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THE STATE OF THE SURVEY

One year completed, two to go.

By: Russ Childers

One year has passed since the **OSU Radio Observatory** started a three year survey of the sky. As of October 27, 1994, the survey stands 34 percent complete — right on schedule. We have had fantastic observing weather, little **R**adio **F**requency **I**nterference, and no major equipment trouble during the past year. The **LO**w **B**udget **E**ti **S**earch (*LOBES*) system has faithfully detected high-intensity, natural radio sources. Thus far, one narrowband celestial point source has been detected: a maser (*Microwave Amplification by Stimulated Emission of Radiation*). No new natural radio sources have been detected in the data analyzed.

The survey started on September 29, 1993, with the telescope pointed at +62 degrees, 20 minutes declination. This is the Radio Observatory's northernmost observational limit. A circle of sky is observed each day, by letting the earth's rotation point the telescope around the sky. Several times a week, the telescope is moved to scan the circle of sky to the south of the area just observed. The telescope is moved 1/3 of a degree each time, so 300 moves will be necessary to complete the three-year, 100-degree survey. By placing data from adjacent telescope moves together, a picture of the sky can be constructed. A map of natural radio sources generated by this survey is slowly growing on a bulletin board outside of the Dreese Lab office.

I keep a log of my activities at the Observatory, and would like to share some highlights from the past year. I must admit that the maser was my most exciting discovery to date. For a time I thought I was really onto something — it was the exact signal the system was set up to detect: narrowband frequency and point-source location. It was too good to be true, however, and proved to be a natural source. Anyway, on to the log book:

November 4, 1993:

* Set Declination to 59 degrees 00 minutes.
* Cass A detected by 2875 channels out of 3000 -> 92%.

[I took some pictures of the **LOBES** display half an hour after the passage of Cass A. Sidelobes could be seen. In fact, it was obvious from the display that

the sidelobes 'squeezed in' at higher frequencies. This makes sense, because at higher frequencies **Big Ear** has a narrower main beam, and hence 'tighter sidelobes'. Cass A should be the brightest radio source encountered in the survey. (The 125 channels not registering detections have continuous interference in them.)]

January 21, 1994:

*At Observatory at 3:50 pm.
* 15 degrees F outside, 67 degrees F inside.
* Horn cart off center - blew a fuse at 8:41 am 18JAN94.
* Horn cart hard to move - snow drift at west end of cart.
-> Leaving unpowered and at center until thaw.
* Can't move flat reflector -> compressor is frozen!
[I could not go up to the Observatory for nearly a week because a large sheet of ice covered the ground and refused to melt. The *Ohio State University* canceled classes on January 19, 1994, because of the cold (-22 degrees F) ... and I was psyched to ride my bike to Marketing class at 8:30 am.]

January 27, 1994:

* At Observatory at 4:50 pm.
* Saw **Whoa!** signal (continuum) at ~0330 UT 24JAN94.
* Whoa! source appears to be OH+519, 06h 11m 34s, +51d 55m (epoch 1950), 0.62 flux units.
[The Whoa! source was named with the **Wow!** signal in mind. The Wow! signal was seen in 1977 by Jerry Ehman at the Radio Observatory. It is interesting in that it was narrowband, point source-like, yet appeared in one of the two twin detectors at the Observatory. The twin detector system of **Big Ear** allows us to detect short-time events in space. The Whoa! source may have been a 'poof' of radio energy which was registered by the detector pointed toward it at the time. We may never know what the Wow! signal was.]

May 14, 1994:

* Open House 10:00 am -> 6:00 pm.

[We had an excellent turnout that windy day. We turned a tidy profit on Radio Snapshots, and attracted several valuable volunteers. Let it be known that no one's voice went out, the air horn still had air, and no knobs were fiddled within the Focus Room.]

June 9, 1994:

* At Observatory at 5:00 pm.
* **!SETI Strike!** 1612.540 MHz RA 20h 44m, Dec 40d 00m
* Positive aspects of new source:
    -> Matches antenna pattern well
    -> Nearly perfect sidereal rate (+/- 2 seconds/day)
    -> Compare to Jupiter: 2 hrs/year = 20 sec/day
    -> Narrowband, close to galactic plane
    -> Follow-up `hops' saw antenna patterns
    -> Occurred at constant rate
* Downsides of new source
    -> Strong power
    -> Seen in more than one 10 kHz channel.

[All in all, the maser seemed like a dream come true: at last a narrow-band transmission was detected. But Bob Dixon brought me down to earth. I called him and hastily explained the source's characteristics. I had to drop on him the phrase '...we might not be alone.' He was not phased. He suggested that I look at the 'OH emission lines.' Sure enough, my enthusiasm had gotten the best of me. It was an OH maser: in fact, it is the granddaddy of all masers. The **LOBES** system may have not discovered the evidence of extraterrestrial intelligence, but we now know where to find a strong narrowband point source. A test point in space.]

September 3, 1994:

* At Observatory at 10:20 am
* Installed HEMT low noise amplifiers.

[Even though this may seem unimpressive at first, let me make clear that just by adding these amplifiers, suddenly we can "see" several times farther into space than before. The HEMT amplifiers are used to amplify the signals received at the end of the feed horns, and convert the free-space waves into

the electrical signals **Big Ear** analyzes. The amplifiers introduce little of their own noise into the received signal, hence the term "low noise". Adding these amplifiers effectively multiplies the size of the antenna.]

October 20, 1994:

* At Observatory at 4:35 pm.
* Set declination to +29d 00m

[This time marks the one-third point in the sky survey. From this point there are 200 more flat reflector moves to go. There are two more years to go in the survey.]

One year has passed in the current survey. Thus far, no new sources have been discovered. This is not bad, since no sources seem to have disappeared, either. In fact, after comparing new contour maps of space with maps made at the Observatory 25 years ago, I find little difference at all. Space is surprisingly the same. Actually, it should not be surprising at all, since 25 years is but a sliver of time in the life of the quasars and galactic structures detected by our telescope.

Tuesday Evening Report for 9/6/94
By: Tom Hanson

Dr. Barnhart led the proceedings, and the meeting was attended by Steve Brown, Russ Childers and Raul Ordonez.

Raul reported that the CD facility on campus has apparently ruined all three of our blank CD's, in addition to three of their own. Raul will be following advice from Dr. Dixon on how to proceed. Since data appears to have been written to all three CD's, several people have offered to attempt to force access to the unreadable CD's, on the theory that the boot track is defective but that the data tracks are ok.

Considerable efforts were made to impress upon your reporter that the LNA's assembled by Ang Campanella are HEMT devices, not ones made of rope.

Russ Childers has moved the flat reflector to 32 degrees, 40 minutes, after collecting two additional days of data at the previous setting, in order to compare the performance of the new LNA's to the old ones. It will take Russ a few days to complete the analysis. In the meantime, Russ speculated that it may be necessary to

retune some or many of the 50 channel receiver channels, due to what may be increased performance. In the short term, Russ changed his software to reduce the workload on the AtoD converters.

Steve Brown has assembled the **Serendip** equipment on a cart, with the implication it is going somewhere. Unfortunately I missed that portion of the meeting.

Dr. Barnhart is hoping to gather a large crowd of workers to perform minor miracles on September 17th. Unfortunately, I have managed to arrange a prior commitment, so trust that someone else will report on the day.

Tuesday Evening Report
By: Tom A Hanson

Dr. Barnhart, Dr. Dixon, Steve Brown, Russ Childers and Raul Ordonez attended the meeting in Room 815.

Raul reported on his meeting with Art Krumsee, and he will follow up tomorrow, to see if he can acquire the defective disks for analysis by **Radobs** volunteers. In the meantime, the CD Rom facility has committed itself to replacing the ruined disks with good new ones, but it remains to be seen if they are capable of actually performing.

Dr. Barnhart has started classes, somewhat handicapped by lack of two books for the students. He has acquired lumber and hardware for shelf construction, and he is planning to be at the **RO** at 8 AM this Saturday, ready to provide volunteers with instructions to carry out the construction and deployment of 7 sets of shelves. Volunteers are needed to move items out of or around in the new trailer, to cut wood, drill holes, assemble components, install bays in the trailer, and to load the shelves. This project will take a good two or three hours, and plenty of assistance will be welcome.

Steve Brown reported that Don James has succeeded in putting the **RO** truck back into operation, with a 'new' used radiator. The hydraulic lift at the back worked, thanks to Russ Childers having recently resupplied the oil reservoir.

Dr. Dixon met recently with the director of the *OSU Astronomy department*. The meeting was friendly and informative, but it appears that radio astronomy is not a

subject well known to the department. *OSU* is continuing advanced work on remote telescope operation, as a consequence of the cancelled *Columbus project*.

Russ Childers reported that the telescope is positioned at 32 degrees even. There was discussion of the possibility of replacing the old LNA's in order to provide data for comparison of the performance of the new devices to the old ones. Russ had already accumulated two days of overlapping data, so the re-installation may not be required, but it was felt that exchanging the LNA's would be easier than working the flat reflector back to a position already worked by the old LNA's.

Steve Brown has moved the **Serendip** computer to the office building at the **RO**, but he is facing difficulty in mounting the equipment in the focus room. There is need for shelving in the focus room. Finally, Steve mentioned the desirability of finding a replacement for the existing bulky phase detector. The detector uses + and - 150 VDC, and 6 VAC, all of which are supplied by equipment mounted in racks near the 11/23. Eliminating the power supplies would free up room to mount the Ang Campanella PC chart recorder in the racks, freeing up table space.

Subject: JPL/Mars Pathfinder landing site
From: Admin@ccmail.Jpl.Nasa.Gov
Date: Thu Sep 08 16:03:40 EDT 1994
Organization: Jet Propulsion Laboratory - Pasadena CA
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CALIFORNIA INSTITUTE OF TECHNOLOGY.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.
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TELEPHONE (818) 354-5011
Contact: Franklin O'Donnell
FOR IMMEDIATE RELEASE
September 8, 1994

NASA has selected an ancient flood plain on **Mars** as the landing site for the 1996 mission of *Mars Pathfinder*, one of the first in a new generation of small, low-cost spacecraft.

Eons ago, when water flowed on Mars, great floods inundated the landing site, located on a rocky plain in an area known today as *Ares Vallis*. The site is 850

kilometers (527 miles) southeast of the location of *Viking Lander 1*, which in 1976 became the first spacecraft to land on Mars. *Pathfinder* will be the first to land on Mars since the twin Viking landers arrived almost 20 years ago.

The spacecraft, scheduled to arrive at Mars on July 4, 1997, will parachute down to *Ares Vallis* at the mouth of an ancient outflow channel chosen for the variety of rock and soil samples it may present.

The purpose of the new *Pathfinder* mission is to demonstrate an inexpensive system for cruise, entry, descent and landing on Mars, said *Project Manager Anthony Spear* and *Project Scientist Dr. Matthew Golombek* of **NASA's Jet Propulsion Laboratory**.

The lander, carrying the microrover, will aerobrake in the upper Martian atmosphere using an aeroshell and a parachute. Just before impact, airbags will inflate to cushion the landing. The microrover will then roll out to examine the rocks and soil nearby.

Both lander and rover will carry scientific instruments and cameras. The lander will make atmospheric and meteorological observations during descent and function as a weather station on the surface, as well as a radio relay station for the rover.

The constraints on the location have to do with engineering considerations, Spear said. Since the space craft are solar powered, the best site is one with maximum sunshine and in July, 1997, the sun will be directly over the 15 degrees north latitude region of the planet.

The elevation must be as low as possible, Spear added, so the descent parachute has sufficient time to open and slow the lander to the correct terminal velocity. The landing will be within a 100- by 200-kilometer (60- by 120-mile) ellipse around the targeted site due to uncertainties in navigation and atmospheric entry.

Ares Vallis, which meets the engineering constraints, was chosen after a workshop earlier this year that involved the invited participation of the entire scientific community concerned with Mars. More than 60 scientists from the United States and Europe attended.

The *Ares Vallis* site is also a "grab bag" location, according to Golombek, set at the mouth of a large outflow channel in which a wide variety of rocks are potentially within the reach of the rover. Even though the exact origins of the samples would not be known, he said, the chance of sampling a variety of rocks in a small area could reveal a lot about Mars.

The rocks would have been washed down from highlands at a time when floods moved over the surface of Mars. Several potential sites were listed where ancient flood channels emptied into *Chryse Planitia*, having cut through crustal units and ridged plains where the water would have picked up material and deposited it on the plain.

Other sites that were considered included *Oxia Palus*, a dark highlands region that contains highland crust and dark wind-blown deposits; *Maja Valles Fan*, a delta fan which drained an outflow channel; and the *Maja Highlands*, just south of *Maja Valles*. All of the sites were studied using *Viking* orbiter data.

Both the *Pathfinder* landers and rovers have stereo imaging systems. The rover, additionally, carries an alpha proton x-ray spectrometer with which it will examine the composition of the rocks. The imaging system will reveal the mineralogy of surface materials as well as the geologic processes and surface-atmosphere interaction that created and modified the surface. The instrument package will also enable scientists to determine dust particle size and water vapor abundance in the atmosphere.

JPL manages the *Mars Pathfinder* mission for **NASA's Office of Space Science**, Washington, D.C.

ed. note: *An illustration related to this article was included in last month's issue of Signals.*

Tuesday, 9/27/94 Meeting Notes
By: Tom Hanson

This is the Tuesday night report for 9/27/94, under the heading of CD success. Steve Brown has confirmed that both CD's which he took home are readable, and one of them was given to our new Administrator, Hemal Mehta, to be shipped to Herb Johnson. A sturdy cardboard box was provided, to attempt to overcome the trained gorilla's in golfing shoes who process such delicate packages. Drs. Barnhart and Dixon, Steve Brown, Russ Childers, Hemal Mehta, and visitors Laura McCracken and Ying Shi were in attendence.

Dr. Barnhart reported several items:
a. news of an **Argus** proposal opportunity
b. Steve Janis will soon have *Internet* access. Steve is seeking one or more positions with the city government in his new home, and he is negotiating for favorable references. A supply is guaranteed.
c. Dr. Barnhart will be absent next Saturday
d. There is a need to begin training for a successor to Russ Childers, who will graduate next June.

Dr. Dixon and Steve Brown confirmed that the **Serendip** system is running. Steve has been working with LNA's and power supplies, to try to understand some unusual or improper behavior. Dr. Barnhart will order a replacement power supply, to replace one which is no longer with us.

Steve brought in four more copies of the complete *Plain Dealer* article. He is working on a document to describe components and provide specifications for a second receiver train for Serendip. Steve is still working on the project, which he described as somewhat difficult due to the 'infinite' number of possible combinations which would achieve the desired result.

A portion of the meeting was devoted to recap of ongoing **Radobs** activities, for the benefit of our two guests.

After the meeting, Russ Childers used ftp to transfer two files of **SETI** data from MVS to his account on a workstation. These files are on a magnetic tape from Dr. Dixon's sealed tape cabinet, in Dreese 817.

VOYAGER MISSION STATUS

October 1, 1994
From: Admin@ccmail.jpl.nasa.gov
Organization: Jet Propulsion Laboratory - Pasadena CA
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Both *Voyager* spacecraft are in good health and collecting ultraviolet data and studying fields, particles and waves in the outer solar system as they search for the heliopause — the end of the sun's influence in space — and the associated termination shock.

Voyager 1 is 8.5 billion kilometers (*5.3 billion miles*) from the sun, traveling at a speed of 17.5 kilometers per second (*39,146 miles per hour*).

Voyager 2 is 6.6 billion kilometers (*4 billion miles*) from the sun, traveling at a speed of 16.2 kilometers per second (*36,238 miles per hour*).

ULYSSES MISSION STATUS

October 1, 1994
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The *Ulysses* spacecraft, the first probe to fly over the sun's south pole, is providing scientists with valuable new data about the forces at work in this region of space after a 2-billion-kilometer (1.2-billion-mile) journey.

Scientists reported preliminary results of *Ulysses's* travels at a science conference held in mid-September at the **European Space and Technology Center** in Noordwijk, The Netherlands. The spacecraft reached its most extreme latitude of

80.2 degrees south of the sun's equator at that time, and is now looping back around the sun toward the equator. *Ulysses* will cross the sun's equator in February 1995 and begin its pass over the north pole of the sun in June 1995.

Ulysses has discovered that the solar wind emanating from the southern pole flows at nearly double the rate — 800 kilometers per second, or about 2 million miles per hour — than it does at lower latitudes in the equatorial region. The composition of the solar wind also appears to differ in the polar regions, and the sun's magnetic field seems to be surprisingly uniform. Continued measurements will yield more information about other solar phenomena as well, such as the mysterious 11-year cycles of solar activity which produce sunspots that are visible from Earth and indicate very hot regions in the sun's corona, or outer atmosphere.

All spacecraft operations and science experiments continue to go well. Ground controllers are carrying out routine data-gathering activities and experiment adjustments as needed. **The European Space Agency's** tracking facility at Kourou, French Guiana and **NASA's Deep Space Network** facility at Canberra, Australia are being used to track the spacecraft 24 hours a day now that *Ulysses* has moved into the sun-Earth region where the spacecraft's axial boom is illuminated by the sun. In the past, this illumination has caused a slight wobbling of the spacecraft, but an on-board control system is operating to stabilize *Ulysses* and keep it pointed at Earth.

Today *Ulysses* is about 79 degrees south of the sun's equator, traveling at a heliocentric velocity of about 83,000 kilometers per hour (52,500 miles per hour) with respect to the sun.

GALILEO MISSION STATUS

October 1,1994
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On Tuesday, September 13, the Jupiter-bound *Galileo* spacecraft experienced a failure in one memory cell of an on-board computer — one bit out of more than 3

million bits total in the computer. This is the only memory failure to have occurred on *Galileo* in the 5 years of its flight to date.

During the development of the advanced computer memories, it was recognized that perhaps dozens of cells would randomly fail over the 8-year mission lifetime. To protect against such failures, special fault protection was included in the spacecraft flight software. Immediately upon detecting the failure on Sept. 13, that fault protection software executed as it was intended to. This stopped the sequence of commands then being carried out to play back science data from *Galileo's* observation of *Comet Shoemaker-Levy 9* impacts at Jupiter in July, and reconfigured the spacecraft in a safe state.

By Sept. 25, the failure had been traced and programmed around, and the transmission of Shoemaker-Levy data resumed. No long-term mission impacts of the memory failure are expected. Some of the data lost due to the problem will be recovered by changing the priorities in a later transmission of data stored on *Galileo's* on-board tape recorder. Transmission of *Shoemaker-Levy* data is planned to continue through January 1995.

Currently, data from *Galileo's* near-infrared mapping spectrometer of *Comet Shoemaker-Levy's* fragment G impact are being transmitted and will be followed later this month by data from the imaging cameras's observations of the impacts of fragments K and N.

The spacecraft continues to operate normally, spinning at about 3 rpm and transmitting at 10 bits per second to ground stations at **NASA/JPL's Deep Space Network**. The spacecraft will reach Jupiter on December 7, 1995, when its probe will descend into the Jovian atmosphere and the orbiter spacecraft will begin two years of observation and measurement of the planet, its moons and magnetosphere.

MAGELLAN MISSION STATUS

October 1, 1994
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The *Magellan* spacecraft is performing acceptably with less than two weeks left in its mission. There has been some further minor degradation of the solar panels, but that is offset by decreasing changes from sunlight to shade and the resulting wide variations in temperature.

The termination phase of the mission will begin Tuesday, October 11, on orbit number 15,018. The spacecraft's communication will be switched from the high-gain antenna to the medium-gain antenna, and all control from that point will be in real-time commands.

Magellan will perform orbit-trim maneuvers on each of the next four orbits to quickly lower the periapsis, the closest point to the planet, to 150 kilometers (*93 miles*). That will enable the gathering of aerodynamic data in the sparsely explored regions of the upper atmosphere. An optional fifth trim maneuver may be performed if needed to lower periapsis to the desired altitude.

It is predicted that communication with the spacecraft will be lost within a few orbits due to depletion of the batteries or attitude control propellant. *Magellan* may go silent by the evening of October 11, perhaps on or before orbit number 15,025, or it may last a day or two.

As with satellites entering Earth's atmosphere, it is difficult to predict exactly when *Magellan* will enter Venus's atmosphere. But the spacecraft will be traveling more than 7 kilometers per second (*15,658 miles per hour*) and will disintegrate from a rapid combination of dynamic force and heat. It is possible that a few pieces, such as the inner hubs of the reaction wheels, may reach the surface as burned cinders lost among the vast lava flows which *Magellan* revealed.

TOPEX/Poseidon Mission Status

October 1, 1994
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The satellite is performing well, and science data processing activities are proceeding on schedule. Science data have been acquired during 75 10-day cycles and *TOPEX/Poseidon* has completed 10,000 orbits of Earth since launch two years ago.

Each 10-day cycle represents a complete topographic map of the world's oceans for oceanographic study.

Six orbit maintenance maneuvers have been performed, and a seventh is scheduled for October 6.

10/1/94 Meeting Notes
By: Tom Hanson

The meeting on October 1st was attended by a cast of many, and the agenda was defined largely by the needs of the film crew from Paramount. The weather was perfect for the occasion. Those in attendance were: Tom Hanson, Russ Childers, Steve Brown, Marc Abel and young son, Ken and John Ayotte, Jerry Ehman, Marilyn McConnell-Goelz, Mark Sundstrom, Ang Campanella, Cindy Brooman, Tom Van Horne, Jim Bolinger, Hemal Mehta, Laura MacCracken, Ying Shi, Bob Dixon, Chuck Klein, Don James, Unnamed Cat. Representing **Paramount Productions**: Steve Feld, director, Andy Gardner, camera, Bob Press, grip, and Tasha Sorge, intern.

When I arrived at 10 AM, several small groups of people were walking about the landscape, and a crew member was piloting a cart full of equipment down the road toward the focus room. I joined a group near the garage, which included Drs. Dixon and Klein, Jerry Ehman, Cindy Brooman and Don James, and learned that the film crew had completed preliminary work and that they were now working in the focus

room. The general meeting was to start at 11 AM.

At 11, the film crew set up in the conference room, and they recorded introductions for several minutes. They then moved to the Visiting Observer's quarters living room, where they interviewed individual members, including Jerry Ehman and Ang Campanella, as well as Marilyn McConnell-Goelz and Russ Childers.

In the open meeting, Marilyn and Russ discussed the issue of whether the flat reflector should be held in position for painting, and if so, where. It would be most difficult to roll the flat back to the northernmost position, somewhat difficult to bring it to vertical, and ideal to leave it wherever it is when the painting starts.

In the meantime, Russ is continuing the survey.

Don James reported that the truck ** was ** running, after repairs which he had made, but the new battery ran down during the most recent attempt to start it.

Cindy Brooman agreed to try to read of the CD's which were ruined during the initial stages of writing MVS data. One good CD was mailed to Herb Johnson, Dr. Klein has one on campus, and Steve Brown has the other. I have made some progress in sorting the directory listing so that an attempt can be made to match up the CD with the original data. This effort is in progress, and it appears that there will be a 3% rate of unmatched items, which must be investigated. Many of the unmatched items will probably turn out to be early versions of data which were subsequently reread.

Tuesday Night Meeting
By: Tom A Hanson

Dr's Barnhart, Dixon and Klein, Mark Sundstrom, Cindy Brooman, Steve Brown, Russ Childers and Hemal Mehta were deep in discussion when I arrived at a little after 6 PM. Steve Brown was. at the blackboard, which was covered with boxes and arrows and labels.

As I walked in, someone was floating the idea of having an additional computer in the facility. Steve Brown explained later on that this proposed additional system would be dedicated primarily to processing output from the **Serendip** system. Another idea proposed was to beef up the 386 system which came with Serendip. A

lengthy discussion followed, during which the benefits of changing the Serendip code here, or negotiating with *Berkeley* to make changes were considered. It appears that negotiating with *Berkeley* is more attractive. A fair amount of time was devoted to considering required capabilities and features of a possible analysis computer. We were reminded that there is need for a second RF chain, if **LOBES + CONTINUUM** are to be fully maintained while SERENDIP is running. Serendip cannot tolerate the Dicke switching required by the older systems. Following the computer discussions, there was an abbreviated report of activities by attendees. Steve Brown has reviewed the first draft of documentation on Serendip. He is compiling a list of items which need clarification or further work.

Dr. Barnhart has received a replacement for the LNA power supply which bit the dust a few weeks ago.

Dr. Dixon is leaving for a two week vacation on Thursday.

HAPPY HALLOWEEN!

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