Saguaro Astronomy Club

Metro Phoenix, Arizona

SACNEWS

August 1992 — Issue #187

History of the Ohio SETI Program

by Robert S. Dixon

This article is from the June, 1992 (Volume 3, Number 11) issue of the Electronic Journal of the Astronomical Society of the Atlantic (EJASA) and is Copyright © 1992 by the Astronomical Society of the Atlantic (ASA). It is reprinted here with permission.

The Ohio SETI (Search for ExtraTerrestrial Intelligence) Program began with a strong impetus from NASA's Project Cyclops. The goal of Cyclops — a paper study conducted in the early 1970s — was to assess what it would take in terms of time, people, equipment, and money to mount a large search for radio signals from interstellar civilizations. The end result was a report which was widely circulated as a NASA Special Publication, recommending a small array of radio telescopes which would grow with time as needed.

During my Project Cyclops research, it became clear to me that many theoretical papers were being written about SETI but no one was doing any extensive actual searching. I also realized that we had a large, fully operational radio telescope available at Ohio State University (OSU) which was designed explicitly to search for new radio signals in the sky. It had just completed the largest all-sky survey of natural radio signals made up to that time. Coincidentally, this telescope was also chosen by the Russian scientist Gindilis as the telescope most suited for SETI, due to its unique surveying ability.

Although we had no money, we did have a crew of able volunteers on hand. Faced with the alternative of ultimately turning off the telescope and letting it rust away, we decided that we had a responsibility to seize the opportunity which had been thrust upon us and start a real SETI program. It did not take too much arguing to convince John Kraus, Director of the OSU Radio Observatory, to allow me to use the telescope for humanity's first full-time SETI program.

The Ohio State Radio telescope is larger than three football fields in size and equivalent in sensitivity to a circular dish 52.5 meters (175 feet) in diameter. The beam of the telescope is elliptical, being forty minutes of arc in the declination (vertical) direction and eight minutes of arc in the right ascension (horizontal) direction. This may be visualized by comparing it with the size of the Moon, which is a thirty minutes of arc diameter circle in Earth's sky.

The telescope surveys the sky by remaining stationary and allowing the rotation of Earth to sweep its beam in a narrow circular path through the sky once each day.

Quick Calendar

SAC Meeting
7:30, Friday, August 14

Star Party
Buckeye Hills Recreation Area
Saturday, August 22

... many theoretical papers were being written about SETI but no one was doing any extensive actual searching.

After a few days of observation, the beam is moved slightly up or down and the pattern is repeated. It takes several years to thoroughly search the sky.

We went on the air in 1973, using an eight-channel receiver system, originally constructed for twenty-one-centimeter (21-cm) hydrogen line observations by Bill Brundage. Bill later went on to become Chief Engineer of the ninety-meter (three hundred foot) radio telescope at Green Bank (NRAO). Later still he was responsible for preparing the Very Large Array (VLA) in New Mexico to receive the faint VOYAGER 2 spacecraft signals during its flyby mission of the planet Neptune in August of 1989.

The bandwidths of the channels ranged from ten to fifty kilohertz (KHz), depending on their distance from the center frequency. The output of the eight channels was plotted as wiggly lines on pen recorders. The charts

were laboriously searched for unusual signals by graduate student Dennis Cole — now a contractor to the Jet Propulsion Laboratory (JPL) — and used as the subject for his master's thesis in Electrical Engineering. This may have been the first graduate degree ever awarded in SETI.

The search strategy chosen at the time was to explore in the vicinity of the 21-cm hydrogen line, Doppler correlated to the Galactic Standard of Rest. Due to the random motions of the stars and the rotation of our Milky Way galaxy, signals transmitted at the hydrogen line frequency (1420.4056 megahertz, or MHz) would be received at somewhat different frequencies because of the Doppler shift. To avoid this frequency ambiguity, we made the deliberate assumption that any civilization transmitting at the hydrogen line would offset their transmission frequency in just the right way to remove all their motions with respect to the center of the galaxy, which is the only unique reference point shared by all the galactic inhabitants.

It was then up to us to offset our receiver frequency to compensate for Earth's motions to arrive at this unique "galactic" frequency. Because of our uncertainty about the galactic rotation velocity (we measure it by observing the motions of the stars and gas in our stellar neighborhood), we still had to search a total bandwidth of several hundred KHz. A lot of chart paper was generated during the two years this effort continued, but no recognized signals of intelligent origin were found.

The old IBM computer came to a premature death at the hands of a mouse.

By 1975, a fifty-channel filter bank receiver had been borrowed from Green Bank. Software for the already old IBM 1130 computer had been developed by Professor Jerry Ehman — now Chairman of the Mathematics Department at Franklin University — and me, to process all fifty channels continuously. The software was sophisticated, with many internal checks for false alarms and equipment malfunctions. Each of the fifty channels was processed independently, and the computer automatically removed the individual gain and baseline variations of each channel.

A number of search algorithms were run simultaneously, including searches for both isolated pulses and continuous signals which rose and fell in intensity in just the predicted way (for a continuous, narrowband signal) as they passed through the antenna beams. The highly processed output data were printed every ten seconds for all fifty channels. Signals the computer thought were "interesting" were also flagged and saved on punched cards for later analysis.

The IBM computer was built like a battleship and ran without fail for many years. Its operating system could run huge programs in a tiny memory very efficiently. It was fast, even by today's standards.

Over the years, a few cold hydrogen clouds were found and huge piles of computer printouts accumulated. There was no magnetic tape drive or equivalent device available, so there was no way to record all the data permanently in computer-readable form. Only the small fraction of data represented by the "interesting" signals were preserved in computer-readable form. Along the way, a small NASA grant was received, which continues today.

Two types of unexplained signals were detected during this search. The first kind is quite rare, with the best example being the "Wow!" signal found in 1977. This name was unintentionally applied from Jerry Ehman's comments in the margin of the computer printout when he noticed the signal. The signal was unmistakably strong and had all the characteristics of an extraterrestrial signal. It was narrowband and matched the antenna pattern exactly, indicating it had to be at least at lunar distance. A signal from a nearer object would show a wider pattern.

However, the strange signal was not coming from the direction of the Moon or any planet, or even any particular known star or galaxy. Of course there are always many distant stars and galaxies in the beam of a radio telescope all the time, but that is not significant. A check of artificial satellite data showed that no publicly-known Earth satellites were anywhere near the position of the signal source. Furthermore, the frequency of the signal was near the 1420 MHz hydrogen line, where all radio transmissions are prohibited everywhere on and off Earth by international agreement. We searched in the direction of the "Wow!" signal hundreds of times after its discovery and over a very wide frequency range.

We never found the signal again. It was gone. In fact, while we were receiving this signal the first time, it turned off as we listened. The radio telescope actually receives two beams from the sky at once (somewhat offset in direction from each other) and subtracts one from the other to cancel out terrestrial radio interference. Objects in the sky are usually received twice with a slight delay, once in each beam. But the "Wow!" signal was received only once, indicating either that it turned off after the first beam received it, or that it turned on after the first beam had passed it.

What was the "Wow!" signal? Probably we will never know. Conceivably it could have been a secret military satellite in solar orbit, transmitting on an illegal frequency. Military transmitters often ignore civilian agreements. Its characteristics rule out any terrestrial transmitter, near-Earth satellite, reflection from space debris, or equipment malfunction. Perhaps it was a transmission from some other civilization. If so, it seems that they were not trying very hard to attract our attention, since the signal disappeared before we could really find out what it was.

The other kind of unexplained signals we receive are much more numerous. These are narrowband pulses (last-

ing less than ten seconds) which go "bump!" in the night. There have been thousands of such signals received, apparently from all over the sky, and never from exactly the same direction more than once. Clearly these signals are not from any single source (intelligent or otherwise), but they are very interesting in their own right. They could be some form of previously unknown astrophysical phenomenon. As an example, pulsars were first thought to be of alien origin when discovered in 1967, due to their regularly timed radio waves. They are now known to be rapidly rotating neutron stars, the remains of supernovae.

Of course pulsed signals like these could easily be caused by terrestrial radio interference or equipment malfunction. But if those were their sources, then they should appear randomly scattered across the sky. The interesting thing is that they do not. They exhibit a zone of avoidance along the galactic plane and areas of concentration above and below the galactic center, along the galactic north and south polar axes.

It is possible that the zones of avoidance and concentration are caused in some complex unknown way by an interaction between the galactic continuum radiation and the automatic gain and baseline correction algorithms in the computer. We simply do not know. A resurvey of a portion of the same area shows roughly the same effect, so the phenomenon appears to be repeatable. We plan to resurvey this area again with all new equipment in the future.

At one point, there was danger that the telescope would be destroyed. The land under and around the telescope was sold without our knowledge to a developer who wanted to enlarge the neighboring golf course. The developer wanted the telescope torn down and completely removed. This created a furor that was widely reported in the world press. After great struggle and with help from many people, the telescope was saved and a long-term lease was signed for the land.

For several years we published the first and only SETI magazine, called COSMIC SEARCH. Its editorial board included all the worldwide luminaries of SETI. The magazine was a technical and popular success, receiving great praise on all fronts. Sadly, it was a financial failure and finally folded after the thirteenth issue.

In the middle 1980s, a new and more powerful computer was donated by Digital Equipment Corporation. We began what we knew would be years of effort to place it into operation in the next generation of the Ohio SETI Program. Unfortunately, while this development was proceeding, the old IBM computer came to a premature death at the hands of a mouse. The mouse had built a nest at the air intake to the disk drive, cutting off the machine's air supply. This caused the disk drive to destroy itself.

IBM said the computer was so old that it would cost a lot of money to fix it. They also would not guarantee it to work normally even after it was fixed. So regretfully we abandoned the IBM computer and devoted all our efforts toward getting the new Digital computer operational. During the years of eight-channel and fifty-channel observations, we accumulated more on-the-air SETI observing time than all earlier or contemporary SETI programs combined.

1993 R.A.S.C. Handbook

Those members who wish to order the 1993 Royal Astronomical Society of Canada's Observers Handbook must prepay by the October meeting.

A new type of radio telescope is being designed, ... called a Radio Camera, since it forms an image of the entire sky at once.

Bus Trip to Kitt Peak

The bus trip is set up for Oct 10. We will leave the Phoenix area at 9:00 AM and make our way to Kitt Peak for lunch and a tour by Dean Kettlesen, President of the Tucson Amateur Astronomy Association. The bus will leave the mountain around 4:00 PM and go to the Mirror Lab at U. of A. Dean works at the Lab and will conduct a one hour tour of the Mirror Lab facility. We then return to wherever we left our cars, being back in Phoenix around 9:00 PM. There will be short stops on the way down and back.

SAC members are invited to "get on the bus" to Kitt Peak for $20 per person. Send your check, payable to SAC, to our Treasurer, Bob Dahl, or bring it to the August meeting. Please don't send it to Steve Coe, he is only setting up the tour, Bob has agreed to handle the money. Thanks, Bob.

The new system (now in test operation) has many improvements over the earlier one. No assumption as to exact signal frequency is made, as the entire "water hole" (1.4 to 1.7 gigahertz, or GHz) is searched continuously in three thousand channels. When a signal is found the search is temporarily suspended, so that the signal may be examined immediately in great detail and studied for an hour or so. We call this the SETI ZOOM system, because of the way it seizes upon any detected signal and focuses in on it.

This systems avoids the problem encountered by other SETI programs where interesting signals are found after-the-fact as part of a systematic search, but are no longer there when further observations are attempted. Russ Childers has now written his masters thesis on this system. An online catalog of known Radio Frequency Interference sources has been developed, to be used by the computer to ignore them.

A new type of radio telescope is being designed and a small prototype has been successfully tested. This telescope is called a Radio Camera, since it forms an image of the entire sky at once. This avoids the possibility that a signal might arrive from an unexpected direction but be missed by radio telescopes that are looking in "likely" directions. Jim Bolinger wrote his master's thesis describing the prototype. Plans are now being made to build a much larger one. Steve Brown is writing his masters thesis on several aspects of this development.

We have named this the Argus telescope, after the being of Greek mythology that had one hundred eyes and could see in all directions at once. It is the physical realization of a concept that has been fictionalized earlier by Carl Sagan in his 1985 book, *Contact*, and by Arthur C. Clarke in his 1976 novel, *Imperial Earth*.

A new method of detecting unknown signals is being developed, based on the Karhunen-Loeve transform. Unlike the Fourier transform commonly used, this method makes no assumptions as to the type of signal being received. It works well with all types of signals, particularly so with complex ones. Professor Chuck Klein and his students are running computer simulations of the signal detection process, comparing the KLT approach to the FT approach.

The Ohio SETI Program has now been merged with the Canadian SETI Program run by Bob Stephens. Bob is now at Ohio State University and we are jointly figuring out how we can best combine our equipment. This was made possible by a large increase in the size of our NASA grant this year.

The Flag of Earth flies at the OSU Radio Observatory and many other SETI locations around the world. It symbolizes the fact that SETI is carried out on behalf of Humanity as a whole. The individual people, organizations, and nations involved are but a part of the incredible work being done to find intelligent life in the Universe.

Newsletter Deadline

Mail items at least two weeks before the end of the month. Items arriving too late for an issue will be included in the next newsletter.

Directions to SAC Events

SAC General Meetings 7:30 PM at Grand Canyon University, Fleming Building, Room 105 — 1 mile west of Interstate 17 on Camelback Rd., north on 33rd Ave., second building on the right.

SAC Star Parties at Buckeye Hills Recreation Area — Interstate 10 west to Exit 112 (30 miles west of Interstate 17), then south for 10.5 miles, right at entrance to recreation area, one-half mile, on the right. No water and only pit toilets. Please arrive before sunset; allow one hour from central Phoenix.

Bits and Pieces

Coming Events

There is a Dugas Road Star Party planned for August 22, see details in this newsletter. The Kitt Peak tour is October 10, details are also in this newsletter. A public star party is tentatively planned for South Mountain in early October. Tucson Amateur Astronomy Association's (TAAA) All Arizona Star Party is October 23, 24.

August's Speaker

The August speaker is Ken Zeigler from Gila Observatory in Globe. He will discuss electronic imaging with a CCD camera.

1992 SAC Meetings	**1992 SAC Star Parties**
August 14	August 22
September 11	September 19
October 9	October 24
November 6	November 21
December 12 Party	December 19

Deep Sky Meeting

The next Deep Sky meeting will take place on Thursday, September 17 at 7:30pm.

SAC Officers

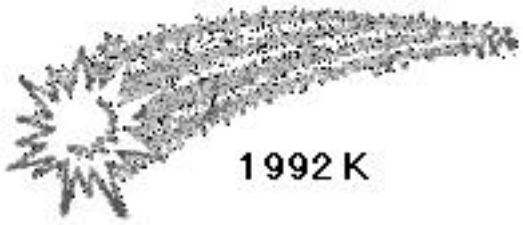
President	Paul Lind	863–3077
Vice President	Steve Coe	878–1873
Secretary	Susan Morse	934–7496
Treasurer	Bob Dahl	582–5526
Properties	Rich Walker	997–0711
SACNEWS Editor	Paul Dickson	841–7044

Comet Comments

by Don Machholz

One returning comet has been recovered, and a new one recently discovered. Meanwhile, Comet Shoemaker-Levy swings southward in our evening sky.

Periodic Comet Ashbrook-Jackson (1992j): A. Gilmore and P. Kilmartin recovered this object on May 4, confirming an observation made over one year earlier. This comet has an orbital period of 7.5 years, it might be bright enough for amateurs to observe next summer.



Comet Machholz (1992k): I discovered this comet on July 2, low in the morning sky. The comet was ninth magnitude, thirty degrees from the sun. During the week following discovery, the comet's small elongation and poor weather prevented accurate positional measurements, so as of this writing no orbit has been computed. [Ed. Note: Ephemerides given are from IAU Circular 5562, published after Don Machholz mailed this article.]

This find came 61 search hours since my previous comet discovery three months before. I was using my 5" homemade binoculars, sweeping from my backyard in Colfax, CA.

Don Machholz (916) 346-8963

Comet	**Machholz**				**(1992k)**
Date	RA-2000-Dec		Elong	Sky	Mag
07–22	06h06.0m	$+21^\circ 59'$	28°	M	9.3
07–27	06h24.2m	$+17^\circ 57'$	29°	M	9.4
08–01	06h41.5m	$+13^\circ 55'$	30°	M	9.7
08–06	06h57.9m	$+09^\circ 55'$	32°	M	9.9
08–11	07h13.6m	$+06^\circ 00'$	33°	M	10.1
08–16	07h28.5m	$+02^\circ 11'$	35°	M	10.4

Comet	**Shoemaker-Levy**				**(1991a$_1$)**
Date	RA-2000-Dec		Elong	Sky	Mag
07–22	11h47.9m	$+35^\circ 38'$	51°	E	6.6
07–27	11h56.9m	$+24^\circ 58'$	49°	E	6.8
08–01	12h02.5m	$+15^\circ 53'$	47°	E	7.0
08–06	12h06.1m	$+08^\circ 21'$	45°	E	7.3
08–11	12h08.4m	$+02^\circ 06'$	43°	E	7.7
08–16	12h10.1m	$-03^\circ 07'$	40°	E	8.0
08–21	12h11.4m	$-07^\circ 33'$	38°	E	8.4
08–26	12h12.4m	$-11^\circ 22'$	35°	E	8.7
08–31	12h13.4m	$-14^\circ 43'$	33°	E	9.1
09–05	12h14.3m	$-17^\circ 44'$	31°	E	9.4

The "Heck with the Monsoons" Star Party

In addition to the regular Buckeye Star Party on Aug. 22, on the night of Aug. 29 the Deep Sky Group will sponsor an observing session at Dugas Road, 60 miles north of Phoenix. To get to the site, take the freeway north (I-17) as if going to Flagstaff and take the Dugas Rd. exit, 5 miles north of Cordes Junction (the turnoff to Prescott.) Turn right (east) on Dugas Rd. and go 7 miles from the freeway. There will be a brown sign that points out Reimer Springs Road. Take a left on Reimer Springs Road and go about half a mile to a large meadow on the left and that's the site. Traditional sedans will need to be careful, the road has some pretty deep ruts. At one point the road crests a ridge and you can look down on what will be the observing site.

If you would like to join a convoy to the site, be at the Carefree Hwy. exit and the freeway at 5:30 PM on Sat. Aug. 29 and we can all go up together. If you have a CB radio, it is fun to converse on the way. So let's go up and get cool for the night. As always, if the sky is cloudy from Monsoons, you are on your own as far as deciding to go or stay home. But beware, you will hear about what a great night it became after the clouds blew away.

Space News

by Paul Dickson

Here is some information on various space probes. What follows is my interpretation of the facts.

The comet probe **Giotto** encountered its second comet a couple of weeks ago. Giotto passed within 200km of Comet Grigg-Skjellerup on July 10. NASA's Deep Space Network collected the data from Giotto for the European Space Agency.

The California earthquakes have been interrupting NASA's communications with various space probes. The "big" quake on June 28 damaged the subreflector of Goldstone's 70 meter antenna. The antenna was off-line until repair were completed on July 28. On July 19, a 4.6 magnitude earthquake centered 5 miles northeast of Barstow caused both of Goldstone's 34 meter antennas to halt reception of data from Voyagers 1 and 2. The antennas at Goldstone are part of the world-wide Deep Space Network.

Due to overheating of **Magellan**'s B side transmitter, JPL switch to the A side to maintain communications with the probe. At the beginning of the year, JPL switched to the B side when the A side became too noisy to send scientific data. Currently JPL is testing options such as only turning on the B side when it's needed. In September it is hoped that Magellan can map about 1% more of Venus's surface that hasn't been mapped before, increasing the percentage to 99%.

The Jupiter space probe **Galileo** is approaching earth for its second fly-by which will occur in early December. A full dump of the data gather at the asteroid Gaspra in planned in October. The High Gain Antenna is still not completely opened. Attempts to open it and data collection to help figure out why it won't open continue. In the event that the antenna can't be opened, work is being done in data compression.

In mid-September a new planetary mission is scheduled to be launched. The **Mars Observer** is set for a September 16 launch. Currently the only question is which batteries it will carry when it is launched. Originally Gates batteries were planned with NiCds purchased as replacements if needed. The Gamma Ray Observatory suffer a failure of a Gates battery, so the decision must be made as to which batteries to use for the mission.

Such-A-Deal

SUCH-A-DEAL is a place to advertise equipment, supplies, and services related to amateur astronomy. This is a free service for SAC members and friends. SAC is not responsible for the quality of advertised items or services.

Telescope—8" $f/6$ Newtonian, Dobsonian mount, Truss tube, easy to transport, easy to setup, Meade mirrors, Novak Cell and Spider. Has Alt-Az Circles to make it easy to find dim objects. Package includes a Casio Pocket Computer for calculating Alt-Az positions from the circles. Includes: Telrad zero power finder, 3 eyepieces: 32mm Erfle, 10mm Plössl and 6mm Kellner. Entire package: Scope, Eyepieces, Telrad and Computer. $700 Steve Coe 878–1873.