NAAPO (North American AstroPhysical Observatory)

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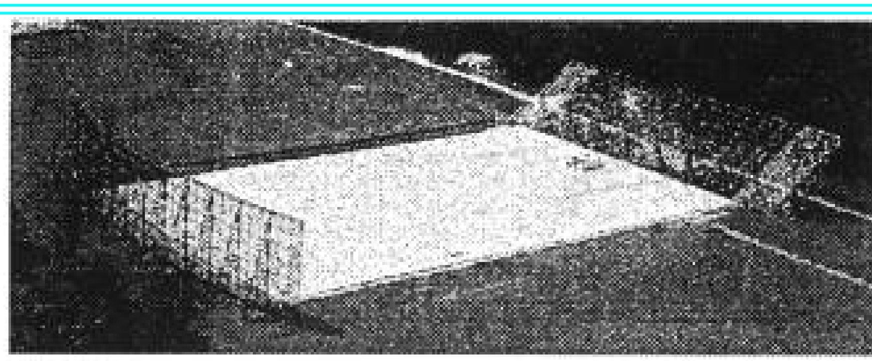
SIGNALS



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IN THIS ISSUE:

Report on Wow! Source Fit to Point Source OY372
Prepared by: Jerry R Ehman
June 7, 1995

I have previously reported on the fitting of two analytical antenna pattern models to the highest 6 points of the **Wow!** source. Those two models were: (**1**) Gaussian (*normal curve*); and (**2**) *((sin x)/x)^2*. One result of that analysis was that the Gaussian model was a somewhat better fit than was the *((sin x)/x)^2* model. The full results were presented in reports named *WOWFIT2P*, *WOWFIT4P*, and *WOWFIT6P*; the first of these was e-mailed to all persons on the **OSURO** listserver.

In the meantime, I have been working on an additional analysis of the **Wow!** source. One of the main goals of this analysis is to compare the actual response of the **Wow!** source with the actual antenna pattern (*instead of with an analytical expression for the antenna pattern*). The actual antenna pattern in the analysis reported herein is approximated by the response of the **OSURO** radio telescope ("*Big Ear*") to the relatively strong point source OY372.

Russ Childers kindly provided me with raw digital continuum data of June 16, 1994 on the 11.53 jansky point source OY372 located at the epoch 1950 coordinates: RA = 22h 43m 32s and DEC = +39d 27m. The source was observed at a (*declination squint*) corrected declination of +39d 40m (*but not precessed back to epoch 1950.0*).

Russ also provided me with similar calibration data taken 2 days earlier on June 14, 1994. The calibration signal had a noise temperature of 5 Kelvins.

The source OY372 was seen in both the negative and positive horns. However, the **Wow!** source (*observed in August 1977*) was seen in only one of the two horns and we do not know whether it was in the negative horn or in the positive horn; this is because in 1977 the computer program (*N50CH*) used to print and analyze the data had not yet included the provision to overprint minus signs on negative intensities. Hence, one of the main goals of this new analysis was to try to determine if the **Wow!** source came in the negative horn or the positive horn.

There are three responses: (1) negative horn response of OY372; (2) positive horn response of OY372; and (3) response of **Wow!** source. In order to compare the three responses, it was necessary to perform the following:

1 For the calibration (*noise tube*) data:

1.1 Select the points on each side of the calibration signal to be used for the baseline and fit a linear regression line to those points.

1.2 Subtract the baseline from all data.

1.3 Select the points when the calibration was on that represent good data and compute the average intensity.

1.4 Since the noise tube had a 5K temperature, divide the average intensity by 5 in order to obtain the number of original intensity units/ Kelvin.

2 For OY372 responses only:

2.1 Compute the precession corrections in right ascension and declination between the date of observations and epoch 1950.

2.2 Select the points on each side of the source response to be used for the baseline and fit a linear regression line to those points.

2.3 Select the points to be used for the source response and subtract the baseline.

2.4 Convert amplitudes (*intensities*) into temperature units (Kelvins) by using the result described in paragraph 1.4 above.

3 For all three responses:

3.1 Fit a Gaussian to the highest few points to compute the following 3 parameters: (**1**) location of the peak; (**2**) amplitude (*intensity*) of the peak; and (**3**) the half-power beam width (*HPBW*). Note that this had been done for the **Wow!** source in the *WOWFIT* analysis previously reported.

3.2 Compute the precession correction for OY372.

3.3 Normalize the data so that the computed peak has a normalized amplitude of 1.0, and shift the data so that positions represent seconds of time (*RA*) from the peak position.

3.4 Correct each differential time (*RA*) position to the equivalent of having the source located at the equator (*where declination = 0*) by multiplying by cos(**declination**).

3.5 Using cubic splines, interpolate among the data so that interpolated data points are created every 5 seconds of time.

4 For the 3 possible comparisons of responses: (**1**) OY372 negative vs. OY372 positive; (**2**) OY372 negative vs. **Wow!**; and (**3**) OY372 positive vs. **Wow!**:

4.1 Compute and graph residuals (*differences between one normalized response and the other normalized response*).

4.2 Compute the cross-correlation coefficient and the error sum of squares.

I used *Lotus 1-2-3* and *Mathcad* to do the operations listed above. Several graphs were prepared in the process. A total of 21 pages of printed output were needed for the combined analysis. Let me list some of the results obtained.

1. The baseline for the calibration was based on 10 points before the calibration plus 20 points after the calibration. The final value for the number of intensity units/ Kelvin was 892.2281 and the rms noise on the baseline (*using 12 + 12 = 24 points*) was 0.03166235 K.

2. The OY372 negative response had a peak amplitude of -3.6594 K, at an observed peak location (*uncorrected for precession*) of 22.696267 hours (= *22h 41m 46.56s*), with an HPWB of 40.8314 seconds (*prior to correcting to the equator*).

3. The OY372 positive response had a peak amplitude of 4.033704 K, at an observed peak location (*uncorrected for precession*) of 22.75047 hours (= *22h 45m 1.69s*), with an HPWB of 41.9007 seconds (*prior to correcting to the equator*).

4. The precession corrections for OY372 back to epoch 1950 were: 120.43 seconds of time for right ascension, and 14.002 arcminutes for declination. Note, subtract these values to go from the date of observation back to epoch 1950.

5. After applying the 14 arcminute precession correction in declination, it turns out that OY372 was observed only 1 arcminute off the peak. To correct intensity values to observing on the peak, all intensities should be multiplied by 1.001734 (*this factor was not needed for the results presented below*).

6. Using the precession correction in right ascension along with the location of each peak for OY372, I deduced the following horn offsets in right ascension (*in the sense that these values should be added to sidereal time in order to obtain right ascension*): squint for the negative horn = -225.87 seconds, and squint for the positive horn = -30.74 seconds.

7. The ratio of the peak amplitude of the positive to negative horn was -1.10229 (*in magnitude, the positive horn was about 10.229% stronger than the negative horn*). Similarly, the ratio of the HPBWs (positive over negative) was 1.02619 (*The positive horn HPBW was about 2.6% wider than the negative horn HPBW*).

8. A computation of the system temperature yielded 285.06 Kelvins (*based on a bandwidth of 40 MHz and a time constant of 10 seconds and using pi over the square root of 2 for the receiver constant*). This is too high. Russ has commented that the 40 MHz figure may not be appropriate due to the shape of the bandpass and the interference that can enter the receiver.

9. The following list contains the cross-correlation factors (*CCF*), the error sums of squares (*SSE = sum of squares of residuals (i.e., differences)*), and the number of points used to compute those values:

Responses	CCF	SSE	Number of Points
OY372 Neg vs. Pos	0.999288	0.004885	29
OY372 Neg vs. Wow!	0.990456	0.042077	15
OY372 Pos vs. Wow!	0.991877	0.03412	15

Note that SSE does depend on the number of points used while CCF is relatively insensitive to the number of points used.

10. The graphs of the residuals confirm the numbers above in paragraph 9. They show that the negative and positive horn responses are extremely similar (*virtually identical*). They also show that the **Wow!** source is an excellent fit to either the negative or the positive horn; I believe that the very small difference in the CCF or SSE is not statistically significant (*although I have not computed any measure of statistical significance to back up that statement*).

11. It should be noted that the negative vs. positive horn comparisons using OY372 do include the first sidelobe on each side of each main beam; since the CCF of 0.999288 is so close to unity, I will claim that this 11.53 jansky source is not strong enough to allow us to see differences (*other than peak amplitude and maybe HPBW*) between corresponding main beams or first sidelobes. It may be the case that we would need to look at the second or higher-level sidelobes to see significant differences between the negative and positive horns.

12. No attempt was made to use any data for the **Wow!** source in the sidelobe areas (*i. e., only the top 6 intensity data points were used and these are all in the main beam*). In light of my findings above (*in paragraphs 9 - 11*), it does not seem worthwhile to consider the very low-level values (*of blanks and 1s, meaning 0.5s and 1.5s after applying corrections for truncation error*) of the **Wow!** source in the first sidelobe regions.

In conclusion, please give me your comments on any of my findings and on possible future areas to investigate.

OPEN HOUSE '95 RULED A SUCCESS
By: Tom Hanson

Congratulations to the many volunteers who helped to put on the **1995 May Open House**. The weather was acceptable to begin with, and got better as the afternoon went along.

Marilyn McConnell-Goelz and Cindy Brooman added a remarkable new aspect to the Gift Shop offerings, by bringing a variety of brownies for purchase by visitors, and a strawberry covered cake for the staff AfterGlow party.

Joe Mitchell took Steve Janis' 'patented' position by the parabolic reflector, and developed it nicely.

Jerry Ehman took Dr. Barnhart's 'patented' position at the control hut, and launched each group of visitors toward Joe's position, filled with facts and anecdotes.

Russ Childers and Phil Barnhart ran their Radio Picture Gift Shop and Horn Cart Explanation program with their usual enthusiasm, and earned $57 for **Big Ear**. They did report afterward (*and even during the afternoon*), that they had observed that the psychology of their station is such that their sales were greater when groups were larger.

Ang Campanella wore his straw cowboy hat for protection from the sun, and gave talks about the flat movement mechanism at the east end of the flat reflector. This was Don James' 'patented' position. Don was out of town for this occasion.

Bill Brown entertained visitors at the entrance to the focus room with a graphic display of focus room equipment, and regulated the flow of people into the confined quarters of Steve Brown's emporium.

Steve Brown maintained his usual position in the focus room, and drew his usual words of praise from visitors.

Dr. Dixon gave many lectures at Position 8, in the Administration Building lecture room. He varied his procedures somewhat, this year, by leaving the Administration to gather up crowds from the focus room, where it seemed that Steve Brown had captured them.

Marilyn and Cindy managed the Gift Shop, whose displays looked varied and impressive to my eye. The refrigerator was stocked full of pop for sale, the brownies filled the room with savory aroma, and assorted t-shirts, magazines and other offerings were set out on tables.

Throughout the afternoon, Al Porter [sic; "Al Horton"] guided visitors to parking positions, and supported the welcome and orientation effort at Station 1.

There are indications that several people may decide to become volunteers.

There a number of visitors from Delaware, including one gentleman who arrived in a gleaming DeLorean, striking a chord of recognition in the mind of this "*Back To the Future*" viewer.

Throughout the afternoon, Dr. Barnhart visited various stations, assembling a photographic record of the event. A couple laden with photographic and video camera equipment also went on the tour, so there by be [sic; "may be"] some further publicity ahead.

All in all, this was a well organized and conducted event, which seemed to please our guests.

TUESDAY MEETING REPORT
By: Tom Hanson

Today's (*Tuesday night*) meeting was attended by Russ Childers, Bill Brown and Mark Sundstrom. The actual meeting was concluded by the time I arrived, but Russ and Mark have been deep in discussion of programming and related issues ever since.

Mark has replicated Russ' analysis software in C++ on his Macintosh, and Russ indicated an interest in learning about C++, and about program design for the Macintosh.

GALILEO MISSION STATUS
July 1, 1995
PUBLIC INFORMATION OFFICE
JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PASADENA, CALIF. 91109

The Galileo flight team is making final preparations for the launching of the atmospheric probe on its solo flight to Jupiter's atmosphere, due to arrive Dec. 7, 1995. The probe release sequence was transmitted to the spacecraft on June 28. This sequence, which was activated on July 5 and continued through July 13, will command a series of activities culminating in the probe release, scheduled for 0530 Universal Time on July 13. Confirmation of release events will be received on Earth 37 minutes later, at 11:07 Pacific Daylight Time on July 12.

The probe's internal timer will be set to activate six hours before atmospheric entry, then be switched to internal battery power and place the probe in its dormant cruise mode. The cable linking the probe and orbiter will be cut and then the orbiter will turn to put the probe in the proper orientation to enter the atmosphere. The spacecraft will spin up to 10.5 rpm to stabilize the probe's orientation. Finally the release nuts will be opened and springs will launch the probe on its 83-million-kilometer (*52-million-mile*) flight to Jupiter.

The previous sequence on June 23 had allowed for a trajectory correction — the 24th since launch — but the navigation team found the aim so good from the 23rd maneuver last April that the last maneuver was not needed.

Galileo is scheduled to use its main engine in a large maneuver for the first time to aim the orbiter away from the probe trajectory and toward its own Jupiter approach path. On Dec. 7 this trajectory will deliver Galileo to travel to within 1,000 kilometers of the volcanic surface of Jupiter's moon Io, and into position to receive and record the probe's scientific data. Next the spacecraft will reach the point where another large maneuver will put it in the first orbit around the giant planet.

The spacecraft continues to operate normally, spinning at about 3 rpm and transmitting telemetry at 8, 10 and 16 bits per second. It has been undergoing a variety of engineering tests as Jupiter arrival draws near, as well as frequent readouts of scientific data on the surrounding space environment. The gravity wave experiment started in May was concluded on June 28.

Galileo is now nearly 789 million kilometers (*490 million miles*) from the Sun, almost as far away as it is to Jupiter. The spacecraft has traveled 3.7 billion kilometers (*2.3 billion miles*) since launch in October 1989. Today its speed in orbit, gradually slowing as it recedes from the Sun, is 16,076 miles per hour.

GALILEO'S JUPITER ATMOSPHERIC PROBE SUCCESSFULLY RELEASED

Packed like an interplanetary paratrooper, the atmospheric probe aboard NASA's Galileo mission successfully sprang loose from the main spacecraft early this morning and began its long, five-month free-fall toward Jupiter.

"*We're delighted to have successfully released the probe on its Jupiter atmospheric mission after having carried it for ahnost six years*," said Galileo **Project Manager William O'Neil** at **NASA's Jet Propulsion Laboratory** (*JPL*), Pasadena, CA.

Data from Galileo received shortly after 2:07 a.m. EDT confirmed that the probe release went as planned. "*The probe is configured for its encounter with Jupiter and is on its way*" said **Marcie Smith**, manager of the probe mission at **NASA's Ames Research Center**, Mountain View, CA. "**We're very excited to have the probe mission underway.**"

The probe's flight across the remaining 51 million miles to Jupiter will end abruptly on Dec. 7, 1995 when it slams into the giant gas planet's atmosphere. After hitting the top of Jupiter's atmosphere at the highest impact speed (*106,000 mph*) ever achieved by a human-made object, the rugged probe will unfurl its main parachute and float downward. Seven onboard instruments will directly measure for the first time Jupiter's chemical make-up, winds, clouds and lightning. The probe will radio its data to the Galileo spacecraft for up to 75 minutes.

The probe mission is likely to end when the main Galileo spacecraft passes beyond radio contact with the probe as the spacecraft enters Jupiter orbit. The ultimate fate of the probe may be determined by its battery lifetime, or it may first succumb to the immense pressure of Jupiter's atmosphere and be crushed. Galileo, meanwhile, will begin two years of close-up studies of Jupiter, its moons, rings and powerful magnetic environment.

On July 27, Galileo will fire its main engine to deflect its own course toward an orbit high above Jupiter's cloud tops.

The overall Galileo mission is managed for **NASA's Office of Space Science**, Washington, DC, and by **NASA's Jet Propulsion Laboratory**, Pasadena, CA. Galileo's atmospheric probe is managed by the **Ames Research Center**, Mountain View, CA.

TOPEX/POSEIDON MISSION STATUS

July 1, 1995

PUBLIC INFORMATION OFFICE
JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PASADENA, CALIF. 91109

The satellite and sensors continue to operate as expected and ground system computers are performing well. The satellite tape recorders have been played back and the daily science and engineering data products are being produced.

The satellite begins the next 10-day data collection cycle — its 103rd — at 6:07 a.m. Pacific Daylight Time. The French solid-state altimeter will be turned on at 5:24 a.m. and will track throughout the cycle.

TOPEX/Poseidon has completed more than 13,508 orbital revolutions of the Earth since its Aug. 10, 1992 launch. The satellite orbits Earth once every 112 minutes.

BROWN DWARF DISCOVERED

The discovery of a brown dwarf, a long-sought celestial object too small to be a star, but far more massive than a planet, has been claimed by a group of California astronomers.

Researchers at the **University of California**, Berkeley, and **San Francisco State University** reported Tuesday that the brown dwarf, known as **PPL15**, was found in the Pleiades, a cluster of stars 400 light years away and within the Milky Way Galaxy.

Brown dwarfs are cool, very dim objects thought to have too little mass to become a star, but which are about 100 times more massive than Jupiter, the largest known planet. The objects emit most of their energy in the infrared spectrum and may be unseen in visible light. They hold an important place in theory because it's believed they account for a key part of the mass in the universe.

Many astronomers have searched for brown dwarfs, but none of the past candidates have been unequivocally confirmed.

Gibor Basri, astronomy professor at *Berkeley*, said PPL15 was confirmed as a brown dwarf because "it passed the lithium test." Lithium is a primordial element that is destroyed in stars within 100 million years. In brown dwarfs, which lack the nuclear fires of a star, lithium is not destroyed. Thus, if lithium is detected, then a faint object may be a brown dwarf.

PPL15 was first posed as a brown dwarf candidate last year, but Basri and his colleagues say they confirmed its identity using the new Keck telescope, the 10-meter instrument on Mauna Kea in Hawaii that is the world's largest. Light collected by the Keck from PPL15 was analyzed by wavelength and revealed the distinctive signature for lithium.

"*This is the first confirmed brown dwarf,*" Basri said. "*It is confirmed by the fact that it has not destroyed its lithium.*"

James Leibert of the *University of Arizona*, Tucson, called the finding a "*tremendously exciting result,*" but said there is the possibility that PPL15 is actually a failed star. He said this would be a stellar object that burned briefly, but then winked out before it could destroy all of its lithium. He said if the object is 70 million years old, the accepted age for stars in the Pleiades, then "*it definitely is a brown dwarf.*"

However, Basri and his colleagues claim PPL15 may be more than 100 million years old. A star this old would have no lithium, but the element would exist in a brown dwarf. Thus, the older age is an element of their conclusion.

Leibert said if the 100 million-year age for PPL15 is correct, then it could be a failed star and not a brown dwarf.

But **Geoffrey Marcy** of *San Francisco State University* said the work has effectively established a definition for brown dwarfs. "*Anything that is fainter than PPL15 has to show lithium to be a brown dwarf,*" he said. "*The condition for brown dwarfdom has been established once and for all.*"

Basri said that other faint objects in the Pleiades have been studied by the Keck telescope and some do show lithium, suggesting that there maybe other brown dwarfs in the star cluster.

Finding brown dwarfs aids astronomers in explaining the so-called missing matter in the universe. The objects visible in the universe do not account for all of the mass that must exist there, based on the observed motion of the stars and galaxies. In the search for the missing matter, it has been suggested that a good portion of it is in brown dwarfs.

A Challenge Grant to the RadObs community:
by Herbert Johnson

We have about a year left with the **LOBES** Survey, and possibly it will be the last year of **Big Ear** operation. I say we end the Survey, and possibly the telescope's history, as we began: with a THOROUGH Sky Survey that retains ALL data possible. That is, we archive the 3000 channel data available from the PDP-11, and not just its reduced version from **LOBES** processing.

I propose, in brief, that we set up another IBM-AT, for the sole purpose of archiving the serial data stream from the PDP-11. Why bother saving this data? Because we are still reviewing similar single-channel continuous data from the 1976-1985 **SETI** survey, and we still do not have ANY CLEAR PICTURE as to the sources of the hundreds of strong, narrow-channel events we found; out of the 30,000 we recorded from 50 channels. If these events have changed in 15 years, we may have a clue as to their origins. If not, then that too is a clue!

We are already producing this data stream today, in a 3000-channel version. To merely archive this data stream requires little or no software: a data communications program with file save, or a simple C program. And, by doing it on a computer seperate from **LOBES**, we are not compromising the **LOBES** Survey.

In the past, this archive would have called for an expensive hard drive and a modestly expensive computer. Now, hard drives are cheap and the AT's are free. In fact, I will start off the challenge with an 8 MHZ Original IBM-AT, shipped to the Observatory, IF the Challenge is met. (*You'll need a monochrome monitor and AT keyboard, and maybe a floppy drive. Big deal.*)

What is the Challenge? Simply that enough members of the Observatory and **NAAPO** contribute the dollars to buy a hard drive. How much money? Well, $170 mail-order will buy 400 Megs of storage. I believe this will be enough for months of storage, if not a year. Backup devices? Take it off line and put it compressed on floppies at 20 cents a meg, or write it to a borrowed tape drive and CD-ROM the data. Missing a few days of data is far better than missing it all!

But these are details. Meanwhile, if we don't collect the data NOW we may never collect it again! If TEN people contribute $20, we can buy the drive and some accessory parts and start collecting! And, a year from now, the Observatory will have another computer and a good amount of storage to support whatever projects are available.

Please respond — money talks loudest! — with a PLEDGE to Dr. Dixon and to Dr. Barnhart. I suspect NAAPO will be the recipients of these funds, but I leave it to these gentlemen to work it out. They'll tell you where to send the money: the pledges will tell them you support this effort.

I thank you for your consideration of this very modest proposal; those who will use this data will thank you even more!

PROJECT PHOENIX UPDATE

They picked up signals from satellites, aircraft, automatic garage door openers and even microwave ovens, but not a peep from an alien. After five months of electronically eavesdropping on the universe for signs of life, scientists ended a sweep of the southern skies Tuesday.

"*We didn't find anything, but we learned a lot,*" said **Jill Tarter**, project scientist for the **Search for Extraterrestrial Intelligence Institute**. "*We'll keep looking. The search has only just begun.*"

The institute, based in Mountain View, Calif., plans to move its **Project Phoenix** search back to the northern hemisphere. Starting Feb. 3, scientists used high-tech scanning equipment attached to the Parkes radio telescope, a huge white dish in Outback sheep country, to listen in on billions of radio waves across the stars. They claim it is the most sophisticated and systematic search ever.

Space is full of natural radio static. The group was trying to find deliberately sent signals that would stand out from the back ground. A big problem was signals from human technology. Special scanning equipment, with the help of the Parkes dish and another nearby radio telescope, cut out much of it. Even so, there were more than 100 false alarms. Satellites and other space probes — and overhead jets — were the worst culprits, but there were more down-to-earth sources as well. Remote-controlled garage door openers puzzled the scientists for a while. "*We had to ban the use of microwave ovens in the kitchen because of the signals they produce,*" said Tarter.

Tarter, like many of her co-workers, once searched for extraterrestrials on behalf of **NASA**. But Congress axed funding for the U. S. space agency program in 1993 after some lawmakers complained the search was pointless. The project was later revived as a private operation funded by donations.

PIONEER 10 & 11 STATUS
UPDATED: 6/1/95

PIONEER 10

- Distance from Earth: 9.48 billion kilometers (*5.89 billion miles*)
- Roundtrip Light Time: 17 hours, 33 minutes
- Active Instruments:
    - Plasma Analyzer
    - Charged Particle Instrument
    - Cosmic Ray Telescope
    - Geiger Tube Telescope
    - Ultraviolet Photometer

The spacecraft is healthy and continues to make observations of the interplanetary environment at the outer regions of our Solar System. As the spacecraft electrical power continues to decline, the instruments are operated according to a power-sharing schedule. Individual intruments, or groups of instruments, are turned on at a time such that the total power consumption is within the available power range.

PIONEER 11

- Distance from Earth: 6.34 billion kilometers (*3.94 billion miles*)
- Roundtrip Light Time: 11 hours, 44 minutes

The Pioneer 11 spacecraft has been reacquired, but telemetry data is not yet being received. The earth is still 1.6 degrees away from the center axis of the spacecraft antenna. During the next few weeks the signal will improve considerably, and data reception will again be possible. The available power from the Pioneer 11 spacecraft Radio-Isotope Thermoelectric Generators (RTG) is declining to the point where there will be insufficient power for any instrument by December 1995. Between June and August 1995, Pioneer 11 will be used as a test-bed to study its performance under sub-normal voltage conditions.

Project Manager: Fred Wirth (*e-mail: Fred_Wirth@qmgate.arc.nasa.gov*)

SATURDAY MEETING REPORT FOR 7/1/95
Tom Hanson

There was a nice turnout for the **Radobs** meeting of Saturday, July 1, 1995.

Byron Blake is a radio amateur who's been interested in the Observatory for years, and he began to volunteer when he moved into the Columbus area. His work with the old LNA's is reported later on.

Dr. Barnhart, Jerry Ehman, Steve Brown, Ang Campanella, Russ Childers, Bill Brown, Dr. Dixon and Phil Shumacher comprise the rest of the attendee list. We were joined later on by Tammy Brown, an OSU Lantern reporter, and by a reporter from the *Delaware Gazette*.

Dr. Barnhart discussed the current initiative to renew Radob's (*NAAPO's*) tax exempt status. As an item of interest, current IRS rules prohibit any one donor from contributing more than 28% of total income for a tax exempt organization. This fact is of interest since donor income to **NAAPO** tends to be on the low side. In the meantime, Dr. Barnhart and Marilyn McConnell Goelz continue to work on this initiative as time permits.

A global working group is studying a concept for building the world's next large radio telescope. The mainland Chinese are interested in siting such a facility in their country, and they are hosting a gathering this year. Dr. Dixon has been invited to give a paper on **Argus**, and if funds are available, he is planning to attend.

Dr. Dixon announced that "**Science Magazine**" (*Volume 268 9 June 1995*) contains an article about a **NASA** search for planets outside the local solar system.

A bid to paint the telescope for $160,000 was received, and it will be forwarded to OSU authorities.

On the overall topic of the fate of **Big Ear**, there is likely to be an announcement toward the end of July. Dr. Dixon is involved in some promising negotiations, but nothing is certain at this time.

Bill Brown was here on Friday (**June 30th**), but he was unable to work on **Serendip** due to activities of the ESL crew. ESL is carrying out radar studies. Bill's report included mention of activities by ESL students which suggests they are not receiving the required instruction about **Big Ear**, and he was encouraged to pass along his observations to Dr. Klein.

Ang Campanella flew over **Big Ear** recently, and he took pictures of the EastWest Railroad for future publicity and seminar activities.

Russ reported the telescope is holding at 10 degrees, zero minutes, due to interruptions caused by the ESL radar studies. Russ added to comments about ESL student behavior by stating that the LNA's have been left off at night. The PDP is about 3 minutes behind in time.

There was a discussion of the degree of flooding in the focus room, after heavy June storms.

Jerry Ehman is continuing his study of the **Wow!** signal. He has reached a figure of 47 Jansky's, still well short of Russ Childers' estimate of 200+ Janskys.

Phil Shumacher introduced some humor into the procedings, but since the fate of **Big Ear** is still not settled, I will omit this part of the report.

As reported earlier, Byron Blake is making substantial progress in restoring the GasFET LNA's to service. He will be working with Steve Brown to solve problems involving power supplies which meet all requirements ... size, quality of output, etc.

Jenny Kelbly has expressed interest in working on the Radio Observatory archives, and Dr. Dixon suggested that the highest current priority for the archives, would be to locate and to catalog all remaining photographs and especially NEGATIVES, because so many photographs have been given to press agencies who subsequently did not return them. A second priority suggested by Dr. Dixon, would be to continue the excellent work of filing publicity about **Big Ear** started by Steve Janis.

As the meeting drew to a close, Russ Childers announced that the time had come for sand blasting of the EastWest Railroad wheels. A crew of volunteers joined Russ for the wheel removal exercise, which went relatively smoothly. Unfortunately, after the wheels had been delivered to the garage, no one volunteered to take them on to a sand blaster, so we can only hope that Russ will find a way to do that.

WOW! REPORT UPDATE
By: Jerry Ehman

At the **OSURO** meeting last Saturday (*6/17/95*), I reported on my recent work on the **Wow!** source. There was a great deal of discussion. In the process, it was noted that I used a value for the aperture efficiency that was significantly too high. Thus, in this e-mail document, I am going to report on the highlights of my report at the **OSURO** meeting but with the corrected results obtained by using a more appropriate value of the aperture efficiency.

Using the raw data from the 11.53 jansky point source OY372 taken on 6/16/94 (*with similar raw data on the 5 Kelvin calibration signal taken on 6/14/94*) given to me by Russ Childers, along with the **Wow!** source results in channel 2 (*taken in August 1977*), I was able to obtain the following major results:

1. The positive horn response was 10.2% stronger in magnitude than the negative horn response.

2. The positive horn HPBW was 2.6% larger than the negative horn HPBW.

3. After normalization, the positive and negative horn responses (including the first sidelobes on each side) are linearly (*cross*-) correlated with a correlation coefficient (*CCF*) of 0.9993 = 99.93% (*almost perfect linear correlation*). Note that we are correlating a positive horn response with a corresponding negative horn response at the same distance from the peak (*where each response has been normalized to a peak amplitude of unity*).

4. Similarly, the linear correlation coefficient between the **Wow!** source response and the negative horn OY372 response was 99.05%; between the **Wow!** source response and the positive horn OY372 response, the linear correlation coefficient was 99.19%. Note that the areas of the sidelobes of the **Wow!** source were not included. The conclusion from these CCFs is that it is not possible from these data to conclude in which horn the **Wow!** source was observed.

5. The highest data value of the **Wow!** source was 30 sigma (*i.e., 30 times the rms noise = 30 times the standard deviation of the data*). Adding 0.5 for the truncation (*to an integer*) error and fitting a Gaussian (*normal = bell-shaped*) curve to the data, the peak of the **Wow!** source was about 30.76 sigma. This also means the signal-to-

noise ratio was about 30.76 at the peak.

6. No sidelobes of **Wow!** were observed. The data of **Wow!** in the areas of the sidelobes were mostly 0s and 1s; thus the sidelobcs were buried in the noise.

7. In the early days of Big Ear, it was believed that the first sidelobcs were 23 dB down from the peak (*i.e., 1/200 = 0.5% of the main beam peak response*). The data of OY372 (*taken in June 1994*) revealed that for both the positive and negative horns, there was essentially no first null off the main beam and that instead the pattern plateaued at about a 10 dB level below the main beam peak before going down to lower levels further out. Both patterns remind me of a Gaussian decaying when going off the peak but with a temporary leveling off before resuming the Gaussian decay. At the meeting it was thought that the figures of the flat and paraboloidal mirrors were deteriorating (*meaning that the flat mirror is less flat now than in the past, and similarly each 10'x10' flat section making up the paraboloid is less flat. The words "less flat" could mean either a twisting from flatness or else periodic or random departures from flatness*). A 10 dB first sidelobe indicates a serious deterioration of the mirrors. Note that if the sidelobes had been only 10 dB down in August 1977 when the Wow! source was observed, we probably should have seen values of 2s and 3s (*and maybe even a 4*) in the sidelobe areas. Since we didn't, that suggests that the sidelobes in August 1977 were more than 10 dB down then, and that the deterioration has occurred since then.

I did some thinking about the possible distance of the **Wow!** source. I considered conceptually the differences in the antenna pattern in the far field region versus in the near field region. The distance of the transition between near field and far field is given by the formula 2*D^2/wavelength. I initially used D = 70 feet (*height of the paraboloid and direction of the electric field that is being detected in the horns*) and a wavelength = 21 cm. This yields a distance of 2.7 miles. It was pointed out to me that I should have used D = 340 feet because we were observing the pattern in right ascension (*i.e., horizontally*); using this value the distance becomes 63.6 miles. In the far field the spherical waves from a point source depart less than 1/16 of a wavelength from plane so that plane waves can be assumed to be hitting the flat reflector and then the paraboloidal mirror. Regardless of this distance I deduced that the **Wow!** source couldn't be in the near field because: (1) the response pattern of **Wow!** was almost perfectly a far-field response pattern (*over a 99% correlation — see #4 above*); and (2) a source in the near field would have to move with respect to the telescope at a rate necessary to maintain a constant right ascension and a constant declination (*and this would be very very unusual*). Thus, I concluded that the **Wow!** source was in the far field of the Big Ear.

I also noted that in order to estimate the distance within the far field, it would be necessary to know how some of the parameters of the far-field pattern varied as a function of distance. Since these parameters would vary little over the considerable distance range, it would be necessary to measure response intensities at each right ascension out to at least 6 significant figures (*and more likely out to at least 12 significant figures when talking about distances beyond the solar system*). This, in turn, requires a signal-to-noise (*S/N*) ratio of 10^6 or 10^12 or more. In the case of **Wow!** we obtained a S/N of about 30, well below our needs for an analysis of distance.

Russ Childers reported on 4/21/95 that he had calculated the flux density of the **Wow!** source to be 212 Janskys (*flux units*). I decided to attempt that calculation as well. My procedure involved 3 steps: (1) compute delta T rms, the minimum detectable temperature; (2) compute the antenna temperature of **Wow!** using 30.76 times delta T rms; and (3) compute the flux density using the antenna temperature.

Step l: For the system temperature I assumed *{low value, middle value, high value}* = *{120, 150, 180}* Kelvins. The bandwidth was assumed to be 10 kHz wide. The time constant was assumed to be 10 seconds. Using pi/square root of 2 for the receiver constant, I obtained the *{low, middle, high}* values for delta T rms = *{0.8430, 1.0537, 1.2645}* Kelvins.

Step 2: Multiplying by 30.76 (*the peak amplitude of a Gaussian fit to the **Wow!** data*), I obtained for the antenna temperature the following: *{25.9300, 32.4124, 38.8949}* Kelvins.

Step 3: To convert the Step 2 results into flux density, it is necessary to use an effective aperture (*which is the product of an aperture efficiency by physical aperture*). In my report I used a value of the aperture efficiency that was too large. Bob Dixon suggested that 0.5 is appropriate, and Russ Childers suggested using 0.45 . I will use the range 0.475 +/- 0.025. I then obtain for the flux density of **Wow!** the following three values: *{64.73, 85.17, 107.89}* Janskys. The middle value of about 85 Janskys is approximately 40% of the value that Russ Childers obtained (*or equivalently Russ's value is about 2.5 times my middle value*). The question is why is there such a discrepancy.

I am currently trying to work out the geometry and related math to directly compute the aperture efficiency of the paraboloid. If I am successful, I'll report the results.

COORDINATOR'S CORNER

I seem to be squeezed into a small pocket this issue. I also feel as if I have a lot to say. If indeed I run over into la-la land I will add a page to this issue -- in spite of the wishes of the editor.

The bad news continues. There will most likely be a Jurasic Park where some day the beneficiaries of our growing wisdom will have to go (for a fee) to see the dinosaurs of the latter part of the 20th Century technology explosion. It has been said, "Necessity is the mother of invention." Certainly the necessities of pioneering research in radio astronomy led to the invention of the Kraus type radio telescope. The design was driven by the demand for the greatest number of "microwatts per kilobuck" (Kraus's words) and a simple device for the purpose of surveying the new territory just opened to astronomy by the discovery of radio emission from the universe.

Arthur Clarke, in his letter to E. Gordon Gee, summed it up admirably when be commented that if for no other reason, Big Bar should be preserved as a historical monument.