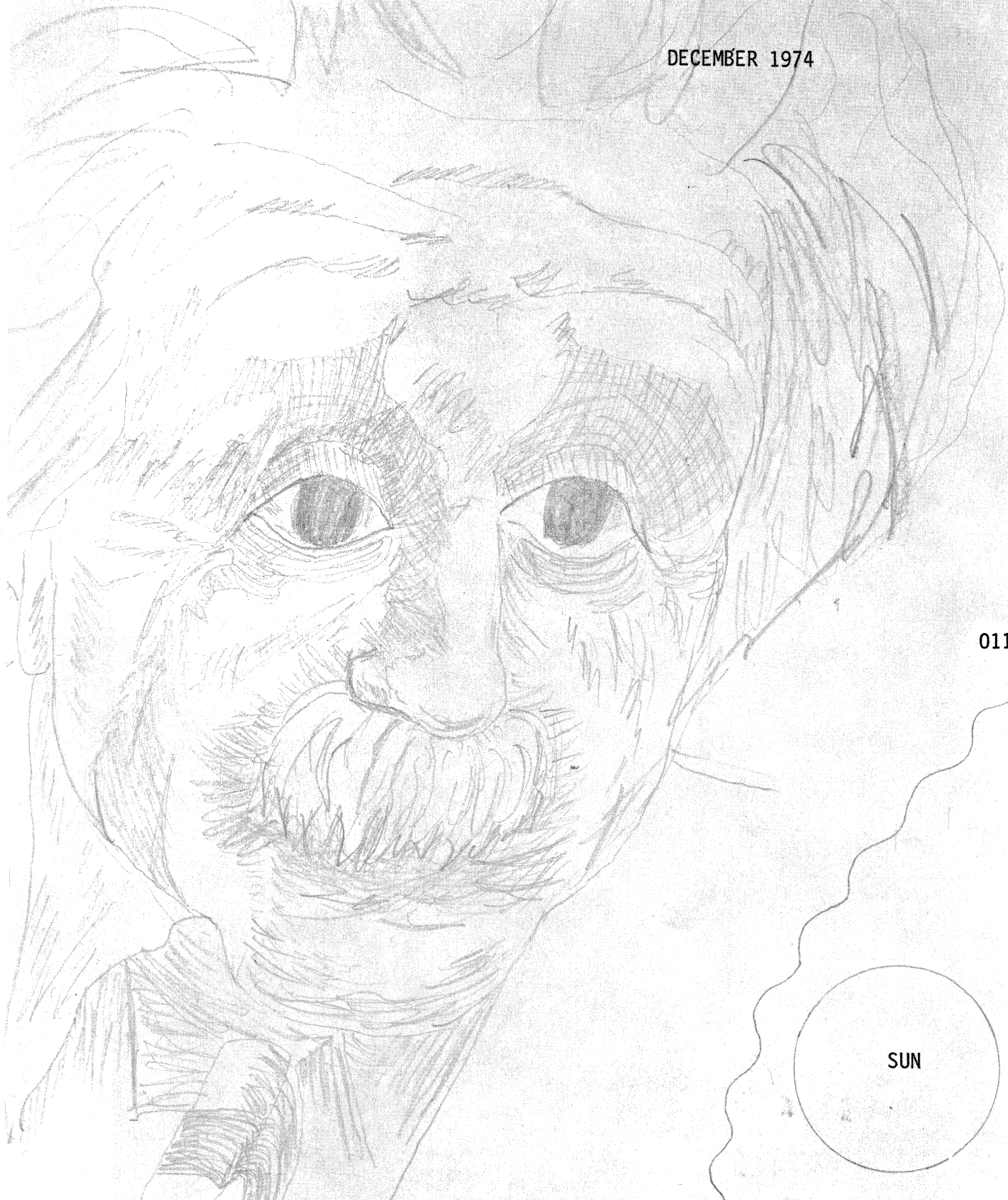
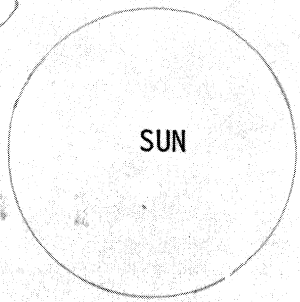


The OBSERVER

DECEMBER 1974



0116+08



TESTING THE THEORY OF RELATIVITY

Story on Page 3





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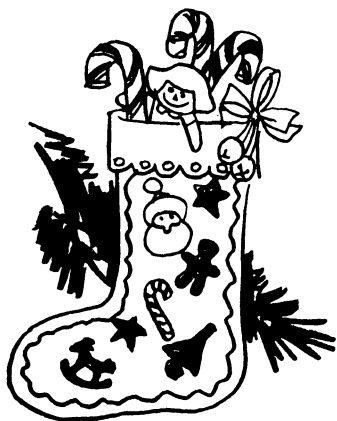
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A special thanks to all of those who helped assemble the OBSERVER.



TESTING THE THEORY OF RELATIVITY

Ed Fomalont

If you mention the name of Einstein anywhere in the world, the response is of reverence and admiration. He is a world figure held in awe by millions. Yet if you ask most people, even scientists, why Einstein is thought in such high regard the answer is usually vague. He has something to do with relativity. In his theories crazy things are supposed to happen when objects move with high speeds--time slows down, shapes distort. The fourth dimension, the curvature of space and relativity are meaningful concepts to very few.

From 1905 to 1925 Einstein was the undisputed leader in physics. During this revolutionary period the classical Newtonian laws were discarded for a quantum theory dealing with the microscopic world in terms of probabilities and the relativity theories dealing with the macroscopic world in terms of weird geometries of space. Although the classical laws are accurate enough for most uses, even today, these new theories are necessary to understand the behavior of atoms and large-scale phenomena in the universe.

One of the more intriguing observations of the 19th century which could not be explained by classical physics was the constancy of the speed of light. In 1887 two American physicists, Michaelson and Morley, devised an interferometer to accurately measure the speed of light arriving from bright stars. Using the earth as it rotates around the sun, they measured the speed of light from a star when the earth was moving toward it at 18 miles a second and then six months later when the earth was moving away from the star with the same speed. Paradoxically, there was no difference in the speed of the incoming light! Classical physics was unable to explain this result but for twenty years ingenious and desperate means were used to explain away the experiment in the framework of the conventional laws.

Finally in 1905, Einstein used the results of the Michaelson-Morley experiment as one of his principles of Special Relativity--that a measurement of the speed of light will always give the same value even if there is relative motion between the source of the

light and the observer. His second principle was that all laws of physics must remain unchanged for all observers even if there is relative motion between them. Some of the classical laws failed to satisfy this relativity principle. Einstein drew all the physical consequences of this theory and showed that they were in complete harmony with the observed physical facts and measurements. Certain predictions concerning the motion of fast particles and the conversion of matter into energy (atomic and hydrogen bombs, unfortunately, the energy of stars) were fully corroborated. The connection of space and time was established and this theory could be formulated in the framework of four-dimensions with time as the new dimension.

Einstein soon realized that this new theory was incomplete. After ten years of incessant ponderings he arrived at a General Theory of Relativity in which he connected space, time and matter into one theory of gravitation. He showed that the presence of matter--stars and galaxies--produced curvature in the four dimensions of space-time. Although this theory predicted results similar to the classical theory of gravitation for most conventional experiments, there were a few small additional effects, not previously predicted, which could be checked by careful measurements. One of them involved the bending of light rays by the sun. In 1919 a group of English astronomers organized an expedition to a solar eclipse where they were able to photograph stars near the sun in the darkened sky. Several months later they rephotographed the same field of stars at night. In comparing the two photographs the relative positions of the stars closest to the sun had changed. The effects of the sun's gravity had, in fact, deflected the star images away from the sun by about 1/5000 of the size of the solar disk. These observations agreed with the prediction of Einstein's theory and he became world-famous.

The amazing thing about Einstein's discoveries was that he did not follow the well-established rule of discovery. Usually a physicist or astronomer has at his disposal a careful set of observations from which by detailed analysis he can establish a set of equations which describe the observations perfectly. For example, Newton had the observations of Kepler when he formulated his laws of gravity. Most of the new ideas used

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in astronomy are developed to understand novel observational results which cannot be described in terms of earlier ideas. On the other hand, Einstein started from vague and speculative ideas about space and time with very little experimental help and followed these ideas to a logical conclusion well beyond the experimental and philosophical abilities of his time. Rather than describing nature in terms of carefully conducted experiments he tried to understand nature on the basis of logical deduction from a set of general principles.

In the last twenty years the ideas of science and the tools of technology have finally advanced to where Einstein's work is no longer just a beautiful theory which predicts small effects difficult to measure. All of our ideas of cosmology are based on simplified solutions to Einstein's equations. Recent astronomical discoveries concerning quasars, pulsars, black holes, neutron stars, clusters of galaxies and gravity waves can only be understood with the tools of relativity.

Other theories of gravity have been formulated but most have fallen by the wayside - victims of the observations. One exception is the theory of Dicke, Brans and Jordan formulated in about 1960. It is similar to Einstein's theory with the addition of a scalar field which has significant effect over long distances or near massive objects. Questions regarding the early stages of the universe or the physics associated with black holes and the like have very different answers depending on which theory is correct. The two theories predict a slightly different result for the bending of light by the sun. Although the eclipse experiment of 1919 and subsequently others could observe the bending, the accuracy is not sufficient to distinguish between the two theories.

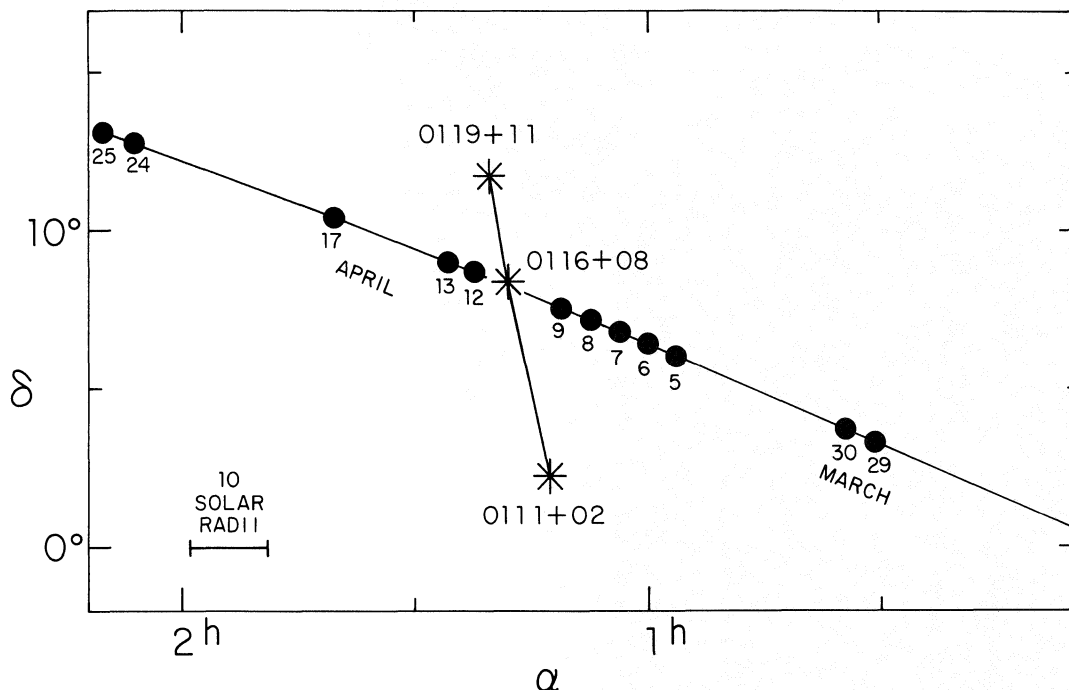
Radio waves from distant sources also are deflected when they pass near the sun. With the advent of sensitive radio interferometers it is possible to measure the bending of radio waves with much higher accuracy than with optical means and since 1969 ten deflection experiments have been made with radio interferometers at Caltech, Jet Propulsion Laboratory, Westerbork, Holland, and Cambridge, England, with a VLB interferometer between MIT and NRAO and with the NRAO interferometer. The most successful of these experiments was

performed by Ed Fomalont and Dick Sramek in Green Bank in April 1974 using the three-element interferometer and the 45-ft telescope near Huntersville, 20 miles away. The results of this experiment agreed perfectly with the Einstein theory and disagreed with the Dicke-Brans-Jordan theory by about seven percent, well outside the margin of error of the experiment.

The method of measuring the deflection of radio waves is quite different than the optical method because radio interferometers cannot make radio "photographs" of the sky. They can, however, measure distances between sources very accurately. You can think of observations with an interferometer as a precision ruler in the sky. Observing many radio sources alternately is equivalent to stretching a ruler between them and accurately determining their separation. In the recent NRAO experiment three radio sources (0111+02, 0116+08 and 0119+11) were observed over the duration of a month while the sun moved through the region of sky. An illustration of the experiment is shown in the figure (see following page). The position of the sun is given at noon for each of the observing days with the size of the sun drawn to scale. Each radio source was observed in turn for seven minutes, over ten hours each day. The observations began in late March when the sun was still far from the sources and produced no measurable deflection. As the experiment progressed into April, the sun's gravitational field began to influence the radio waves from the sources, especially for 0116+08 which lay in the path of the sun. The radio waves were slightly bent so that the position of this source was shifted away from the sun. By alternately observing each of the three radio sources we were able to watch the position of 0116+08 shift more and more as the sun approached. We also monitored the separation of the outer sources 0111+02 and 0119+11 which were only slightly affected by the sun. The interferometer does not produce a perfect ruler but must be continually fine-tuned, and we were able to adjust the scale of our ruler by using the separation of the outer sources as a standard rod.

On April 9, 12, and 13 the radio waves from 0116+08 actually passed through the solar corona (the corona can only be seen during a total eclipse of the sun). The additional distortion and anomalous bending

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of the radio waves could be removed by observing at two frequencies - 2695 and 8085 MHz. At this time the sun produced a deflection of only 1/10,000 the size of the sun. However, with the great resolution afforded by the radio link interferometer we were able to measure this deflection to an accuracy of 1/1,000,000 of the sun size, or about an accuracy of one percent. As the sun moved away in late April, the position of 0116+08

gradually returned to the undeflected position measured in March. Next April we will repeat the experiment in order to obtain an even more accurate result.

One still has to marvel that Einstein in 1915, using basic ideas of how he thought the laws of physics should behave, came upon a simple and elegant theory which has withstood the scrutiny of many scientists and accurate experimentation for nearly sixty years.

140-FOOT NUTATING SUBREFLECTOR

Chuck Brockway

The nutating subreflector was installed on the 140-ft telescope last October as part of the modification to a Cassegrain feed system. The purpose of nutating or "wobbling" the subreflector is to achieve beam switching but without the losses, narrow bandwidth, and fixed beam displacement associated with a dual feed and front-end switch.

The nutator design centers on two important specifications. First, the subreflector must move from one rest position to another very rapidly; that is, in about 0.04 second and at a maximum of 10 transi-

tions per second. Secondly, once the subreflector has been commanded to a rest position, that position needs to be maintained to a high degree of repeatability and stability; in particular, the push rods moving the subreflector must be positioned to .001 inch or better

To move the subreflector, equal push-pull forces are applied equidistant from the axis of rotation by hydraulic linear actuators. If the necessary torque of over 7000 foot pounds were applied to the subreflector alone, the torque acting on the telescope feed support structure would be excessive. Consequently, a compensating mass with the same moment of inertia as the subreflector is simultaneously rotated, but in the opposite

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direction, reducing the resultant torque acting on the feed support structure to an inconsequential amount. The principle can be demonstrated by considering a boat resting on the surface of a calm lake. If one were to throw an object straight off the stern by exerting a force on it (as to the subreflector), the boat (feed support) would move forward. If, however, a second object were simultaneously thrown straight off the bow and with the same force (compensation), the two forces acting on the boat would cancel and no motion of the boat would result.

The total weight of the subreflector and associated structure under rotation is about 300 pounds. To rotate such a mass through the maximum required displacement in the specified time calls for a peak power of over 70 horsepower and an average of 35 horsepower at a nutating frequency of 5 Hz. This in turn requires forces of over 2 ½ tons to be applied to the subreflector, resulting in a tangential acceleration (and deceleration) at the subreflector edge of more than 28 G's.

The control of these forces for positioning and moving the subreflector and compensator is by means of an electrohydraulic servomechanism using hydraulic pressures of up to 3000 psi. This pressure is supplied by a hydraulic power unit weighing about one ton and installed on the telescope yoke. To protect the subreflector and feed support structure from possible damage, pressure is removed and nutation stopped automatically if applied forces become excess or poor moment cancellation occurs.

The subreflector and nutating mechanism are attached in three pieces to the same mount that holds a standard front-end box at the prime focus. Changeover is not as straightforward as changing front-end boxes but can still be done in a half day or so. Warm hydraulic oil is kept circulating in the lines even when the nutating mechanism is not the place, further reducing changeover time.

Performance on the telescope has so far been encouraging, but many more hours of data and observations are needed to further evaluate the system.

NEW - GREEN BANK WAVEGUIDE PROGRAM

Is there something you always wanted to know but were afraid to ask? Do you have a gripe that's bugging you? Do you have a question that needs answering? Do you have a comment or suggestion you want to make? If so, the Green Bank site director's new "Waveguide" program will let you be heard and answered.

Green Bank employees are invited to send signed letters to the Editor of the *OBSERVER* who will code the letter and sender's signature with a number. The signature is filed in a safe place and the numbered letter is re-typed and sent to Bill Howard, and he or someone else will reply. The person answering the letter has no way of knowing who wrote the letter.

Bill Howard will decide if the reply will appear in the *OBSERVER* (if it is of general interest) or go only to the writer. In either case, both reply and signature stub will be returned to the writer by the *OBSERVER* editor. The *OBSERVER* hopes to publish many questions and answers of general interest to employees at all Observatory locations. We invite you to try "Waveguide".

"Waveguide" starts in this issue with this question. The answer follows.

Question. Why was the price of coffee raised to ten cents a cup when it has always been understood that come hell or high water, feast or famine, a cup of coffee will always be five cents? An answer based on simple economics is not sufficient. The Observatory employees and visitors liked to boast that Green Bank was the only place left where you could get a nickel cup of coffee. This pride and feeling has been sacrificed for an extra income of \$5.00 per day.

Answer. My goodness, this sounds like a "no win" question! I'll do my best to answer, but I'm afraid that the answer is based on simple economics, coupled with good business practice. Ever since the NRAO cafeteria began operation, we have used as a guideline that the retail price of all the food we sell should be as near to twice the cost to us as possible. Until recently, before inflation set in with a vengeance, coffee could be rounded down to the nearest nickel (i.e. 5¢), but when we recently adjusted the cafeteria prices, we noticed that a 10¢ coffee retail

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price was necessary. Coffee subsidization was considered, but that would have been unfair to the non-coffee drinkers and would have been a bad business precedent to set. As prices climb due to our current inflationary situation, even further increases are in store unless we can, as a nation, gain control of our economics. I am sorry if anyone felt that a 5¢ cup of coffee was a "forever thing", or that we have lost that nickel cup to boast about, but I am afraid that 5¢ coffee, like the good 5¢ cigar, is a thing of the past. Looking on the bright side, however, I note that coffee in most restaurants is still twice as high as it is in the NRAO cafeteria. Try comparison shopping for a good steak dinner!

'J' PARTICLE DISCOVERED

At 1:00 a. m. on November 11, 1974, a group from MIT headed by Samuel Ting of MIT and Y. Y. Lee of BNL discovered a new elementary particle which they named the 'J'-particle because of its strong angular momentum.

The MIT/BNL discovery of the 'J'-particle may well be the physics discovery of the decade. Particle-'J' is extremely heavy, having a mass equivalent to three protons. For a particle this heavy, its decay rate is relatively slow - about a billionth of a billionth of a second (10^{-18} sec) before breaking down into an electron-positron pair (most elementary particles do not live longer than 10^{-24} sec).

What does this discovery of the 'J'-particle mean to the physics world and to us ordinary people? According to Ronald Rau, BNL Associate Director for High Energy Physics, "It could be the first in a series of clues that tell us something about the fundamental forces of nature which hold the nucleus together, something we have been studying in physics for the last 20 years."

A complete story on the discovery of the 'J'-particle appeared in the November 22, 1974 issue of the *BROOKHAVEN BULLETIN*. If you want to read that issue, see W. Oref.

IMPRESSIONS

Nicholas Fourikis

At first I admired the variety and colors of the trees in and around Green Bank; this is not to say that I remained unimpressed by the little light buckets, the Pocahontas Public Library and the Recreation Area because I did. But trees this time of the year have a unique beauty.

On the second day we performed a few thought experiments: How would the Parkes telescope look in Green Bank? Perhaps someone can beat William the III at table-tennis. The resident guru took us to Ancient India to examine their numbering system. How would Green Bank look with a few hundred gum trees?

The days go by and I can't believe that next week we will both be in Tokyo. When we do we will remember Green Bank everytime Robya uses Mrs. Snyder's deerskin coat.

Why did I use so many words instead of saying I had a beautiful time in Green Bank?

The next time you think about "The Good Ole Days", remember that now is the time your children will look back to.

CREF Unit Value for October - \$30.27

We are sorry to announce in this issue that Vicki Taylor, our Assistant Editor and Typist, has left NRAO. She did an excellent job in both capacities. We all wish her the best in her new job.

The Editor apologizes for neglecting to mention in the October issue that Ken Kellermann provided the fine photograph for the cover.

ATS-6, SMS-1, AND RADIO ASTRONOMY

Jim Dolan

So you think Green Bank, West Virginia is an isolated pocket in Appalachia? Does it seem like it is hundreds of miles to any place? According to some of our more "enlightened" city dwellers, the only way in here is by grapevine (or dog sled)! Most everybody knows that one reason the Observatory was placed here is because of the relative isolation and the resulting low levels of man-made radio frequency emissions, particularly in the ultra high frequency (UHF) range and beyond. Just try to pick up a UHF TV channel in this area!

The area around the Observatory, about 13,000 square miles, is a radio-controlled zone, and since 1958 the NRAO has attempted to keep man-made emissions as low as possible. One area of trouble has been with aircraft emission and reflections. Several airways cross the zone, and aircraft regularly fly over and sometimes cause interference to NRAO operations. Although this has been a source of concern and irritation, this type of interference is usually of a transient nature, and the effects are short lived. But consider another possibility. What if an airborne emitter was just hanging up there sending energy into the hemisphere continuously? Everybody knows airplanes can't do that. But our space age marvel, the earth satellite, can -- and is!

Rapid advances in some fields of technology can cause repercussions in other fields, and that is what has happened between radio astronomy and satellite technology. At present, two satellites are in stationary earth orbit sending signals into the area that can and have been observed by our instruments. The first to go into operation was the ATS-6 satellite used mostly by the Health, Education, and Welfare Department to send TV signals from one area to another. One purpose for the TV link is to send medical information to hospitals in Appalachia. (Clarksburg has a participating hospital.) This satellite operates very near one of the interferometer's primary frequency bands, and part of the energy spills over into the interferometer system causing interference. The other satellite presently causing concern is the SMS-1. It is the first of a planned

series of meteorological satellites. This satellite takes TV-type raster-scan pictures in the visible and infrared spectrum and sends the data to Wallops Island, Virginia for processing. The frequency used for data transmission is a few megahertz (MHz) above the 1660 to 1670 MHz radio astronomy band used for observations of OH spectral lines. Some of the energy from this satellite spills over into the radio astronomy band and can cause errors in the astronomer's measurements.

Needless to say, the radio astronomy community is trying to prevent the sky from becoming full of transmitters that may obscure a large part of the radio spectrum. Most of the activity in this area is taking place with the National Academy of Sciences, the Interdepartmental Radio Advisory Committee and the Federal Communications Commission. Both Dr. Hvatum and Dr. Howard sit on committees acting in the interests of the scientific community. On October 11, 1974 a meeting was held at Green Bank of the TSC/EMS Working Group. This group is drafting a report defining the problems and suggesting possible alternatives. The problems are many and complex, and no easy solutions are in sight. It should be interesting to see the solution that will emerge from the current studies.

NRAORA NEWS

Richard Fleming

The first of the winter movies was shown on 23 November and over 80 people came to see John "Duke" Wayne star in Circus World. Future movies have been selected from the returned questionnaire sent out in November. A movie calendar appears later in this article.

Nominations for next year's board members have been made and go out on a ballot to all members in December. Also in December, dates for other events have been set: the Children's Christmas Party will be on 15 December; the Teens' Christmas Ball on 21 December; and the Adults' Dance on 28 December 1974.

There will be more news in the next issue concerning election of new members and officers for the next year.

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NRAORA-GB Movie Calendar

(All movies scheduled to begin at 7:00 PM)

Jan. 18, 1975 - Horse in the Gray Flannel Suit
 Feb. 15, 1975 - That Darn Cat
 Mar. 15, 1975 - The Story of Robin Hood
 Apr. 12, 1975 - Pollyanna

EWEN-PURCELL HORNBill Howard

Everyone now recognizes the Jansky and Reber antennas located to the right and left, respectively, as we come in the main entrance at Green Bank. Each was a historic "first" in radio astronomy -- in the discovery of radio waves from space and in the mapping of the ridge of radio radiation from the Milky Way. To these antennas we have now added the original Ewen-Purcell Horn, with which the 21 cm line of neutral hydrogen was discovered in 1951. Located near the Jansky Lab, diagonally across from the cafeteria, this horn antenna, looking like a miniature version of the Little Big Horn, has been painted up and weatherproofed and now takes its place as one of the historical sights near our entrance.

The following plaque will appear near the horn:

"This horn antenna was used by Harold I. Ewen and Edward M. Purcell at the Lyman Laboratory of Physics at Harvard University in 1951 for the first detection of radio radiation from neutral atomic hydrogen gas in the Milky Way at a wavelength of 21 centimeters."

After the discovery of the hydrogen line, the horn was sent to Harvard's Agassiz Station where it remained for nearly ten years. Then it was sent to Green Bank and it rested in the Jansky Lab basement for some time and finally was stored in the barn near the airstrip. In July we decided to fix it up and add it to our collection of historic antennas near our Green Bank entrance.

Special thanks to to our Works Area personnel, to Bill Brundage and to Kochu Menon

for helping with various aspects of this new display.

1975 NRAO HOLIDAY CALENDAR

January 1 - Wednesday	New Year's Day
February 17 - Monday	For Washington's Birthday
May 26 - Monday	For Memorial Day
July 3 - Thursday	Holiday*
July 4 - Friday	Independence Day
September 1 - Monday	Labor Day
October 27 - Monday	For Veterans' Day
November 27 - Thursday	Thanksgiving Day
November 28 - Friday	Holiday*
December 24 - Wednesday	Half-Day Holiday
December 25 - Thursday	Christmas Day
December 26 - Friday	Holiday*

*Additional Holiday

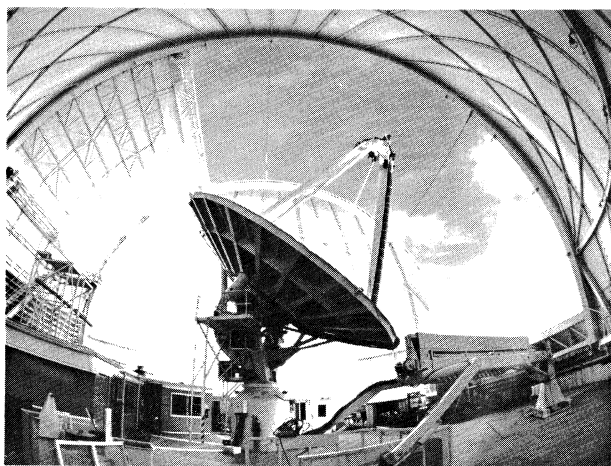
Pocahontas County High School is considering offering an Adult Education Class in Beginners Shorthand. This class will begin in early 1975. if there are as many as ten persons interested in attending. Please contact Bev. Workman, ext. 227, if you are interested.

LADIES - if you are interested in playing basketball on Tuesday nights, please come to the Green Bank Elementary gym at 6:45 p.m.

GRAIN ALCOHOL FOUND IN SPACE

Tucson, Arizona--Scientists have detected interstellar grain alcohol (known to chemists as ethyl alcohol or ethanol) in gas clouds near the center of our galaxy.

Radio emissions with wavelengths characteristic of ethanol molecules were picked up with a radio telescope in two different observing sessions early this month by observers from the University of Maryland, the National Radio Astronomy Observatory, the National Bureau of Standards in Washington, and the Commonwealth Scientific and Industrial Research Organization in Australia, in collaboration with the University of Chicago and the Center for Astrophysics, in Massachusetts. The 36-ft millimeter wave telescope used for these observations belongs to the National Radio Astronomy Observatory and is located at Kitt Peak near Tucson, Arizona. The



36-ft Millimeter Wave Telescope

National Radio Astronomy Observatory is operated by Associated Universities, Inc., under contract with the National Science Foundation.

Identification of ethyl alcohol in space brings to 31 the number of known interstellar molecules. Of these, the ethyl alcohol molecule (C_2H_5OH) is one of the largest (nine atoms) and most complex spectroscopically.

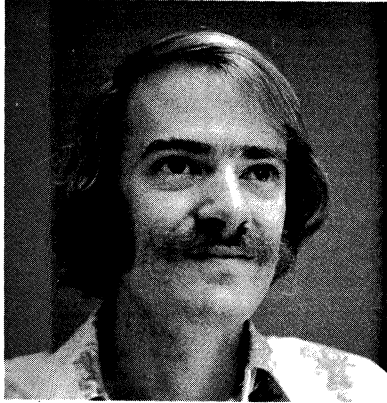
The interstellar clouds within which molecules are found are vast regions, containing perhaps as much mass as one million suns, and measuring up to 50 light years in diameter. They are composed mainly of simple molecules such as molecular hydrogen. The ethyl alcohol is spread out as a very thin vapor within such a cloud, and is undoubtedly produced by chemical reactions which are quite different from the well-known terrestrial sequence of reactions which involves fermentation of sugar by yeast organisms.

A rough estimate shows that there are enough molecules of ethyl alcohol near the galactic center to produce, if condensed, 10 billion billion billion fifths at 80 proof. If there were any way to make this accessible, it would supply the world needs of alcoholic spirits for longer than anyone can perceive.

The scientists are quick to point out, however, that the palatability of any condensed interstellar sample is in serious doubt because of the wide variety of contaminants known to exist in the galactic center gas clouds, such as formaldehyde, ammonia, wood alcohol, and hydrogen cyanide. The prospect of anyone getting "high" in the sky is thus greatly diminished. Not all contaminants are so noxious, however. For example, yet another new substance, heavy water, was discovered at the same time as ethyl alcohol. On earth, the heavy hydrogen (deuterium) contained in heavy water in the oceans is currently being looked to as a future source of nuclear power.

Scientists who collaborated in the discovery of interstellar alcohol were:

B. Zuckerman	U. of Maryland
B. E. Turner	N.R.A.O.
D. Johnson	
F. Clark	N.B.S.
F. Lovas	
N. Fourikis	C.S.I.R.O.
P. Palmer	
M. Morris	U. of Chicago
A. E. Lilley	
J. Ball	
C. Gottlieb	Center for Astro-
M. M. Litvak	physics
H. Penfield	



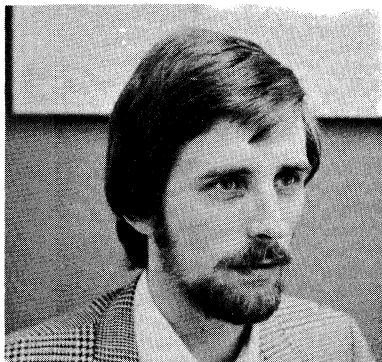
Paul R. Woodward
Research Associate
Basic Research - CV



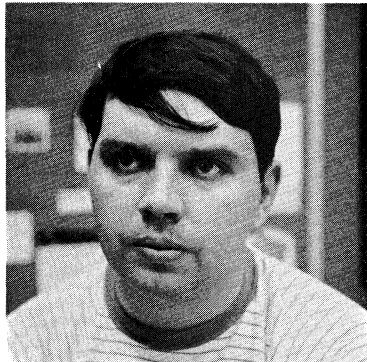
Gloria N. Racey
Recept./Tel. Operator
Business Office - CV



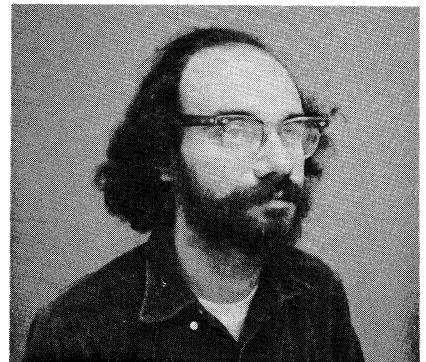
Chun Ming Leung
Research Associate
Basic Research - CV



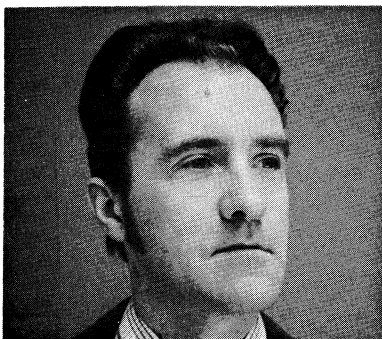
Arnoldus H. Rots
Research Associate
Basic Research - CV



Robert F. Fromm
Scientific Programmer
Computer Div. - CV



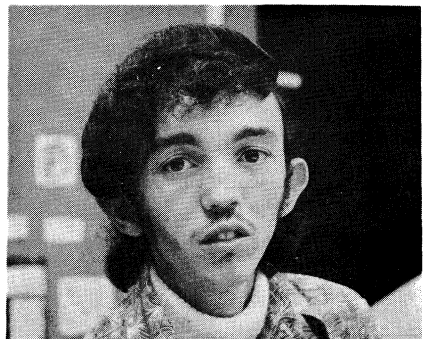
Kenneth P. Sowinski
Scient. Prog. Analyst
VLA Project - CV



Jerzy Machalski
Vis. Asst. Scientist
Basic Research

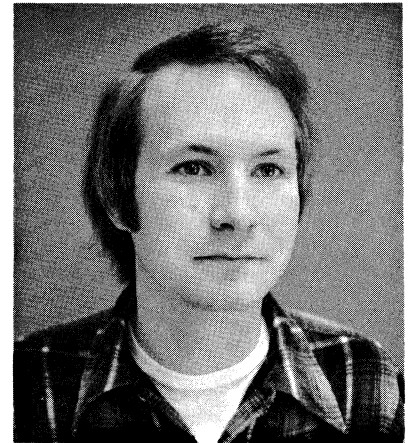
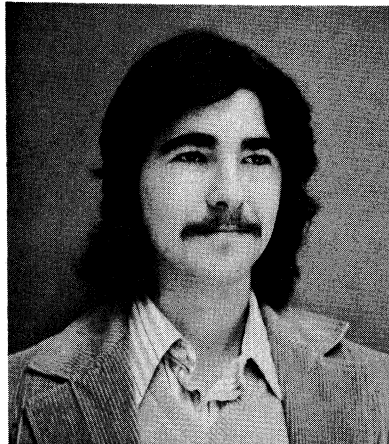


Janet C. Warner
Recept./Tel. Operator
Admin. Services - GB



Harry L. Beasley, Jr.
Jr. Computer Operator
Computer Div. - CV

Photo Not Available



Patrick B. Lewis
Tech. Specialist
VLA Project - NM

John P. Lagoyda
Jr. Technician
VLA Project - CV

Gregory A. Shoemaker
Scient. Programmer
Computer Div. - CV

Photo Not Available

James C. Peele
Jr. Computer Operator
Computer Div. - CV

TERMINATIONS

Stephen W. Wisely
Victoria L. Taylor

VLA Project - CV
Adm. Services - GB

LEAVE OF ABSENCE

Richard A. Sramek
Sebastian von Hoerner

Basic Research - CV
Basic Research - GB

ASTRONOMY IN CHINA

George Miley

This is the third of five articles by Dr. Miley describing his visit to China as a guest of the Chinese Academy of Sciences. Much of this article has been published in Sky and Telescope.

Chinese astronomy has a long and impressive history. The Chinese have been documenting eclipses regularly for the past 3500 years and they began compiling catalogues of stars fully two centuries before astronomers elsewhere. Some of the ancient records have proved invaluable to modern astronomers. For example, in 1054 AD the Chinese noted the sudden appearance of a bright "guest star" in the constellation we call Taurus. This event was the gigantic stellar explosion which gave birth to the Crab Nebula, still one of the most spectacular and interesting objects in the sky, and among the strongest sources of radio and X-ray radiation.

Very little is known about astronomy in modern China. During my trip I visited large observatories at Shanghai, Nanking and Peking and spent some time at the astronomy departments of Nanking and Peking Universities.

This tour began in Shanghai. Shanghai Observatory has its headquarters in the former French concession of the city. It was founded by a group of French Jesuits in 1872. Since 1882 this observatory has been using measurements of bright stars to provide a time service. The time pips were broadcast, and used mainly for navigation by the French Navy. In 1949 the observatory was taken over by the government and since then it has been the headquarters of a Chinese time network of three stations.

It was in Shanghai Observatory that I gave my first talk. This was delivered beneath an imposing picture of Chairman Mao, flanked by large portraits of Marx, Engels, Lenin, and Stalin. Giving a talk in China was a memorable experience. An English-speaking astronomer always sat by my side acting as interpreter and continuously replenishing the mug of tea in front of me. Each talk usually lasted three hours. Translation was carried out a few sentences at a time, giving me a very useful breather, but

providing no respite whatever for the interpreter.

From Shanghai it is a five-hour train journey through some of the richest agricultural land in China to Nanking, several times capitol of China and now a thriving community of some two million people. On a hill overlooking Nanking - with a spectacular view of the Yangste River - stands the Purple Mountain Observatory. Known in Chinese as "Purple Golden Mountain Observatory" it was established in 1932 and is the most famous of modern Chinese observatories. Its director, Professor Chang Yu-cze, is president of the Chinese astronomical society and a distinguished astronomer. He speaks fluent English and warmly recounted a visit he made to Dublin seventeen years ago for a meeting of the International Astronomical Union. Every year at Purple Mountain, the Chinese independently assemble an enormous body of astronomical data which they publish in their own almanac. Here one can see several ingenious instruments beautifully constructed by ancient Chinese astronomers, side by side with a 25-inch reflector telescope built at a nearby optical factory in 1964. The new telescope is used mainly for charting the orbits of the two Chinese satellites and for studying the minor planets.

By contrast with Purple Mountain, Peking Observatory is a relatively new institution. Astronomy has been carried out near Peking for thousands of years, but the modern Peking Observatory was only founded in 1958. It possesses a radio telescope in addition to the more traditional optical facilities.

The radio observing station lies on the shores of the giant Mi-yun reservoir about 160 km northeast of Peking. There Professor Wang Shou-Kuan showed me a large array - over 1 kilometer long - which was completed in 1967. It is at present being used to observe the sun, but there are plans to extend it for observations of more distant objects both inside and beyond our galaxy.

About the same distance from Peking - perched 900 meters high on the Yen-Shan Mountains - is Peking Observatory's optical station. It is a four-hour drive along a rugged mountain road that winds past the Great Wall. By contrast with the locations of Shanghai and Nanking Observatories this is a fine site for optical astronomy, far from the city with an average of about 200 clear nights per year.

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Most of the building was completed in 1968, but a giant 80-inch telescope is still under construction. The acquisition of this new telescope should open many new avenues of research to the local astronomers.

Building a large telescope or launching an artificial satellite requires a highly developed engineering capability. I was impressed with the state in which I found Chinese technology. During my trip I found astronomers using rubidium frequency standards (clocks accurate to 1 second in 50 years) and countless examples of advanced solid state circuitry. At the industrial exhibition in Shanghai I saw a medium sized computer. All of these devices were made entirely by the Chinese and compared well with their Western counterparts. Although sophisticated technology is still very thinly spread in China compared with that in the West, the groundwork seems to have been laid throughout Chinese society for a future technological "leap forward".

According to Marx, "The problem is not to understand the world but to change it," and at first sight astronomy can contribute little to Chinese development. What therefore is the ideological justification for doing astronomy in China? That was a question that intrigued me and which I put to several Chinese astronomers. Their motivation seems not too different from our own. It is threefold. First there is the direct geophysical importance of some branches of astronomy such as timekeeping and solar research. Secondly, the Chinese are very aware that advances in applied science must rest on a solid foundation of pure research. Thirdly, they believe that a wider knowledge of Man's place in the universe must weaken superstitious beliefs, encourage a scientific attitude, and foster a greater awareness of society.

It would appear that the Cultural Revolution had little effect on the motivation for carrying out research, but it is difficult to assess its impact on Chinese astronomy as a whole. As we saw in a previous article, the universities have gone through a period of unprecedented turbulence. Virtually closed for six years, they are now gradually readmitting students under a drastically reformed system. At present the university teachers are busy preparing new curricula and have little time for research

work. By contrast with the universities, the observatories and research institutes have emerged relatively unscathed. Although the Chinese Astronomical Journal was temporarily suspended, most of the important timekeeping and solar service work continued throughout. The height of the Cultural Revolution even saw the completion of the new optical and radio observing stations near Peking. The organizational structure within the observatories has so far undergone only minor changes. The director of each observatory is still appointed by the Academy and important decisions are taken by him in consultation with the revolutionary committee of the institute.

Even before the Cultural Revolution, Chinese astronomers were relatively isolated. Although I found a keen awareness of the current literature, this cannot be a substitute for personal contact. Such contacts are usually made at astronomical conferences, but in the case of China this is complicated by the fact that she is no longer a member of the International Astronomical Union (IAU). The Chinese withdrew in 1959 after a delegation from Taiwan was admitted. A similar situation exists in many international organizations.

Last September in Sydney, Professor Goldberg, the newly elected president of the IAU, said in his acceptance speech that one of his most important tasks would be to try and bring Chinese astronomers back into the organization. I discussed this question several times during my visit. There is no possibility of China rejoining the IAU as long as Taiwan remains a member. Any compromise would violate one of the most basic cornerstones of Chinese policy which has been consistently held over the past two decades. It is argued by some that this attitude brings politics into the IAU, but since the IAU is financed by governments of member states, politics is an inherent part of the organization. Moreover, the Chinese astronomers argue that the original application by Taiwan was politically motivated. It was part of a general plan devised by the US State Department under Dulles, to isolate China from all international organizations. The Chinese have little doubt that eventually the IAU will follow the example of the United Nations and withdraw recognition from Academia Sinica in Taipei. "But," one of them said,
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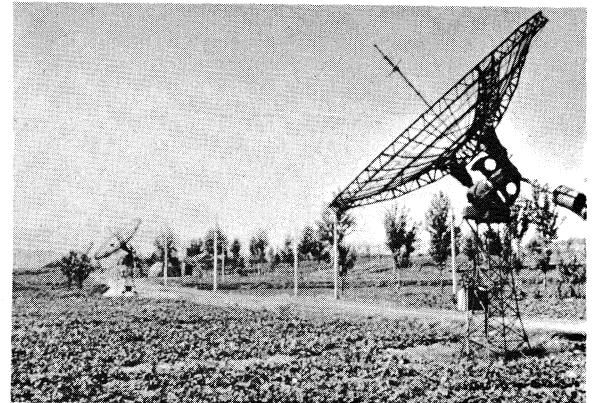
"Welcome to our Irish Visitor"
The entrance to the Chuan Wu May 7 School



Chinese intellectuals and administrators
studying at Chuan Wu May 7 School



Vice-President Kao Chi-yu (center) with
some members of the staff of Nanking
University



Part of the new radio telescope
near Peking



Students in Peking University



The new optical observatory near Peking,
completed during the Cultural Revolution

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"until then we can be patient."

Meanwhile, how will Chinese astronomy develop? With the shock of the Cultural Revolution at an end there will be a mushrooming of personal contacts and exchange visits between Chinese and foreign astronomers. In a country as relatively poor as China (or Ireland), astronomy cannot have a high priority. However, the Chinese Academy of Sciences has a sizeable budget allocated to pure research and spending should increase substantially during the next few years. I am convinced that an important new era in Chinese astronomy is beginning.

PUBLIC TOUR SEASON - 1974

Wally Oref

Despite the gasoline crisis and the slumping economy that fostered predictions that Americans would be travelling less during the summer and fall of 1974, the NRAO had a good turn out for its public tours. When the season closed on 27 October 1974, the visitor register showed that 22,819 people had taken our regular tour. This total was a little less than the 24,562 in 1973 but a little more than the 21,987 in 1972.

As in past years, most of our visitors came from five nearby states. West Virginia was the most represented state with 44.9% of the total. Virginia was second with 13.1%. Ohio was next with 12.8%, Pennsylvania followed with 10.4%, and Maryland was fifth with 9.7%. Only 9.1% of the visitors came from the other forty-five states and twenty-two foreign countries. In contrast, last year 16.3% of our visitors came from these same states and foreign countries. One might conclude from this decrease that in 1974 people were travelling closer to home.

During the latter part of the season the new film, "The Invisible Universe" was shown to the public. After each showing a selected number of the viewers were asked to comment about the film. Our poll indicated that most of the people who saw the new film enjoyed it very much. It also turned out that there was no grounds for our fears that the public might misinterpret the "mad scientist" sequence. The film makers (Shostak, O'Connell,

and Sramek) use of humor with science was well received. Next year "The Invisible Universe" will become the tourist film and will replace "The Observatory" film that is now nine years old.

WHAT IS AN ISBN?

Virginia Van Brunt

What is an ISBN? This is a frequent question from staff members who see ISBN's listed as part of advertising information for new books.

An ISBN is an "International Standard Book Number", a ten digit code that publishers assign to their books. The ISBN provides unique identification for ordering or maintaining inventories of books, especially when records are stored by computer. The system was adopted in Great Britain in 1967, and by US publishers in 1968.

Typical ISBN numbers look like this: ISBN 0-7167-0568-9.

In examining these groups of digits, from left to right, the first group (the zero) indicates that this book was published within the geographical borders of Australia, Canada, New Zealand, South Africa, the United Kingdom, or the United States; other regions have their own code numbers. The second group of digits identifies the publisher, in this case W. H. Freeman and Co. The third group indicates the title code. The total number of digits in the publisher and title codes combined is always eight. The final number is called a check digit. The check digit is an integer from zero to ten (if ten, the symbol "X" is used, so that the total number of characters does not exceed 10). This digit helps to identify incorrectly written ISBN's.

International Standard Book Numbers are used in handling the records of large quantity book orders, and are not regularly used by libraries yet. Now you know....

GARDENING, FIRST TIME AROUND
or
THE RAINING WET WATER SEASON

Claude Williams

In October of this year the questionnaire appearing on the next page was circulated to discover the best conditions and crops for gardening in the Green Bank area. Thirty-four of the sixty-four copies (53%) distributed to the Lab and five of the twenty-two copies (23%) to the telescopes were returned. One copy from the Works Area and Shop Area was also received (where distribution was doubtful at best). Four of the forty copies returned (10%) reported they did not plant a garden. With the thirty-six left, correlations between conditions under which the crops were grown and the overall performance of the gardens were assessed. The overall performance of the individual crops was computed and suggested brand names are noted.

Preliminary Correlations

The following is a list of correlations, or non-correlations from the data received.

- 1) Of the thirty-six who planted gardens the average crop seemed to do slightly better than 3.00, the rated average in the survey. The average crop came out to 3.33 on the same scale as the questionnaire with 66% of the crops falling between 2.79 and 3.87.
- 2) The location of the garden, whether on a hillside, hilltop, valley or riverside did not matter when the overall performance of each garden was computed; i.e., averaging the performance of all the crops planted.
- 3) Whether the garden was sunny or shady did matter because the overall crop performance of the garden in the sun was 3.43 for 24 marked and only 2.60 for the four shady gardens marked.
- 4) The longer a plot had been gardened, the better it performed, but only slightly. Four first year gardens averaged 3.04,

thirteen two to five year gardens averaged 3.39, and fifteen more than five year gardens averaged 3.55.

- 5) Fertilizers made no garden perform better than another, but everyone used fertilizer of some sort, from chicken manure to commercial fertilizer.
- 6) The number of crops had a little to do with the gardens' performances. Less than ten crops planted averaged 2.29, ten to twenty crops per garden averaged 3.51, and more than twenty crops averaged 3.47.
- 7) Insecticide use without restraint seemed to have a detrimental affect on the crops. Gardens where no insecticide was used came out with a 3.60 average, those with insecticide on one to five crops averaged 3.45, those with insecticide on five to ten crops averaged 3.40, and those with more than ten crops insecticided averaged 3.22.

Crop Performance

Many, many crops averaged between 2.79 and 3.87 on the scale of 5 in the questionnaire. Some notable exceptions on the high side with 50% or more of the gardens having the crops were: leaf lettuce (4.29), celery (4.00), and yellow onions (3.93). On the low side for the same group was red tomatoes at a depressingly low 2.36 caused mainly by the weather and blight. In the 10-50% group the high yield crops were: sunflower (4.44), dill (4.25), kale (4.14), zucchini squash (4.10), and summer squash (3.94). Low performance went to: white radish (2.67), asparagus (2.50), lima beans (2.40), head lettuce (2.40), spinach (2.29), watermelon (1.50), and the lowest of the low small yellow tomatoes (1.40). Three plants were not put on the graph because of space; they were turnips (3.20), rutabagas (3.00), and red pepper (2.80). Other than these mentioned here and in the graphs the rest of the crops just were not planted enough to be able to rely on the numbers.

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GARDEN QUESTION SHEET

Did you plant a garden this year? Yes ___ No ___ If no, just return this sheet.

Where is your garden planted: Hillside __, Hilltop __, Valley __, Riverside __, Shady __, Sunny __.

How many years has the plot been gardened? This is the first __, second __, third __, fourth __, fifth __, more than fifth __ year.

What kind of fertilizer did you add to your garden? None __ Commercial fertilizer __ Horse Manure __ Cow Manure __ Other _____.

On a scale of 1 to 5, where 1 is very poor and 5 is very good, rate each of the following by how well you thought your crop did this year. If you did not plant one of them, leave the space blank.

If your crop was harmed by Weather, Animals, Slugs, or Insects please put W, A, S, or I respectively in the second space before each plant. If the crop was not harmed, leave the second space blank, but if a crop was harmed by something else, please note.

Vegetables:

___ ___ Asparagus	___ ___ Celery	___ ___ Melons: Cantaloupe	___ ___ Radish: Red
___ ___ Beans: Bush	___ ___ Celtuce	___ ___ Pumpkin	___ ___ White
___ ___ Pole	___ ___ Collards	___ ___ Watermelon	___ ___ Rhubarb
___ ___ Lima	___ ___ Corn: Yellow	___ ___ Mustard Greens	___ ___ Rutabaga
___ ___ Beets: Red	___ ___ White	___ ___ Okra	___ ___ Soy Bean, Edible
___ ___ White	___ ___ Popcorn	___ ___ Onions: Yellow	___ ___ Spinach
___ ___ Yellow	___ ___ Cucumber	___ ___ White	___ ___ Squash: Summer
___ ___ Broccoli	___ ___ Eggplant	___ ___ Peanuts	___ ___ Zucchini
___ ___ Brussel Sprouts	___ ___ Garlic	___ ___ Peas: Green	___ ___ Pan
___ ___ Cabbage: Celery	___ ___ Horse-Radish	___ ___ Blackeyed	___ ___ Sunflower
___ ___ Red	___ ___ Kale	___ ___ Peppers: Bell	___ ___ Tomato: Red
___ ___ Savory	___ ___ Lettuce: Leaf	___ ___ Pimento	___ ___ Small Red
___ ___ Carrots	___ ___ Red	___ ___ Bananna	___ ___ Small Yellow
___ ___ Cauliflower	___ ___ Head	___ ___ Red	___ ___ Turnip

Herbs;

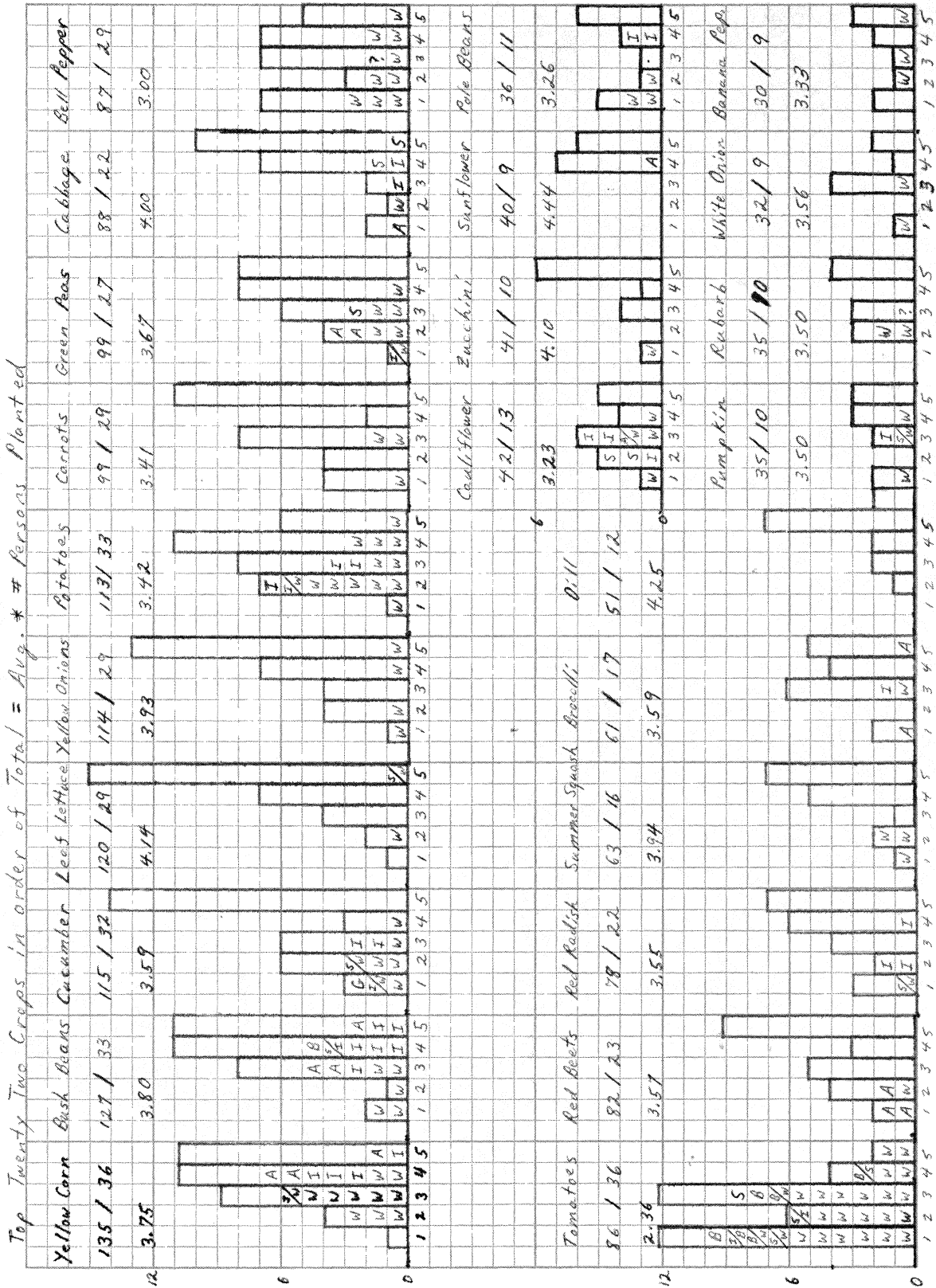
___ ___ Anise	___ ___ Dill	___ ___ Parsley	___ ___ Sage
___ ___ Borage	___ ___ Fennel	___ ___ Roquette	___ ___ Savory
___ ___ Chives	___ ___ Horehound	___ ___ Rosemary	___ ___ Spearmint
___ ___ Caraway	___ ___ Lavender	___ ___ Tarragon	___ ___ Woodruff
___ ___ Catnip	___ ___ Marjoram	___ ___ Thyme	___ ___ Basil
___ ___ Chervil	___ ___ Oregano		

Please list any vegetable or herb you planted that I did not list and rate as above.

Which crops did you use insecticides on?

Please list the vegetables you would recommend to grow in this area and any brand names for special hybrids you would suggest.

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Recommended Brand Name Hybrids

<u>Crop</u>	<u>Hybrid</u>	<u>No.*</u>
Green Bean	Tenderette	4
	Half-Runner	1
Corn	Early Sun Glow	4
	Illinois Xtra Sweet	2
	Silver Queen	1
Tomato	Big Early	2
	Delicious	2
	Pixie	1
	Patio	1
	Earliana	1
	Marglobe	1
Potato	Red Pontiac	1
	Early Rose	1
	Kennebec	1
Lettuce	Black Seeded Simpson	1
	Tom Thumb	1
Cabbage	Early Jersey Wakefield	1
	Red Acre	1
Cucumber	Mrs. Pickler #363	1
	Hybrid Victory #350	1
Cauliflower	Early Snowball	1
Zucchini Squash	Early	2
Broccoli	Green Comet	2
Peas	Wando	1
Brussel Sprouts	Jade Cross	1
Spinach	Bloomsdale	1

*Number of people recommending

THE Garden

THE garden for the Green Bank area would probably be as follows: planted no where in particular in a sunny plot that had been used for at least five years, sprinkled with some type of fertilizer (the most common being commercial, but it has no advantage over various manures), planted with high yield crops of celery, cabbage, kale, leaf lettuce, yellow

onions, summer and zucchini squash, sunflower, and dill along with at least twelve medium yield crops to get variety. Strictly out are lima beans, all melons (except for pumpkin), and all tomatoes. Insecticides would be used only where absolutely necessary.

The above would probably give you a better than average garden next year given that the weather, animals, slugs, insects, blight, seed germination, kids, negligence, whatever, and frost do not get to your harvest before you do. Good luck and happy gardening.

GALLERY MALL

Gallery Mall, located on Ivy Road (250 West), about one-half mile from our Ivy Road Building, is the home of the Asynchronous Computer Group (half of the VLA Computer Group who work with data reduction).

This is the work place for Al Braun, Dave Ehnebuske, James Torson, Jerry Hudson, Nancy Vandenberg, Ray Guthrie, and Bob Hjellming.

The Asynchronous Computer Group moved from Edgemont Road around September, 1974, because of crowded conditions at Edgemont.
