



## NAAPO (North American AstroPhysical Observatory)

"Signals"  
Volume 9 Number 6  
The NAAPO Newsletter  
(July 1993)



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## **WARNER CABLE DONATION — PHOTOS**

**[Note. Click on each photo to see a larger image.]**

Figure 1: Warner Cable employee delivers spool of guy wire.

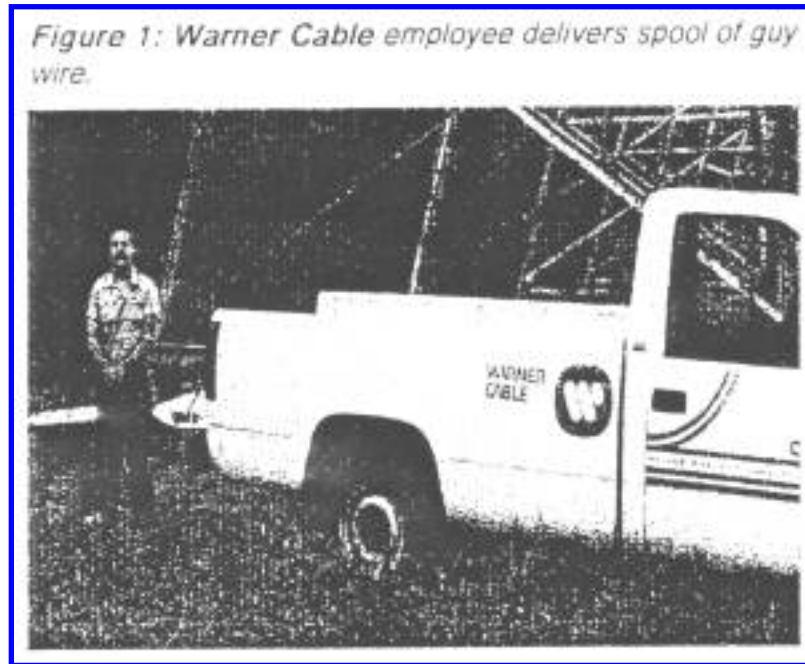
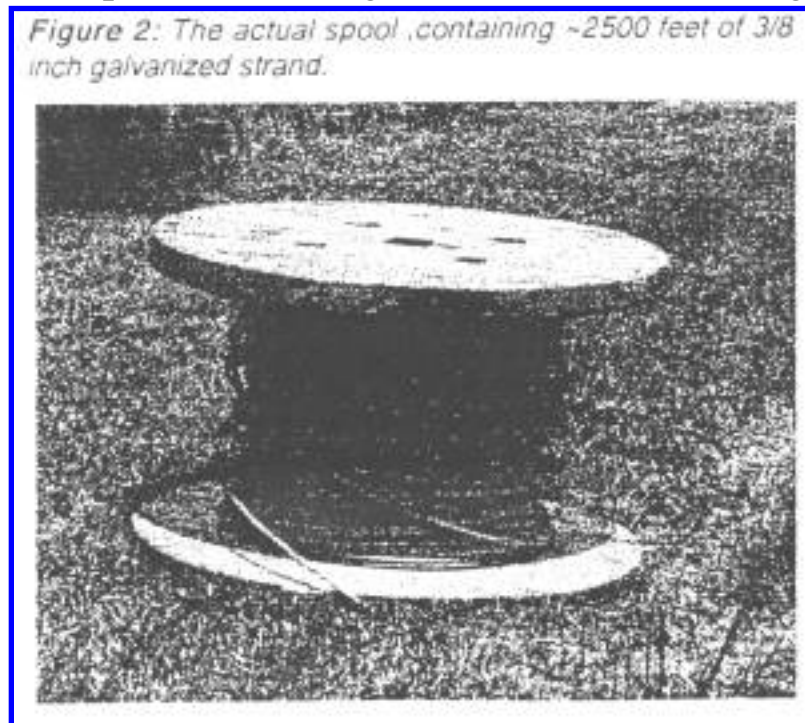


Figure 2: The actual spool, containing ~2500 feet of 3/8 inch galvanized strand.



The preceding pictures are of the delivery of the guy replacement wire donated by Warner Cable recently. Unfortunately, I received the images just a couple of days late to include them in the last issue of Signals. The photos were taken by Steve

Brown. The photos were then scanned into computer format by John Ayotte.

## Summer Interns Turn Up the Heat

By: Dr. Philip Barnhart

**Chris Slack** and **Malinda McKay** have signed on as **NAAPO** Summer Interns. They add greatly to the labor force at the **RO** during a time of great activity and development. Chris is a 1993 graduate of Greenfield High School, Greenfield, MA where he did an outstanding job with a radio astronomy related science fair project. He was introduced to us and we to him by Steve Willard — a newly found friend of the observatory and benefactor. Chris has been named the **Jansky Intern** and will be with us through the month of July. He starts his Freshman year at Clarkson University in upstate New York toward the end of August. Malinda is a Senior at Fort Hays Alternative High School in Columbus and expressed an interest in some work connected with the Observatory earlier in the year. Malinda has been named the **Reber Intern** for the remainder of the summer.

## NASA Grant Comes Through

By: Dr. Philip Barnhart

A new contract from **NASA** has begun at the **Radio Observatory**. The first annual installment in a three year project began June 1 with the financial authorization arriving July 1. This means a significant shot in the arm for the work of the **RO** and will allow obtaining a four million channel receiver with a bandwidth per channel of 0.6 Hz. The instrument is a **SERENDIP III**, based upon the model currently in use by the **NASA SETI** group. The observatory staff will now hold our heads a little bit higher.

## 7/3/93 MEETING NOTES

The meeting began at roughly 10:02am. Those in attendance were Phillips, Barnhart, Childers, Ayotte & son, McKay & daughter, VanHorne, James, Campanella, Dixon, Schumacher, Chris Slack, and Bowling Green physics teacher Ron Stoner and his student Hemant Shukla. A general round of introductions for the benefit of the visitors started today's meeting.

Barnhart reports that he has received a grant proposal from Ken Ayotte, for equipment for his radio telescope research.

Dixon reports that we have received the new **NASA** grant of \$100,000 a year for the next three years. He notes that while this is the largest grant we've ever received from **NASA**, it still does not pay for everything we do, and that the volunteers are just as important to the organization as ever. We will be purchasing a new 4 million channel spectrum analyzer of the "*Serendip*" design. This will produce a challenge in the areas of data storage and detection algorithms. He brought up the subject of a possible get-together at his new house for **RO** personnel.

Childers reports that he has taken some pictures of computer generated images of the "mystery source" he has been tracking, as well as of the hydrogen cloud he has been mapping. He also brings a photo-chronology of the cleaning out of the feed horns. He has been calibrating the narrowband channels to determine their gain. He also has all the computer programs auto-rebooting in case of power outages. The focus room air conditioner went out recently but was repaired within a day.

Ayotte reports that he may have a line on the possible donation of a VAX and associated documentation. He is still working on scanning the **Ohio Survey** into PC format.

Phillips reports that he has been busy doing light pollution work, but still intends on knocking down the old feed horn but as soon as the monsoon season has passed. He will also donate a software program that will automatically call up the **USNO's** atomic clock so that the **RO** clocks can be set automatically. He has also (*finally*) obtained a laser printer to produce *Signals* on.

James reports that he has gotten the old crane operative again, and continues to work with Campanella on the **SCR** project.

Slack reports that he will be setting up his PC in the focus room today, and will soon be working on the **RFI** detection and recognition problem.

Schumacher is back to working on the **KLT** project after a long rest, and brings some graphs of his most recent work. He will reestablish his connection to Magnus and begin posting his **KLT** work there once again.

The meeting broke at roughly 12:10pm, with most going off to their respective tasks.

## Card Project staggers back onto its feet; still wobbly

By Tom A Hanson

24 Jun 1993

Following our return to Dreese 805 after the asbestos removal project, it appeared that the work crew had misplaced boxes which had been read, and ones which had not been read. Today, Steve Brown and I spent some time on various aspects of the card project, in addition to Steve's ongoing testing of computer equipment.

**Milestones:** All 214 boxes previously written to magnetic tape on the IBM MVS system are now recorded on a two volume disk pack file, on the VAX 11/750. The next step for this file will be separation of individual boxes into separate files on the VAX, to be followed by transfer to floppy diskette, so that Dr. Dixon can take the data home to add his comments to the comments section. All original boxes were located in Dreese 817 and 805, and collected in Dreese 817, except for Box 001. Fortunately, Box 001 is safely stored on magnetic media. Unread boxes have all been located and moved into proper sequence, except for Box 528. There is a slight chance this box was not numbered during the manual numbering activity two years ago. During the count, two occurrences of duplicate numbers were found, so omission of a number cannot be ruled out. In any case, loss of only one box is much less than I had been worried we would see. The MicroVAX has apparently suffered some deterioration of the system disk, which is a 60 megabyte drive. The operating system would not permit logins, and an attempt to restore the operating system from magnetic tape resulted in numerous bad verify reports and an unbootable system. Air conditioning is to be connected to Dreese 805 in the near future. If this is done, it may correct the MicroVAX problem, as well as problems which Steve Brown has observed on the VAX 11/750.

## Conference Preparations

By: Bob Dixon

28 Jun 1993

I am working on the preparations for the two upcoming **SETI** conferences. We will be presenting papers about **ARGUS** at both. **1.** August in Santa Cruz Calif. They want a "brief" abstract by June 30, no format specified. It will be printed in the conference program. I'll send something. **2.** October in Austria. This is much larger and more formal conference. They requires a formal abstract, with specified font, type size, paper, margins etc. I struggled and did this last Friday and it is on its way. Must be there by June 30. The abstract will be published in the program. Then they



want the full paper (12 or more pages, all in the same very specific format. It was real struggle for me to manually make all that work in the abstract, using the word processor on my NeXT workstation, with no manual. I can't do it for 12 pages. I need significant help, first to write the paper, and then to get it formatted onto the pages. All of the papers will be printed and available for purchase at the conference. We can also buy extra copies for ourselves, printed officially, and we should. Some of the papers will be selected for publication in the later conference proceedings. I am optimistic that ours would be selected, since it is unusual and future-looking. The full paper must be in by July 15, so we have little time. I envision writing up an updated version of what we presented earlier this year at **NASA Ames** and **JPL**. We need to correct all criticisms made there, and incorporate new suggestions, such as moving to a lower frequency range. We have many nice illustrations that will be fine for the presentation. They allow overheads (which we have), plus slides, but the slides must be 50x50 mm, the European standard, not our 35mm style, so I think we should forget that option. But all illustrations we use in the printed paper have to be black-and-white, and fit in half a page width, square. So we must convert those. I suspect that photos will not work well as such illustrations, but diagrams will.

### **Tuesday Night Meeting 29 Jun 1993**

By: Tom A Hanson

Drs. Dixon and Barnhart, Steves: Brown and Janis, and Russ Childers gathered at Dreese 805 for tonight's meeting. The air conditioning is still not connected, but the cooler day made conditions acceptable. Steve Janis reported that workmen were standing on ladders again near the meeting room, earlier in the day. There is still no word on when the long anticipated connection will be made. Steve Brown and Russ Childers reported that Don James has succeeded in restoring the crane to operation. Don replaced a failing mechanical fuel pump with an electric pump. He has exercised all the machinery except for the crawlers. Russ said the engine sounded surprisingly good. Steve Brown has continued to work on software at the focus room. He corrected a bug in operation of the Drift program, and he is developing a program to assist in evaluating the gain of the 50 channel receiver channels. The failing air conditioner was mentioned in an earlier message. All equipment except for a couple of PC's has been powered down. Chris Slack will be arriving for his summer internship on Thursday, and he will be met by Dr. Barnhart. Steve Brown will meet Chris at Otterbein on Friday, and will take him to the observatory for a tour. There was discussion of the possibility that Chris might be willing to work on programming activities on the VAX 11/750 at Dreese Hall, assuming the air

conditioner connection is made. Dr. Kraus sent a fax to Dr. Dixon, cautioning that when the parabolic reflector cables are replaced, the adjustment of tension should be done carefully to avoid deforming the surface. There was discussion of a conversation with ElectroScience Lab personnel, suggesting that the parabola may be shifting. Russ has been collecting more data on the "Van Horne" gas cloud. He reported a shift in frequency since previous observations two months ago. Current work on computing doppler shift will be applicable to resolving the changes, but preliminary study indicates more work on the doppler shift program is needed. Dr. Barnhart conducted a tour of Big Ear for a group of Space Campers last Friday. Steve Janis has been looking for references for Dr. Dixon's Argus paper, and working on correspondence. Dr. Dixon mentioned again an idea he is developing for Argus, to observe a number of sources simultaneously, and to gather data about interstellar scintillation. The resulting observations may provide an understanding of the 'structure' of the medium as it changes. Please mark your calendars to attend a presentation on fuzzy logic, tentatively scheduled for the 3rd Saturday of July at the observatory. Chris Slack has done work in this area, and he has expressed interest in giving a talk on the subject for observatory supporters.

### **The Planetary Report & OSETI**

From: Stuart A Kingsley

30 Jun 1993

I spoke with Tom McDonough last night and he informed me that **TPR** will have an **OSETI** article but it will be written by a yet unnamed distinguished scientist. I have just received more info ion the Santa Cruz meeting. I am down to present a paper on **SETI**. Although the provisional program indicates that the paper's title is the familiar one of "*The Search For Extraterrestrial Intelligence (SETI) In The Optical Spectrum*", other material included states that the paper that has been accepted is the one called "*The Columbus Optical SETI Observatory*". The committee has agreed to offset my conference expenses by making a \$300 contribution to my travel expenses. Is anyone else from OSU presenting at the conference?

## **Warner Cable Sends Letter of Thanks**

25 Jun 1993

The following is the text of a note received by Dr. Dixon at Dreese:

June 17, 1993

Dear Dr. Dixon, Earl Phillips, et al,

I would like to thank you for your hospitality on June 5, 1993. My colleagues and I certainly enjoyed the special tour of "Big Ear." None of us had ever had the opportunity, and it was a very interesting and informative morning for all of us.

Again, thank you for inviting us, thank you for the pictures, and it has been a pleasure to meet all of you.

We are looking forward to seeing you again sometime.

Sincerely,

Ingeborg May

(of Warner Cable)

## **Tuesday Night Meeting 23 Jun 1993**

By: Tom A Hanson

Drs. Klein, Barnhart and Dixon attended this week's meeting, along with Steve Brown and Russ Childers. Steve Janis had called in that he had suffered an injury, but that he hoped to be back at the lab the following day. A new copy of *Signals* is in the mail. Congratulations on format and content to Earl Phillips and the *Signals* authoring team! The Ethernet terminal in Dreese 805 is once again running. Russ Childers is continuing his sweep back over the "Van Horne" hydrogen cloud. Steve Brown showed us a report from the PDP 11/23, produced by the doppler shift program from the "purple" book. Results were impressive looking, and Russ indicated they looked promising. Future direction is to process incoming data in real time, but the immediate next project will be to process previously collected data on the hydrogen cloud, to see what effect correcting for doppler shift will have on the graphs of the cloud readings.



*ed. note: I received a letter from **Signals** reader **Amy S. Bouska** mentioning that she enjoyed the article on M-15 in the last issue. Thanx for the note Amy! She further mentions that she'd like to see more such articles in **Signals**. I will try to include articles of general astronomical interest whenever possible. Let's hear from the rest of you! What would you like to see in future issue? Anything we should cut out? Let us know what you think!*

## **JPL MISSION UPDATES**

06/29/93

By: Ron Baalke

Organization: Jet Propulsion Laboratory

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

### **PLANETARY MISSION STATUS**

**GALILEO:** The spacecraft is now en route to Jupiter, scheduled to enter orbit December 7, 1995. Galileo will also fly by asteroid Ida, at 2400 kilometers, on August 28, 1993. The spacecraft's performance and condition are excellent except that the high-gain antenna is only partly deployed; science and engineering data are being transmitted via the low-gain antenna, which the mission team is planning to use for the Jupiter mission and the Ida encounter. Galileo was launched October 18, 1989, flew by Venus in 1990 and Earth in 1990 and 1992 for gravity assists, and flew by asteroid Gaspra in October 1991 for scientific observation.

**MAGELLAN:** The Magellan spacecraft controllers are conducting an aerobraking program, begun May 25, to lower and circularize the spacecraft's orbit, permitting higher-resolution global gravity mapping. In this 80-day innovative procedure, the spacecraft dips into Venus's upper atmosphere each orbit, slowing and shortening the orbit without expending fuel. Magellan was launched May 4, 1989. It radar-mapped more than 98 percent of Venus's surface from September 1990 to September 1992, and surveyed parts of the gravitational field from its elliptical orbit for the next 8 months.

**MARS OBSERVER:** Spacecraft health and performance are normal. Mars

Observer is scheduled to enter Mars orbit August 24, 1993; it will be maneuvered into a mapping orbit by November 8 and science operations are planned to start November 24. Mars Observer was launched September 25, 1992.

**TOPEX/POSEIDON:** The satellite is healthy, and all scientific instruments are performing normally, typically providing three playbacks per day. The mission is mapping global sea level changes, reflecting seasonal warming and cooling and winds. So far it has accumulated 6 months of data. TOPEX/Poseidon was launched August 10, 1992.

**ULYSSES:** The spacecraft is in a highly inclined solar orbit, now more than 33 degrees south relative to the Sun's equator, in transit from its Jupiter gravity assist in February 1992 toward its solar polar passages (about 80 degrees south and north) in 1994 and 1995. Spacecraft condition and performance are excellent, with Ulysses gathering data on the heliosphere — the realm dominated by the solar wind, a stream of charged particles flowing from the Sun. The Ulysses spacecraft was built by the European Space Agency and launched October 6, 1990.

**VOYAGER 1 and 2:** The two Voyager spacecraft are continuing their Interstellar Mission, having remotely detected the heliopause, the boundary between the solar magnetosphere and interstellar space, for the first time last month. Voyager 1, launched September 5, 1977, is currently 7.9 billion kilometers (4.9 billion miles) from the Sun after flying by Jupiter and Saturn in 1979 and 1980; Voyager 2, launched August 20, 1977, to fly by Jupiter (1979), Saturn (1981), Uranus (1986) and Neptune (1989), is now 6 billion kilometers (3.8 billion miles) from the Sun.

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## **LIGHT POLLUTION UPDATE**

### **"BILLBOARD IN SPACE" PROPOSED**

A Roswell, Ga based firm has proposed to launch into orbit a mile-long, inflatable Mylar platform that will carry a commercial advertisement. The platform is scheduled to fly in 1996 and will rival the full moon in both size and brilliance. The project is being designed by the *Lawrence Livermore National Laboratory* and at the *University of Colorado Office of Space Studies at Colorado Springs*.

Obviously, such a proposal, if allowed to fly, will add significantly to the light pollution astronomers must struggle with to ply their trade. Many individuals and groups have already voiced their opposition, and the *American Astronomical*

**Society** has issued a press statement opposing the proposal.

On-going monitoring of this proposal is being handled by *Faith Vilas*, who can be reached at her office at (713) 483-5056. For more information, contact Faith or, to voice your opinion of the proposal, contact the *Lawrence Livermore* lab and/or the *University of Colorado's Office of Space Studies* directly.

*ed. note: Information for the above article was taken from the American Astronomy Society's newsletter # 65, June 1993.*

## **COORDINATOR'S CORNER**

By: Dr. Philip Barnhart

Activity is picking up all over the place this summer. We have begun a systematic sweep of selected regions in the sky for the purpose of honing our powers of analysis of such objects as isolated hydrogen clouds and the re-calibration of system temperature and aperture efficiency which has not been carried out for several years. We welcome two summer interns, Melinda McKay and Chris Slack. They are finding out in a hurry that the radio astronomer's life is not an easy one. The real meaning of 'grunge work' is becoming crystal clear.

Again we approach that time in the year when we must examine the level of feedback and gain in mailing the newsletter to so many people. I suggest you examine your mailing label attached to this newsletter. If it shows no unusual marks or icons you can count on the fact that we treat you as a regular contributor to the **Radio Observatory** — either as a volunteer or a donor of equipment or money. There are also a few long-time supporters of our efforts that we would not remove from the mailing list, even if they request it. On the other hand, if you find a row of asterisks by your address, thus;

Dr. P. E. Barnhart \*

Dept. of Physics/Astronomy \*

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it means we have flagged your file to indicate we have neither heard from you in a long time or have lost track of contributions you may have made. ***IN ORDER TO CONTINUE RECEIVING SIGNALS ON A REGULAR BASIS ALL YOU HAVE TO DO IS WRITE TO US AT THE ABOVE ADDRESS TELLING US YOU ARE STILL INTERESTED AND INTEND TO EXERCISE THAT INTEREST BY MAILING IN A***

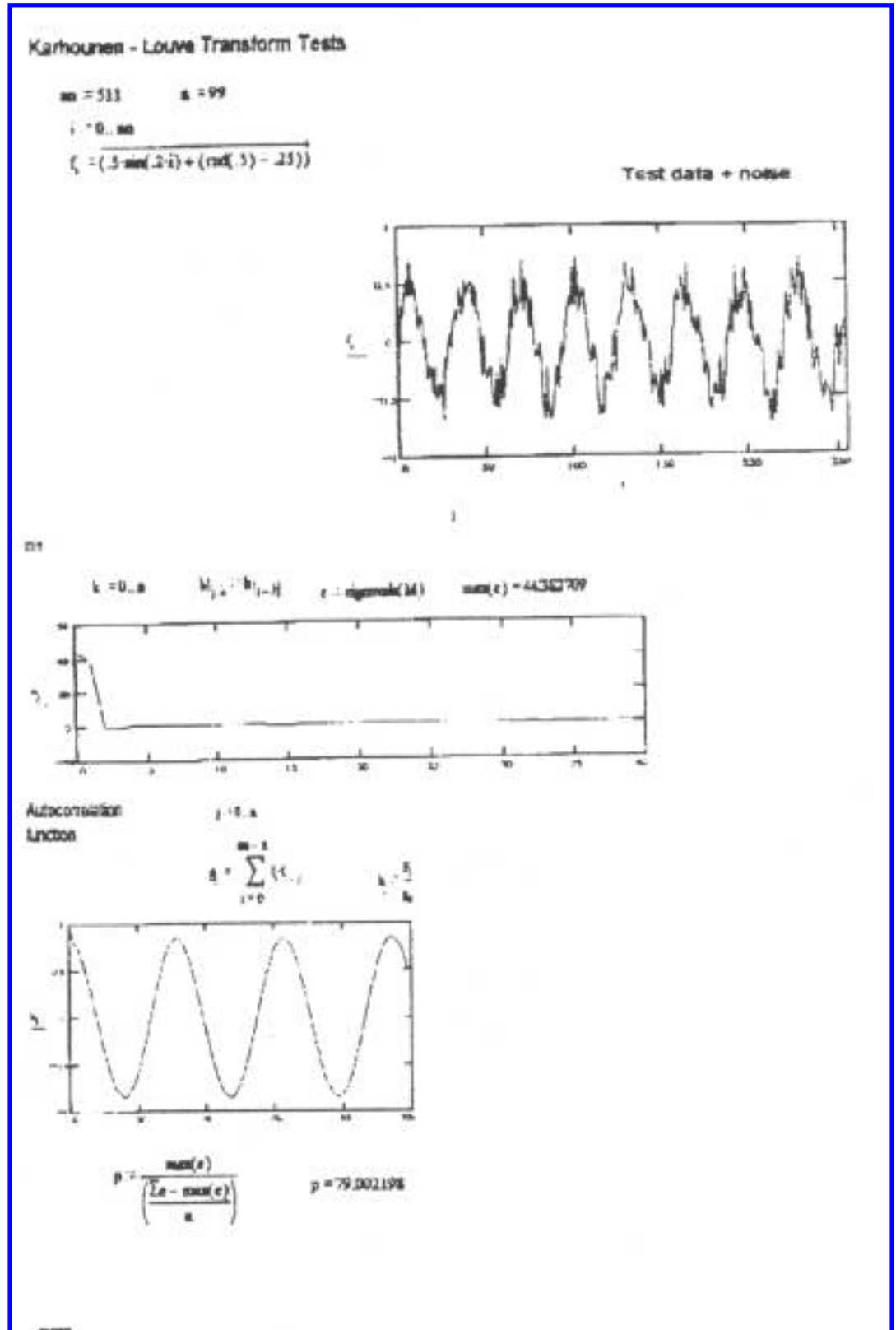
*CHECK, GIVING US A GREAT IDEA TO EXPLORE WITH BIG EAR, OR JUST TELL US WHAT GREAT PEOPLE YOU ARE TO DESERVE CONTINUED SERVICE FROM NAAPO.* Service will not be terminated abruptly so you can procrastinate for a while. Needless to say, we are always glad to hear from anyone, even those who contribute regularly to our cause.

## KLT - FFT COMPARISON

By: Phil Schumacher

Following up on Bob Dixon's suggestion that the **Karhounen - Louve transform (KLT)** might provide a better method of identifying **SETI** signals observed by a radio telescope, such as **The Ohio State University Radio Telescope**, Dr. Klein and a graduate student and several **NAAPO** volunteers have been comparing the performance of the KLT with the more commonly used **Fast Fourier transform (FFT)**.

The FFT uses a highly optimized algorithm to transform a block of data acquired at



equally spaced time intervals into a frequency spectrum.

The FFT

decomposes the observed signal, composed of  $2N$  data points, into  $N$  equally spaced sine wave frequencies.

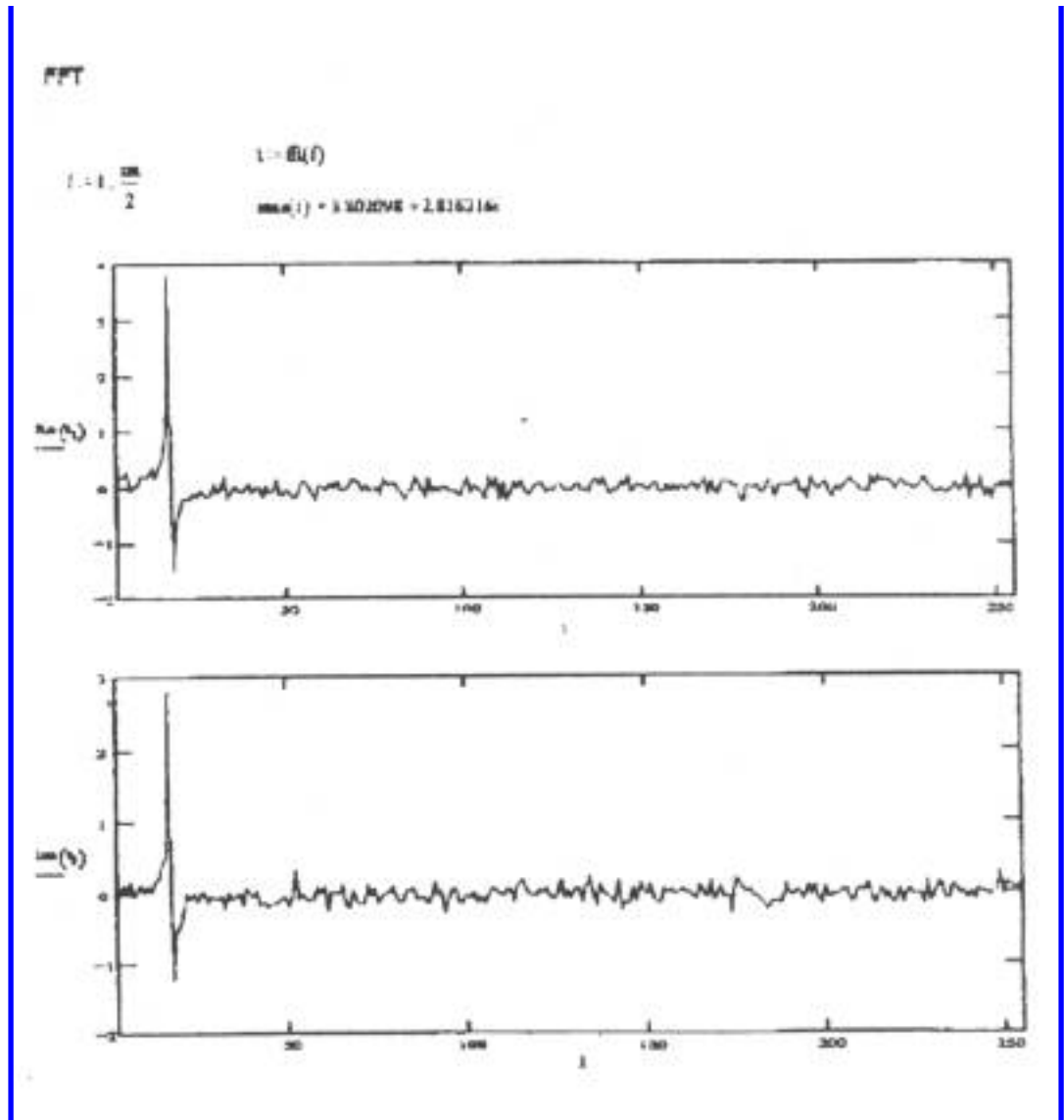
Peaks in the FFT correspond to the frequencies present in the original signal.

Signal analysis using the FFT assumes that any signal can be represented by one or more sine waves, which is true

provided that the

signal is measured often enough. A minimum of two measurements are needed within one oscillation of the radio telescope signal to obtain an accurate frequency measurement; for example, to accurately measure a 1 MHz frequency component in a signal using the FFT, the signal must be measured a minimum of 2 million times/second. Data systems are available which can perform measurements at this rate, but they are quite expensive.

A possible limitation of Fourier analysis, on which the FFT is based, is the use of sine functions to describe the observed signal. Some types of signals may not be well represented by sine waves. Since **SETI** investigators do not know the form of the signals they are searching for, a data analysis method that assumes that the signals are sine waves may not be the best choice. We are investigating the KLT, because it makes no assumptions about the form of the signal. Therefore, the KLT may be able to detect a signal that would be missed by FFT processing. To date we have evaluated the relative performance of the KLT and FFT using synthetic data





composed of a periodic signal of known shape, combined with a uniformly distributed noise signal. A comparison of the KLT and FFT is shown in the figures for 3 types of signal added to the noise: one sine wave, one square wave and two sine waves. A set of 5 figures is presented for each signal type:

- 1) Synthetic data
- 2) Autocorrelation function
- 3) Autocorrelation matrix eigenvalues
- 4) Real portion of the FFT frequency domain
- 5) Imaginary portion of the FFT frequency domain

Examination of the FFT frequency domain demonstrates a potential problem of the FFT; the maximum response may occur at any frequency and may appear in either the real or imaginary portion of the frequency domain. This complicates identification of a signal of interest. Calculation of the KLT is performed in three steps:

- 1) Calculation of the autocorrelation function of a selected region of the data.
- 2) Construction of a matrix using the values of the autocorrelation function. A sample matrix for a 10 point autocorrelation is shown below.
- 3) Calculation of the eigenvalues of the matrix constructed in Step 2.

The largest eigenvalue found in Step 3 indicates the signal strength. The values of the largest eigenvalues from the KLT and the largest frequency component found by FFT are compared in Table 1. The examples in the accompanying figures were calculated using 512 data points. A 100 point autocorrelation and 100 x 100 autocorrelation matrix were used to calculate the KLT. The sensitivity of both the KLT and FFT increases as the number of data points increases. The computational load also increases with the number of data points. The KLT has an additional parameter, the size of the autocorrelation function and the resulting autocorrelation matrix. If the signal is not continuous throughout the data interval, the response of both methods decreases. We are currently investigating the effect of signal duration on both methods.

**Table 1: Comparison of KLT and FFT responses for 3 Signal Types**

Signal Type	KLT (Maximum Eigenvalue)	FFT (Maximum Freq)
Single sine wave	44.4	3.80 + 2.82i

Single square wave	37.3	$4.73 + 0.29i$
2 sine waves	21.1	$1.74 + 2.13i$

*ed. note: The preceding article and graphs on this page were supplied by Phil Schumacher, who is currently researching the use of the **KLT** as it may apply to the **RO**. My apologies for the rough appearance of the graphs and related data; the cause is my rather rough scanner. If interested, I can supply a copy of the original 2 pages of graphs and data; just contact me for them. Phil is an active amateur optical & radio astronomer, and is now returning to his work on the KLT after a much needed rest.*

[Notes from the webpage editor. Click on the above graphic to see a much larger version. However, you should have your preferences set so that large images are NOT fit to the screen. That is, if your browser preferences are set to fit all images to the screen, no vertical scroll bar will appear, and the observed image may even appear smaller than the one on this webpage.]

Also note that even if the image is displayed in the larger size, much of the text and labeling is unreadable. It was also unreadable on the printed copy due to the original editor putting the long sequence of figures onto one printed page rather than resizing to a larger size each of the 5 contained graphs and distributing them onto more than one page.]

[\[Back to List of Issues in Volume 9\]](#) | [\[Back to List of Volumes\]](#) | [\[HOME\]](#)

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Designed by Jerry Ehman

Last modified: March 4, 2004