The OBSERVER

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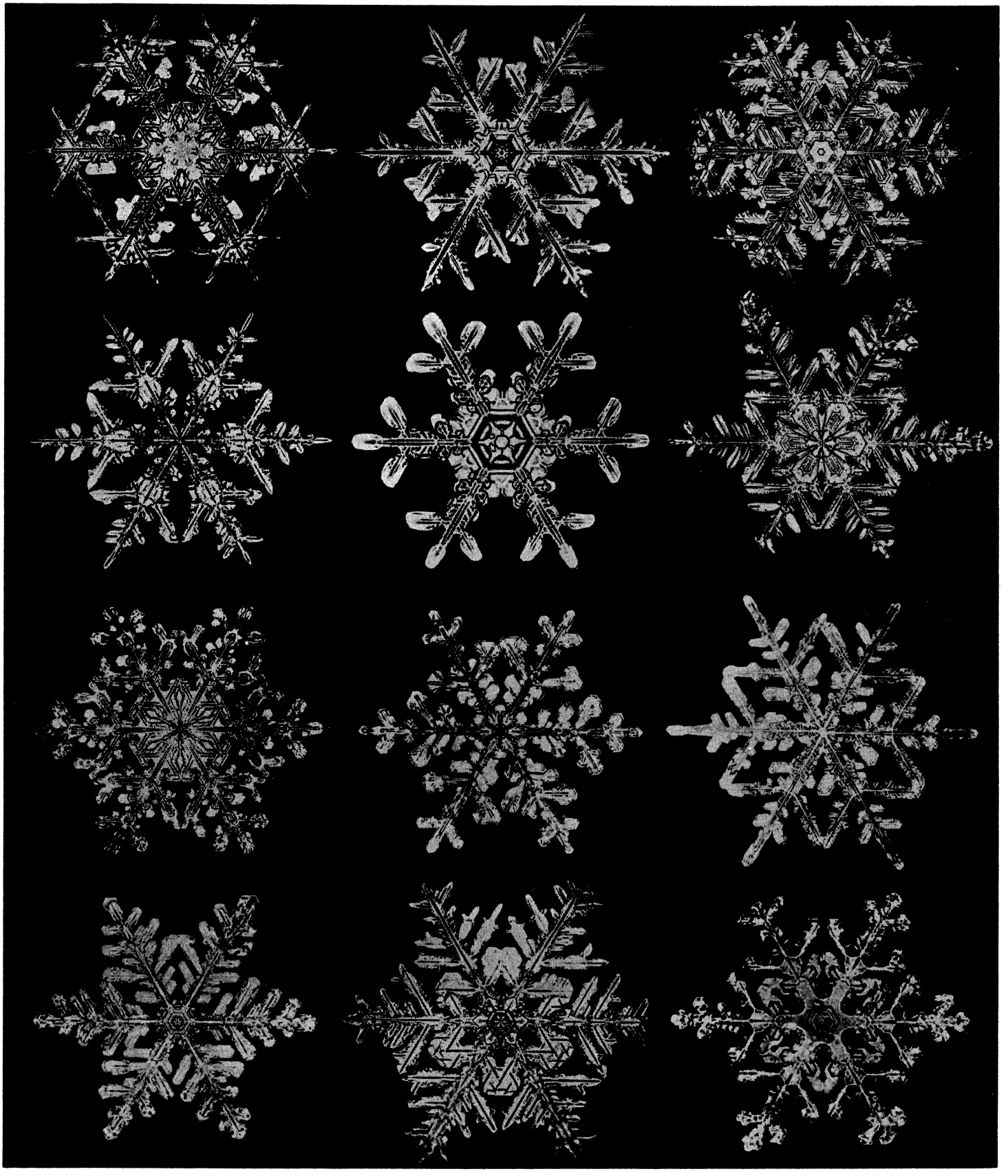

Story on page 2

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SNOW FLAKES

Pat Crane

The collage of photographs of snow flakes on the cover of this issue of the *OBSERVER* has been reproduced from the remarkable book Snow Crystals by W. A. Bently and W. J. Humphreys (Dover, 1962, $6.00). The cover shows only twelve of the more than 1000 beautiful crystals collected in the book from Bently's half century of effort in his workshop at Jericho, Vermont. The scope of Bently's work is extraordinary when one realizes that the work must be done quickly and in extreme cold (even body heat will melt the rarest specimen) and that Snow Crystals was published in 1931.

Science and art obviously overlap in the study of the forms of snow flakes. The text of the book covers the technique of photographing snow flakes, their classification and markings, and the fundamentals of crystallography. All the amateur need know is that those needles and plates (occasionally even pyramids), triangles and twelve-pointed stars are based on a common (six-sided) hexagon.

Consider the exquisite detail revealed in these photographs, and ignore their kin outside your door. Spring is on the way!

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RADIO EMISSION FROM NEARBY GALAXIES

Jim Condon

Lists of the strongest extragalactic radio sources and the brightest optical objects have very few members in common. The brightest radio sources are rare and peculiar objects, such as quasars, spread throughout the universe, while the brightest optical objects are relatively nearby "normal" galaxies. It is unfortunate that most bright galaxies are only weak radio emitters, because understanding the origins of their radio emission would be valuable, for several reasons. Some nearby galaxies contain what appear to be miniature versions of the powerful radio sources found in quasars and "radio" galaxies. Since they are not extremely distant, they are easier to study in detail and may provide clues to the nature of the most luminous extragalactic radio sources. It is possible, for example, to determine the separation between the position angles of the radio major axis and the optical major axis of the nuclear region of a nearby galaxy and see whether or not sources expand along the galaxy rotation axis.

The Hubble classification of galaxies is based on optical morphology alone, but it is supposed to have a real physical significance. Radio observational support, or lack of it, would help us to judge the relative merits of Hubble's and other classification methods. We would also like to find out which characteristics of our own galaxy are typical and which are unique by comparing it with a representative sample of nearby galaxies. In order to make a systematic study of the radio emission from nearby galaxies, Linda Dressel and I have made a sensitive 2380 MHz survey of 2095 galaxies brighter than m = +14.5 with the Arecibo 1000-foot ("millipede") telescope. We have reobserved the strongest detected sources with the Green Bank interferometer to obtain accurate positions of the most compact sources.

The most striking characteristic of the radio emission is that there are two distinctly different kinds of radio sources in nearby galaxies. These two types are associated with the "spherical" and "disk" components of galaxies, respectively. The spherical component of a galaxy consists of a more-or-less round cloud of stars that are all billions of years old. There is little or no interstellar gas from which new stars could be formed. One of the Hubble galaxy types, the elliptical (E) galaxies, consist only of spherical components and have no disks. Figure 1 shows such a galaxy. The

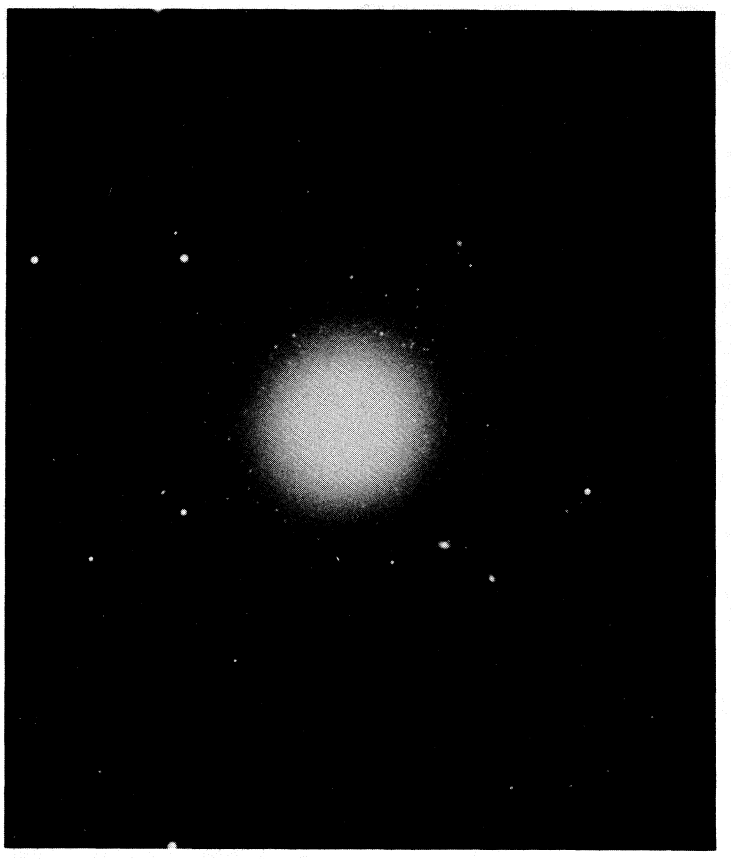

FIGURE 1: *The elliptical galaxy Virgo A. It contains a spherical component but no disk component.*

disk component of a galaxy is a much more flattened circular region containing stars of all ages along with clouds of interstellar gas and dust, typically concentrated in spiral arms. The Hubble classification of a galaxy with a disk depends on the relative prominence of its spherical and disk components. Figure 2 shows this progression from S0 galaxies, with large spherical components and faint disks, to Sc

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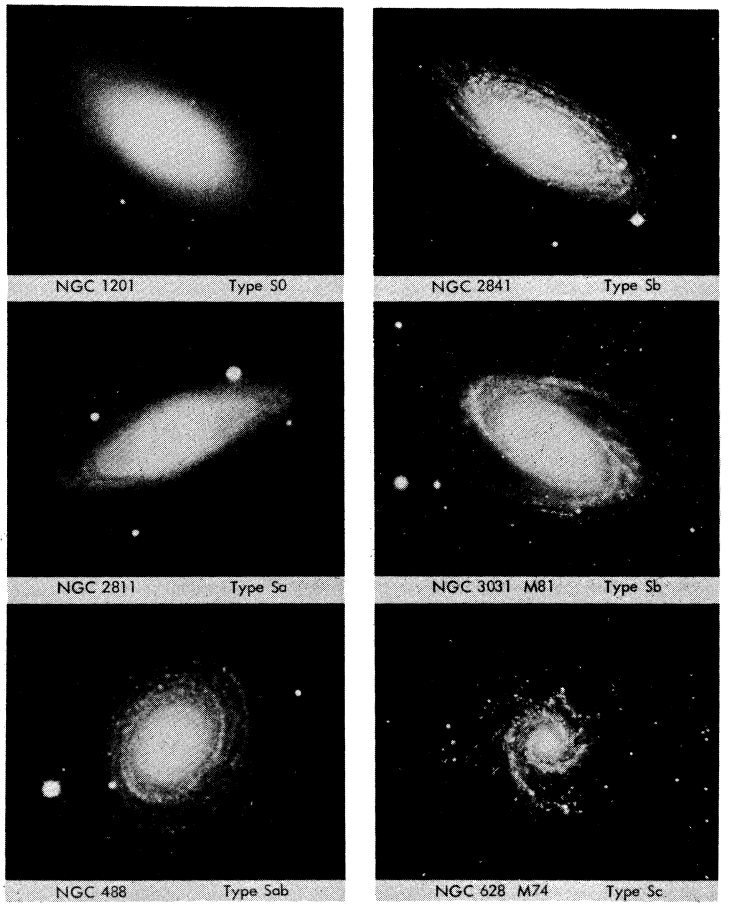

FIGURE 2: A sequence of galaxies with increasingly prominent disk components and decreasingly prominent spherical components.

galaxies, which have prominent disks and only tiny spherical components in their centers.

Old stars are exceedingly feeble radio sources, so the spherical components of most galaxies are not detectable as radio sources. About 3/4 of the E and SO galaxies observed at Arecibo were not seen at 2380 MHz, and a statistical analysis of these non-detections indicates that most of the galaxies are fainter than 1 mJy. Some spherical components of galaxies do, however, produce radio sources; these must have something more than just "old stars" in them. The structures of radio sources associated with the spherical components of galaxies consist of some combination of compact central components and extended radio lobes which appear to have been shot out of the central region. Because the galaxies we observed are less than 100 Mpc distant, it was possible to measure accurate positions of the central sources with the interferometer and show that, in every case, these sources fall within about 0.01 galaxy diameter of the galaxy optical center, or nucleus. Whatever the "something" is which makes spherical-component radio sources, it lies at the very center of the spherical component. It is also remarkably small, considering how much radio energy it produces. The flat or inverted radio spectra of more than half of the nuclear sources indicate that they are smaller than 1 pc in size; that is, they occupy less than a trillionth (10^{-12}) of the volume of the galaxy. On the other hand, the radio lobes ejected from the nucleus can grow to be much larger than the parent galaxy.

The spherical-component radio sources can also be quite strong. For example, the source in the E-galaxy Virgo A shown in Figure 1 produces a stronger radio signal than all the remaining 2094 galaxies combined! It is this sort of exceptionally powerful radio source that is common in lists of the strongest extragalactic radio sources.

In order to explain how so much energy originates in such a small volume, astronomers have invoked hypothetical massive objects (spinars), black holes, or extremely dense clusters of stars in which there are frequent star collisions and supernova explosions. Since there are radio sources in about 1/4 of the bright elliptical galaxies, at least this fraction must contain these objects in their nuclei. Perhaps there are black holes in nearly all large galaxies, but they are only triggered into radio activity for a fraction of the time. We do not know if this is the case, but there is one clue that may lead to the answer: spherical-component radio sources are preferentially found in galaxies which are not isolated, but which have close companions. In the case of E galaxies, those in Zwicky clusters and those with 3 or more bright-galaxy companions within 10 arcminutes are much more likely to be radio sources than those outside of Zwicky

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clusters or having fewer close companions. A few of the spiral galaxies with large spherical components (mostly type Sa) contain nuclear radio sources, and these also tend to have close companion galaxies. When two or more galaxies are suffering a disruptive collision, they are more likely to have a compact radio source. One such system with a compact radio source is shown in Figure 3. Computer simulations of galaxy collisions show that the other por-

FIGURE 3: Colliding galaxies NGC 2623 containing a compact radio source.

tions of galaxies can be torn apart and can form tails as shown in Figure 3, but that the nuclear regions of the galaxies should remain intact. Thus it is hard to understand how galaxy interactions would produce the nuclear object responsible for the radio source. The collision might rather cause fuel, in the form of interstellar gas, to fall into an already existing nuclear object and activate it as a radio source.

Radio emission from a galactic disk is not due to any single powerful source, but instead to the superposition of many faint sources spread throughout the disk. The disk radiation appears to consist of nonthermal radiation from supernova remnants and thermal emission from HII regions. The relative intensities of the thermal and nonthermal contributions in a typical disk radio source are still a matter of dispute. Since thermal and nonthermal sources have different spectra, we plan to measure the spectra of all sources found in the survey in collaboration with Richard Porcas, who is now at Bonn. Because both HII regions and supernovae are associated with the optically brightest stars in a galaxy, there is a fairly good correlation between the strength of the disk radio emission and the optical magnitude of a spiral galaxy. Disk sources are never as luminous as the more powerful spherical-component sources, but they are probably always present, and we can see evidence of faint disk emission in nearly all of the spiral galaxies observed. The purest disk galaxies, the Sc spirals, have such a narrow range of radio-to-optical luminosity ratio that they can be used as standard radio-optical "color" indicators. For example, they show that the Rubin-Ford effect is not caused by greater optical obscuration in one half of the sky than in the other.

Disk-component radio sources are about as large as the galaxies in which they lie. There are not strong, compact radio sources in galactic disks, and there are no giant radio lobes blasted out of disk galaxies. We had hoped that young (less than 30 years old) supernova remnants would have been detectable as compact radio sources in disks; but they are not, indicating unexpectedly weak magnetic fields or delayed particle acceleration in supernova remnants.

A free bonus from a radio survey of bright galaxies is the detection of radio quasars near galaxies. Some astronomers believe that quasars are more common near bright galaxies than elsewhere on the sky. This is taken as evidence that quasars have been ejected from nearby galaxies and that quasar redshifts are not cosmological. We find, however, that there are only a few quasars near bright galaxies--no more than expected by chance. But there is one intriguing case which deserves further study.

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It is shown in Figure 4--a quasar which appears to lie in a spiral arm of the galaxy NGC 1073!

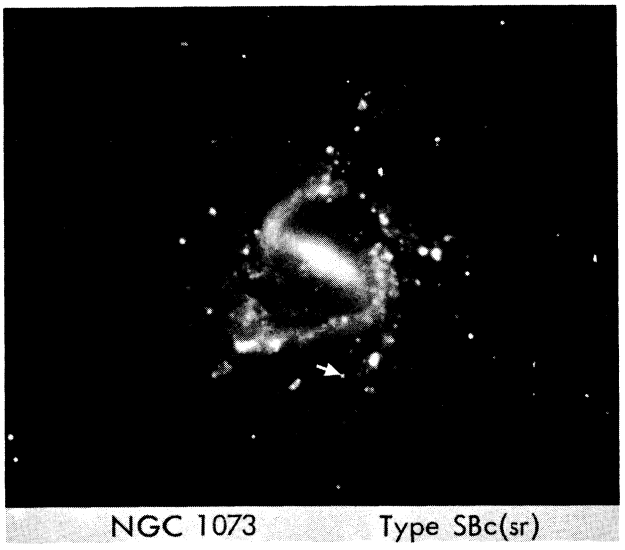

FIGURE 4: The galaxy NGC 1073 and the quasar which appears to be in a spiral arm.

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TRAVELS WITH BARRY AND MARILYN

Barry Geldzahler

Wie gehts, y'all. Before I tell you about some of our adventures, Marilyn and I want to thank the people at NRAO--especially those in Green Bank and Charlottesville--who helped make our stay at NRAO so very enjoyable. There are friendships we developed there that we shall treasure for the rest of our lives, and no matter where we go a piece of Green Bank will always be with us. If I tried to write letters to everyone, I wouldn't have time to fill in the many forms Germany requires. So please accept this quick form of writing to everybody.

White Knuckle Flight to Bonn

While at NRAO the bulk of my work dealt with VLBI which means that I did (and do) a lot of traveling. However, one becomes accustomed to the life of a jet-setter, and I rather enjoyed the travel whether it was for short or long trips. My latest long trip took me from New York City to Bonn--about an eight-hour flight.

The day after I booked our flight on Luftansa, Walter Cronkite told me that the German terrorists were going to blow up three randomly selected Luftansa flights. Not wishing to spend my first full day in Germany pushing up daisies, I quickly rebooked on Air France which goes through Paris. After all, I reasoned, French stewardi and French cooking can't be all bad. Okay. So I'm all set. After about ten days passed and about five days before we were set to leave, Walter now told me the ground crews of Air France in Paris were on strike and most international flights were being canceled. So there we were, caught between a rock and a hard place. We rebooked on the Luftansa flight since the terrorists hadn't blown up any planes in the previous two weeks.

Despite the inactivity of the terrorists, all the way we kept thinking about the possibility of watching a missle go through the fuselage. I decided that if I was going to die, it would be with my boots off (much to the dismay of my fellow passengers' olfactory nerves, I'm afraid). I went to sleep, but Marilyn stayed awake ready to give any approaching missile the choice of missing the plane or tangling with her.

We landed safely, and you know instantly that you haven't landed at Elkins International when you step off the plane. On each side of the cabin door was a guy in combat fatigues carrying a machine gun. There was another guy with a machine gun at the window where passports are inspected. I presumed this was all in response to the terrorists. Ken Kellermann and Arno Witzel met us at the airport and drove us to the Kellermann home. I am not sure if I was more scared on the Luftansa flight or on the autobahn.

Superheroes, Skylights and Buses

We found an apartment in the village of Morenhoven about ten kilometers southwest of Bonn (in the direction of the telescope, of

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course). Unfortunately, one can bum rides to work only so often and the time comes eventually when one must take a German bus. Not speaking or understanding any German, this can be--and is--a frightening experience, as I soon found out.

In America when you get on a bus, you pay your fare to the driver and then take a seat. Not so in Germany. Here you have tickets bought previously, and you may enter the bus by either the front or back door. It's up to you to cancel your own ticket in a box provided on each bus--but you don't have to. It's the little man's right to beat the system anyway he can, and one of the ways is by not paying the fare. The System, however, has vays off dealink viss such "blackriders". It employs ticket checkers. (This also helps to keep down unemployment.) As the name implies, these people go around on the buses and check riders' tickets to ensure the cancellation. Since they don't ride on every bus, you can sometimes get away without paying, but if they catch you having not paid, it's a fine of 2 DM (10 bucks). No appeal!

To make matters worse, the ticket checkers are sometimes disguised as ordinary people. Amongst their various weaponry are fear, surprise, ruthless efficiency, and fanatical devotion to the SWB (Stadtwerke Bonn--essentially the Bonn bus company). There is a fifth weapon. You could be riding the bus and making your best moves on the beautiful fraulein next to you, and as you put your hand on her knee she suddenly stands up, rips off her clothes to reveal a red, blue, and yellow costume with a big  on it and says, "You're ticket, bitte!" Gott im Himmel couldn't save you if you hadn't paid.

Sometimes a slumped over old man in a trench coat who looks like he is sleeping is their man. When a bump in the road seems to jar him to consciousness, he goes trudgingly to the front of the bus, turns, faces the passengers, and opens his coat to reveal his...SWB badge. (An ex-SWB trench-coat-man recently retired to the U.S. to become the Fernwood Flasher.)

The first time I took the bus into Bonn alone, I saw a guy in an SWB uniform get on my bus. I thought he was only another driver hitching a ride. Not so! This was one of the infamous checkers. He was mean-looking; the kind of guy that might kick a cane out from under an old lady or go into hysterics after giving a raccoon a sugar cube. The old lady sitting across from me must have screwed up with the tickets because this guy gave her a really hard time. I didn't catch all (read that "any") of the conversation, but the look on her face told the sad story--doomed! Fortunately, my ticket was punched that day, but it wasn't the day before.

Now I didn't tell you before, but these buses have skylights in them also. Although I've never seen it happen, I'm convinced that there are company-persons sometimes lurking up there waiting to pounce on some unsuspecting dupe. Nobody expects the SWB person!

On another trip, Marilyn and I were taking the bus to the train station in Bonn so we could get to Cologne. We got on the bus and punched our red tickets by the correct amount like any conscientious American. About five minutes from the station, the Man got on. Everybody's tickets were OK until he got to us (we were in the back of the bus). When we showed our tickets, he said, "Duisdorf?" (a village nearer Bonn than ours). I replied in fluent German, "Morenhoven." "Morenhoven?!?!?" Oh Lord, I thought, it's all over. Heart pumping furiously, head swimming in panic, cold sweat breaking over our bodies, waves of adrenaline drowning us, I cracked. I forgot all five words in my German vocabulary. The guy said something, but I didn't catch it. All I saw was his evil eye. When we arrived at the end of the line, he asked if we were getting off (Marilyn translated). With heads hung low, we slowly exited. The guy must have taken pity on us because after getting off the bus, he just walked away! (The Lord really does smile on fools and drunkards.) As we walked away, a middle aged woman walked over to us and said chuckling, "You have to use white tickets for Morenhoven. The red ones are good only in Bonn." Now how the hell was I supposed to know that?

Auf wiedersehen, y'all.

* * * * *

WEATHER FACTS AND FIGURES

Duane Sizemore

Presented here are some weather data taken from the 24 hour continuous recording thermometer at the Green Bank interferometer. Temperatures monitored at the interferometer are forwarded to the weather bureau and are considered "official" data.

January 1978

Average Low: 08.0°F
Average High: 30.0°F
Monthly Average: 19.0°F

There were 10 days when temperatures fell to 0° or lower (5 less than in 1977) -

Low: -18.0°F on January 23
High: +50.0°F on January 08

A barometer reading of 883.7 mb (28.8 mercury, corrected to sea level) on January 26 is the lowest ever recorded at the interferometer (see accompanying graph). This intense low produced wind gusts to 67 mph, 2.23 inches of rain, lightning, thunder, and a temperature change of 39°F.

February 1978

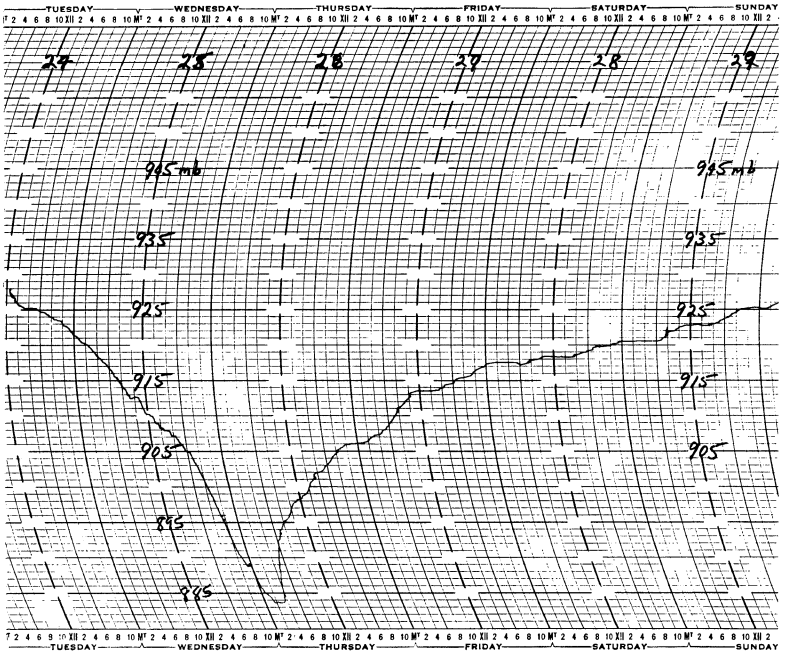
Average Low: 07.3°F
Average High: 31.7°F
Monthly Average: 19.5°F

There were 8 days when temperatures fell to 0° or lower (same as in 1977) -

Low: -08.5°F on February 11
High: +44.0°F on February 25

Average temperatures for January and February: 19.45°F (that's for 59 consecutive days) --- the same average as for the same period last year. Ain't that amazing!

The first snow flurries for the 1977-78 winter season occurred October 16, 1977.



Low Temperatures For 1974-1978

Year	Date	Low Temp.--F°
1974	13 January	+07
	27 February	+05
	27 November	+06
	05 December	-08
1975	21 January	-06
	10 February	-08
	09 March	-01
	24 November	+15
	24 December	+03
1976	20 January	-12
	02 February	-04
	14 November	+01
	30 November	+01
	25 December	-07
1977	13 January	-18.5
	18 January	-18.5
	08 February	-20
	27 November	+09
	11 December	-04.5
	28 December	-07
1978	11 January	-12
	23 January	-18
	01 February	-06
	11 February	-08.5
	23 February	-08

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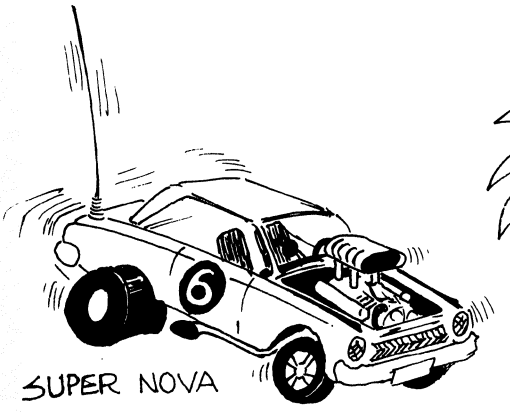
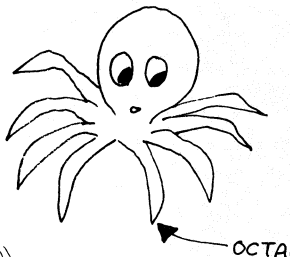
more of The VLA Astronomical Illustrated Dictionary

SUPPLEMENT TO The VLA USERS GUIDE for visiting scientists as an aid to recognition of various cellestial objects

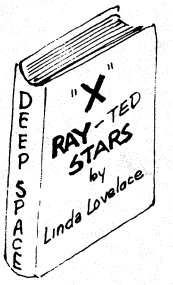
Drawn by: Paul Marden
Based on Graffitti of numerous authors as found on the VLA premesis. Circa 1977



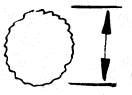
SUPER NOVA



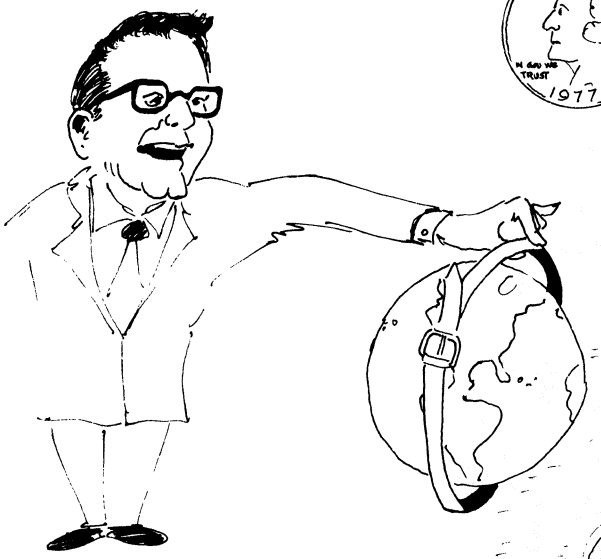
OCTAL DIGIT



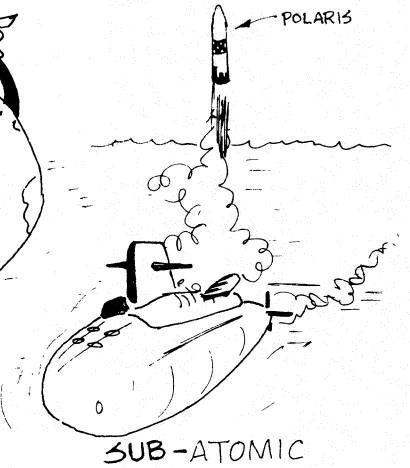
2-BIT WORD



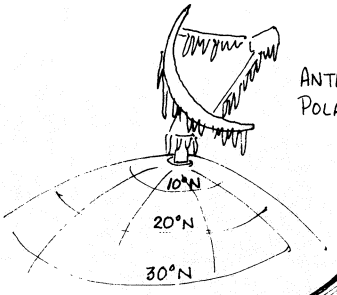
DIAMETER (BRITISH)
DIAYARD (AMERICAN?)



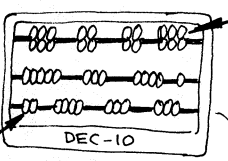
The "Stevie" VAN ALLEN BELT



SUB-ATOMIC



ANTENNA POLARIZATION

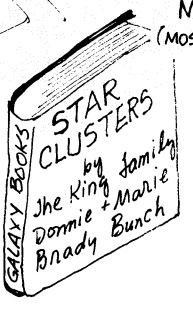


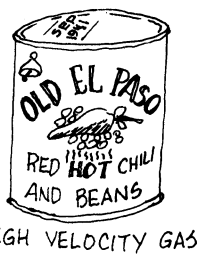
DOUBLE PRECISION ARITHMETIC

MSB (MOST SIGNIFICANT BEAD)

0

BIT BUCKET





HIGH VELOCITY GAS

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RED GIANT
DATA TAP
1 0 1
0 1 0
1 0 1
1 0 1 0
0 1 0 0 1
0 1 0
DE-BUG
SQUISH
CHOMP
CHOMP
BURP
ANTENNA FEED
Yo quiero, Yo quiero, pero no mas tequila porque me mal cordazon
TEQUILA
THE "EL-BAND"
ARIES
TAURUS
GEMINI
CANCER
LEO
VIRGO
LIBRA
SCO
SAGGIT
CAPRICORN
AQUARIUS
PICES
National Radial Astrology Observatory

* * * * *

CORRECTIVE LENS FOR THE 140-FOOT TELESCOPE

Woon-Yin Wong

Corrective lenses are hardly anything new. In the 10th century the Chinese and the Europeans had already used magnifying glasses to aid reading. The earliest record on optical use of lenses in Europe was in 1268, being introduced by the Italians. Today, a third of our school children wear eye glasses. At NRAO 37% of the employees in Charlottesville and Green Bank use corrective lenses. (Employees who wear glasses only for reading were not counted.)

If bad eyes need corrective lenses, isn't it logical to try and improve the performance of telescopes by doing something similar? As early as 1827, the British astronomer, Sir George Airy made the first attempt to correct the astigmatism of optical telescopes. More recently a corrective refractor was installed in the front of the 48-inch Schmitt telescope to enhance its performance.

In 1970, NASA developed the concept of active optics, by installing an array of actuators behind a mirror to make constant corrections optically, and successfully improved the accuracy of a 30-inch mirror from an error of 1/2 wavelength to 1/50 wavelength. Now it is possible to place an optical telescope in orbit whose performance is better than its diffraction limit.

During the same period of time, Cowles and Parker from the University of Kent, England, had improved the performance of a 2.8-m radio telescope from an original observing frequency of less than 7 GHz to a range of 28-40 GHz, by installing a secondary reflector with a permanent error profile similar to that of the main dish.

In the past two years, NRAO has been developing a corrective lens for the 140-ft radio telescope in Green Bank. At first we called it a "deformable subreflector", but recently we changed it to "correctable subreflector". You might ask, "Why does the 140-ft telescope need a corrective lens? Is it getting old or have the scientists overextended this instrument in the past 15 years?" The answer is "No." The correctable subreflector is intended to make this telescope better.

The 140-ft was designed as a 10 GHz instrument and it observed well at that frequency. Now we want to use it as a 25 GHz instrument and we believe that the correctable subreflector will help make it such a telescope. While this idea is not new, the attempt to install an active, correctable subreflector 10-ft in diameter to a 140-ft diameter reflector is the first of its kind.

R/D History and Some Background

Back in 1974, when the VLA project preoccupied the minds of most people at NRAO, two small meetings were organized to discuss the possibility of improving the 140-ft surface. After some in-house studies, a paper published in the IEEE Journal late in 1975 indicated a better performance was possible with a deformable subreflector.

Initially we had considered many possible methods of shaping the subreflector. For example, S. Weinreb suggested using a rubber membrane attached to an array of air cylinders. By actuating these cylinders the subreflector can be shaped to any contour with a large degree of freedom. P. Napier suggested using a discrete panel system, with each panel attached to an actuator, something similar to the ceiling of the old version of the Philharmonic Hall in the Lincoln Center of New York City.

We also considered many other concepts such as deformation by cam followers, by pulling cables, and even by heating and cooling rods connected to the surface. We finally decided to use the less innovative approach of using a subreflector made of flexible material with a reinforced framework. It would be similar to the one we have been using since 1973 which is directly deformed by actuators.

More work was done during this feasibility study period on the arrangement and the number of actuators to use. After six months of studies, we decided that we should deal only with the large scale astigmatic error, and leave the smaller scale corrections for the future. Study results indicated an astigmatic correction could improve the performance of the telescope by a factor

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of 2 to 3 and thus make the telescope usable at 25 GHz at any position in the sky with a higher efficiency.

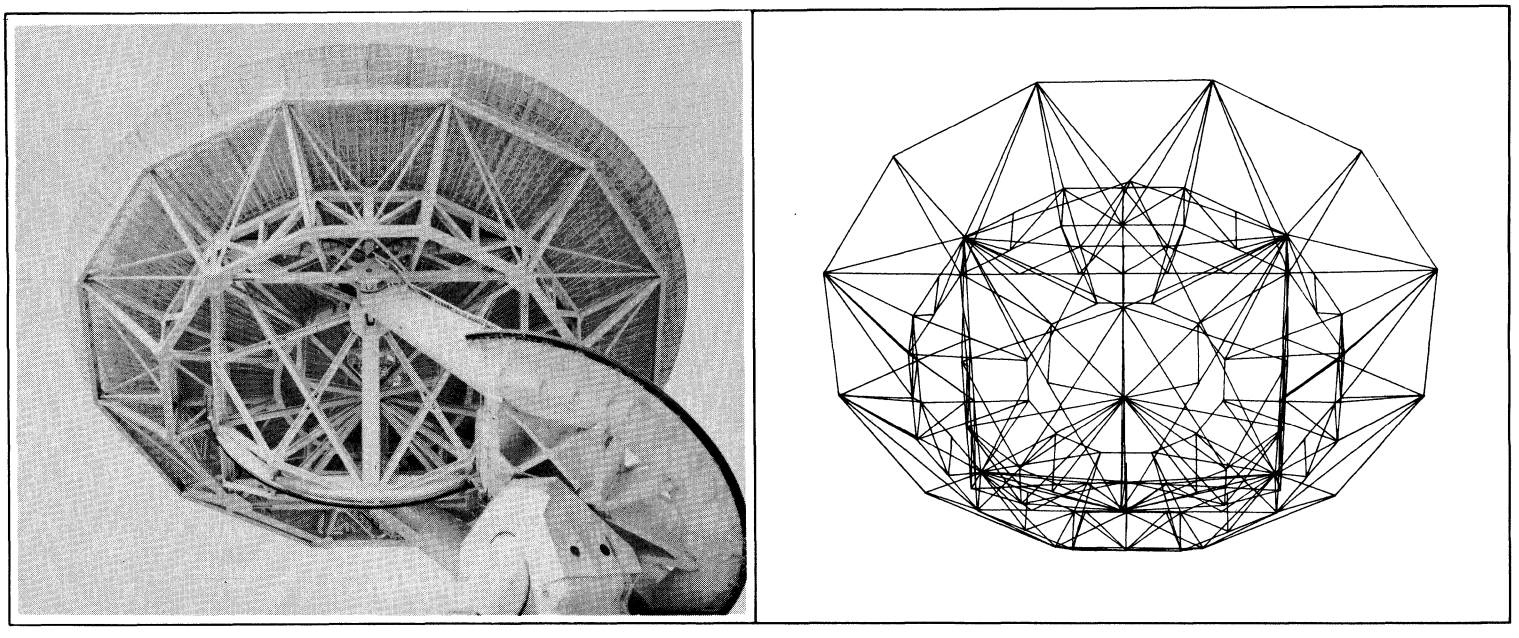
Internal funding was agreed upon in mid-1976. We prepared the specifications together with stacks of governmental procurement documents, and sent the proposal request to 32 firms. Seventeen firms said they weren't interested, two firms were, but only in the fabrication of the surface, and the rest never bothered to reply.

It became apparent after a few months of paperwork that our only choice was to rely on our own development and design efforts. The final, detailed structural analysis and fabrication of the subreflector were contracted to two firms in California. Due to these reasons, the cost of this project turned out to be much less than the original cost estimate.[1]

Will the Correctable Subreflector Work?

Before we address ourselves to this question, let us first try to understand the tasks we are intending to deal with on the 140-ft telescope. The main reflector structure itself is an aluminum weldment, consisting of 423 major structural members, and weighs about 330 tons. (For those who are not familiar with the 140-ft telescope, please refer to Figure 1; a photograph is shown on the left, and on the right is how the computer sees it.)

When the main reflector is moved from one position to another, the relative distances between any two points on the telescope structure changes, mainly due to the reflector's own weight. These same changes cause constant changing distortions to the parabolic surface, so that incoming electromagnetic waves are no longer reflected to a



(a) Photograph (b) Computer Model

FIGURE 1: 140-ft Radio Telescope at Green Bank.

[1] The cost estimate for the five motor/actuators is about $2000 apiece. Lacasse, who is responsible for the electronics, came across an advertisement of 14 actuators for sale by a clearing house firm. They were built for the air force back in the fifties, and were in good condition, but were long since obsolete--cost was a mere $50 each. We bought one to test and to evaluate. We found it to be quite acceptable, so we bought all of them, and designed our system around it.

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single point, but to a focal region (larger area than a point). The extent of this region depends on how badly the reflector is distorted, and sets a limit on the telescope's performance. The limit of the 140-ft telescope's observing frequency is 10 GHz when the telescope observes near the horizon. However, when the telescope is looking almost straight up, the limit is extended to 25 GHz.

The rule of thumb to judge the performance of any telescope is based on the highest observing frequency one can use effectively at different telescope positions after the surface of the reflector has been adjusted to a true paraboloid. When the observer uses the telescope at its best adjusted position, he gets the best performance. As he moves away from the best adjusted position the performance gets progressively worse.

There are two main concerns in designing telescopes: one is how well can we adjust the surface to a theoretical paraboloid and the other concern is how well we can maintain this paraboloidal shape as the telescope moves. The correctable subreflector deals only with the second concern.

Just before engineering work began on the correctable subreflector, S. von Hoerner, given an estimated distorted shape of the main reflector, developed theoretical profiles of subreflectors using the ray trace method. The combination of shaped subreflector and the main reflector enable all incoming waves to travel with the equal path lengths.

The general conclusion of these investigations is: if the amount of distortion in the main reflector is small, a corrective amount of distortion could be reproduced on the corresponding locations of the subreflector in order to improve the performance of the system. This is exactly what we intended to do on the 140-ft telescope.

The Mechanics Behind the Subreflector

The subreflector surface is held by a frame through eight points on 45^{o} radii forming a circle. Four points, one in each quadrant, are held rigidly (fixed) to the frame. The other four points, one in each quadrant, are held to the frame with a lever arm, and can be actuated by a d.c. motor worm gear combination called an actuator. (See preceding footnote 1.) It is illustrated by a simplified drawing shown in Figure 2. The motors are connected to an electronic system, which is controlled by a computer.

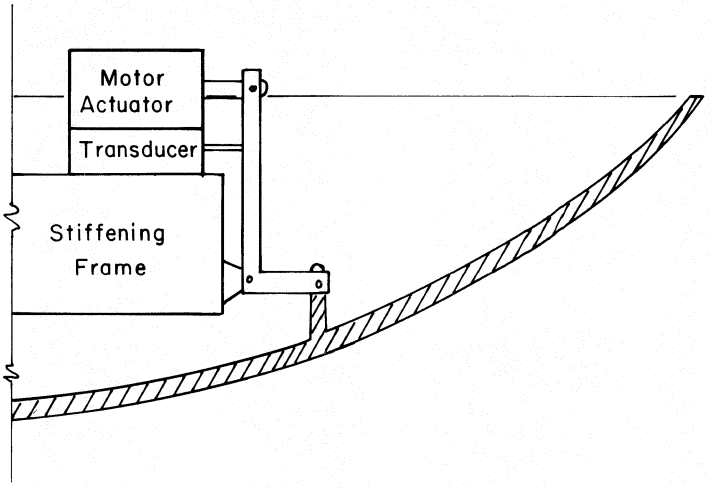

FIGURE 2: Schematic arrangement for the deforming device (actuator).

A command signal from the computer will operate the motor until the lever arm reaches the corrective position. The lever arm's position is monitored by a position transducer, a device that can detect a movement as little as .005 inches. This transducer produces signals constantly, and feeds the information to the computer which makes corrections if the measured position differs from the commanded position.

The subreflector-frame combination will be attached to the existing beam-tilting system. (The one that makes all the banging noises when the Cassegrain system is being used.) The beam tilting system permits the observer to alternately switch between a radio source and the cold sky for better observing results.

The Construction of the Subreflector

The framework, which holds the subreflector and the actuators, is a result of in-house design effort and fabrication in the Green Bank shop (Figure 3). Four, 6-inch diameter aluminum tubings forming two

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crosses, provide the required stiffness to the subreflector. After fabrication in Green Bank, the framework was shipped to California and connected to the subreflector surface.

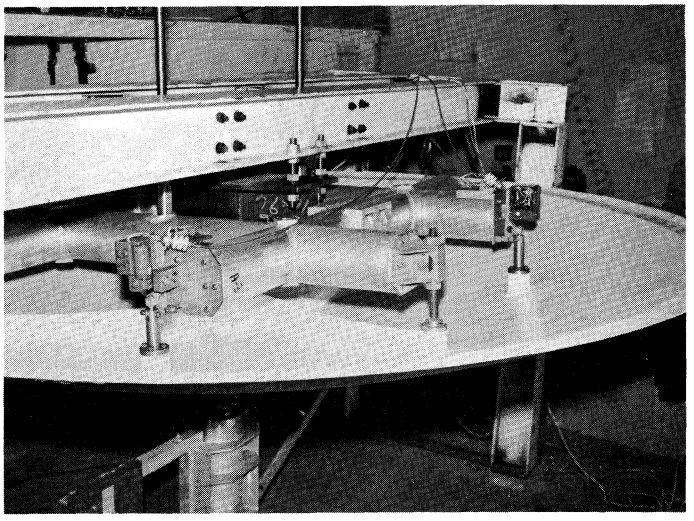

FIGURE 3: Framework attached to subreflector by four fixed points and four actuators.

The subreflector, about one inch thick, is basically composed of fiberglass cloth and an aluminum honeycomb core. It is lightweight and, although relatively stiff, flexible enough to deform. The construction of the subreflector began with a mold made of high quality, non-shrinking plaster accurately formed. Inside this mold the subreflector was constructed in four layers: (1) a layer of flame-sprayed aluminum, (2) a layer of fiberglass cloth, (3) a honeycomb aluminum core, and (4) more layers of fiberglass cloth.

Evaluation of the Subreflector Surface

The evaluation of the subreflector surface is currently taking place in the Green Bank cable building. (Herb Hanes' crew provided a large portion of their work space, and assistance.) Four main tasks are to be done: (1) finding the weight of the assembly, (2) measuring the undeformed surface profile, (3) measuring the deformed surface profile, and (4) evaluating actuators and their electronic components.

What Are the Next Steps?

Making the 140-ft telescope better basically involves three major tasks: (1) building better receivers, (2) improving the pointing, and (3) correcting surface distortion. The first two items are virtually completed. The 18-25 GHz maser receiver has been ready since May of 1977, and subsequent tests on the telescope in November proved its sensitivity and stability. The large pointing error (due to the heating of one side of the instrument relative to the other) was reduced from about 20 arcsec to about 7 arcsec by covering the yoke and pedestal with 3 inches of insulation. Item 3 (correcting surface distortion), however, is far from complete. The correctable subreflector, we hope, will be ready by April or May of this year.

Many people feel that the full potential of the correctable subreflector will not be realized until the shape of the main reflector is known and the surface plates improved. The development of a surface measuring procedure for the main reflector is currently underway.

*****

NEW MEXICO MADNESS

Yes, West Virginia, there is a VLAPRA. However, it appears we will never synchronize our activities with the deadlines for the *OBSERVER*. There was a successful Christmas party for the children - the basketball team playing in the Socorro league has done the VLA proud - in addition to participation by many VLAers in different leagues at the newly-opened bowling lanes in Socorro there is an official VLA Mixed League functioning spritely on Wednesday evenings - intrepid skiers went to Aspen for a week-long skiing vacation after several day-long jaunts this season to Sierra Blanca at Ruidoso - and plans are underway for another spirited St. Patrick's Day party March 17th.

A new member elected to the Board of Directors in December was Ernie Caloccia;

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re-elected were Gareth Hunt and Linda Martinic - joining members Dave Archuleta, Skip Lagoyda, Larry Carlisle, and Peter Napier. Officers elected during the January meeting were Skip Lagoyda, President; Ernie Caloccia, Vice-President; Linda Martinic, Treasurer; and Larry Carlisle, Secretary.

*****

GREEN BANK BOWLING

This is the Chinese Year of the Horse. It has affected the bowling team -- all of that get up and go has got up and gone. Yes, we are in last place in our league. The only consolation is that on January 24, 1978 Wendell Monk had a 598 series, bowling three games of 213, 209, and 176.

We have 8 more league games this half. Any interested bowler who can help bail us out may call ext. 309.

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ASTRONOMY AT THE NRAO

R. L. Brown

Certainly the second most frequently asked question heard at the NRAO--a question asked by visitors, tourists, NSF officials (endlessly!), staff and occasionally by despondent astronomers--is simply, "What do you do with those telescopes?". In the past it has been extremely difficult to answer this question as a result of the apparent enormous disparity of research that is conducted here. However, recent progress (both observational and theoretical) allows one now to tender a reasonably comprehensive answer: "We study galaxies."

Galaxies, you'll recall, are those enormous aggregates of stars and gas that have been aptly described by Marc Price as the fundamental particles of the universe. And so they are. The Sun is in the Galaxy, the Milky Way, but it is simply one of billions of similar galaxies that comprise the universe. Galaxies come in many types. Those that have thousands of times the energy in relativistic particles--cosmic rays--than we find in the Galaxy are referred to as radio galaxies since the interaction of these particles with the galactic magnetic field gives rise to synchrotron radio radiation. Adjectives abound here. If the relativistic particles are found in lobes wholly exterior to that of the visible galactic light, then we have a large (or extended, or giant) radio galaxy. If the particles are nearly confined to the galactic nucleus, then we refer to a compact radio galaxy. Finally, if the compact radio source in a galaxy dominates the optical luminosity of the galaxy so that it appears as a point source of visible light, then we refer to it as a quasi-stellar object or, perplexingly, as a BL Lac object.

Nearby galaxies, particularly spiral galaxies, that have a great quantity of gas and dust are usually very weak sources of radio radiation. However, it is possible to study these galaxies by means of their line radiation. The line most frequently studied is the 21-cm line of neutral atomic hydrogen, although recently a considerable effort has been directed toward surveying the distribution of molecular material in nearby galaxies using the 115 GHz line of CO. Such line studies reveal not only the motion of the galaxy relative to its neighbors and relative to us, but they also have the potential to allow us to determine the motion of gaseous matter within a galaxy and even the distribution of molecular matter relative to the atomic gas within a galaxy.

Finally, closer to home (at least on this scale) are the line studies of molecular and atomic gas within the Galaxy. But even these studies, which have been actively pursued for several years, are now viewed with a wider lens. Rather than studying individual objects for their own sake, astronomers are presently seeking to determine the manner in which atomic gaseous matter is swept-up into enormous clouds; how these dense molecular clouds are finally fragmented into pieces that form stars; and ultimately, how the newly formed stars affect the structure, dynamics, evolution, and appearance of the galaxy in which they

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reside.

On the one hand, radio astronomical studies of galaxies, limited as they are to the study of gaseous material (be it thermal or relativistic matter) is a curious probe since the gas content is but a miniscule part of the total mass of a galaxy. However, the results gleaned from this research are in many cases unique (half the gas in spiral galaxies is molecular) while in others they are no less than astounding (radio source components separating at several times the speed of light).

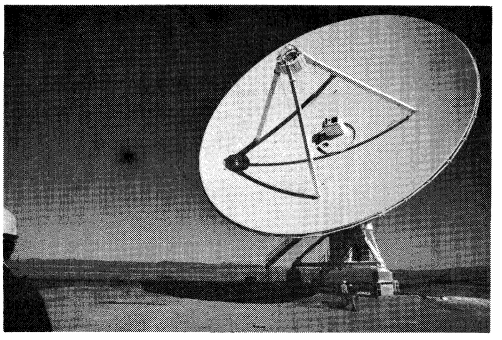
I anticipate that future radio astronomical research will continue in this vein of being directed to the specific but readily extensible in space (conclusions drawn from studies of the Galaxy are applicable to other spiral galaxies as well) and in time (emission mechanisms operable now are equally applicable at z = 1.5). This isn't to suggest that all or many of the answers are on the horizon; certainly they aren't. Indeed, it's unlikely that the fundamental questions have even been asked!

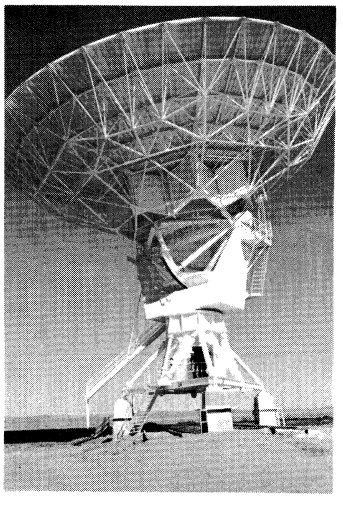
* * * * *

THE HALF-WAY MARK
VLA - PHOTO UPDATE

photos by Dave Rosénbush

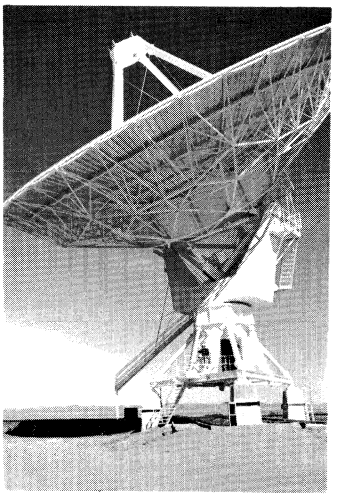
Antenna number 14 was "bought" on October 21, 1977 during special acceptance ceremonies attended by dignitaries of NRAO, VLA Project, and E-Systems.....





Completed Antenna number 14 on Master Alignment Pad.

Two views of tilted antenna showing apex support and vertex feed mounts.



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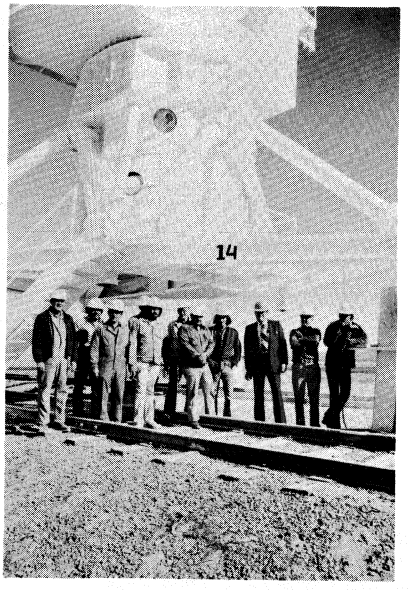
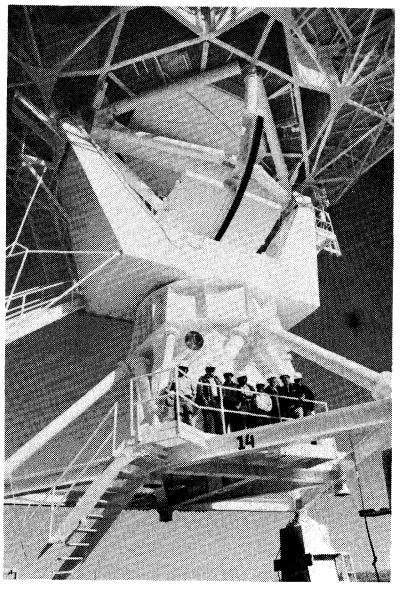
Bill Horne, Head, Antenna Division, VLA Project, on the left, accepts keys from William Findlay, E-Systems, Senior Program Manager for the VLA Project.

L to R - Aubrey Simmons, E-Systems, Site Manager, VLA Project; Bill Horne; William Findlay; Les Temple, Antenna Engineer, VLA Project; and Paul Butler, E-Systems, Director of Satellite Communication Product Line.



Paul Butler and William Findlay with E-Systems on-site construction crew.

L to R - VLA Personnel: Lewis Serna, Antenna Electrician; Larry Carlisle, Draftsman-Antenna Division; Ramon Gutierrez, Antenna Mechanic; Ramon Molina, Antenna Mechanic; Nick Montoya, Antenna Mechanic; Les Temple, Bill Horne; and Jon Spargo, Senior VLA Operator.



CRYOGENICS FOR CHILDREN

Anne Observer

The following dialog is wholly fictitious, and any resemblance of the speakers to real persons, living or dead, is entirely (intentionally) coincidental.

"Daddy, what's cryogenics?"

"Ask your mother."

"We did, and she said to ask you."

"Why do you want to know?"

"Well, when you forget the bubble gum, and we ask Mommy why, she says, 'Oh, he's just got cryogenics on his mind.' And at the supper table, you always just talk about JT loops and venturis and heat exchangers and compressors and never ask us what we did today. Mommy just smiles and nods and after supper we ask, 'What was he talking about?', and she says, 'I don't know, but I think it has something to do with cryogenics."

"Well, you see, if it weren't for cryogenics, I probably couldn't afford to buy bubble gum. Remember when I took you down to see my shop? That's where I work, and they pay me money to buy bubble gum with."

"Well, what do you make in your shop?"

"You might say that we try to make cold. See, that's what cryogenics really means: very, very cold."

"Is that why that lady doesn't have very many clothes on?"

"What lady?"

"The one in the picture on the wall in the back room of your shop."

"Hey, you didn't tell Mommy about that picture, did you? That has nothing to do with it. Forget the picture. Now, do you remember those big metal boxes sitting around? And those metal cylinders? Well, the big boxes are compressors, and the long round things are refrigerators..."

"But how do you get the Coke and 7-Up in the refrigerators? They don't have any doors."

"They're not that kind of refrigerators. We use them with the compressors to make cold for the observatory."

"Why does the observatory need cold? Didn't they get enough cold this winter?"

"Well, you see, the observatory uses receivers....."

"What's a receiver?"

"Well, the TV set is a receiver. The FM is a receiver. They receive radio waves that are sent out from the broadcast station. But the observatory is trying to receive radio waves from space."

"Oh, can you talk to Artoo Detoo?"

"No. I'm talking about radio waves from stars and planets. These signals are very, very weak, and the observatory needs low-noise receivers to pick them up."

"What do you mean, low-noise?"

"Well, you know what molecules are, don't you?"

"I think we had that one time in science."

"Well, molecules move. And when they move, they make noise."

"Is that why Mommy won't let us lead cheers in the living room?"

"Well, anyway, when molecules are cooled down they don't move so fast, and they don't make as much noise, so we try to cool the receivers. We use refrigerators that can cool them down to less than 6 degrees Kelvin."

"Who's Kelvin?"

"That's the name of the scale we use to measure temperature. We use the Kelvin scale because it can be used to measure temperatures down to absolute zero, which would be about 459 degrees below zero on a Fahrenheit scale."

"Gosh, that's even colder than last winter, isn't it? Are you sure Kelvin's not a new boy at school?"

"Now back to the refrigerators. To cool them down, we use helium gas. Gases are very interesting. Once I was working with some liquid nitrogen, about 77 degrees Kelvin. Someone found a little green snake nearby. We held him by the tail and dipped him in the liquid nitrogen, and it froze him so hard that when we threw him on the ground he shattered into a million pieces.

"Oh, Daddy, that's gross!"

"Well, I just told you that to show you how cold gases can get. Now, in our shop at the observatory, we have built some very good compressors, and we have got some re-

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frigerators to working very, very well."

"Which one is the Damn refrigerator?"

"What?"

"When you are watching M*A*S*H and the phone rings and you answer it you say, 'It's that Damn refrigerator again!' and off you go and don't come back 'til midnight. Mommy thinks it has something to do with the lady in the picture."

"Shut up about that picture! Now, as I was saying, we have built some very good compressors in our shop. It's fun to build compressors, and we are going to build more and more of them, and that's why we are going to move into a nice new shop that the observatory is fixing up for us, so we'll have more room to work in."

"And you'll have more wall space for your pictures, and room for your coffee pot, and....."

"Never mind. What are you two doing?"

"We're taking everything out of the refrigerator. If we take out the shelves, we can get the TV in here, and then we'll get a better picture. And Daddy, please don't freeze any little snakes in your shop!"

*****

STEVE HAWLEY, ASTRONAUT

Perhaps you remember Steve Hawley. A summer student at Green Bank in 1973 and 1974. Tall and wiry, kinky hair and freckles as orange as a sunset on a sultry summer day in his native Kansas. In his two stints as a summer student he battled the computer to reduce and interpret source count data one year and worked on a maximum entropy technique for making radio maps the next. I remember looking at his original application for employment as a summer student and wondering if he would make a good volleyball player. He did. They were pleasant summers. Besides the volleyball and computer there were occasional bridge games where Steve and his alter-ego Tom Chester (then a Charlottesville student, now at Princeton) would try to smash my partner and me. Steve is about to get his Ph.D. in astronomy from the University of California at Santa Cruz.

Steve Hawley is one of 35 candidates who have been selected for positions as astronauts aboard the space shuttle. NASA began its recruiting drive for the astronauts about a year ago and over 8000 applications were received. Detailed interviews were carried out for the 240 finalists and the final selection was made about February 1. Fifteen of the candidates are experienced pilots and they will be in charge of flying the rocket-glider to and from its orbital positions. The other twenty, including Steve, will be trained as "mission specialists" and will handle the main facets of the scientific and engineering experiments on board the shuttle. Six of the twenty candidates are women who have received a lot of publicity in the news media. The two years' training program will begin in July and the first space shuttle flight is scheduled for March 1979.

We wish Steve well in his exciting and important career.

*****

A SLICE OF THE SOUTHWEST

Doris R. Gill

Surely Christmas bills are paid, weekend TV is getting old and besides - spring is in the air in the southwest. It's time to get out and move around New Mexico... especially if we head south.

Indian arrows have gone and rockets have come, and Alamogordo has changed from a sleepy, peaceful land to the hustling, bustling fast-growing city. Guided missles, target drones and jets streak above the desert, once crossed on foot by Spanish padres.

Alamogordo, 84 miles north of El Paso and 215 miles southeast of Albuquerque, is a new city as cities go. It was selected as the county seat when Otero County was created from parts of Lincoln and Dona Ana Counties in 1899 and became a trade center for a large livestock and agricultural area.

Elevations in the area vary from about

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4,156 feet....at Holloman Air Force Base, home of the 49th Tactical Fighter Wing and 6585th Test Group - testing guided missiles and pilotless aircraft are part of that work - the high-speed test track is also a major facility, along with high altitude balloons and a central inertial guidance laboratory....to 12,003 at Sierra Blanca in the Sacramento Mountains which offer some fine skiing.

Atop Sacramento Peak is Sunspot, site of the world's largest solar observatory where observers make a daily record of the sun's activities (that information not from our learned colleagues but from the Alamogordo Chamber of Commerce).

Also north of Alamogordo are the Three River Petroglyphs, an outstanding example of early American Indian "rock" art. These carvings were made with stone tools, between 900 and 1400 A.D. by the Jornada branch of the Mogollon culture. The site contains more than 500 petroglyphs.

Alamogordo is also home of the truly international International Space Hall of Fame which opened on October 5, 1976. The golden cube of the building sits high on a mountainside. The facility is open 364 days a year in order that visitors may study artifacts that relate specifically to accomplishments of space pioneers enshrined.

Fifteen miles southwest of Alamogordo is White Sands National Monument with its two hundred and twenty-four square miles of sparkling white sand. More than a half-million visitors annually have enjoyed the ever-changing bodies of gypsum crawling slowly toward Alamogordo at the rate of eight inches a year. The eight miles of road, with picnic areas in between the dunes, provides ample opportunity to find a private spot for an outing.

During a trip the last weekend of February it was noted that many visitors to the park were running through the sand enjoying the sun in true summer attire of shorts and, yes, even halters. It is a photographer's delight during the different hours of the day. And even old stodgies take off their shoes and socks and run up and down the up-to-50-foot high dunes - or ridiculously leap off the sides of the dunes in a race with children to see how far down the slope one can land.

There are several fine dining spots in Alamogordo. But after a trip in October to El Greco's Cattlemens - it's quite difficult to stop anywhere else. And Nancy Jones and this author wouldn't think of spending the evening anywhere else but at The Golden Spur for some fine western dancing.

One of the peculiarities of the Alamogordo area is that you can take the equivalent of a trip from Chihuahua, Old Mexico, located in the true Sonoran Desert life zone (where Alamogordo is also located) to Calgary, Alberta, in the Canadian Mountain life zone (where Sierra Blanca is located) in 25 minutes via paved highways.

Try a little "southwest" - you'll like it.

*****

THINGS THAT GO BUMP, BOOM, HISS, CRACKLE, RERP, AND GNAF - AND NOT JUST AT NIGHT

Lee J Rickard

One of the minor peculiarities of human thought is the commonly made distinction between optical and radio telescopes: that the former are like big eyes, while the latter are like big ears. I suspect that the reason for this is that the widespread use of radio preceded that of television by several decades, firmly imprinting the idea of radio waves as something one listens to. The concept can provoke curious images. Imagine, for example, the VLA as 27 enormous ear trumpets. At each focus, a wizened, grey astronomer leans forward, hand cupped around his ear, shouting "What? What?".

Having just finished R. Murray Schafer's book The Tuning of the World (A. A. Knopf), I have become particularly sensitive to such sonic images. Schafer is a Canadian composer and author, and apparently the leading expert on the global acoustic environment - for which he has coined the term "soundscape". He heads the World Soundscape Project, which coordinates and initiates research into all manner of things about

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sound. He teaches courses in ear cleaning (a program of training in careful listening) and is compiling a recorded archive of disappearing sounds (butter churns, old cash registers, hand coffee grinders, etc.).

It's an unusual business, but Schafer shows what a large subject he has for study. His book is an encyclopedic collection of facts about sound - sound in history, sound in literature, the psychology and sociology of sound. Consider:

A defining characteristic of the Dark Ages is the absence of brass horns. The art of smelting brass was lost during the decline of the Roman Empire, and not recovered until the vicinity of the 14th century. In the meantime, people made do with animal horns.

One of the major historical reasons for legislation against street concerts was the tendency for street musicians to be unmusical people who performed in the hope of having their silence bought.

In an international survey of sound preferences, the sound most often found pleasant was the purring of a cat. That most commonly found unpleasant was the noise of traffic.

One can estimate the change in the ambient sound level over historical times by measuring the change in the loudness required for fire alarms and emergency vehicles. In Vancouver, this indicates an increase of 20 to 25 dB (more than a factor of 100) just over the past 60 years.

Anti-noise legislation is very culture-specific. Thus, one finds laws specifically directed against tin-beaters, drum-beaters, and charcoal-stove makers in Mombasa, Kenya; against backyard panelbeating and boat building in Auckland, New Zealand; and against unruly behavior at bus terminals in Izmir, Turkey.

The average number of times that car horns are sounded at major intersections in various world cities ranges from 17 per hour in Moscow to 1150 per hour in Cairo (measured in 1974-1975). New York falls near the high side of the distribution, at 336.

Some facts about the Canadian soundscape: One of the fundamental soundmarks of Canada is the E-flat minor triad (based on 311 Hz) sounded by the airhorns of the Canadian Pacific Railroad. The largest public health problem in the Canadian Artic is deafness and ear disease, caused by exposure to snowmobiles. In British Columbia, the ambient sound level (for purely natural sounds) peaks in early April, when it is dominated by the singing of frogs.

In fact, the study of the soundscape covers such a wide range of phenomena and ideas that even a tyro like myself can find some slights and omissions in Schafer's book. For example, the only discussions of natural sounds in language concern the problem of describing birdcalls (what standard notation would do equal justice to the great titmouse's complex "biple-be-wit-se-diddle" and the corncrake's undistinguished "rerp-rerp"?), and the various representations of animal sounds in different languages (happy German cats go "schnurr-schnurr"; angry French poodles go "gnaf! gnaf!"). Missing, though, is any discussion of how we incorporate inanimate sounds into our language, in order to describe the soughing of the wind through the trees, the tintinnabulation of bells, or the squelch of muddy boots. No direct mention is made of purling streams, plashing fountains, or crepitating fires. Not a single susurrus or dolorous ululation. Absent as well are those curious Latin derivations that make one wonder whether the Romans had ears to lend: stridulating crickets, latrating dogs, bombilating bees. (Even onomatopoeic isn't, although the fault there lies with the Greeks.)

There is, at least, some discussion of thrumming. To thrum originally meant to play a stringed instrument badly. Presently, its meanings include to hum, especially to hum monotonously during meditation (a sort of nonviolent way to disturb the peace). In several experiments, American students, asked to thrum whatever tone felt most "natural" during meditation, tended to prefer a B natural (no pun intended). Curiously, on a scale where C is 256 Hz, the audio hum in radios that arises from contamination by the 60 Hz power line current is a B natural. Coincidence? In a European

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version of the same experiment, the students preferred a G sharp, corresponding to their 50 Hz power lines. Curiouser and curiouser.

This brings to mind something that may have been excluded from the book because it was until recently of only dubious authenticity: the possibility that one can "hear" electromagnetic radiation directly. In 1969, Dr. Allan Frey reported that human subjects (himself included) could hear pulsed microwave radiation (radar) over a frequency range from 300 to 3000 MHz. The perceived sound was described variously as a buzzing, hissing, crackling, chirping, or clicking, depending on the pulse characteristics. His findings were not well received - especially after he claimed that the radiation was directly stimulating the nerves. The reason was simple: the energy required to excite a nerve is much more than microwave radiation can provide. (The radiation power level can be high, but the energy available for stimulating an individual nerve cell is fixed by the radiation frequency, through Planck's Law. Frey's radars missed the mark by several factors of ten.)

Subsequent work, though, has confirmed that the phenomenon exists. Laboratory studies on cats, guinea pigs, and chinchillas have shown that microwave radiation does evoke auditory responses. However, they have also shown that the evoked responses disappear after destruction of the round window of the cochlea (an essential part of the inner ear). This suggests that the effect is not due to direct nerve stimulation, but instead involves a mechanism similar to conventional hearing. James Lin, one of the leading researchers in this field, holds that the perceived sound wave is generated in the brain tissue itself. The radar pulse produces a heating of the brain matter. This heating is not uniform, though, but rather is strongly concentrated to the center of the head. This produces an expanding pressure wave that bounces off the inside of the skull, which then transmits a sensation of sound to the cochlea (hearing by bone conduction).

This subject gives nightmares to people who used to think that you could set safety standards for microwave exposure by assuming only simple thermal effects. Who knows what medical effects may accrue from walking around with your head chiming in harmony with the local radar speed trap?

There are other sounds, also not mentioned in Schafer's book, that were once thought to be related to radar noises. These are the anomalous sounds of aurorae and meteors and the brontophonic sounds associated with lightning. When a fireball breaks up at relatively low altitude, one hears (after a suitable time interval) a loud thump rather like the explosion of a faulty skyrocket. But some fireball observers have reported hearing hissing, swishing, or crackling sounds simultaneously with seeing the meteor's light. For example, Frank Drake found that several people heard such sounds in conjunction of the Mad Ann fireball seen over West Virginia and Virginia on September 1, 1962. Indeed, one person near Covington said that it was the noise that first drew his attention to the meteor! (These reports were collected by RAND researchers M. Romig and D. Lamar in the early 60s).

Such noises are called anomalous because they could not have been transmitted at the speed of sound from the altitude of the fireball and yet heard at the same time the light was seen. Similar sounds have been reported associated with bright auroral displays at least since the time of Tacitus, around 100 A. D. (S. Silverman and T. Tuan have catalogued these reports in Advances in Geophysics.) These sounds are also anomalous in that they are reported to vary in synchronization with brightness variations in the aurora, with no obvious time delay. (Also, the high frequencies characterizing the reported hissing sounds would have been utterly attenuated if they had travelled as sound waves from the 60 to 100 km altitudes of the aurorae.) Brontophonic sounds - crackling or rustling sounds associated with the lightning leader stroke - are also apparently transmitted faster than the speed of sound. They are heard well before the thunderclap from the return stroke.

Some early work on anomalous sounds quoted Frey's experiments as offering a

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possible explanation: it was the electromagnetic radiation, travelling at the speed of light, that was being perceived directly. But Frey had established a minimum power level required to produce his effects, and the electromagnetic power produced by aurorae and meteors is far below that. Now, the ascendant opinion (that of Silverman and Tuan) is that the sounds are produced by brush discharges in the local brush. The normal average electric field over open ground is about 100 Volts per meter. But during the kind of auroral displays associated with anomalous sounds, the local fields can become much larger. (Some aurorae over Duluth and Minneapolis have produced fields at ground level as large as 10,000 V/m.) In such fields, the tips of pointed grounded objects (leaves, twigs, some noses) will produce electrostatic discharges, which make hissing or crackling noises. Lightning produces similar local field effects, and it is conceivable that low altitude fireballs can also do so.

Before leaving the subject of mysterious sounds, I am virtually compelled to mention the strange booming noises that have been rattling the East Coast for the past several months. Generally described as sounding like heavy explosions or artillery fire, the booms may well be part of a well-known, if poorly understood, set of sonic phenomena. Called the Barisal guns in India, Moodus sounds in Connecticut, mist pouffers in Belgium, and the Seneca gun in New York, they are generally attributed to leaks of subterranean methane beneath lakes or the shallow ocean floor. When methane is vented from dry land, it can be ignited by a local static discharge to produce the eerie weak glow known as marsh gas (most frequently seen in swamps, where the methane arises from decaying vegetation). Underwater, though, it tends to collect into rather large bubbles; one account from Lake Seneca (New York) tells of a canoe that was nearly swamped when such a bubble rose under it. When these bubbles are ignited by atmospheric electricity, the result doesn't just sound like an explosion - it <u>is</u> an explosion.

The Naval Research Laboratory has been asked to study the recent East Coast booms, and the Seneca gun interpretation is not the only one they've had to consider. Two NASA officials have suggested that they are unusual sonic booms produced by military training flights off the coast of Virginia and North Carolina - unusual in that they are reflected by warm air layers above the aircraft (linking their occurrence to this winter's unusual weather), and heard 100 to 200 miles away from their source. Other explanations range from oil rig tests and Russian submarines to clandestine Defense Department experiments and UFOs. That, however, is NRL's headache.

In all, it sounds as if the variety of phenomena in our soundscape has yet to be fully reckoned - and that there is enough work to keep Murray Schafer busy for a long time.

*****

THE INTERSTELLAR INVESTMENT CLUB

Robert E. Elcox

The Interstellar Investment Club is a group of about 15 -- mostly employees of NRAO living in Charlottesville -- who meet regularly on the first Monday of every month to study the stock market and invest in it. Every month each member puts $20 or more into a common fund which is used to buy stock for the club. That is, the club owns the stock portfolio and each member owns a portion of the club's assets, depending upon the amount of his or her contributions. We have an account with a stock broker who trades for us and provides advice and information about companies we are interested in.

Investment clubs, such as the Interstellar Investment Club, are widespread. According to the National Association of Investment Clubs, there are associations of investors clubs in 13 countries and there are tens of thousands of investment clubs in the USA, some of them in existence for more than 30 years. The NYSE publishes literature directed at clubs, and brokerage houses have salesmen who specialize in them.

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The purposes of forming and joining the Interstellar Investment Club are educational and social, as well as to provide an opportunity to invest small amounts. The members are able to invest more often and in more different companies by pooling their money via the club than they could alone, and to save money by distributing the broker's commission which is disproportionately large on small transactions. Owning a portfolio of shares in a number of companies and being able to buy more shares every few months together with others promotes a sustained interest in the market which grows with the size of the portfolio and the investment. One or two of our members have already started to trade on their own for the first time since joining the club.

The Interstellar Investment Club has bought shares in four different companies so far, each recommended by a different member and then accepted by vote of the membership. We have invested in ships, kidney dialysis centers, steel, and silver. None of our stocks has made any money for us yet, but our interest is in long term value. Investment clubs like ours try to buy stock for their long range value rather than to speculate on risky stocks in the chance of fast profits. Taking the advice of the National Association of Investment Clubs, we evaluate the past performance of a company in terms of its growth, profitability and consistency before buying. Our broker sends us literature about recommended stocks weekly and will provide reports on any company we ask about.

The Interstellar Investment Club welcomes new members. We prefer that they be able to attend our monthly meetings regularly and we particularly need members with experience in trading on the stock market, or who have been following the market. We would also like to hear from anyone interested in forming a club themselves. We will put them in touch with the National Association of Investment Clubs, which can provide anything needed to start and run a club and publishes an excellent investors manual. If you have the desire to be a Wall Street tycoon and read the financial pages with some personal interest in them, all for $20 per month, a stock market investment club may be for you too.

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NRAO ROUNDUP

Reprinted from the NRAO Quarterly Report for October 1, 1977 - December 31, 1977

ELECTRONICS DIVISION

Green Bank

The first 18.3 to 26.4 GHz maser was installed and operated at the cassegrain focus of the 140-ft in October. System temperatures of about 50 K at 20 GHz, 70 K at 22.3 GHz and 60 K at 26 GHz were measured under the best weather conditions. Most of the observing so far has gone to the study of telescope deformations at 1.3 cm. Two additional masers have been completed in the Green Bank lab; one shipped to Tucson and one for the first set of upconverters for Green Bank.

The 6/25 cm receiver built for the NAIC was shipped to Arecibo in December. NRAO and NAIC staff will begin tests on the telescope in January.

An HI maser derived 5 MHz harmonic generator is now available at the 140-ft for checking VLB local oscillator setups up to 3 GHz. Another generator will have to be built for higher frequencies. A temporary receiver is being constructed for prime focus tests of the 140-ft telescope at 1.3 cm.

Reflections from the cassegrain house and feeds were reduced with an aluminum spoiler. Methods for reducing some of the other baseline ripple causing reflections on the 140-ft and 300-ft telescopes are being considered. Additional tests of the multiple reflections on the 300-ft were conducted in December.

A four-channel digital switch/integrator has been built to interface with any of several 16-bit computers to be used as a digital continuum standard receiver. Selection of a computer for this purpose will be made in February.

--continued, next page--

Charlottesville

Development work on the Model IV autocorrelator is continuing. The Univac V77-400 computer which was due to be delivered August, 1977, was delivered December, 1977. The equipment racks have been received, and multi-layer boards are being manufactured. The completion date is now likely to be early 1979.

The VLB Mark III experiment run in September was successful. A design review meeting was held at Haystack during November to discuss necessary changes before more record terminals are manufactured by NRAO, NASA, and other organizations.

A second version of the 1-mm harmonically pumped mixer has been built and is being tested. A third version with independent biasing of the two diodes is also being constructed. The NRAO copies of the A. R. Kerr 2-mm mixer are not yet giving as good performance as the original version. This problem is currently being investigated.

Tucson

During this quarter both the 130-170 GHz receiver and the cooled dual-channel 33-50 GHz receiver have been tested on the telescope.

The 33-50 GHz receiver performed well as a spectral-line receiver with both channels having noise temperatures around 500 K SSB.

The 130-170 GHz receiver had a higher noise temperature than expected (1500 K DSB instead of 1000 K DSB) and work continues on this problem. The antenna aperture efficiency and beam shapes appeared unaffected by the quasi-optical L.O. injection system, an important result as the new varactor down-converter receiver will use a similar system.

The dual-polarization mechanical switch for the 9-mm channel receiver has been completed and will be installed in the receiver during the next few weeks.

Work continues on the varactor down-converter receiver, a computer controlled local oscillator and a new klystron locking system. The second 1 MHz, 256-channel filter bank is nearing completion, and we expect to install this at the telescope during the next quarter.

ENGINEERING DIVISION

The Engineering Division started design of a new traveling feed system for the 300-ft telescope and a study of some method of measuring the 140-ft telescope surface. Development continued on the deforming system for the deformable sub-reflector. Some inspection assistance was provided the VLA project. Research and conceptual design continued for a future 25-m millimeter wavelength telescope and an astrodome to protect it. Routine engineering assistance was provided operations and maintenance in Charlottesville, Green Bank and Tucson.

COMPUTER DIVISION

140-Foot Telescope

Development work continued between observing runs on the control system and some new features have been added. The user can now bypass the automatic scaling and instead specify a desired range for the spectral values on the on-line display. He can also display on-line the quotients for total power observations.

A quick-look continuum system has been added to the off-line data analysis MODCOMP. The user can display, map, baseline, smooth, scale, accumulate, average and fit one-dimensional gaussians to his data.

300-Foot Telescope

A quick-look, off-line continuum system similar to the system at the 140-ft telescope is being added to the 300-ft off-line MODCOMP.

VLBI

Hardware - The WANCO automatic magnetic tape drive has been replaced with a manual tape loading unit. The manual unit is considerably more reliable.

Software - The delays which are sent to the correlator are now rounded to the nearest integer value, rather than truncated. Also, delays, LO offsets and "clock" parameters may now be interrogated from the teletype.

360 Support - A new version of PREPTAPE (the correlator preparation program) has been written and is being tested. The pro-

--*continued, next page*--

gram will calculate baselines if station names are input to it. Also, if only a source name is given, it will look up source coordinates and precess them to the time of the scan. All Besselian day number corrections are applied automatically.

A program to aid in "fringe searches" (INDEX288) has been added to the VLBI program library. It will Fourier transform all 288 correlator channels for the number of time points specified by the user.

VERY LARGE ARRAY PROGRAM

The array was scheduled for 841 hours of test and observations during the fourth quarter. By the end of the quarter, the array was operating with nine antennas on a baseline of 10.5 km. Fifteen antennas have been accepted from E-Systems by the end of December.

In the electronics area, the performance of the 17-20 GHz local oscillator modules has been improved to the point where several usable units are now installed in the array, thus allowing useful astronomy to begin at 1 and 1.3 cm. A program of retrofitting of antennas 1 to 10 with improvements and modifications designed over the past year was begun in mid-December, and the first antenna was completed on schedule by the end of the month. Phase stability measurements on the test array (two antennas) have been extended to include the 18-21 cm band. The phase stability at 6 cm is close to satisfactory, and tests of the phase variation with temperature in the antenna vertex room show a coefficient of 2 to 3 degrees per degree centigrade at this wavelength.

In the computer area, work has continued on the software interface between the DEC-10 computer and the PDP-11 minicomputers. An order has been placed for a communications line expander to support additional terminals.

The hearing on the Davis-Bacon wage matter was held at the Department of Labor Wage Appeals Board in Washington, D. C. on December 8, 1977. A decision is expected around mid-January. Legal problems have been resolved and the archaeological work on the southwest arm of the array is expected to begin by New Mexico State University the last of January.

JANSKY LECTURE

Professor E. Margaret Burbidge delivered the Twelfth Annual Karl G. Jansky Lecture on November 19, 1977 in Charlottesville. Her lecture topic was "Galaxies, Quasars, and the Space Telescope".

Professor Burbidge, who received her Ph.D. from the University of London, has held positions at a number of institutions, including Yerkes Observatory, the California Institute of Technology, and the University of Chicago. She has been at the University of California, San Diego, since 1962 except for a period during which she served as the director of the Royal Greenwich Observatory.

In recognition of her contributions, Professor Burbidge has received many honors, including honorary doctorates from several institutions. She is a Fellow of the Royal Society of London and of the American Academy of Arts and Sciences. In 1959, Margaret and Geoffrey Burbidge were jointly awarded the Warner Prize of the American Astronomical Society for their work on nucleosynthesis and on the properties of galaxies. She is now serving as president of the American Astronomical Society.

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CREF UNIT VALUES

December 1977	$38.21
January 1978	35.72
February 1978	34.96

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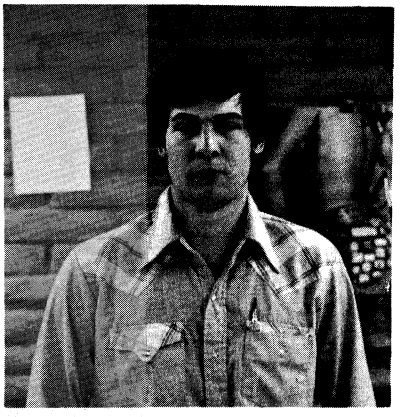
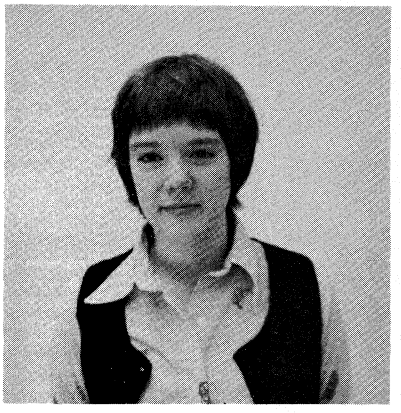
PERSONNEL UPDATE

NEW EMPLOYEES

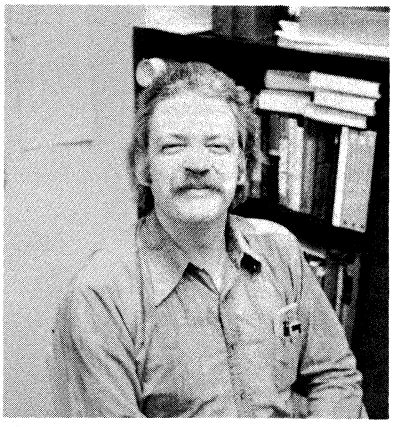


Steven C. Ayers
Tech Trainee
VLA - New Mexico



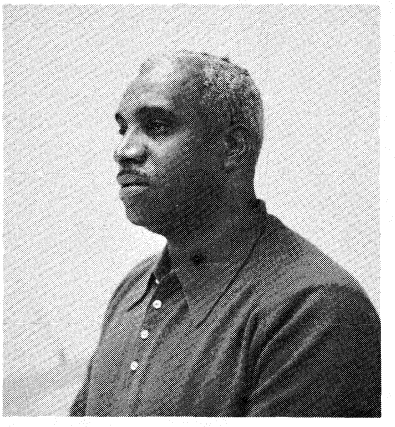
Carole A. Black
Tech Trainee
Computer Division - CV

Annie L. Chavez
Tech Trainee
VLA - New Mexico



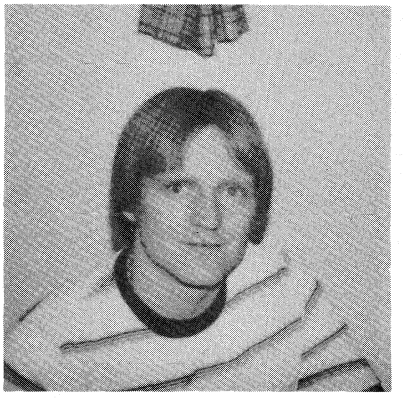
Michael T. Duggan
Scientific Programmer
VLA - New Mexico

Reva F. Heuston
Secretary
VLA - New Mexico

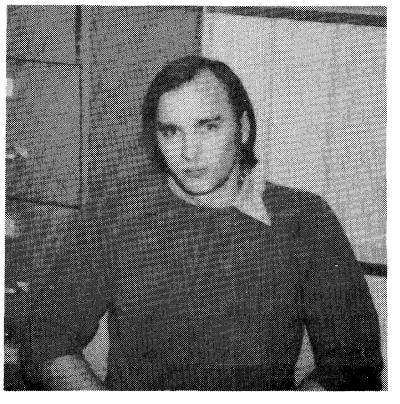


Floyd F. Jackson
Tech Trainee
Computer Division - CV

Carol A. MacDonald
Typist
Director's Office - CV



Paul R. Mehle
Accountant
VLA - New Mexico



Richard L. Norton
Tech Trainee
VLA - New Mexico

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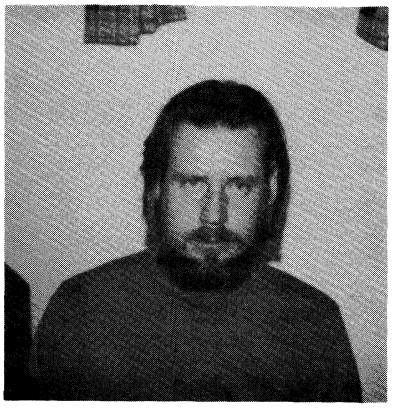
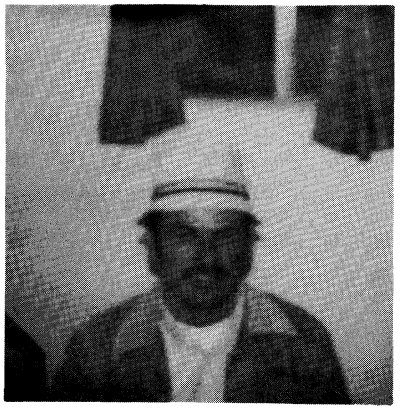
NEW EMPLOYEES (continued)



Edward A. Pencak
Technician
VLA - New Mexico

Elizabeth J. Schwab
Computer Operator
Computer Division - CV



Robert S. Sefcovic
Electrician
VLA - New Mexico

RETURN FROM LEAVE OF ABSENCE

Judith S. Kampf
Benno Rayhrer

TRANSFER

C. M. Wade
Basic Research - VLA - NM

TERMINATIONS

Cynthia K. Baca
Kenneth M. Barbier, Jr.
Edward W. Burke, III
David B. Coombs
Wilbur J. Crouch
Michael E. Fusco
Jane Gordon
Jesse K. Hill
Bruce D. Hillhouse
Paul A. Lane
Stephen A. Maas
Carolyn H. O'Brien
Orrin G. Sumner
Nancy R. Vandenberg

* * * * *

VLA

Gerrit Verschuur

WELDERS SUSPENDED,
DANGLING,
FROM PERCHES OF STEEL
SPARKS DRIFT DOWN AS
THEY BUILD,
AND BUILD.

DISTANT MOUNTAINS,
LACED BY RAIN
CURTAINS PULLED ACROSS THE SKIES
FILL THE PICTURE.
BETWEEN THERE
AND THEM,
A PLAIN, BRUSH, SAND
AND EMPTINESS.

AND RAILROAD TRACKS.

THAT START HERE
AND END THERE
GOING NOWHERE.
THEIR PURPOSE?
GUIDES FOR METAL GIANTS,
TELESCOPES,
EARS,
AND EYES,
ARRAYED PUNCTUATION-LIKE
ON THE DESERT,
PLACED JUST SO,
AND SO.

AS WAVES FROM SPACE
ARE PUSHED TO A FOCUS,
CONCENTRATED,
TRANSFORMED,
FED,
ALONG METAL CYLINDERS THAT GUIDE,
NERVES, STRETCHING OUT
FROM THE CONTROLLING BRAIN,
AS HUMANS BUSTLE AND
THINK AND PUSH
BUTTONS,
SENDING MORE WAVES
STREAMING OUT TO GUIDE,
SURELY,
ITS APPENDAGES,
MILES AWAY,
WORKING SILENTLY TOGETHER.

THERE'S THE CONTROL CENTER,
ITS BRAIN SPREAD
EXPANSIVELY, COLORFUL,
THE RIGHT HEMISPHERE
GUIDING THE LEFT.

IT ALL COMES TO THIS ONE ROOM.
THERE A HAND GUIDES THE THINKING
OF THE MACHINE.

BUILT OF NUTS AND BOLTS,
TRACKS AND TIES
STEEL AND COPPER
CABLE AND CONDUIT
AND MODULES AND SOCKETS
AND PRINTED CIRCUITS,
DELICATELY WOVEN TO AN INVISIBLE PATTERN.

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AT THE TERMINAL
A MAP FLASHES UP
AS A DISTANT
SO VERY DISTANT,
A FAINT
SO VERY FAINT,
SPOT IN THE SKY
IS UNCOVERED,
IS REVEALED,
IN THE SEARCH.
ENERGIES,
GENERATED IN AEONS PAST,
NOW TRAPPED,
MANIPULATED,
DISPLAYED,
AND STUDIED,
AND LOCKED IN THE GIANT'S BRAIN,
AS THE HUMANS SWING THE MACHINE AGAIN
TOWARD ANOTHER
UNEXPLORED MYSTERY
DEEP,
SO DEEP IN OUR UNIVERSE.

*****

NRAORA ANNOUNCES NEW REC AREA POLICIES

Rich Lacasse

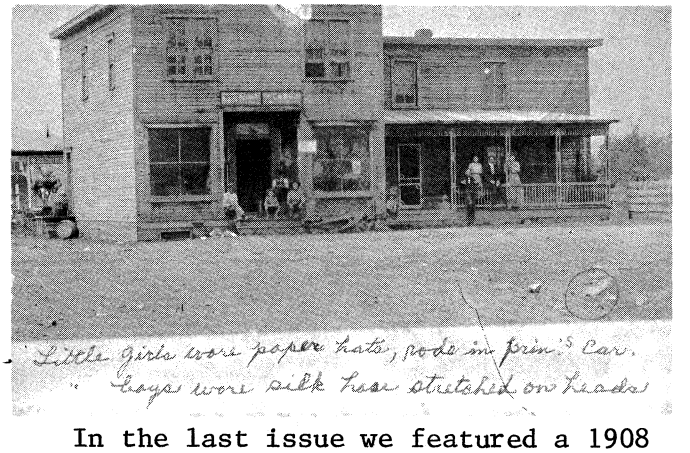
The Recreation Association in Green Bank, in cooperation with management, has come up with a few changes in the policy concerning the use of the recreation area. It is hoped these will lead to a greater enjoyment of the facility by the NRAO community and area groups.

The first change is that I.D. cards, issued by the NRAORA, will be required for entrance into the pool area and for checking out equipment. Four classes of cards are presently proposed: employee, employee family, visitor, and guest. All employees and their families will automatically receive cards. Visitors include visiting scientists and others who come to work at the NRAO but are not employed by the NRAO. They will receive visitor's cards upon checking into the residence hall. Guests include any reasonable number of people designated by an employee. Guest cards will not be transferable, will admit only the bearer, and will expire in one week. This card system should allow freer access to the pool and equipment by the NRAO community.

A second change requires that non-NRAO groups desiring to use the Rec Area notify the president of the Rec Association in writing. This letter should be specific in requesting facilities and equipment, e.g. tennis courts and horseshoes. This procedure should lead to a more orderly management of the Recreation Area, and to a "funner" time by those using the area. Constructive comments from the community will be cheerfully considered!

*****

OLD PHOTO COLUMN



In the last issue we featured a 1908 photo of Green Bank. Our old photo this issue shows a prominent landmark in Arbovale as it looked back in the 'early days'. The author who penciled in the notation at the bottom of the photo is unknown. Note the advertising on the building.

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OIL FOR TELESCOPES

*Yervant Terzian**

It may seem strange to us that in a land where public executions are still common for even such reasons as disobeying ones parents, where women are not allowed to be seen publicly, and where an absolute monarchy reigns, there are plans of creating the world's largest observatory. The Kingdom of Saudi Arabia is indeed interested in possessing an outstanding Astronomical Observatory with perhaps the world's largest telescopes.

In early November of 1977, Saudi Arabia organized an International Week in Astronomy to discuss various proposals for a National Observatory and to obtain advice from the international astronomical community. The U. S. delegation consisted of various commercial groups including telescope manufacturers, NSF and NASA representatives, and one astronomer -- myself. Clearly I thought, a very small scientific representation to meet the demands of three lectures in four days, setting up two exhibits, and acting as the official U. S. Scientific Advisor. However, at the meetings I discovered that the delegations from France, England, and Germany were very similar in structure to the U.S. one.

The meetings and exhibits were held at the University of Riyadh. I was loaded with slides, movies of Kitt Peak and NRAO, modern astronomy texts, etc. when I checked at the airport in Cairo, Egypt, to board a Saudi Arabian 747. First, I had the unusual luck to find myself behind a Saudi travelling with his "40" wives each with a separate passport to check! Soon I discovered that no seat assignments were necessary and when the gate officer blew his whistle to board the plane, a mob of people with miscellaneous luggage stormed the slick looking 747 -- some unlucky people had to wait for the next flight!

At first the customs official in Riyadh was too formal with me -- until he discovered the movies and slides I carried --when he insisted on viewing each slide one by one, but gave up on the movies!

Riyadh, the capital of Saudi Arabia, is a city of about 170,000 people. Almost everywhere one sees new, tall, modern buildings under construction (none finished yet!). The land is flat, sandy and dry, hot and really sunny.

Fortunately, I was to stay in a modern Hotel in town -- where food and water was imported from Paris -- room and board was about $150 per day. (In addition, the guests were provided with chauffeured cars). Very soon one discovered that only men can be seen around -- women are nowhere to be seen. One also asked the sad question "where can be drier than West Virginia?" Right -- Riyadh has a 0% alcoholic drink called "cider" -- and water costs 21 times the price of gasoline!

One morning some of my American colleagues who were staying in another hotel were very late for the meetings. Apparently during breakfast the hotel manager announced that all the guests had one hour to evacuate -- a prince and his entourage (i.e. wives, etc.) were arriving in town and had selected to stay at their hotel -- in all 400 rooms!

Saudi Arabia was founded as a modern Kingdom early in this century by Abd el Aziz II ibn Sa'ud, and today is still an absolute monarchy. It occupies most of the Arabian peninsula from latitude $\sim +15^{\circ}$ to $\sim +30^{\circ}$, at a longitude of $\sim 45^{\circ}$. The total area of this country is about ¼ that of the U.S. mainland. The population is somewhat uncertain -- as about half of its people are nomadic -- I did hear reports however that the population ranges from 4 to 10 million people.

Arabia is really known for its oil, which was discovered in 1938 and was exploited only after World War II -- and the "poor became instant rich". In the north, the Great Naf'ud desert and in the south, the Rub' al Khali (The Empty Quarter) are connected by the Ad'Dahna sand belt. Normally the summer heat is intense everywhere, reaching more than 55°C (132°F). Most of the interior is very dry, but along the Red Sea coast the humidity can be high. The only mountains are along the Red Sea coast and reach up to 2750 meters. The

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average rainfall per year is 8 to 10 centimeters -- however no rain has ever been reported in numerous desert regions.

In this dry land, even today it seems that to some extent Astronomy is connected to Islamic practice, where it is used in fixing prayer times, in determining the orientation of the holy city of Mecca from cities all over the Islamic world, and in sighting the new moon announcing religious festivities.

Historically, science and religion were closely associated in Islam. Arab astronomers such as El-Battani (850-929 AD), and Ibn Younis (944-1009 AD) are considered the pioneers of spherical astronomy and trigonometry. It is said that Ibn Younis was the first to use the pendulum as a time measuring machine for astronomical observations. Another great Arab astronomer was Abn El-Reihan Mohamed Ibn Ahmed El-Beirouni (973-1048 AD), who developed new astronomical instruments and built a large Astrolab seven and a half meters in circumference.

Until very recently the religious and conservative element in Saudi Arabian life has acted as an obstacle to integration with Western society. Large scale efforts to provide elementary education were only started in the 1960s. Today two universities operate in Saudi Arabia, the University of Riyadh, and King Abd el 'Aziz University. Scientists from these institutions have persuaded the ministries of Education and Finance to create a major National Observatory in Saudi Arabia. Already in Riyadh the Space Theater Simulator which contains a Planetarium and a Science Museum is nearing completion.

The proposals by the local scientists concerning the new observatory were very ambitious -- and contained almost everything from small specialized telescopes to sophisticated Time Service Laboratories and Islamic Almanac Centers, to 2.2, 3.5, and 5.2 meter optical telescopes. It was also proposed to develop centers with γ-ray, x-ray, infrared and radio astronomy capabilities. All to be acheived in a "reasonable" period of time!

Oil for telescopes is not a bad idea. The guest astronomers suggested a "modified western 5-year plan".

- To begin a vigorous educational program in astronomy, and to send their talented students abroad for graduate education.

- To order several small optical telescopes (one meter aperture) and place them near the two universities.

- To start a site selection program along the Red Sea mountains.

- To order 1.5 and 2.5 meter telescopes for their National Observatory.

- To consider development of a radio astronomy laboratory and a 33 meter steerable antenna.

- And to develop a Time-Service Laboratory.

A successful five-year plan can produce wonders for our science, -- and then "Oil for Cyclopes" may indeed be realistic.

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* *Cornell University*

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WHAT I DID ON MY SPRING (?) VACATION, OR, WHY I NEED THREE MORE WEEKS OFF TO RECOVER FROM MY ONE WEEK OFF

Sarah Martin

There comes a time in the life of most individuals in this world when one realizes it is TIME TO GET AWAY. There are a plethora of signs that may indicate that the TIME has arrived and myriad causes of the signs. In my particular case, suffice it to say that the causes involved the January weather in Charlottesville and the signs that it really was time to get away ranged from daydreaming about sunshine and seashores to the realization that if I didn't get away, either the books would have to be removed from the shelves to make my wall-climbing less dangerous to my person, or I would be shipped off for a stay at the Virginia Home for the Mentally Bewildered.

Okay - it was decided - away I'd go. I'd hie me southward by gosh. As it turned

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out, I should have decided to go via gosh, because Piedmont Airlines was in no mood to cooperate. My anticipated destination was Columbia, South Carolina. There were three reasons I had selected Columbia: two of them were old college friends who'd settled there and the third was the weather report from South Carolina in early February: sunny and 65°. Fantastic! I thought. Such a neat place to be, it must be easy to get there. Oh, was I ever mistaken. The hub of the universe (Charlottesville) and the rising star of the New South (Columbia) may as well be mythical kingdoms for the trouble one encounters trying to fly between them. However, my determination to get there overruled my rational inclination to forget all travel plans after looking in the airline guide. Let me tell you, folks, if you ever want to tour the southeast, I highly recommend Piedmont. To get to Columbia, I had to go to Washington (doesn't everyone go south by heading north?). From Washington, I went to Norfolk, followed by New Bern, North Carolina (where??? We were given to understand that the reason we had such a small plane [there was some discussion as we intrepid souls waited for our boarding call about whether the vehicle had two propellers or one....] was that the New Bern airstrip can't accomodate anything larger than the Wright brothers' plane). Finally, a mere seven hours after I'd left Charlottesville, we touched down in Columbia; or should I say, we bounced down in Columbia. I think the pilot (presupposing there was one - several times I wondered) was as tired as I.

That was merely a taste of what was to come. I should have turned around there and then, but eternal optimist that I was, I told myself: "Self," I said, "now you can relax and talk to old friends and do nothing more strenuous than bending your elbow for a week." "Yea!" I responded. (Talking to and answering oneself is another sign that one needs a vacation.) It was late at night when I arrived, so I wasn't too concerned about the apparent chill in the air or the light mist falling. The next day, I discovered that in order to bring in the tourist trade, the South Carolina State Chamber of Commerce sends out false weather reports to the north. It was cold; it was rainy; the only reason the ground hog didn't see his shadow there is because there was such a monsoon going on, one could see no further than an eyelash length in front of one's face.

Oh, not to worry, I thought. Even if the weather is almost as miserable as Charlottesville's, I'll just stay indoors in the warm house with my neat friends, talking and so on. There were two minor problems that interfered with the execution of that thought. First, it turned out that friend number one, who had just been promoted and transferred to Columbia, was a week away from moving into her new apartment and was herself camping out with a friend. Second, friend number two had developed some rare monsoon-connected illness, manifested by excruciating pain whenever the victim tried to move or talk. The warm house part fell through when I discovered that my friend's house had electric heat and earlier winter bills mandated that the maximum thermostat setting was to be 45° if they were to be able to afford food the rest of the winter. The peace and quiet I had anticipated was interrupted approximately every 32 seconds by my friend's kids (ages 4 and 7), who, because of the terrible weather, had to stay indoors. They ran and jumped and yelled a lot in order to stay warm. So did I.

Okay, so things didn't go well. I figured I'd have a nice flight back and prepare myself mentally to return to work and all of the snow that was to have fallen on Charlottesville while I was away. I went bouncing up to the security check-in at the Columbia airport and waited, while the man in front of me was checked. They decided the 6 inch scissors in his briefcase were okay to take aboard, because skyjackers wouldn't carry briefcases and dress neatly. Nope. Skyjackers would carry purses, wherein they would have secreted lethal weapons in the form of a keychain that looks like a large safety pin. That's right, folks. Your friendly neighborhood librarian had her keychain confiscated because she looks like such a dangerous person. (Oh women's lib! What have

--continued, next page--

you wrought??!!!).

The flight back from Washington to Charlottesville was delayed for an hour and a half (in 15 minute intervals, so they'd be sure to keep everyone close-by). I arrived back to find that the anticipated snowfall had been postponed until that evening, so I'd be sure not to miss it; the leak in the library roof had grown to a 9 trashcan array and repair is no more in sight than it had been before; three of my houseplants had died; and the cat was very surly. Do I take all of this personally? Of course not. Even paranoids have real enemies and it's obvious that mine are winning. Why should I take it personally??? Just do me one small favor: do not, under any circumstances, ask me if I had a nice vacation. I don't want to think about it....

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REFLECTED WAVE MASER

A significant advance has been made in radio astronomy receiver sensitivity at the National Radio Astronomy Observatory in Green Bank, WV with a reflected wave K-band maser. A total system temperature as low as 50°K has been obtained at 20 GHz which includes receiver, atmospheric, spillover and cosmic background contributions. The receiver temperature is 13°K $\pm$ 2 at the dewar input. The maser tuning range is 18.3 to 26.5 GHz with an instantaneous bandwidth of 250 MHz near the center of the tuning range. This is a considerably wider bandwidth than has been realized with maser devices in the past.

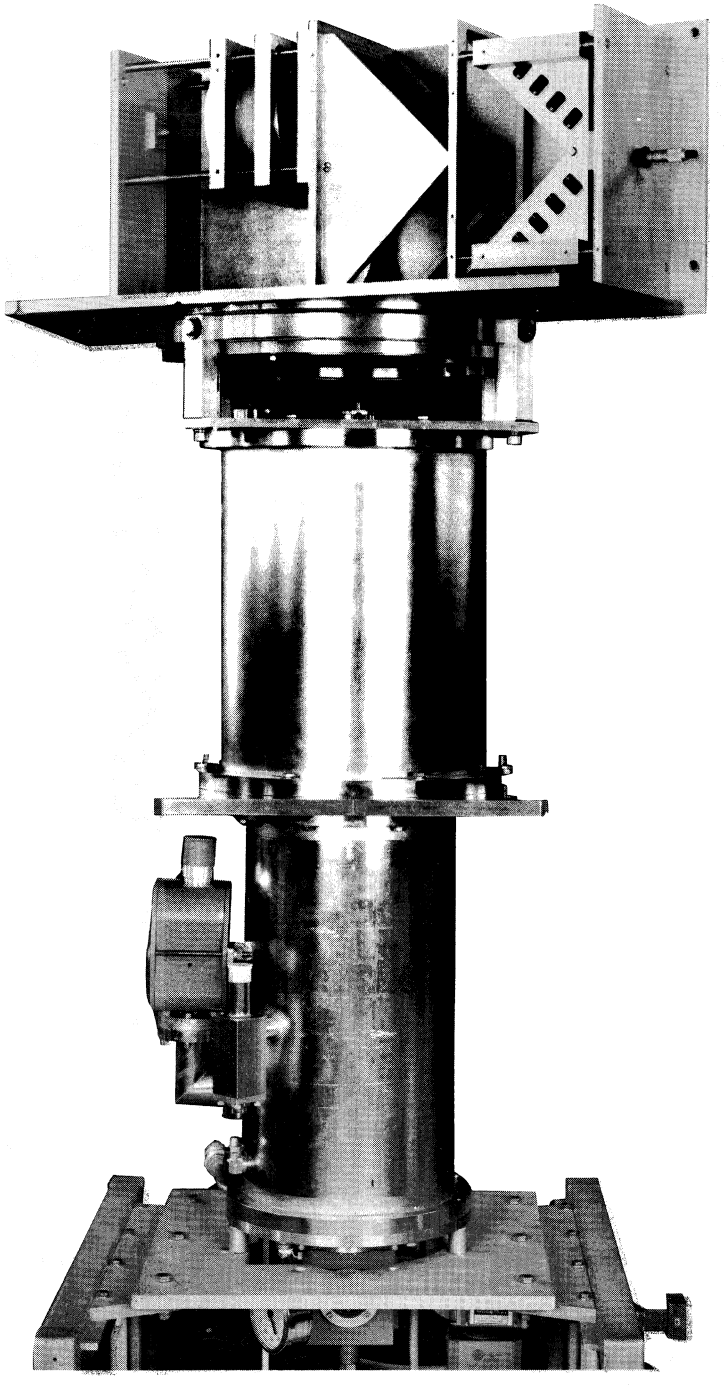
The reflected wave maser was developed for the NRAO by a group at the Jet Propulsion Laboratory in Pasadena, CA under the direction of R. C. Clauss with C. R. Moore of the NRAO participating in the final design and construction and continuing improvements at Green Bank. The maser is a 4-stage device with each stage incorporating a ruby-filled waveguide tied to a 3-port circulator. The 39 to 56 GHz pump power is injected at the end of the waveguide opposite from the circulator. The wide bandwidth is obtained by tapering the magnetic field along the length of the ruby and sweeping the pump frequency at a rate faster than the relaxation time of the maser states. This device takes advantage of the double pass of the signal through the ruby as well as enhanced pumping by aligning the axis of the material so that two transitions are excited at the same pump frequency.

The maser system has been installed on the 140-foot telescope at the Cassegrain focus. The system developed by C. J. Brockway of the NRAO incorporates a frequency/phase-locked local oscillator system which has a lock-up time of less than 10 milliseconds for a frequency change of 500 MHz at K-band. This rapid acquisition is necessary for spectral line observations where instrumental effects are reduced with frequency switching. Receiver output changes due to atmospheric noise fluctuations are largely removed by a beam switching method where the telescope subreflector is nutated causing the beam to move on and off the source at a 3 Hz rate.

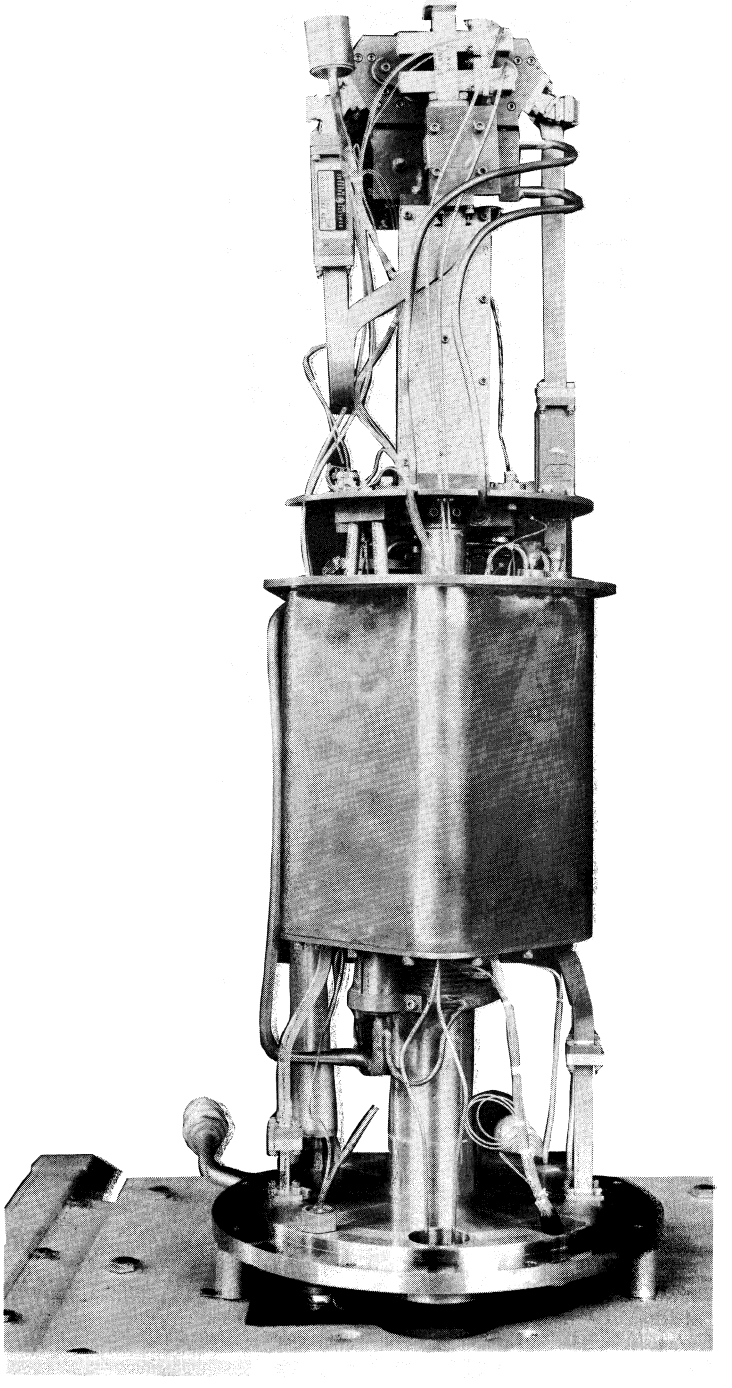
The ruby maser material lends itself nicely to amplification up to about 40 GHz because the required magnetic field is realizable with a superconducting magnet and sufficient gain is obtained at the boiling point of atmospheric liquid helium, 4.2°K. Many earlier masers required evacuation of the liquid helium system to reach a temperature of 2°K which added to refrigerator complexity. The NRAO system uses a closed cycle 4.5°K, three-stage, helium refrigerator with a dissipation capacity of 1 watt. A 2.5 watt refrigerator is being developed and will be used on future systems.

The ultimate goal of the NRAO maser program is to provide nearly continuous receiver frequency coverage from 1 to 26 GHz with the addition of parametric upconverters ahead of the maser. This should provide system temperatures of about 30°K below 15 GHz. Cooled mixers or varactor downconverters will also be used with the maser IF amplifier to provide low noise receivers at millimeter frequencies up to 230 GHz for use on the NRAO 36-foot telescope at Tucson, AZ.

--maser photos next page--



↞ *The maser package with millimeter diplexer mounted on top. This unit will be used on the 36-foot at Kitt Peak for CO observations.*



The maser with vacuum dewar and heat shields removed. The refrigerator is in the lower half of the picture and the superconducting magnet and maser microwave structure are mounted above. ↠

* * * * *

SERVICE AWARDS

Bob Moore

Ten Year Awardees

L to R: Bill Campbell, Carl Chestnut, Jerry Turner, Roy Pennington, Woon-Yin Wong, George Liptak, Barry Turner, John Payne, Mike Balister, Irene Varner, Ronald Weimer, Donald Stone, Alvin Hogan.

Twenty Year Awardees

L to R: Beaty Sheets, Dave Heeschen, Harry Wooddell.

The 11th annual NRAO Service Awards Banquet was held in the Green Bank Cafeteria on March 10, 1978. In past years the event was held in January. However, the Green Bank winter prevented it this year. Employees were honored who completed ten and twenty years of continuous service as of December 31, 1977.

Certificates and lapel pins were presented to the awardees by Dave Heeschen, Director, NRAO. In addition, a necklace and bracelet were presented to Harry and Beaty and a tie tack and cuff links to French for recognition of twenty years of service.

Twenty Year Awardees

French Beverage
Beaty Sheets
Harry Wooddell

Ten Year Awardees

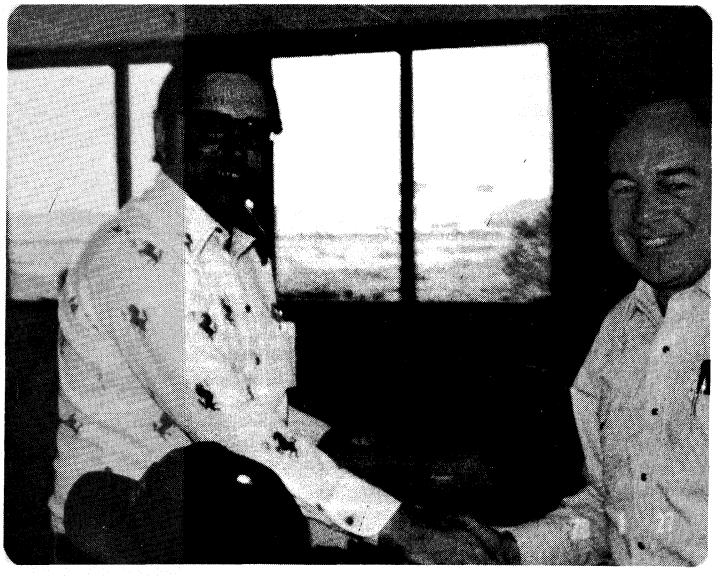
Mike Balister
Bill Campbell
Carl Chestnut
Kenneth Cottrell
Wade Davis
Alvin Hogan
Lee-Jong King
George Liptak
John Payne
James Pennington
Roy Pennington
Donald Stone
Jonathan Spargo
Barry Turner
Jerry Turner
Irene Varner
Ronald Weimer
Woon-Yin Wong

This brings to 150 the number of employees who have completed ten or more years of service. Of this number 6 have completed 20 years. 133 of the 150 are still employed by the NRAO.

* * * * *

SERVICE AWARD AT THE VLA

Doris R. Gill



Jack Lancaster, right, presents the certificate and lapel pin to Jon Spargo.

The first NRAO Service Award at the VLA was presented January 27, 1978 to Jonathan Spargo for 10 years of continuous service as of May 29, 1977.

A certificate and lapel pin were presented to Jon by Jack Lancaster, Project Manager, during a recognition party held in the VLA Site Cafeteria with all site employees and several Socorro employees in attendance.

*****

WHAT'S COOKING?

Pikelets

from the kitchen of Annette Sinclair

1 cup self-rising flour
pinch salt
¼ teaspoon bi-carbonate of soda
2 tablespoons sugar
1 egg
½ cup sour milk, or ½ cup fresh milk with 1 teaspoon vinegar added
1 tablespoon melted butter

Sift dry ingredients together. Add sugar, lightly beaten egg and half the milk, mixing until the mixture is smooth. Add remaining milk and melted butter.

Lightly grease and heat an electric skillet or a plain skillet and drop 1 dessert-spoon of mixture for each pikelet onto the hot skillet. Cook until bubbles appear then turn and cook other side.

Serve spread with butter or topped with strawberry jam and whipped cream. Australians usually serve these as a snack with morning or afternoon tea or coffee.

Yield: 2 - 2½ dozen.

Chilli Enchilada Casserole

from the kitchens of Michele Fomalont & Celia Gottesman

1 pound ground beef
1 large onion, chopped
1 can kidney beans
1 8-ounce can tomato sauce
½ teaspoon chilli powder (approximately)

Topping:

8 ounces commercial sour cream
12 ounces colby cheese, grated
12 ounces cottage cheese
Some corn chips

Brown beef with onion. Add kidney beans, tomato sauce and chilli powder to taste. Cook for one-half hour. Put in casserole. Mix topping and put on top. Top with corn chips. Bake at 350° for one-half hour. Freezes well.

Yield: 6 servings.