which have been detected in space by their microwave radiation or absorption in the past eighteen months or so. Since the end of 1968 there have been reports of microwave emission lines characteristic of ammonia and water, and a formaldehyde line has been detected in absorption. The existence of the hydroxyl radical in several regions of space has been known for some time, of course. But carbon monoxide is the first addition to the list since formaldehyde was found just over a year ago—after the successes of late 1968 and early 1969 it looks as if further lines are proving harder to detect. The reason is that the burst of activity last year exhausted the list of molecules which are likely to be abundant and which also have microwave lines in a part of the spectrum where the Earth's atmosphere is not an obstacle.

This is why the search for the carbon monoxide line at 2.6 mm was from the outstation of the National Radio Astronomy Observatory at Kitt Peak, Arizona, at an altitude of 2,064 metres. Lines from the other molecules at wavelengths of 1 cm or more have been in slightly more accessible parts of the spectrum. The 2.6 mm line was first observed on April 4 by Keith B. Jefferts, Arno A. Penzias and Robert W. Wilson of Bell Telephone Laboratories using the NRAO 36-foot telescope. According to the preliminary announcement of the discovery in *International Astronomical Union Circular No. 2231*, carbon monoxide has been detected in emission in five sources: Orion A, Sgr A, Sgr B, W3 and W51. These are believed to be regions where stars are in the process of formation. Sgr B, for example, is a dust cloud which is also known to contain ammonia at an estimated density of $3 \times 10^{-3} \text{ cm}^{-3}$ and formaldehyde to the extent of 10^{-5} cm^{-3} .

To a certain extent it is surprising that carbon monoxide should have been detected when the CH combination was thought to be the most likely next addition to the list on account of its expected abundance. This was not accepted by everybody, however. Last year W. Klemperer of Harvard was giving reasons why carbon monoxide might be expected to be more abundant than CH, for example. And in any case the presence of formaldehyde, H_2CO , must have made the detection of carbon monoxide likely. So far, however, there are no details of the abundances in the five sources containing carbon monoxide.

Not least of the problems which this new branch of astronomy has raised is the question of how the molecules come to exist in the first place when they are expected to be dissociated easily by the ultraviolet photons of starlight. The answer is probably that the molecules are shielded by the dust clouds in which they are often found, and it follows that grains of dust may somehow act as a catalyst encouraging the aggregation of atoms into molecules. This is one way in which the microwave work is adding to an understanding of interstellar dust clouds. Another is that the displacement of the microwave lines from their expected positions by the Doppler effect is beginning to give information about motions within the clouds. In several cases evidence is accumulating that the clouds are ring structures surrounding a central object. According to the *IAU Circular* the carbon monoxide line from Sgr A has a complicated structure indicating a range of velocities of more than 100 km s^{-1} , in line with the sort of values indicated by other microwave lines.

A different kind of problem is set by the observations of the formaldehyde absorption line. In several cases the absorption line has been detected in directions in which there is no continuum source—in other words, the 2.7 K background radiation is being absorbed. What the explanation of these so-called "black holes" is remains the most important mystery in this branch of microwave astronomy.

MATERIALS

Carbon and Graphite for Industry

from a Correspondent

MODERN economic trends clearly influenced the programme of the conference held in London by the Society of Chemical Industry on April 14–17 to discuss the properties and usage of carbon and graphite. Reduced interest in the resistance to ablation of nuclear graphite reflected the recent government decision to proceed, not with the AGR, but with the high-temperature nuclear reactors, cooled by helium, using a pyrolytic graphite in the capsulation of the uranium fuel. There was, however, much interest in the structure and properties of carbon fibres, revealing that a break-through in bulk production is still awaited. Adsorptive carbons are becoming more important in pollution control and a significant development, illustrated by Dr E. A. Boucher (University of Bristol), could be the use of the activated carbon fibre, not as a reinforcing agent, but in the construction of purification filters, complementing the use of the hard, granular active carbons. The need for materials with exotic properties occupied Professor A. R. Ubbelohde (Imperial College, London). Exploiting the versatile electronic properties of graphite, he described graphite intercalates with electrical conductivities approaching those of metals, markedly anisotropic composites, and a carbon floc, resembling a carbon black, but with a bulk density of only 0.003 g cm^{-3} .

But such developments should not overshadow persistent and intensive research into the physics and chemistry of carbon and graphite, news of which formed the backbone of the conference. Professor J. M. Thomas (University of Aberystwyth) outlined how the kinetic energy of electrons emitted from carbons and graphite consequential to irradiation by high-energy electrons can yield information about the chemical composition of surface layers, a matter of great relevance to all aspects of carbon combustion chemistry. On carbon fibres there was a mood of pessimism, perhaps unfounded, that the polyacrylonitrile fibre was falling short of expectations and significant application was lacking. The fibre produced from pitch is much cheaper and will no doubt receive much more attention.

The intensity of the basic research into fibres is considerable. Drs K. F. Rogers and D. M. Kingston-Lee (Royal Aircraft Establishment, Farnborough) have enhanced the thermal stabilities of the bonding polyimide resin, and Dr D. H. T. Spencer (BCURA, Leatherhead) is examining porosity in fibres. Dr W. N. Reynolds (Atomic Energy Research Establishment, Harwell) reported the crystallography and mechanical properties of fibres and Dr W. W. Watt (RAE, Farnborough), describing the chemistry of carbonization within the PAN fibre, disapproved, in true boffin fashion, of all the publicity which has come his way.