year as the Earth moves in its orbit around the Sun, its velocity relative to ζ Oph changes. Owing to the Doppler effect, this velocity produces a shift in the wavelengths at which the C_2 lines appear, relative to the positions of the stationary oxygen lines. Only at a certain time of year are most of the C_2 lines not directly obscured by oxygen lines: this effect had to be taken into account in preparing our ESO observations request. The second named author, who has a knack for making sign errors in such velocity calculations, was naturally nervous about the prediction, and was greatly relieved when C_2 lines appeared between the oxygen lines as expected.

Observations of Highly-Reddened Stars

Since the C_2 absorption lines lie in the far-red part of the spectrum where the extinction is much smaller than in the blue, they may be observed in thicker interstellar clouds than most other molecules, in particular the H_2 molecule for which only resonance lines in the UV exist. We have therefore extended our search for interstellar C_2 to fainter stars ($V \simeq 8$) with a higher reddening ($A_v \simeq 3$ mag). Such clouds with $A_v \simeq 3$ are very interesting since they are generally dense enough to permit radio observations. They would therefore bridge the gap between the classical diffuse clouds investigated only optically, and the classical dark clouds studied only with radio techniques. The C_2 searches have already been successful for the clouds in front of the stars HD 147889 ($V = 8.1$, $A_v \simeq 3$), HD 29647 ($V = 8.3$, $A_v \simeq 3$) and very recently HD 169454 ($V = 6.6$, $A_v \simeq 3$). The last two clouds appear to be quite cool, $T \simeq 15$ K with $n \simeq 350$ cm^{-3}, in agreement with radio observations. On the other hand, the C_2 data suggest that the HD 147889 cloud is warmer, $T \simeq 70$ K, than the temperature $T \simeq 40$ K, inferred from radio observations. Much remains still to be learned about such clouds.

C_2 Abundances

Apart from the physical conditions, information about the abundance of interstellar C_2 can also be extracted from the observations. For the classical diffuse clouds, such as that in front of ζ Oph, the total C_2 column density is about 2×10^{13} cm^{-2} and its abundance relative to H_2 is about 5×10^{-8}. For thicker clouds, C_2 column densities up to 10^{14} cm^{-2} are found. No comparison with H_2 column densities is possible in these clouds, since the background stars are too faint to permit UV observations of the H_2 lines.

Detection of the Red System of CN

Recent observations of the CN molecule (Federman et al., 1984, ESO preprint no. 336) suggest a very interesting relationship between the abundances of the C_2 and CN molecules. Although ion-molecule reactions are generally thought to control the formation of small interstellar molecules in diffuse clouds, a neutral-neutral reaction must be invoked to explain the observed relationship between the C_2 and CN abundances. Further observational tests of this relationship are clearly needed, especially for denser clouds. So far, all CN observations have been performed in the blue around 3874 Å. However, there also exist resonance lines of CN in the red around 7900 Å, which are more suitable for studying the denser clouds. These lines have been observed extensively in the atmospheres of cool stars and comets, but not previously in the interstellar medium. If the relationship between the C_2 and CN abundances would also hold for the denser clouds with $A_v \simeq 3$ mag, then the clouds which have large C_2 column densities should also show strong CN lines. As a test, we have performed very recently observations (van Dishoeck and Black, in preparation) around 7900 Å toward the star HD 169454, which shows strong interstellar C_2 lines. A two-hour integration produced clearly the strong $R_1(0)$ line of CN with an equivalent width of about 9 mÅ! In addition, the $^RQ_{21}(0)$, $^SR_{21}(0)$, $R_1(1)$ and $^RQ_{21}(1)$ lines have been detected, whereas the $Q_1(1)$ and $^QR_{12}(1)$ lines are lost in atmospheric features. These atmospheric absorptions are due to water vapor; in order that they be as weak as possible, it is advantageous to have a very dry observational site like La Silla (see Brand, *The Messenger* **29,** 20).

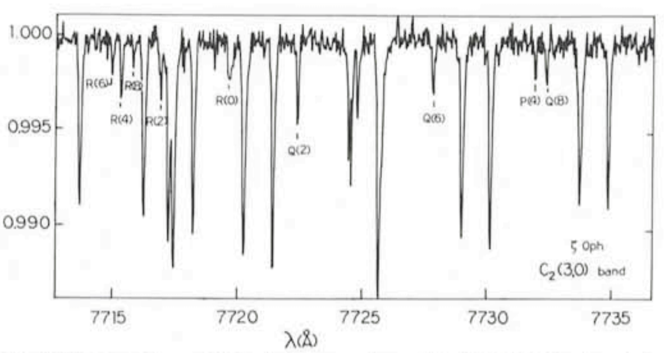

Fig. 4: *The spectrum of ζ Oph in the region of the (3,0) Phillips band of C_2, obtained with the CES. The total integration time was 7 hours. All features without identification are due to molecular oxygen. The C_2 Q(4) line is lost in one of them; the Q(10) line has been detected longward of 7735 Å.*

This (first) observation of the red system of interstellar CN is not only interesting for the determination of the CN abundance. It may also provide an important tool for measuring the temperature of the cosmic microwave background radiation at 2.64 mm wavelength by comparing the strengths of the lines originating from $J = 0$ and 1. Because CN has a large dipole moment, the population in $J = 1$ is very small and it can only be maintained by absorption of the cosmic background radiation. This analysis of the rotational population of CN has been done previously using lines in the blue system of CN (see e.g. Meyer and Jura, 1983, *Astrophysical Journal,* **276,** L1) with the result $T_b = (2.73 \pm 0.04)$ K, in agreement with a 2.7 K blackbody spectrum. A preliminary analysis of the red system gives $T_b = (2.6 \pm 0.3)$ K. Although this result is not yet as accurate as for the blue system, it provides an independent measure of T_b. Obviously, the data may be improved upon by using longer integration times or by choosing a more suitable background star, such as HD 147889 or HD 29647.

Concluding Remark

Because the CES affords very high resolution with excellent sensitivity in the far red part of the spectrum, it is now possible to invade the domain of radio astronomers and probe the interior of molecular clouds using optical absorption lines. Because the CES is so convenient to use, it is also possible for theorists like us to masquerade as observers from time to time with some success!

ESO-IRAM-Onsala Workshop on (Sub)mm Astronomy

In the context of the planned installation at La Silla of the 15 m (sub)mm telescope "SEST", a workshop will be held near Onsala from 17 to 20 June 1985. The scientific aspects will be stressed, and in particular the connection with work at other wavelengths. Further information may be obtained from Dr. P. Shaver at ESO in Garching.