Sharpening the View of the Radio Sky

The first radio telescopes had such low sensitivity that on the sky maps they made it was impossible to tell whether the radio galaxy Cygnus A was a discrete source or merely a local enhancement of the general sky brightness. Cygnus A was the first radio galaxy to be identified. In the decade since, as sensitivity of receivers has improved, many more have been identified and catalogued. Radio galaxies are the largest single structures astronomers study. Though associated with optical galaxies, radio galaxies extend over much more space than their optical counterparts. Their structures and dynamics pose fascinating questions for theorists.

The world's most sensitive instrument for the study of extended radio objects is the array of telescopes at Westerbork in the Netherlands. It has been engaged in a general survey of the statistics and morphology of radio galaxies, and a report on the latest results of those studies was presented at last week's meeting of the Astronomical Society of the Pacific at Berkeley, Calif., by Harry van der Laan of the Leiden Observatory. Van der Laan summarized the work of a large number of astronomers, some of whom consider themselves collaborators and others perhaps competitors. But all gave him permission to refer to new and in many cases as yet unpublished results. It was especially fitting that he do so at a symposium in honor of the late Rudolph L. Minkowski, since it was one of the prime activities in the latter part of Minkowski's life to cooperate with radio astronomers in finding optical identifications for radio sources.

One of the prime things to do with a new and more sensitive instrument is a general survey that looks especially for fainter examples than previous work could find. The Westerbork array has so far surveyed 96 chosen fields in the sky and found 1,100 radio sources. Of these, 1,000 are weaker than those in the third Cambridge catalogue (3C), previously the standard list. In 53 fields there are 623 radio sources, and of these, 289 could be identified on plates from Mount Palomar.

Once the radio sources have been found, their optical counterparts must be identified. "Minkowski warned us not to be too hasty" in making identifications, van der Laan reminds his colleagues, and even with today's sharper equipment it is still good advice. The work is painstaking and involves collaboration of radio astronomers in Westerbork and in Bologna, Italy, and optical astronomers in California and at the McDonald Observatory in Texas. Optical spectra and redshifts, important for astrophysical and cosmological studies, can then be obtained.

Van der Laan points out that there is a bonus involved in such surveys for other astronomers. The instrument looking over such a field records a lot of data not relevant to the immediate purpose but that could be useful to other astronomers at other times. The information is being collected in a data bank for reference.

One of the statistical things the surveys have revealed is a relation between the optical and radio luminosities of the galaxies. It involves a doubly complete sample: 54 giant elliptical galaxies that are known radio emitters. The study produced what van der Laan calls the first published bivalent luminosity function, a function that relates visible and radio luminosities to each other. It seems that the brighter a giant elliptical galaxy is in visible light, the more likely it is to be a strong radio emitter.

Close looks at individual radio galaxies are removing some questions about their morphology and dynamics while opening new ones. It was generally thought that the radio sources were double—two large lobes of radio-emitting material extending on opposite sides of an optical galaxy. It is now seen that most are at least triple. A third radio source generally coincides with the core of the optical galaxy.

One counter example—a source previously thought quadruple, that is, two pairs of lobes—has been removed from the mystery list. A sensitive look has shown that the source, 3C315, is really two lobes with large loops at the ends.

A curious geometric quality that occurs in some cases is a rotational symmetry. If one lobe is rotated around the central galaxy and brought to coincide with the other, the shapes of the two are often seen to be more or less congruent. The material in the lobe is electrically charged, and so there are magnetic fields there. The polarization of the radiation can tell the direction of the fields, and curiously in the relaxed or more tenuous parts of the lobes, they lie parallel to the lobe axis. In the denser areas they wrap around the periphery. The shapes of the radio galaxies have led most astronomers to assume that the lobes are made of material pumped out by the nucleus of the optical galaxy. It now appears that there are tunnels in the galactic and intergalactic material through which these ejecta from the nucleus move. The tunnels tend to be narrow within the boundaries of the optical galaxy and wide outside it. Whether the tunnels are real or a kind of radio-optical illusion—and they drew some sharp questions from the audience—remains for further study.

Finally there is the remarkable persistence of the directions of the lobe axes. One example, 3C273, has a triple structure in its central radio component. Yet these three small components lie on an axis parallel to the large lobes, though there is a difference in length between one to ten parsecs in the axis of the central triplet and hundreds of kiloparsecs for the large lobes. The lobes tend to come and go over astronomical stretches of time, but somehow the central pumping mechanism remembers the direction it was pumping and rebuilds along the same axis.

Van der Laan presents all these questions to theorists in the hope that they will begin cogitating about them. □

Age of supersonic passenger travel begins

Two supersonic Concorde aircraft rest nose to nose in front of the Dulles Airport terminal after their first commercial transatlantic voyages to the United States from Britain and France. Critics charge that the $60 million planes will serve only the rich (one-way fare to London, $804) and that their noise and emissions will damage the environment. Federal Aviation Agency officials said on landing, the two planes produced noise readings on the ground of 112.7 and 116.5 decibels—less than the 118 decibels produced by a Boeing 707 that landed a few minutes earlier. On takeoff, however, one Concorde produced levels of 129 decibels—two and a half times louder than other commercial jets—exceeding some noise regulation standards.