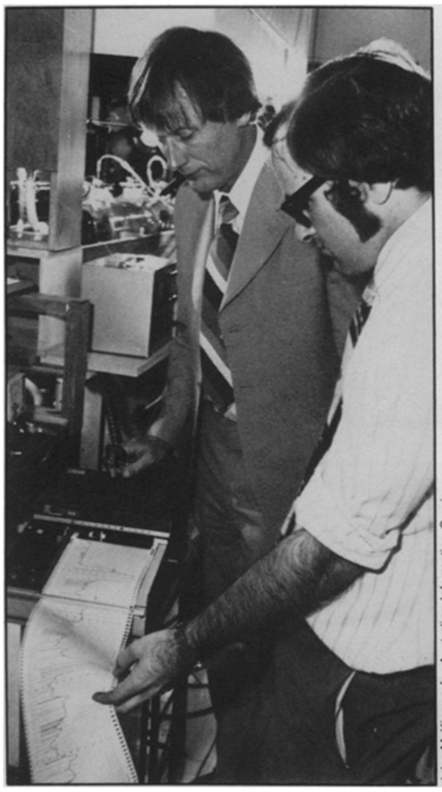
An interstellar radical identified: HNC

Up to now, radio astronomers have identified 35 different molecules in the gas clouds of interstellar space by the particular patterns of microwave frequencies they emit, and have laid the foundations for a new science, sometimes called molecular astronomy and sometimes astrochemistry. Among the identified microwave emission lines there have been a few that remained mysterious. One of these, first seen in 1971 in a cloud near the center of the galaxy and since often referred to as X-ogen, has now been identified by chemists at Monash University in Australia. It makes the 36th identification.

A five-year search by a team led by Ronald Brown, chairman of the university's chemistry department, ended when Hugh Gunn, a post-doctoral fellow at Monash, who comes from New Zealand, identified the mystery molecule as HNC. The molecule (HNC), which really hasn't a name, is the chemical twin of a molecule with a slightly different order of the same three atoms, HCN, hydrocyanic or prussic acid. Hydrocyanic acid, a common insecticide, is also a favorite way of making corpses in mystery novels. Its existence in the interstellar clouds has been known for some time.

When X-ogen was discovered, HNC was one of the prime candidates for identification. Why it took so long to confirm—and the people at Monash weren't the only ones in the world working on it—illustrates a serious two-fold difficulty of molecular astronomy. Chemistry knows millions of compounds. Until the advent of astrochemical studies by radio telescope in 1968, there was not a great deal of interest in the microwave spectra of many of them, even the simplest. So it often happens that when the radio astronomer detects a particular microwave emission line in an interstellar cloud, he cannot find it listed in spectral catalogues, but has to go to the laboratory and determine for himself the spectra of plausible candidates and see if any fit the discovery.

Here, frequently, the second part of the difficulty enters. The physical conditions of interstellar space permit the long-term persistence of many highly reactive radicals, combinations of atoms that cannot maintain their independence under terrestrial conditions for very long before they combine with something else into a new compound. For example, HNC lives only a fraction of a second under terrestrial conditions. Trapping such radicals in the laboratory long enough to measure their microwave spectra is an arduous undertaking, but the Monash group succeeded in developing an apparatus and a trapping technique that allowed them to prolong HNC's independent existence enough to get its spectrum.


John McKinnon for Australian Information Service

Brown and Gunn read HNC spectrum.

The newly identified radical is only one of many organic compounds found in the interstellar clouds, and more and more theorists are beginning to suspect that interstellar matter makes an important contribution to the beginnings of life. To those who think that way, the discovery of an amino acid in the interstellar clouds would be a great coup. Chemically, the simplest amino acid is glycine, and the Monash group's next project is to identify glycine's microwave spectrum in the laboratory so that it can be searched for in the sky. □

A quasar that's far, far away

The light that comes to us from objects outside our galaxy exhibits spectra that are always more or less shifted to the red. If these redshifts are Doppler shifts (that is, due to difference in speed between us and the extragalactic objects), then it is possible to deduce the distances of the objects by means of the relation Edwin Hubble worked out from his expanding-universe hypothesis.

Some of the largest redshifts ever measured are found in the spectra of quasars. If these are Doppler shifts, that would mean the quasars are at the far edge of the observable universe. But the observed brightness of quasars is such that for them to be so far away requires them to have fantastic powers of energy generation. Some astrophysicists don't like this and propose that the quasars are really much nearer and that most of their redshifts come from a different cause: gravity. A strong gravitational field at the source of the light will cause a redshift, and quasars appear as though they might be the sort of dense, compact objects whose gravitational fields could produce appreciable redshifts.

Proponents of Doppler redshifts for the quasars and proponents of gravitational redshifts have argued back and forth for 14 years. Now a group of astronomers, including Arthur M. Wolfe of the University of Pittsburgh; John J. Broderick and James M. Condon of Virginia Polytechnic Institute, and Kenneth J. Johnson of the U.S. Naval Research Laboratory, report an observation that they say gives "strong evidence" for the Doppler shift side and therefore cosmologically important distances for quasars.

The argument on which the observation is based goes like this: If one can find a galaxy in front of a quasar, the quasar has to be at least as far away and probably farther than the galaxy. The redshifts of both can be determined. The distance of the galaxy can be determined from its redshift. Galactic redshifts have to be Doppler shifts; galaxies don't have strong enough gravity for an appreciable gravitational shift. Then the quasar's redshift, if it is larger than the galaxy's must be all or nearly all Doppler and thus a fairly reliable guide to the quasar's distance.

According to an announcement by the National Science Foundation, which funded part of the work, what Wolfe and his associates found was a cloud in front of the quasar 3C 286. This cloud is not the kind often found associated with quasars and believed to be emitted by them, but rather one typical of a galaxy, so it indicates the presence of a galaxy there. The cloud has a somewhat smaller redshift than 3C 286. The cloud's redshift would put it at 17 billion light-years. That in turn puts 3C 286 at 22 billion light-years.

(These distance estimates seem to be greater than the highest current estimates of the age of the universe. However, determining distance from redshift requires use of an equation containing the factor known as Hubble's constant. Astronomers' estimates of this constant have been rising lately as techniques of determining it are improved. It is possible that for a while distance determinations by the Hubble constant may outrun estimates of the age of the universe done by other means. Eventually a reconciliation ought to come about.)

It is probable that proponents of gravitational redshift will not lie down quite this easily. Wolfe concedes that "further experiments must be performed to confirm this result." And some of the gravitational-redshift people may demand further examples as well. Nevertheless Wolfe says, "it seems the end of the great quasar-distance debate is in sight." □