North American
AstroPhysical Observatory

# NAAPO (North American AstroPhysical Observatory)

## "Signals"
## Volume 11 Number 1
## The NAAPO Newsletter
## (January 1995)

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## ATTENTION FRIENDS OF THE OBSERVATORY: CRISIS! PLEASE HELP US!!
### (NAAPO 1983 -- ????)

We are just learning that decisions at the top level of the Ohio State University administration affecting the future of the 110-meter radio telescope — Big Ear — are moving toward withdrawing support of all forms from the operation of the telescope. Negotiations are under way toward terminating the lease arrangements with the landlord of the land upon which the telescope is situated.

Present options include, among others:

1. Evacuation of the site by all parties by July 1, 1995, the final date of the current 10 year lease.

2. Occupation of the site for an additional 3 year period, for which certain conditions of the original lease will not be demanded of the University.

3. Re-negotiation of a ten year lease in which case the University would be responsible for such things as painting the telescope and buildings at the site. It is the third option at which the University has balked.

We now need the help of the people who have stood by our activities for the past 15 years. It is not money nor equipment we seek now, but sincere support in the form of letters and phone calls to Dr. Gee, President of the Ohio State University.

This needs to be done immediately, as the landlord has required a declaration of intention by FEBRUARY 1, 1995. This is two weeks at most from the time you receive this request. We in the immediate central Ohio region have already begun our letter writing campaign.

Here is all you need to do! address your mail to:

E. Gordon Gee, President
205 Bricker Hall
190 N. Oval Mall
Ohio State University

Columbus OH 43210

or

FAX (614) 292-1231

or

Phone (614) 292-2424

In your communication, spell out who you are, listing any credentials you might bring to bear, your contributions, — financial, philosophical, in the spirit of adventure, etc. — your interest in the work being done at the telescope, and what you see as the positive contribution being made by such a unique facility. Please do not emphasize any negative reactions such as criticism of the University administration for short-sightedness or uninformed self interest. We would like to have a very positive presentation from as many of you as possible.

For your information matters that are being addressed in some of the local conmunications include the modern instruments being used at the facility, the unique character of the telescope itself, the value of an instrument available full time to on-going, sometimes routine research, the discoveries and mysteries associated with new kinds of data yet unexplained, the development of new telescope technologies and the efficiency with which the research is carried out by a dedicated staff of university personnel and volunteers. You may express your interest in the search for evidence of extraterrestrial technologies, especially if that is the route through which you became interested in the work of the observatory. Also, you might include the educational benefits you or your groups have gained from the presence of this installation.

I realize the time is short and I have not always gotten such a quick turn-around on issues of SIGNALS. The time is now. Please help us out. Do not put off writing, even if it is just a hand-written note. If you send a copy to us, we would appreciate seeing the kind of support you have been willing to invest for us.

**Phil Barnhart,**
**NAAPO Coordinator**

## GALILEO MISSION STATUS
## January 1, 1995

PUBLIC INFORMATION OFFICE
JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PASADENA, CALIF.
TELEPHONE (818) 354-5011

On December 1 the **Galileo** spacecraft passed through superior conjunction, on the opposite side of the Sun from Earth. Galileo and the Sun were as close as 0.2 degrees apart as seen from Earth. Because of solar radio noise, communication at these small angles is extremely difficult. A series of uplink and downlink tests was carried out during the weeks before and after conjunction, in anticipation of similar conditions to come soon after Jupiter arrival next December. Performance of the telecommunications link between the spacecraft and the **Deep Space Network** stations was satisfactory.

After conjunction, Galileo resumed sending to Earth data from its observations of impacts of **Comet Shoemaker-Levy 9** with Jupiter, including near-infrared mapping spectrometer data on the impact of *fragment G* and images of *fragment W*. Galileo will continue sending this data into January, followed by infrared and other data on *fragment R*, which concludes Galileo's transmission of the Shoemaker-Levy observations.

Data collection for the solar wind experiment continued through December 28, 1994. This experiment is designed to measure the charged-particle environment very near the Sun by measuring the effect of those particles on the radio signal beamed from Galileo to Earth.

Galileo continues to operate normally, spinning at about 3 rpm and transmitting at 10 bits per second to ground stations of the NASA/JPL Deep Space Network. The spacecraft is currently 884 million kilometers (*549 million miles*) from Earth and 171 million kilometers (*106 million miles*) from Jupiter. It 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 measurements of Jupiter, its moons and its magnetosphere.

## TOPEX/POSEIDON MISSION STATUS

**January 1, 1995**

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The satellite and sensors continue to operate as expected and ground system computers are performing well. The mission has entered its 84th 10-day data collection cycle. The satellite tape recorders have been played back and the daily science and engineering data products are being produced.

Last Friday, the weekly set of ephemeris commands was uplinked to the satellite. The ephemeris load consists of two tables, one with information regarding the satellite's relationship to Earth and allows the satellite to remain correctly pointed for data collection. The second table has information about the location of the **Tracking and Data Relay Satellites** (*TDRSS*) which allows for correct pointing of the high-gain antenna for communications.

## ULYSSES MISSION STATUS

**January 1, 1995**

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The **Ulysses** spacecraft has completed the first phase of its primary mission to explore the polar regions of the Sun and is now headed for the Sun's equator, where it will make its closest approach of 1.3 astronomical units (*192 million kilometers or 120 million miles*) on March 12, 1995.

Today the spacecraft is about 51 degrees south of the Sun's equator, traveling at a heliocentric velocity of about 106,500 kilometers per hour (*66,000 miles per hour*) with respect to the Sun. All spacecraft operations and science experiments continue

to go well. Ground controllers are monitoring the spacecraft and an onboard control system that is designed to stabilize Ulysses and keep it pointed at the Earth while its axial boom is illuminated by the Sun.

Scientists have reported some surprises in the solar environment at high latitude from data acquired during the first pass. Most notably, the gas being continuously carried by the Sun's solar wind was found to be flowing very fast and very smoothly. Surprisingly, scientists found that the strength of the Sun's magnetic field over the polar region did not increase as much as expected. Large amplitude "Alfven" waves are continuously present in the polar region and may contribute to the heating and speeding up of the solar wind. In addition, the intensity of cosmic ray particles arriving from the galaxy did not increase as much as was expected when Ulysses headed toward the southern pole, another condition which surprised scientists. These and other findings were presented in more depth at the December 1994 meetings of the **American Geophysical Union** in San Francisco.

## VOYAGER MISSION STATUS

**January 1, 1995**

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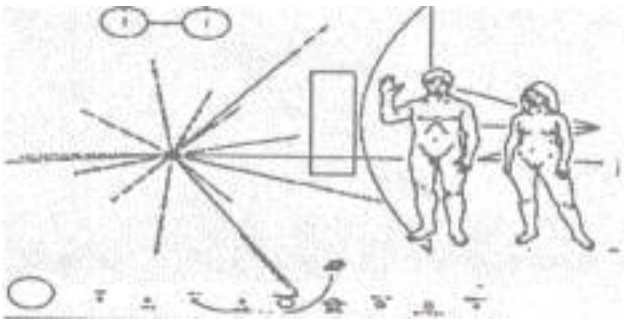

Both spacecraft are healthy and are continuing to make observations of their interplanetary environment.

They are using their ultraviolet spectrometers to map the heliosphere and study the incoming interstellar wind. The cosmic ray detectors are seeing the energy spectra of interstellar cosmic rays in the outer heliosphere. The magnetometer sensors are still measuring the strength and direction of the solar magnetic field. The plasma detectors looking back at the Sun record the solar wind parameters. The low energy charged particle experiment studies the energy spectra of particles coming from the Sun. The plasma wave instrument is studying the incoming signals from the direction of the he1iosphere.

**Voyager 1** is currently 8.8 billion kilometers (*5.5 billion miles*) from Earth and is traveling at a speed of 61,200 kilometers per hour (*39,000 miles per hour*). **Voyager 2** is 6.8 billion kilometers (*4.3 billion miles*) from Earth and is traveling at a speed of 57,600 kilometers per hour (*36,000 miles per hour*).

## TUESDAY MEETING REPORT
**By: Tom Hanson**

After several weeks of arriving at 6 PM, after the meetings had ended, or missing altogether such as last week, I was able to attend. This evening, Dr. Dixon, Russ Childers, and Hemal Mehta (*?sp?*) were conversing as I arrived. We all prepared to depart shortly afterward, and Cindy Brooman arrived. After Cindy had given her report, we prepared to depart again, and Steve Brown arrived. We'll never know if Tom Van Horne arrived at his usual time (*unless he tells us << grin >>*).

Dr. Dixon will be driving north to visit his family, departing December 22nd. The family gathering will be even further north than usual this year. Cindy Brooman's family has decided to have their Christmas gathering in Pennsylvania this year, so she and Andrew will be spending 16 hours or so on the highway.

Russ Childers and Hemal had completed their reports when I arrived, so we pick up with Steve Brown:

Steve has been talking to Tap Lum about the HEMT amplifiers, and Steve received several suggestions for problem analysis. On Thursday, Steve gave a tour of the **Observatory** for Dan Fleisch and the president of Dan's company. The visit was arranged in part so that an estimate of the cost of a second receiver chain for Serendip could be estimated.

Bill Brown, Dr. Klein and Steve carried out tests of the **Serendip** system on Friday. Steve reported several birdies in the system, including one which rose infrequency gradually over the period of testing. Steve discussed various experiments which will need to be carried out, to identify sources of spurious signals, both in and outside of the Focus Room.

At a recent Satuday meeting, just as I was leaving, Steve reported on a seminar he had attended, which gave him insight into a possible non-digital **Argus**, using optical technology. The key to the potential idea is (*I gather*) that an optical lens

acts as an analog FFT device. Steve said this evening that there are some significant technical hurdles to be overcome to realize such a device, but that he feels it is worth exploring.

In closing, Dr. Dixon brought to our attention that locks will be changed in Dreese Hall in the very near future, and it is certain that anyone holding a key to the outside door will be unable to gain entrance. It is unclear whether keys to the **Observatory** rooms will be changed, but Steve Brown will investigate.

## SATURDAY, 12/17/94 MEETING NOTES
**By: Tom Hanson**

Today's meeting was well attended by regular members, and a group of guests. While Russ Childers gave a tour of the Focus Room for our guests, Dr. Dixon convened a meeting in the Administration building. Dan Fleisch, Phil Schumacher, Mark Sundstrom, Ang Campanella, and Marilyn McConnell-Goelz were present, along with first time visitor Joe Mitchell. Joe was invited by Phil. He graduated from *Union College* recently with a degree in Physics and Astronomy, and he has begun graduate work at *OSU*. The visitors, Rick Ireland, Bill Walker, Rodney Waugh, Paul Frederick, Brent Ogle, Michael Riggs and David Comstock are members of an amateur astronomy group from West Virginia. They have taken up an interest in radio astronomy, and came to **Big Ear** to see the facility, but also to take actual observations. Russ planned to provide them with data taken during their visit.

Topics covered during the meeting included status of the lease renewal (*no news*), KLT (*good review for guests*), status of **Argus** proposals submitted by Dan's company (*nice response from **NASA** but no funding yet*), a "*Hmmmm*" signal observed by Russ and the astronomers during their visit, and status of activities by Mark and Ang.

The telescope is positioned at 24 degrees.

## NASA HAS NEW EVIDENCE ON OZONE DEPLETION

***WASHINGTON (Reuter)***

**NASA** scientists will unveil firm scientific evidence supporting the belief that manmade chlorine is causing the ozone hole above Antarctica, space agency officials said Friday.

Details will not be released until Monday, but **NASA** spokesmen said the data gathered by the **Upper Atmospheric Research Satellite** makes clear chlorine, an ingredient in chlorofluorocarbons (*CFCs*), is responsible.

CFCs, used in antifreeze, refrigerants, and insulation products, are being phased out under international agreements but scientists fear it will take decades before there is significant improvement in the ozone layer.

Ozone is a form of oxygen that provides a natural, high-altitude shield for the earth against the sun's harmful ultraviolet rays.

Without that protection, ultraviolet radiation is believed to cause skin cancer, cataracts and crop damage. It also harms the marine organisms that are the starting point for much of the world's food chain.

Its depletion is seen most clearly in the hole, roughly the size of North America and first noticed in the 1970s, that opens each year over the South Pole.

Despite a plan to halt production of the most ozone destructive chemicals as of Jan. 1, 1996, many related chemicals will still be made.

The banned products, though no longer manufactured, will still be in use for years in existing refrigerators, air conditioners and cooling systems.

## RESEARCH WITH KECK TELESCOPE STRENGTHENS CASE FOR DARK MATTER IN TINY BUT COMMON GALAXIES
## December 16, 1994

*THE FOLLOWING PRESS RELEASE WAS RECEIVED FROM THE UNIVERSITY OF CALIFORNIA, SANTA CRUZ, AND IS FORWARDED FOR YOUR INFORMATION.*
*Steve Maran, American Astronomical Society*

*Contact: Robert Irion (408/459-2495)*

Astronomers have long suspected that dark matter, the mysterious material composing most of the mass in the universe, envelops galaxies and clusters of galaxies in tenuous shrouds. Now, they have found strong clues that dark matter also exists in a far smaller object: a dwarf galaxy in orbit around our Milky Way.

A team of researchers used the powerful **W. M. Keck Telescope** in Hawaii to chart the motions of individual stars in the tiny galaxy **Leo II**, some 720,000 light-years from earth. The rapid motions of the stars led the team to conclude that Leo II contains about six times more mass than meets the eye. Without the gravitational pull from the unseen mass, stars moving that quickly would escape the galaxy altogether.

Some astronomers believe that dark matter also lurks in other nearby dwarf galaxies, which dot space near the Milky Way like moths around a lamp. Others argue that the motions of stars in those galaxies might arise from tidal forces generated by the Milky Way's gravitational field. However, Leo II is so distant — more than twice as far from the Milky Way as most other dwarfs — that researchers have ruled out tidal forces as an explanation for the stars' motions.

"This is the first study to nail down the hypothesis that dwarf galaxies have large amounts of dark matter," says lead author Steven Vogt, professor of astronomy and astrophysics at the *University of California, Santa Cruz*. "This result has significant implications for cosmology, because dwarfs are among the most common galaxies. If they all contain dark matter, they may contribute an unexpectedly large amount of total mass to the universe."

Vogt and three colleagues will publish their study in the January 1995 Astronomical Journal. His coauthors are Mario Mateo, assistant professor of astronomy at the *University of Michigan*; Edward Olszewski, associate astronomer at *Steward Observatory, University of Arizona*; and Michael Keane, graduate student at *UC Santa Cruz*. Mateo and Olszewski brought years of dwarf-galaxy research experience to their collaboration with Vogt and Keane.

Eight well-known dwarf galaxies, called "dwarf spheroidal galaxies" by astronomers, orbit around the Milky Way. A ninth was spotted close to the Milky Way's center earlier this year. The dwarfs are unspectacular conglomerations that barely register as smudges on old photographic plates; each contains perhaps one to ten million stars. Leo II, discovered in 1950, is one of the most remote of the dwarfs — fully one-third as far away as the gigantic Andromeda Galaxy but yet still bound to the Milky Way.

To search for signs of dark matter in the dwarfs, astronomers use spectrographs to examine how quickly their stars move. Dark lines in the spectra of many stars shift either toward the blue or the red end of the spectrum, revealing that each star is moving toward or away from earth. Many such observations yield an average picture of the motions in a swarm of stars. Just as cars can drive faster on a steeply banked curve, stars can orbit more quickly in a strong gravitational field. Thus, speedy motions point to a massive galaxy, while slower motions indicate less total mass. In this manner, astronomers including Mateo and Olszewski have found that most of the Milky Way's dwarf galaxies seem to contain much more mass than is apparent in their visible stars alone.

However, there are complications. Astronomers use red giant stars for this research because they are the brightest and hence easiest stars to see. The atmospheres of some red giants are unstable; their pulsations can create the illusion of rapid motions in space. To address that concern, the Leo II researchers chose only stable but much fainter red giants. Further, some stars revolve around other stars in binary systems, producing yet another kind of motion. The team used computer simulations and long-term observations of red giants in other dwarf galaxies to show that the small number of binaries they might have observed in Leo If would barely affect their results.

In addition, some researchers claim that the Milky Way inflicts serious tidal pulls

on its nearby dwarf companions. Stars on the near side of each galaxy feel a stronger tug toward the Milky Way than those on the far side. Astronomers disagree about whether the resulting motions ofstars would swamp a dark-matter signature. The minuscule tidal forces on Leo II, however, could not possibly account for the stellar motions seen by the team.

"With information about only one dwarf spheroidal, you can find ways to wiggle out of dark matter," says Olszewski. "With knowledge of each additional system, wiggling becomes harder. But Leo II provides a very clean test of the dark-matter hypothesis for dwarf spheroidals, because it's so far from the Milky Way."

Leo II is so distant, in fact, that its individual stars are beyond the pale of all telescopes except the ten-meter Keck. To get the precise measurements needed, the team used the **High-Resolution Echelle Spectrograph** (*HIRES*), designed by Vogt and built at the *UCO/Lick Observatory* shops at UC Santa Cruz. HIRES produces exquisitely detailed spectra, for it contains the largest lenses and gratings of any spectrograph. Thanks to the telescope's light-gathering power, difficult observations that require heroic efforts at other observatories are routine with HIRES.

"These observations were not even a challenge for Keck," says Mateo. "We were ecstatic that we got such a large sample of stars so fast. Keck and HIRES are letting astronomers do science that they had thought was unfeasible in their lifetimes."

The team obtained spectra of 31 red giants in Leo II during several hours of observations on the nights of March 19-21, 1994. Most stars needed only 10-minute exposures; a few exposures ran to 20 minutes.

The final result was a "velocity dispersion" — a statistical measure of how quickly stars move within a galaxy. If Leo II contained no dark matter, the astronomers would have expected a velocity dispersion of about 2.5 kilometers per second. Instead, they found a dispersion of 6.7 kilometers per second, with a margin of error of about 15 percent. That is not as high as the value seen in some other dwarf galaxies, but still solid evidence that dark matter composes about 85 percent of Leo II's mass.

The role that dwarf galaxies and their halos of dark matter might play in the universe is not clear. Because stars in dwarfs are spread out, the galaxies are quite

faint and difficult to find. Some astronomers argue that dwarfs may outnumber all other galaxies in the universe by a factor of 10, 100, or even more. In addition, it appears that more dwarfs existed in the past. Over time, the Milky Way and other large galaxies may cannibalize these stragglers and absorb the dark matter into their own enormous halos of material.

"Dwarf spheroidals are an extreme class of galaxy, and many of them might not be visible at all, "Mateo comments. "If they are a lot more common than we think, they could become an important mass component of the universe without contributing much light." So far, he notes, all dwarfs seem to contain about the same amount of dark matter: a mass equal to tens of millions of suns. Further, their dark matter must be of the "cold" variety — heavy and sluggishly moving material. Because of their relatively weak gravitational fields, dwarfs could not capture neutrinos or other fast-moving "hot" dark matter.

The team is now pondering whether to examine other distant dwarfs — such as those around the Andromeda Galaxy — in the same way. Meanwhile, Mateo and Olszewski are conducting more detailed studies of stellar motions in some of the Milky Way's dwarfs.

The W. M. Keck Observatory is operated by the **California Association for Research in Astronomy**, a partnership of the *University of California* and the *California Institute of Technology*. Both Mateo and Olszewski were supported by grants from the **National Science Foundation**.

## NEW SPACELAB SCIENCE MISSION TO FLY IN 1996

**NASA** has begun planning for a new multidisciplinary life and microgravity sciences **Spacelab** research mission tobe flown on the **Space Shuttle** in mid-1996.

The 16-day mission is scheduled for launch aboard the orbiter **Columbia** on *Shuttle flight STS-78*. The flight, carrying a crew of seven, will involve 21 investigations: fifteen in life sciences and six in microgravity sciences.

The life sciences experiments will continue studies probing the changes and adaptive mechanisms of living systems including plants, animals and humans under weightless conditions. Human and animal studies are focused on the effects of microgravity on the musculoskeletal system and on sleep and performance.

Life sciences experiments will investigate changes in the musculoskeletal system (*bone and muscle deterioration*), neurovestibular system (*balance disorders*), cardiopulmonary (*heart and lungs*) and regulatory physiology (*changes in body chemistry, fluid regulation and immune system*).

The microgravity science investigations will focus on protein crystallization, fluid physics and materials science. In addition, vibration measurement instruments will support these experiments by characterizing in detail the microgravity environment aboard the Spacelab.

Microgravity experiments will include protein crystal growth, electrohydrodynamics, fluids interface studies, high temperature directional solidification of multi-phase materials and solidification with particle pushing and engulfment.

The **Life and Microgravity Spacelab** (*LMS*) mission, as the flight has been designated, is being managed by the **Marshall Space Flight Center** in Huntsville, AL, for the **Office of Life and Microgravity Sciences and Applications** at **NASA** Headquarters, Washington, DC.

Mark Boudreaux of the **Payload Projects Office** at Marshall has been named mission manager and Dr. James P. Downey of the Center's **Space Sciences Laboratory** is the mission scientist.

Principal investigators selected to date for the LMS mission include: Dr. J. Barry Andrews, *University of Alabama* at Birmingham, AL; Dr. Christopher Cann, *University of Calif.* at San Francisco, CA; Dr. Paolo Cerretelli, *Universite de Geneve*, Centre Medical Universitaire Geneve, Switzerland; Professor Pietro E. di Prampero, *Universita deglie Studi di Udine*, Udine, Italy; Dr. Y. Reggie Edgerton, *U. of Calif.* at Los Angeles, CA; Dr. Robert Fitts, *Marquette University*, Milwaukee, WI; Dr. Adrian LeBlanc, *Baylor College of Medicine*, Houston, TX; Dr. Norman Lewis, *Wisconsin State University*, Pullman, WI; Dr. Alexander McPherson, Jr., *University of Calif. at Riverside*, CA; Timothy Monk, *University of Pittsburgh*, PA; Dr. Shunji Nagaoka, *National Space Development Agency of Japan*; Sam Schiflett, *USAF Armstrong Laboratory*, Brooks AFB, TX; Dr. Doru M. Stefanescu, *University of Alabama at Tuscaloosa*, AL; Dr. T. Peter Stein, *U. of Medicine and Dentistry of New Jersey*, Stratford, NJ; Dr. Peter A. Tesch, *Karolinska Institute*,

Stockholm, Sweden; Dr. Douglas Watt, *McGill University*, Montreal, Canada; Dr. John B. West, *University of California*, La Jolla, CA; and Dr. Thomas J. Wronski, *University of Florida*, Gainesville, FL.

## MISSING SOURCE??

The accompanying figures illustrate one of the aspects of the re-surveying of the radio sky that makes the exercise worth while. While comparing the maps of the region around 2 hours right ascension and +30 degrees declination, Russ Childers noticed a strong (about 1 flux unit) source that did not appear in that position on the Ohio Survey map published in 1968.

Upon further examination the source did indeed appear (see Figure 3) where he found it, but the source was not included in the survey with a source ID number. This seems to be a gap in the processing of the original data. The fact that it was not catalogued is probably due to the location being on the border between three adjacent regions of the sky and this source was just overlooked.

[Note: Each of the three figures below is available in a larger size; just click on each figure.]

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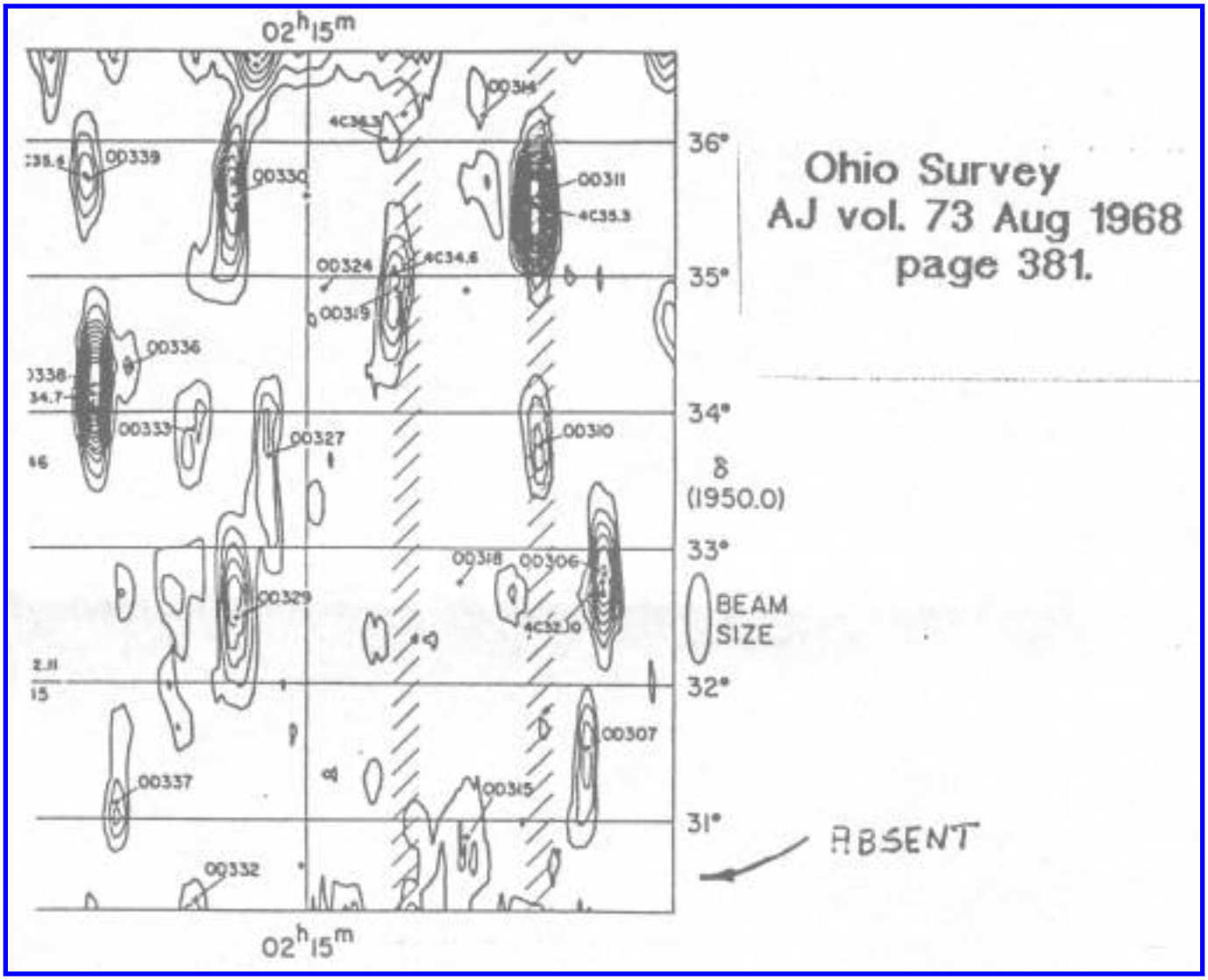
**Figure 1**
**Ohio Survey**
**AJ vol. 73, Aug 1968, page 381**
**(portion of 1st map in article)**




Ohio Survey
AJ vol. 73 Aug 1968
page 381.

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**Figure 2**
**"New" Survey**
**Russ Childers 1994**

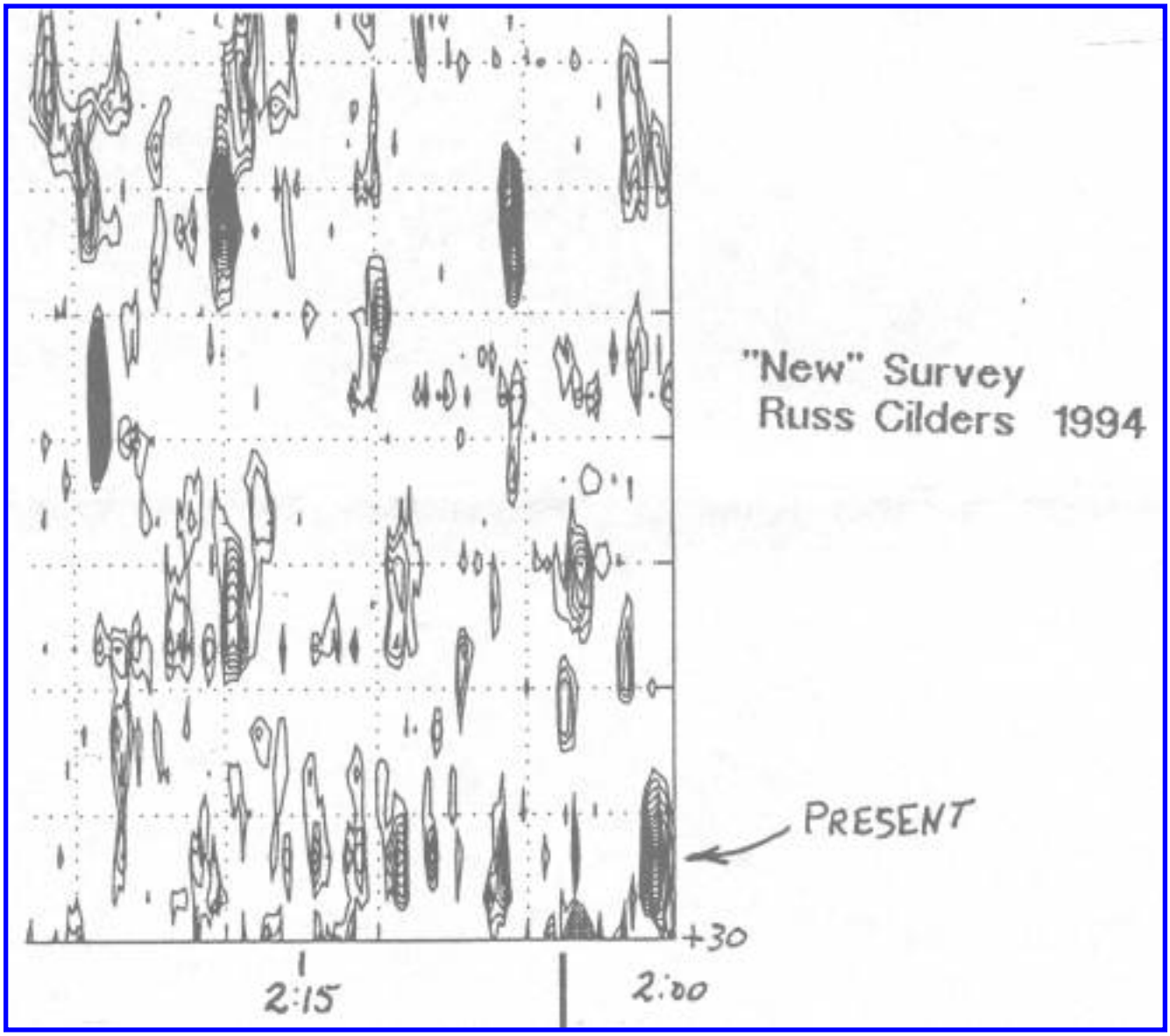
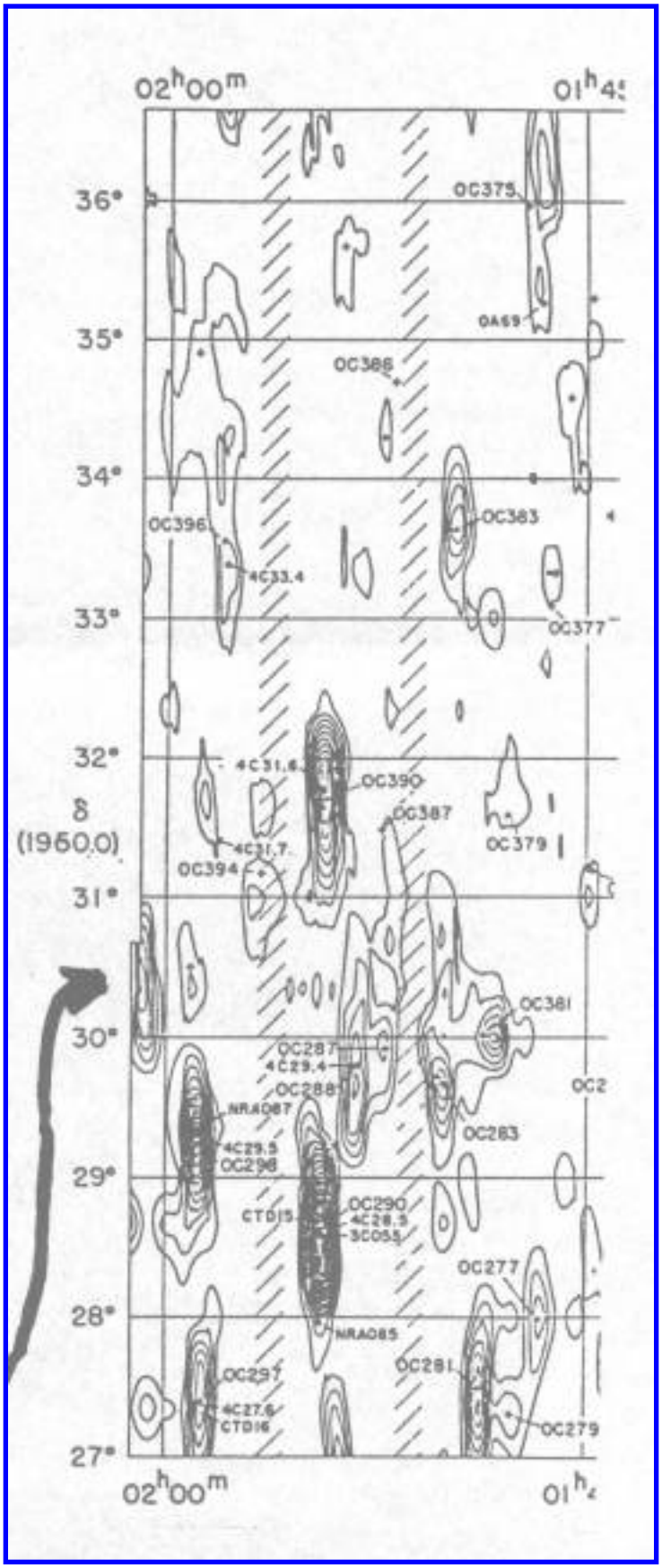



**Figure 3**
**Ohio Survey**
**AJ vol. 73, Aug 1968, page 381**
**(portion of 2nd map in article)**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