AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 107th meeting of the American Astronomical Society at New York City, December 28-31, 1960. Technical abstracts will appear in the Astronomical Journal.

First True Radio Star?

In an unscheduled paper, Allan R. Sandage, Mount Wilson and Palomar Observatories, described a 16th-magnitude object in Triangulum that appears to be the first case where strong radio emission originates from an optically observed star. It was found in the course of the survey now being conducted at the radio observatory of California Institute of Technology to obtain very precise positions of radio sources. Twin 90-foot parabolic antennas, movable to various positions along a huge cross formed by a pair of tracks, are used for this work.

Thomas A. Matthews first determined a six-times more accurate position for the source 3C-48 than had hitherto been established at Cambridge University in England. The world's largest steerable paraboloid, the Jodrell Bank 250-foot radio telescope, had set the source's diameter at less than four seconds of arc.

At 96 megacycles, the Caltech instruments gave a radio flux intensity of 21.3×10^{-26} watt per square meter per cycle per second, while in England values of 50 and 43 were found at 159 and 178 megacycles, respectively. So strong a flux from such a small area led Dr. Matthews to suggest that the 200-inch telescope be used to search for an optical object in the same place in the sky.

Dr. Sandage, in a recent 90-minute exposure, found a star at the precise position. It is accompanied by a faintly luminous nebulosity measuring about five by 12 seconds of arc. The star is at right ascension $1^h\ 34^m\ 51^s$, declination $+32°\ 54'.2$ (1950 co-ordinates), just where the radio source is located, so there is practically no doubt that the two are the same.

Spectrograms taken by Jesse L. Greenstein and Guido Münch of Caltech, and by Dr. Sandage, show a combination of strong emission and absorption lines unlike that of any other star known. The star or its gaseous envelope contains ionized calcium, ionized and neutral helium, and possibly oxygen ionized many times. The spectrum shows no hydrogen, the main constituent of all normal stars.

Since the distance of 3C-48 is unknown, there is a remote possibility that it may be a very distant galaxy of stars; but there is general agreement among the astronomers concerned that it is a relatively nearby star with most peculiar properties. It could be a supernova remnant. The radio output may be intrinsically 10 million times stronger than the sun's.

If the star were surrounded by high-energy electrons traveling in a magnetic field at near the velocity of light, the resulting synchrotron radiation would produce both its light and the radio energy. Despite its yellow color, the star is unusually bright in the ultraviolet region of the spectrum, an indication of synchrotron radiation.

Radio Observations of a Planetary Nebula

During the past four years, several observatories have attempted to detect radio emission from planetary nebulae. The first definite success was recently achieved by University of Michigan astronomers A. H. Barrett, W. E. Howard, and F. T. Haddock, in measuring radiation from NGC 6543. This planetary, at right ascension $17^h\ 58^m.8$, declination $+66°\ 38'$ (1950 co-ordinates), is one of the brightest in the sky and remarkable for its seemingly helical structure.

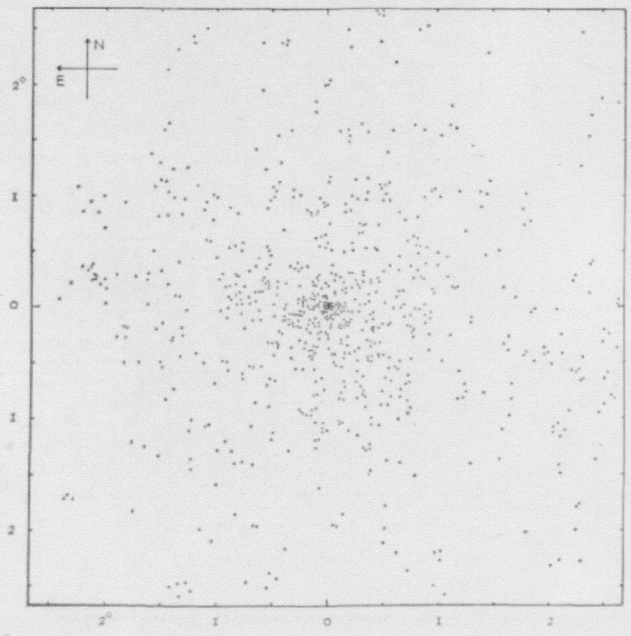
For their 3.45-centimeter (8,700 megacycles per second) measurements, the Michigan team used the 85-foot Portage Lake radio telescope equipped with a ruby maser developed by M. E. Bair, J. J. Cook, and L. G. Cross. On two occasions the nebula was observed by the drift-curve method, in which the antenna was pointed just west of the object, which was then allowed to drift through the antenna beam. On two other dates, the antenna was alternately pointed toward the nebula and away from it.

These observations demonstrated the existence of a radio source agreeing in position with the nebula, and having dimensions considerably smaller than the antenna beam-width of 6½ minutes of arc. A radio flux of 4.0×10^{-27} watt per square meter per cycle per second was indicated by the antenna temperature of 0.034° Kelvin.

This is a considerably weaker source than predicted. From the properties of NGC 6543, determined by optical observations, the Michigan astronomers had computed an expected antenna temperature of 0.074° K. A second calculation, based on data furnished by Donald E. Osterbrock, gave 0.135° K. Both predictions depend on an idealized model of the planetary, whose assumed distance of 1,100 parsecs is uncertain.

Recently Thomas A. Matthews has observed NGC 6543 at a wave length of 31.2 centimeters, using a 90-foot telescope of California Institute of Technology. He finds an antenna temperature consistent with the Osterbrock prediction.

On the other hand, microwave measurements of NGC 6543 that agree with the Michigan results have been made by Roger Lynds at the National Radio Astronomy Observatory.



The tendency of the members of the Coma cluster to be irregularly distributed is shown in this plot by F. Zwicky. In the central part, the average distance between galaxies is only about a tenth as great as in the general field of the sky around the cluster. Taken from the "Astrophysical Journal."

Clustering of Galaxies

Photographs taken with wide-angle telescopes show that the distribution of galaxies over the sky is distinctly non-uniform. Most astronomers believe that this is due to a tendency of galaxies to occur in clusters. This belief was critically weighed in a paper presented by Sidney van den Bergh, David Dunlap Observatory, University of Toronto.

He raised the question: Is a cluster of galaxies an indivisible unit, or divisible into subclusters? Furthermore, are clusters of galaxies the largest aggregations of

matter, or parts of still larger organizations?

Several lines of evidence against the clusters being basic units were advanced by the Canadian astronomer. He first called attention to the local group of galaxies (including our Milky Way, the Magellanic Clouds, the great spirals M31 and M33, and a dozen or more nearby systems). Often the local group has been regarded as forming a small cluster, but its members tend to occur in clumps of twos and threes, indicating subsystems.

Dr. van den Bergh also pointed out that the surface distribution of galaxies in the famous Virgo cluster is quite irregular. His recent study of radial velocities in the Virgo cluster shows that it contains stable binary and multiple systems.

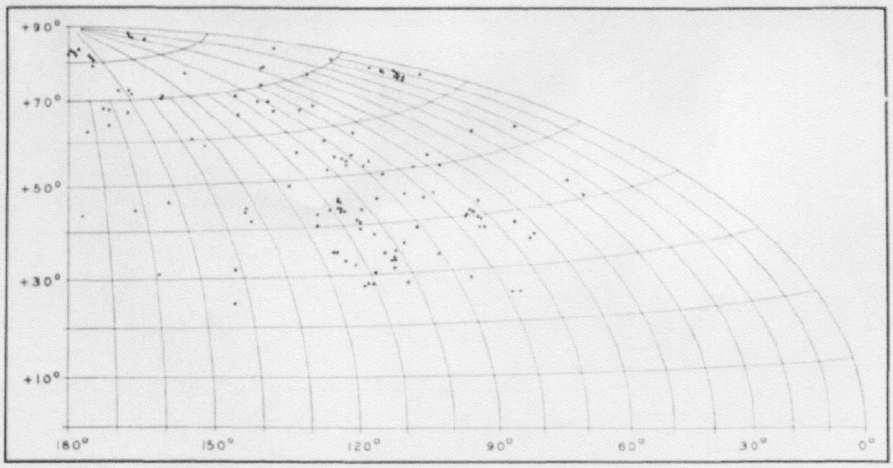
Another well-known cluster of galaxies, that in Coma, seems to have a rather smooth structure, on a simple examination of photographs. But Dr. van den Bergh has applied a more searching test. On pictures taken with the 48-inch Palomar Schmidt telescope, he measured the apparent separations among more than 100 galaxies near the core of the Coma system. Then he made similar measurements for a synthetic cluster whose members had the same radial distribution as in the Coma cluster, but whose directions from the center were purely random.

The test showed that small projected separations were more frequent in the actual cluster than in the synthetic one. This result implies that subclusters occur in the Coma system. They would be at least 225,000 light-years across, if the distance is of the order of 200 million light-years. However, as Dr. van den Bergh comments, this apparent subclustering might also be due to an incorrect choice for the cluster center, or to the existence of one or more small background clusters.

Although the Coma cluster seems to be an isolated unit, there is growing evidence that the clusters in general are not randomly spread over the sky, but have a tendency toward clumping. In 1958, George O. Abell, University of California, studied the distribution of 2,712 clusters of galaxies, demonstrating the existence of superclusters. At Lick Observatory, C. D. Shane and C. A. Wirtanen compiled contour maps from their counts of galaxies, showing many clouds consisting of one or more major clusters surrounded by lesser ones.

This Lick Observatory contour map indicates galaxy distribution in parts of Serpens, Bootes, and Virgo. The cloud at the upper left contains over 1,200 counted members in 20 square degrees; below center is a complex of 2,800.

In the sky chart below, the Canadian astronomer has plotted the rich clusters from the Abell catalogue that are so distant their red shifts approximate 50,000 kilometers per second. The arrangement is distinctly nonuniform, and inhomogeneities as large as 20 degrees in angular size are indicated. This pattern is not due to patchy absorbing clouds within our own Milky Way masking distant galaxies, Dr. van den Bergh argues. For example, the richest areas do not coincide with those in plots of somewhat less distant clusters. He therefore believes that the indications of superclusters are real and not merely apparent.



The galactic longitudes and latitudes of rich and very distant clusters of galaxies have been plotted here by Sidney van den Bergh, from data by George O. Abell. Below latitude +25° Milky Way dust clouds affect the counts.

Water Vapor on Mars

All spectroscopic searches for water vapor in the atmosphere of Mars have been negative, and lead to the conclusion that there cannot be more than 0.035 gram of water above each square centimeter of the planet's surface. Carl Sagan, of the University of California, reported recent calculations on the problem.

It has long been known that the observed surface temperature of Mars is about 30 degrees centigrade higher than would result from the sun shining on an airless planet at its distance. The amount of this greenhouse effect depends on the abundance of carbon dioxide and water vapor in the Martian atmosphere, and upon the infrared emissivity of the surface. Since the quantity of carbon dioxide is known from observation, and since the emissivity can be estimated within narrow limits, Dr. Sagan deduced that there is between 0.02 and 0.002 gram of water over each square centimeter.

He was able to make a second evaluation from the vapor pressure of water at the edges of the polar caps, where ice is subliming to vapor. This method gives about 0.01 gram per unit area.

Dr. Sagan concludes that the Martian water vapor could be measured directly if the sensitivity of present infrared spectroscopic methods were improved about 10 times, which might be possible if the observations were made high above the earth's surface.

He points out that such very low water vapor contents do not preclude life on Mars. There are terrestrial organisms (obligate halophiles) that fill their entire H_2O requirements from the moisture that collects on a crystal of salt.