about the grounds. We believe the green paint has long since left the arms and eyebrows of all concerned.

A mathematics graduate of the University of California in San Diego, Mark is working on a program to analyze the continuum data being gathered in the current survey. The output of the program will be contour plots of the radio sources useful in comparing the current program with the survey completed thirty years ago.

When asked what satisfaction he has gained from his affiliation with this group, Mark replied, "besides finding ways to contribute to the organization I've enjoyed working with the other volunteers, who have an amazingly wide variety of professions and interests."

We have greatly appreciated Mark's contributions and have enjoyed his valuable input and smiling presence at the working sessions. Samples of his work have appeared from time to time in these pages and in lectures all over the world. Many thanks, Mark.

GALILEO MISSION STATUS
October 18, 1996

0bservations of Io and Jupiter's atmosphere were among the data received from NASA's Galileo spacecraft this week. Included were data from the imaging camera and near infrared mapping spectrometer, which looked at Io "face-on" for new volcanic deposits from a distance of 441,000 kilometers (about 274,000 miles).

Galileo's ultraviolet spectrometer also returned data from observations made of Jupiter. The measurements specifically map several gases — ammonia, acetylene and phosphine among them — in the atmosphere along a strip from north to south.

On October 14, two optical navigation images of the moon Callisto were taken, but neither was successful. Analysis of the failed images is ongoing, but preliminary results indicate the problem may be attributed to the expected brightness of Callisto; brightness dictates the exposure settings that were selected on the camera. Callisto data returned to date suggest that the models used over-estimated the brightness of Callisto and that the exposure settings were inappropriate.

Galileo's ground data system team this week conducted three more tests of the new array of four different antennas that are electronically linked together and will be used in concert to enhance the data return from Galileo's upcoming November encounter with Callisto and each of the subsequent encounters for the balance of the mission. The telecommunications array links the receiving power of the three largest antennas (one 70-meter and two 34-meter antennas) at the Australian Deep Space Network communications complex in Tidbinbilla, near Canberra, along with the large Parkes radio telescope located about 100 miles from the Tidbinbilla site. It also links the 70-meter antenna at Goldstone during periods when both Goldstone and Canberra are able to "see" the Galileo spacecraft at the same time.

On Wednesday night (October 16), the team was successful in demonstrating recovery from simulated equipment outages. Of the 19 ground data system tests conducted so far, 11 have been successful, five partially successful and three unsuccessful in real time.

Post-test analysis of problems have identified explanations and/or simple workaround solutions for most anomalies. No problems are anticipated in completing testing in time for the start of operations support on November 1.

SUMMER INTERN LEAVES

Greg Charvat, high school junior out of Grosse Pointe, Michigan finished up a dual internship this summer with Dan Fleisch in Powell and **NAAPO** at Big Ear. The cooperative effort brought benefit to both organizations and especially to Greg.

Greg is a self-starter and brings enthusiastic talent to central Ohio. Our RFI program is getting back on line and his efforts at calibrating the low noise amplifier for the RFI system proves most useful. He expresses the desire to come back next summer to help with fabricating receiver/amplifiers for the **ARGUS** project. I am sure we will be glad to welcome him again for the summer and hopefully be ready for him to help begin the move to a new location.

RANDOM THOUGHTS
By: Phil Barnhart

The hubbub is over concerning the demise of the second largest aperture radio telescope in the United States. We are becoming used to the phasing out of historic instruments from the realm of active research programs. The Mount Wilson 100-inch Hooker Reflector was mothballed several years back only to be revived by a commited group of concerned educators and friends of the observatory. (*Walt Mitchell of NAAPO and Joe Snider of Oberlin College — and NAAPO — were instrumental in reviving the 100-inch telescope.*) The 100-inch fitted with new detectors is returning to the ranks of world class instruments in spite of the Los Angeles sky. Its new quest is the search for nearby stars with planet companions. Who said obsolete telescopes aren't useful?

The discovery of potentially organicly produced substances from the surface of Mars highlights one of the major contentions in the origin of life debate — that given the chance, life is a normal consequence of the nature of the universe. Good news for the proponents of the ability to detect the technological results of life beginning in a hospitable environment that remains favorable for the order of a few thousand million years.

As we go to press we await the return of Bob Dixon from a round of conferences in Holland and France. Indications from the dark end of the Internet indicate he is coming back with many ideas and having heard much enthusiasm for the **ARGUS** concept. We look forward to debriefing him at the second working session of

September at the RO.

We continue to work toward the time we must abandon the premises containing Big Ear. It has been a long and fruitful occupancy and will be tough to see the telescope go down before the wrecking crew. At least it has the distinction not only of serving as a pioneering survey instrument, but has engaged in the longest continuous search for evidence of extraterrestrial technology. This endeavor led directly to the development of the concept of the **ARGUS** array which will serve as the new generation radio telescope and potentially invaluable instrument of extreme importance in commerce, transportation and research. This is a truly magnificent legacy for a telescope which includes within its structure nearly ten thousand window weights. A truly proud career!

9/21/96 MEETING NOTES
By: Tom Hanson

This is the first of three messages intended to provide a glimpse of the experience of attending a Dixon trip report. This message will cover the two conferences which Dr. Dixon was able to attend, thanks to the generosity of the donors and patrons of **NAAPO**. Of note is the fact that the Radio Observatory is part of at least one international committee thanks to Dr. Dixon's attendance at these meetings.

In attendance on September 21st were: Dr. Dixon, Mike Brooks and two of his guests, Connie and Neil Ostrove, Cindy Brooman, Earl Phillips, Jerry Ehman, Bob Tournoux and Ron Leeseberg. Steve Brown attended briefly via the Red Hotline Phone in the meeting room.

Before beginning his presentation, Dr. Dixon expressed his admiration and appreciation for the graphic images which were prepared by John Ayotte, to illustrate the **Argus** talks. It appears that no one else was supported by graphics of such quality or effectiveness.

Dr. Dixon's frequent and eloquent exposition of the **Argus** concept is leading to increased acceptance among international scientists. At the same time, increased critical attention is being paid to **Argus**. As reported in an earlier message on the Radobs list, Radio Astronomers are used to multiplying factors in forming beams, whereas the **Argus** proposal currently proposes the use of addition for this purpose. Because of criticism received on the recent trip, Dr. Dixon will ask Steve Brown to investigate this issue.

There appears to be solid interest on the part of some of the scientists who attended Dr. Dixon's talks, for use of the **Argus** concept for RFI detection. This possible application is likely to be investigated by the **Argus** team.

One of the conferences attended during the recent trip was devoted to consideration of a plan for a one kilometer square telescope design. While this design is conceived as producing only a small number of beams, Dr. Dixon was able to offer a vision of a future in which the two designs grow toward each other.

There was a special session on earthquake detection, based on results of research done by Russians in observing the ionosphere from above. It appears that there is a distinctive reduction in the frequency of passage of radio signals through the ionosphere in the hours before a major earthquake. At the moment, while the observations appear to be quite reliable, they do not offer hope of finding an alarm system for specific earthquakes. Much more work remains to be done in this area. Because of their particular vulnerability to seismic activity, the Japanese will launch satellites to study the effects reported by the Russians.

Jill Tarter gave a talk on her work in Australia. Of note is the use of a telescope located some distance away for RFI detection and elimination. A telephone line is used coordinate observations by the two sites.

Jackie Hewitt of MIT gave a talk on her project "STARE". This effort uses three receivers at widely dispersed locations in the U. S., from which data is transmitted to MIT. GPS receivers are used for precise timing. The project has detected two non-recurring pulses. One has been correlated to a solar burst, and the other is of unknown origin.

At this point in the meeting, Dr. Dixon introduced his latest thinking about the optimum placement of **Argus** antenna elements. In a departure from earlier concepts of logarithmic spirals, a new approach would deploy antenna nodes in circular rings. The discussion which followed included the following points:

A. Multifrequency beam detection
B. Circular arrangement simplifies computational burden for optimizing beams
C. Bessel functions are associated with circular arrays.
D. Varying phase around the ring to reduce side lobes.

E. Concentric rings logarithmically spaced
F. Limitations — inability to optimize sidelobes for all frequencies at one time
G. Altitude/Azimuth coordinate system as alternative to Right Ascension, Declination system.

The Motorola folks are proceeding with their Iridium plans. They have decided not to provide a transmitter to control local hand held units, as a response to the Federal requirement for protection of Radio Observatory research. Instead, they are thinking of trying to use a system which will track client location, in order to turn off hand held units which are near to radio telescopes.

Returning to discussion of the conferences: There is a new concept for traditional design, called "focal point arrays", which will involve 10 or 20 horns at a focal point.

There were presentations on Masers and pulsars.

The Indians are building a new telescope to work the 150 MHz band from an island in the Indian Ocean.

There are numerous enhancements around the world to existing facilities. Genetic algorithms have been adapted to antenna design. This presentation generated a lot of interest, and it may be applicable to **Argus**.

The new Green Bank radio telescope will use laser range finders to achieve 50 micron accuracy in reflector segment positioning. The Green Bank design is an offset paraboloid. All segments have actuators which work in conjunction with the laser range finders, which can test five positions per second. About a year of work remains for the Green Bank construction project.

CASSINI SPACECRAFT READIED FOR "SHAKE AND BAKE" TESTS

NASA's Cassini spacecraft, scheduled for launch to the planet Saturn less than a year from now, is being prepared at the Jet Propulsion Laboratory (JPL), Pasadena, CA, for a series of so-called "shake and bake" tests that imitate the vibration forces and extreme temperatures the spacecraft will have to withstand during its upcoming launch and flight through space.

"We're ready to put Cassini through the toughest tests it will face before launch," said Cassini Program Manager Richard J. Spehalski of JPL. "These tests will prove Cassini has the right stuff to get to Saturn and do its job."

In coming days, the 35-foot-tall Cassini spacecraft structure will be transported to JPL test facilities where it will face enormous speakers that blast the spacecraft with acoustic vibrations like those it will encounter during launch. Engineers will then test the spacecraft's response to random vibrations it is expected to experience during flight. Finally, the spacecraft will be fitted with custom-made thermal blankets and subjected to the extreme hot and cold temperatures it will reside in once it is launched into space from Cape Canaveral, FL, on October 6, 1997.

Cassini will reach Saturn in July 2004. After entering orbit around the ringed planet, Cassini will make detailed observations of Saturn and its largest moon, Titan, some smaller icy moons and study the magnetic environment surrounding the planet over a four-year period. The mission is an international effort of NASA, the European Space Agency (ESA) and the Italian Space Agency.

On October 11, JPL engineers and technicians completed the painstaking assembly of the spacecraft's major components with the installation of a model of the 8.8-foot (2.7-meter) diameter Huygens probe, provided by the ESA. The giant disk-shaped probe, covered with shiny amber-colored thermal blanketing, was fitted on the side of the Cassini spacecraft. Huygens will be carried to Saturn then released by Cassini to drop, via parachute, into the thick atmosphere of Titan. Huygens will take scientific measurements and observations of Titan's atmosphere, which is thought to be chemically similar to that of Earth's early atmosphere before life began.

The Cassini Program is managed by JPL for NASA's Office of Space Science, Washington, DC.

TOPEX/POSEIDON HELPS MARINE BIOLOGISTS STUDY WHALES

Marine biologists aboard a ship in the Gulf of Mexico are using maps of ocean currents produced with data from the ocean-observing satellite TOPEX/POSEIDON to help them locate and count sperm whales and dolphins.

The TOPEX/POSEIDON altimeter data, combined with information from the European Space Agency's ERS-2 satellite, are being used in near-real-time to generate circulation feature maps that will be faxed to scientists aboard the research ship R/V Gyre. These maps provide scientists with timely information about rapidly changing ocean features so that scientists can direct the ship toward those areas to determine if whales and dolphins are present.

"There is evidence that whales prefer to feed in the edges of cyclonic eddies, and the satellite data gives us a good picture of where those oceanographic features are located," said Dr. George Born, a principal investigator on the TOPEX/POSEIDON project from the University of Colorado at Boulder.

The university is generating the ocean maps and sending them directly to the scientists in the Gulf. "The data from TOPEX/POSEIDON and ERS-2 greatly enhances our ability to identify and map circulation features as they occur in the Gulf," said Dr. Robert Leben, a co-principal investigator on the project at the University of Colorado at Boulder.

The R/V Gyre left Pascagoula, MS, on October 10 and will survey the northeastern Gulf of Mexico until October 28. A previous survey indicated that whales and dolphins were contacted most frequently in the area where warm water eddies break off from the Gulf Loop Current, a strong ocean current that circulates around the Gulf of Mexico.

"The goal of our cruise is to make a visual and acoustic census of marine mammals and to define their physical and biological habitat in the northeastern Gulf in areas potentially affected by oil and gas activities now or in the future," said Dr. Randall Davis, head of the Marine Biology department at Texas A & M University at Galveston. "Altimeter data like that from TOPEX/POSEIDON are the only information that enable on-site adjustments to the cruise plan to optimize the survey track, ultimately saving us time and money."

The TOPEX/POSEIDON satellite was developed to study global ocean circulation but it is providing unexpected benefits for marine biologists. "We are very excited that these data are being used in new and different ways. Scientists are continuing to find new applications for this project and are proving they can study not only ocean currents, but also the creatures that inhabit the oceans," said Dr. Lee-Lueng Fu, TOPEX/POSEIDON project scientist at the Jet Propulsion Laboratory, Pasadena, CA.

The TOPEX/POSEIDON satellite uses an altimeter to bounce radar signals off the ocean's surface to get precise measurements of the distance between the satellite and the sea surface. These data are combined with measurements from other instruments that pinpoint the satellite's exact location in space. Every ten days, scientists are able to produce a complete map of global ocean topography, the barely perceptible hills and valleys found on the sea surface. With detailed knowledge of ocean topography, scientist can then calculate the speed and direction of worldwide ocean currents.

The R/V Gyre expedition is sponsored by Texas A & M University, the Texas Institute of Oceanography and the National Biological Service.

TOPEX/POSEIDON is a joint mission of NASA and the French Space Agency, the Centre National d'Etudes Spatiales. The Jet Propulsion Laboratory manages the U.S. portion of the mission for NASA's Office of Mission to Planet Earth, Washington, DC. The Mission to Planet Earth is a long-term, coordinated research effort to study the Earth as a global environmental system.

SFSU RESEARCHERS DISCOVER NEW PLANET WITH OBLONG ORBIT

"Eccentric" orbit shatters long-held theory of circular orbits

A remarkable new planet around a Solar-like star (16 Cygni B) has been discovered by Drs. Geoff Marcy and Paul Butler of SFSU, and Drs. Bill Cochran and Artie Hatzes of the University of Texas — two teams working independently. This planet orbits its star with the most extreme "eccentricity" (i.e., oblong shape) ever found for any planet, e = 0.6, on a scale of 0 to 1. All of the planets in our Solar System reside in nearly circular orbits, having eccentricities less than 0.2. This new planet dismantles the long-held theory that other planets in the universe would all have nearly circular orbits.

The discovery was made by measurements of the Doppler shift of the light from the

Solar-type Star, 16 Cyg B, (spectral type = G2.5) which is 85 light years from Earth. The star exhibits a periodic Doppler variation, with a period of 804 days (= 2.2 years). The star changes its velocity by +/- 46.5 meters/sec every 2.2 years, in a pattern that is NOT a perfect sine wave. This wobble implies that a planet orbits the star with an orbital period of 2.2 years and has a mass of at least 1.5 Jupiter masses. The actual mass of the planet may be slightly greater than 1.5 Jupiter masses, the uncertainty being due to the unknown tilt of the orbit plane which enters into the orbital physics (as the trigonometric sine of inclination).

Of extreme importance is the unprecedented eccentricity of the orbit, unlike that for any other planet. Its orbit carries the planet from a closest distance of 0.6 Earth-Sun distances to 2.7 Earth-Sun distances at its farthest from its host star, 16 Cyg B. The planet would experience extreme variations in the heat energy it receives from its star, as it varies from Venus-like distances to Mars-like distances. The oblong shape of the orbit is easily determined from the graph of Doppler-shift versus time. This graph is not a sine wave, which occurs for circular orbits. The departure from a sine wave is due to the speeding-up of the planet as it rounds the star at closest approach, much as the sound of a car engine changes pitch (also by the Doppler effect) as it rounds a sharp curve.

This planet adds to the mystery of a previously discovered planet around the star, 70 Virginis (discovered by the SFSU Marcy and Butler team). Its planet also has a large eccentricity of 0.4, the previous record holder. But that non-circular orbit was so discordant with the expected circular orbits from theory, that some theorists hoped it could be dismissed as a failed star (i.e., a "brown dwarf"), thereby ignoring the problem of how a planet (or any object) might become so eccentric. Now, new theories must be found to explain these two eccentric planets. Proposed theories involve collisions of two planets that scatter them into wacky orbits (Doug Lin, UC Santa Cruz and Fred Rasio MIT), or gravitational perturbations from the disk of gas and dust out of which the planets formed (Pat Cassen of NASA Ames Research Center, and Pawel Artymovicz of Stockholm Observatory).

This new planet was discovered completely independently by two teams: Drs. Bill Cochran and Artie Hatzes from the University of Texas and Drs. Paul Butler and Geoff Marcy of San Francisco State University and U.C. Berkeley. Each team has an ongoing, extremely sensitive technique for measuring the Doppler shifts of stars, designed explicitly to detect the perturbations imposed on the stars due to the gravitational force exerted on it by orbiting planets. This planet represents the sixth

planet discovered by the team of Butler and Marcy, and brings the total of known planets outside our Solar System to eight.

TECHNICAL SOLUTION

Formally, this is the solution for 16 Cyg B from the COMBINED measurements of both teams. The San Francisco State team provides Doppler measurements that have better precision (8 m/s compared with 27 m/s). But both teams detect virtually the same orbit.

ORBITAL ELEMENTS

P = 804.4 days; s.e. = 12.4 [Note. s.e. denotes "standard error"]
T(JD) = 48941.508 J.D.; s.e. = 10.523
K = 46.592 m/sec; s.e. = 8.219
e = 0.666; s.e. = 0.091
w (omega) = 86.807 degrees; s.e. = 12.908

PHYSICAL ELEMENTS

a*sin(i) = 3.84328E+08 meters; s.e. = 6.21915E+07
f(m) = 3.49068E-09 solar masses; s.e. = 1.69798E-09

One deduces that 16 Cyg B is about 1.0 solar mass, as it's spectrum (G2.5 V) is nearly the same as the Sun's (including age and metalicity). Indeed, it is often deemed a "Solar Twin". This gives a companion mass of: M comp = 1.52/sin i Jupiter masses. The semimajor axis of the planet about the star is: a = 1.7 AU (1.7 earth-sun distances) coming directly from Kepler's 3rd Law.

JUPITER'S LARGEST MOON HAS THIN OXYGEN ATMOSPHERE

Astronomers using the Hubble Space Telescope have found evidence for a thin oxygen atmosphere on Jupiter's moon Ganymede, the largest of the Jovian satellites. The same team of scientists had previously found a tenuous veil of oxygen around another Jupiter moon, Europa.

The observations also suggest that Ganymede, like Earth and Jupiter itself, has polar aurorae — light displays created when charged particles collide with atmospheric gases. The findings will be presented as a poster paper on display throughout a meeting of the American Astronomical Society's Division of Planetary Sciences, from Oct. 23 to Oct. 26 at the Tucson Convention Center in Tucson, Ariz.

A team of astronomers used the Hubble telescope's Goddard High Resolution Spectrograph on June 21 to make ultraviolet observations of Ganymede. The astronomers were excited when they saw the spectrum had the characteristic fingerprint that indicates the presence of oxygen gas. But they were puzzled because the spectrograph had detected two peaks, where the astronomers were expecting to see at most a single spike. They soon realized, however, that the two spikes could be explained by the existence of light emitted from two regions near Ganymede's north and south poles.

"The bright spikes correspond nicely to the poles of Ganymede," said Doyle Hall, the Johns Hopkins University astronomer who led the team making the oxygen discovery. Hall called the data "very tentative evidence for the existence of polar aurorae."

Ganymede and Europa are both at least partially covered with water ice. The scientists believe that the atmospheric oxygen comes from the icy surfaces, where oxygen atoms are split off from water molecules that are bombarded by charged particles; exposure to sunlight and meteor impacts also could create some of the gas, Hall said.

The atmosphere on Ganymede is likely to be as thin as the gas previously detected on Europa, comparable in pressure to Earth's atmosphere at an altitude of several hundred kilometers, roughly as high as the space shuttle orbits.

"I want to emphasize that all of the results that we have seen related to oxygen do not

require nor imply the presence of life," Hall said. This is in contrast to the oxygen in Earth's atmosphere, which is generated by biological activity. "In fact, the surfaces of these moons, as far as we can tell, are completely inhospitable to any life form that we can imagine."

The other members of the research team were Paul Feldman, a professor in the Johns Hopkins Department of Physics and Astronomy; Darrell Strobel, a professor in the Department of Earth and Planetary Sciences; and astronomer Melissa McGrath from the Space Telescope Science Institute in Baltimore — the same scientists who used the Hubble telescope to detect an oxygen atmosphere on Europa about two years ago.

Polar aurorae are created when charged particles are guided by a planet's magnetic field toward its poles. As the charged particles collide with atmospheric gases they create brilliant and colorful emissions, which on Earth are known as the Northern and Southern lights. Earth, Jupiter, Saturn, Uranus and Neptune are known to have polar aurorae. If confirmed, the Ganymede findings "would be the first detection of polar aurorae on any planetary satellite," Hall said. The astronomers observed ultraviolet light from Ganymede because in the visible spectrum the faint oxygen emissions would have been overwhelmed by bright sunlight reflecting off the moon's surface.

Scientists believe there are three prerequisites for the existence of polar aurorae on a planet or satellite: an atmosphere, a magnetic field, and a population of charged particles. At nearly the same time that the astronomers were using the Hubble telescope to detect the atmospheric oxygen, scientists operating NASA's Galileo spacecraft discovered both a magnetic field and charged particles around Ganymede.

The research is being funded by a two-year grant from the Space Telescope Science Institute totaling $76,000.

Ken Ayotte's Research Report
8/26/96

Many people have shown an interest in my projects lately and Earl suggested that I compose something for him to put in *Signals*. Unfortunately there is more I could say than anyone could conceivably squeeze into *Signals*. I'll take this as an opportunity to explain the awards I won earlier this year for my work in radio astronomy, and talk about the projects I'm working on now.

In April I received awards from the International Society for Measurement and Control, the American Institute of Aeronautics and Astronautics, and from the American Society for Quality Control. These organizations all belong to the Columbus Technical Council, which is responsible for and which organizes and holds an annual awards banquet where I was presented these awards. The three awards were based on a paper I wrote entitled, "*Construction and Operation of a UHF Amateur Radio Telescope for Radio Astronomy Research*." I was given a total of $350 and two plaques from these awards. The representative who presented those awards jokingly said that the two papers were so close that they eventually decided based on mass. Jim Markkam, representative of the ISA said, "Your paper was selected not only on the basis of technical content, scientific knowledge, organization and format and creativity, but also for direct individual effort and the obvious lessons learned as described in your paper," in a letter sent to me.

I've been operating around 614 MHz which is a radio astronomy reserved band. This band also lies in the UHF TV band, channel 37, which makes the receiver equipment much simpler to build. I have a GaAsFET preamplifier located at my antenna array and the signal is run into my basement through 25 feet of CQ 1001. It's amplified again by a broadband amplifier which I built myself out of a MAR-3 MMIC. The signal then goes into a commercial TV UHF tuner which converts 614 MHz to 45 MHz and a 45 MHz TV IF strip. Then it is detected, integrated, and the DC is amplified. The receiver output connects to a strip chard recorder and A/D converter.

I'm now using a different antenna than the one used for the paper with the very long and unflattering name. The new antenna consists of nine corner reflector yagi combinations which I purchased from radio shack [sic; Radio Shack] for $20 a piece. They are all configured in a linear phased array from east-to-west in order to give me a narrow beam in right ascension. The main beam is approximately 40 min. of time wide at the half-power points, and about an hour from the first nulls. It also has side-

lobes about an hour to each side of the center of the main beam. The side lobes are not very large however and do not even seem to show up with weaker objects than the sun.

Overall my new antenna system gives me much better results than I could achieve with the four helix array I used when I wrote my paper. The main beam is fairly narrow and clean which [sic; with] minimal side-lobe activity. However, I'm not getting as much gain as I expected. First I tried using just four of the antennas. The four seemed to work well but the beam was wider than I wanted so I expanded to eight. The beam was twice as narrow as with four, but I really didn't seem to be getting any more gain. I decided that that must have been because of an impedance mismatch. I then added a ninth antenna, which was suggested to me by Steve Brown, and modified my feed system to try to correct the impedance mismatch. Unfortunately this did not fix the problem, in fact it made it a little worse. From that I decided that the impedance of each antenna was different than I believed, and I would need to correct that somehow. Dan Fleisch offered to help me test my antenna impedances with a Wiltron network analyzer at Lintek. I made several VSWR and Smith charts using the instrument that told me the fault was in the individual antenna impedances after all. According to the analyzer I was getting about 100 ohms when I expected around 300 ohms. To raise this impedance to a value closer to what I needed I added a quarter-wave open-ended stub to the driven element of each of the antennas.

Then I experimentally adjusted the feed points for the lowest SWR. When I get everything up and running properly I'm going to start taking drift scans over the galactic plane. I want to try mapping the region of sky from 12 to Oh RA and from -35 to 45 degrees in declination. I've written several programs to run on a Macintosh which will allow me to analyze the data from my A/D converter. The first program I wrote was done using HyperCard, and can automatically start logging data at a set sidereal time and save that data to disk. With another program which I wrote in FutureBasic I can read the data and graph it. It also allows me to integrate the scan farther, and add scans from different days together to increase the sensitivity. I'm also working on a program that when I'm finished with my survey will draw a map of the sky.

Saturday, 10-19-96 Meeting Report
By: Tom Hanson

0n this occasion, Dr. Dixon, Dr. Barnhart, Steve Brown and Russ Childers were engaged elsewhere, so we turned immediately to individual reports.

In attendence were Ron Leeseberg, Ang Campanella, Mike Brooks, Cindy Brooman, Jerry Ehman, Ken Ayotte, John Ayotte and Jody McKean.

Ron Leeseberg is continuing work on his home observatory, which is to include a 4 meter radio telescope dish, and a 13 inch optical telescope. Ron had brought a video tape duplicator and display, in order to view the Big Ear video tape which Ang Campanella brought to the meeting.

Ang Campanella has been keeping up with email, and he once again brought the Penn State videotape of the Big Ear program which we viewed at a previous meeting. At the conclusion of reports, Ang played the video on Ron's equipment.

Mike Brooks ran tests on the RFI system on a recent Saturday. He used the signal squirter, and the output was seen by both the RFI system and **SERENDIP**, which proved the effectiveness of the system. On a following Thursday, the signal squirter died. Steve Brown has agreed to take a look at it. On a related failing equipment note, Bill Brown's test device seems to be failing as well.

Cindy Brooman received acclamation for the work she has done on the Big Ear web site, www.bigear.org. Of particular interest was the animated sequence she has designed to accompany an image of Radobs volunteers associated with the Guiness Book of Records entry. Cindy asked members to visit the site to test the feedback function in the members only section. For those readers who visit the site and wish to visit the members section, there is a standard 'member name' of radobs, and the password can be obtained at Saturday Meetings until Drs. Dixon and Barnhart have worked out a distribution method. Cindy spoke briefly about the tour she conducted for an enthusiastic radio amateur recently. She mentioned that an Ohio Wesleyan security guard drove through the property at the time of the tour. I have noticed this guard on a previous occasion, since he drives a distinctively marked vehicle, and am of the opinion he must be bored out of his mind if he amuses himself driving around the telescope site.

Jerry Ehman returned a video tape "*NASA: The Quest for Contact*", and it was immediately checked out by the Ayotte family. Jerry continued discussion of the Big Ear web site. Cindy has been announcing the existence of the new site a various places on the web, and she informed us that an entity called Alta Vista now has a record.

Ken Ayotte has completed another CD set, covering dates between 4-24-96 and 5-28-96. It is my understanding that the new CDs and the original Zip disks were delivered to Russ Childers after the meeting. The Ayottes have been moving recently, but Ken still had time to work on modifications to a new receiver system which he has packaged in a Craftsman tool box. The new receiver will now be close to the antenna, which Ken believes may compare to the vision of Argus antenna/receiver systems. There was a discussion of the potential value of locating the receiver system in a housing 30 inches under ground, in order to take advantage of stable temperatures at that depth.

John Ayotte led an interesting discussion of the ongoing email argument about what kind of equipment should be constructed at Argus antenna sites. The consensus seemed to be that electronics at the antenna site should be as simple as possible, and that only digital data should leave the antenna for distribution to a collecting facility.

Jody McKean has prepared an interim copy of the member roster, and she will send it to Cindy for installation at the web site. This roster is protected from public viewing by a very long password which is currently available only at Saturday meetings.

We then watched the Penn State **SETI** video which features Dr. Dixon and photographs of the site provided through the courtesy of Ang Campanella. Ang flew the camera crew over the site in his airplane.

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E-mail Webmaster

Designed by Jerry Ehman
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