ASTRONOMY

New Universe Signaled

Astronomers find that "radio stars" are not stars at all. Some are nebulae and galaxies. Reception of short radio waves from all parts of sky provides research tool.

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➤ VAST REGIONS of the heavens are now being explored through a new "window" in our atmosphere.

Astronomers for centuries have used one "window," that of light in the visible or near-visible range, to chart and study the stars. Now they are using radiation in the region of short radio waves to learn things about the universe that were unknown until the radio window was discovered.

Using the short radio waves, new objects were found in the sky—"radio stars"—a puzzle because they could not be matched up with visible objects. It now appears that radio stars are not stars at all, but much bigger things, with a measurable size. Some of these strange objects have been shown to be hazy masses of gas, of the kind which astronomers call nebulae. Others are far-distant galaxies, giant aggregations of stars well outside our Milky Way system.

Karl G. Jansky of Bell Telephone Laboratories, opened up the new science of radio astronomy in 1932, when he found that radio waves are striking the earth from all parts of the sky. The first extensive study of these waves was carried out by Grote Reber in his own backyard. Soon after the war, scientists in Australia and England showed that some of these waves are coming from a few special points in the sky. These became known as "radio stars."

The discovery greatly excited astronomers, who tried to find visible stars or other objects that could be sources of the radio waves. In most cases, however, this could not be done. The radio stars were nowhere near the brightest visible stars, and usually there was no conspicuous objects at all in the region of the radio source.

It appeared that a radio star must be some new type of object in the sky, a body that produces a lot of radio energy, but not much light, or perhaps even no light at all.

Called "Radio Stars"

Early observations showed that the apparent sizes of the sources were all smaller than a fraction of a degree, but how much smaller could not be determined. Stars are the best-known objects in the sky so the first thought was naturally that the new celestial bodies were stars. Thus the sources were named "radio stars" without any real justification.

When the first attempt to identify the radio stars with the nearest and brightest visible stars had failed, radio astronomers set to work to make more refined observations and build better—usually bigger—equipment in order to pinpoint the radio stars more accurately.

Soon John G. Bolton of the Radiophysics Laboratory, Sydney, Australia, was able to show that a radio source in the constellation Taurus, the bull, was associated with the Crab Nebula. This hazy object is known to be the remains of a supernova, a star whose violent explosion was witnessed by Chinese astronomers 900 years ago.

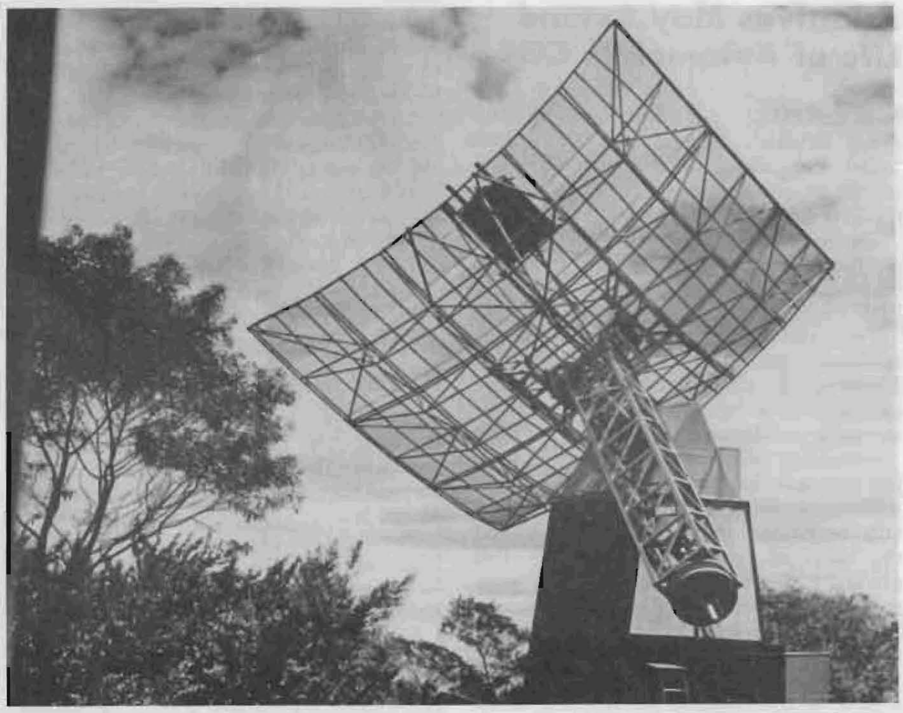
Following this first identification, Mr. Bolton found that two radio stars in the constellations of Centaurus, the centaur, and Virgo, the virgin, were very close to external galaxies of an unusual character, and suggested that these were the radio sources.

Soon afterwards, Bernard Y. Mills, also of the Radiophysics Laboratory, showed that three sources in other constellations have angular sizes of about half a degree, and therefore must be some kind of nebulae.

Thus there was a lot of evidence that some kinds of nebulae and galaxies were powerful sources of radio waves, but none pointing to stars or starlike objects. Only a handful of the known radio stars had been identified, however. In particular, the sources in the constellations of Cassiopeia and Cygnus, the swan, which are by far the most powerful of the radio sources, could not be associated with any visible object.

R. Hanbury Brown of the University of Manchester, England, Mr. Mills and Dr. F. G. Smith of Cambridge University, England, have recently, working independently, found it possible to "resolve" the Cygnus source. That is, they have been able to distinguish it from a blurred-out point. The two English scientists have also resolved the Cassiopeia source, which cannot be seen from Australia. Both sources are found to have angular sizes of about one-twentieth of a degree, and must therefore resemble nebulae.

While these radio measurements were being made, Drs. Walter Baade and Rudolph L. Minkowski had been looking in the directions of these radio sources with the 200-inch telescope at Mt. Palomar Observatory, and had found two very interesting objects that were in the right positions and proved to be just about the size obtained in the radio measurements.



RADIO TELESCOPE—One of the antennas used by Australian astronomers to catch the radio waves being broadcast from the heavens. The 17-foot square reflector, of parabolic shape, is also used to observe radio noise from the sun.

The radio source in Cygnus is a very unusual galaxy, far beyond our Milky Way system. It appears, in fact, to be two galaxies that have collided with one another.

While the stars of one galaxy are passing through between the stars of the other, the tenuous gas between the stars must be stirred up into violent motion, evidently generating powerful radio waves.

The Cassiopeia source is a hazy and faintly shining nebula. The shape is very irregular and the various parts are apparently moving rapidly. Perhaps it, like the Crab Nebula, is the result of some long-ago explosion. A very similar object has now been seen by Dr. Baade in the constellation Puppis, the stern, in the position of a radio source previously discovered by Mr. Bolton.

Although astronomers cannot yet say with certainty that all radio sources are nebulae, all present evidence points towards that conclusion. Certainly there are no proved radio stars, but there are many proved radio nebulae. Some of these are very distant galaxies of unusual types. Others are nebulae inside our own Milky Way galaxy, vast patches of shining gas, millions of times the size of a star.

Doesn't Show Fine Detail

A major difficulty in identifying radio stars with visible objects lies in the fact that a radio telescope, although a very sensitive instrument, is not very good at seeing fine detail. The resolving power of a telescope, either an optical or radio type, is proportional to its diameter. Therefore, the bigger the telescope, the more clearly can it register detail. The resolving power, however, also depends on the wavelength. For visible light the wavelength is very small.

The diameter of an optical telescope is very many times greater than the wavelength, and so the images it produces are sharp and clear. The wavelength of radio waves is a million times greater than that of light, and the diameter of a radio telescope usually contains only a few wavelengths. The resolving power is therefore low. The images are blurred, and the position and size of a radio source cannot be accurately fixed.

For measurements, to settle the question of the size of radio sources, a radio telescope is needed that can resolve sufficiently fine detail. A single antenna would need to be several miles across—clearly impracticable. Work on radio stars is usually done with an interferometer, in which the antenna is split into two separate parts. The resolving power of the system increases as the two parts of the antenna are separated more and more. Systems with antenna separations of several miles have recently been set up.

It is with such antennas that Dr. Smith, Messrs. Mills and Brown, and others are now trying to resolve sizes of other heavenly sources of radio waves.

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