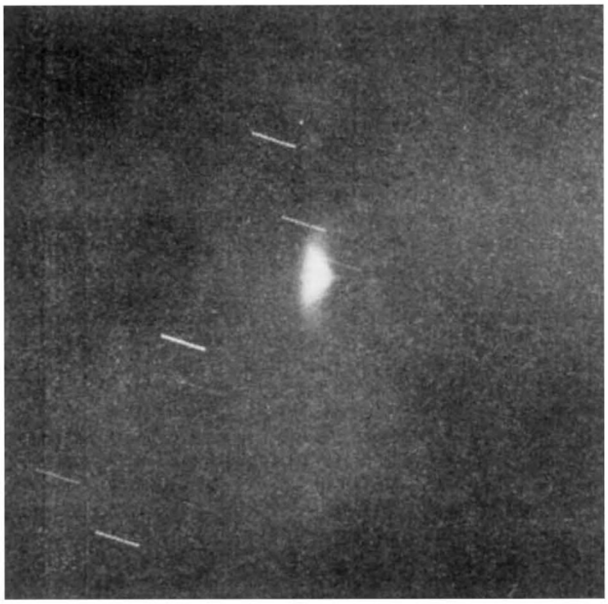

Fig. 1.

unintentional display of luminosity by Apollo 8 and its rocket shows that unburnt propellants in the rocket booster of a space vehicle might provide a glowing gas cloud throughout a journey to the Moon. Analysis of photographs of such a cloud might yield useful information on the structure of the outer reaches of the Earth's magnetosphere, just as analyses of clouds of glowing vapour from sounding rockets have been valuable in studying the upper atmosphere at heights between 100 and 200 km.

Fig. 1 is a photograph of the glowing clouds taken by Commander H. Hatfield at Sevenoaks, Kent, using a 12 inch telescope for guidance (1820 UT).

ASTRONOMY

Ammonia Line Detected

from our Astronomy Correspondent

THE spectrum of the radiation which radio astronomers collect is usually continuous, but a few spectral lines have been found and have turned out to be exceedingly useful. The most important are the well known neutral hydrogen line at 21 cm, which has made possible the charting of interstellar gas, and the line at 18 cm due to the hydroxyl radical. The detection of weak microwave emission from ammonia molecules in interstellar space by a team at the University of California, Berkeley, has now added another line to the list (*Phys. Rev. Lett.*, **21**, 1701; 1968). Although the result is not entirely unexpected, the measurement is nevertheless a considerable achievement by the five scientists responsible—A. C. Cheung, D. M. Rank and C. H. Townes of the Department of Physics and D. D. Thornton and W. J. Welch of the Radio Astronomy Laboratory. To pick up the ammonia signal, a new 20 foot diameter antenna, tuned to 1·25 cm, was set up at the Hat Creek Observatory of the University of California. The team directed its telescope at a number of objects, including Cassiopeia *A*, *W*51 and *NML* Cygnus, without finding ammonia emission or absorption. But observations of a dense cloud of gas and dust in the direction of the galactic centre yielded a profile of the predicted ammonia line after several hours of recording. During the observations the movement of the telescope to track the source was controlled by a computer, which also superintended an observing sequence designed to rule out the possibility of the signals coming from the Earth's atmosphere. Two lines corresponding to inversion transitions of rotational levels in the vibrational ground state of the ammonia molecule were picked up, but the detection of the weaker of the two lines is not definite.

A dense dust cloud in Sagittarius *A*, just south of the direction of the galactic centre, is probably the source of the emission. The region is also one in which there is strong absorption by the OH radical, which is presumably why the cloud was singled out for observation. According to the report, the frequency of the line is Doppler-shifted, corresponding to a velocity with respect to the local frame of rest of $+23$ km s^{-1}.

In its report, the California team speculates on conditions in the cloud, based on these preliminary measurements of the ammonia emission. Assuming that the cloud of ammonia is not optically thick, the number of ammonia molecules in all states in the line of sight comes out as 2×10^{16} cm^{-2}. Taking into account the size of the cloud, the volume density of ammonia molecules is roughly 10^{-3} cm^{-3}. This means that perhaps one per cent of the nitrogen in the cloud is combined with hydrogen as molecules of ammonia. Adsorption of hydrogen and nitrogen on grains of interstellar dust is the most likely source of the ammonia molecules, followed by sublimation, photodetachment or particle bombardment.

The detection of the ammonia line is important because of its relevance to the processes of star formation, which are believed to take place in the relatively cool regions of gas and dust clouds, where the hydroxyl radical is present. The cloud in Sagittarius is a typical example. Observations of the ammonia emission should help, among other things, in discovering the part played by nitrogen, and to this end radio astronomers will be scanning cool dust clouds for further signs of ammonia molecules.

RAW MATERIALS

Sweet Sense

ANYONE who was shrewd enough to invest his money in cocoa futures last January would now be sitting pretty with a very handsome profit. This January, the Cassandras of the commodity markets are tipping sugar as a sound gamble even though, at the United Nations this week, it looked very much as if as many as thirty-three of the major sugar exporting and importing countries, but not including the United States, which is not a member of the International Sugar Commission, had signed a new International Sugar Agreement in an attempt first to increase and then to stabilize the price of sugar on the world market. Since the expiry of the last international price agreement covering the five years 1959–63, the price of sugar has fluctuated between £100 and £10 a ton. In the past four years, however, it has been depressed at about £20 a ton. The sugar