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ASTRONOMY AND ASTROPHYSICS

Research Note

The Area Around the Orion Nebula Observed in the CO ($J=1-0$) Transition

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Summary. An area 1 deg^2 around the Orion Nebula has been surveyed with a 2.6 km s^{-1} wide single-channel receiver. The map shows considerable structure in the east including a bright spot 24′ (2.8 pc) from the main CO peak.

Key words: Carbon monoxide – H II regions – interstellar molecules – Orion Nebula

Introduction

The Orion Molecular Cloud has been studied using all the known molecular lines, and with many different spatial resolutions and sampling intervals. These observations have shown that the optical nebula is at the front of a much larger molecular cloud. Many of the observations of the molecular cloud are of its CO emission and these tend to fall into two categories: detailed observations of a small area near the Kleinmann-Low nebula with good angular resolution (e.g. Liszt et al., 1974) and low resolution observations of the whole molecular cloud (e.g. Kutner et al., 1977). There is also the high resolution, but poor angular sampling data of Phillips et al. (1975). More recently maps have been made of areas around the KL nebula with reasonable resolutions, such as Loren's (1979) work in an area of 0.18 deg^2 round the nebula and White et al. (1980) 0.6 deg^2 single channel map in the CO(2-1) line. This paper presents a map of the CO emission in a 2.6 km s^{-1} wide, band with complete angular sampling over a larger area (1 deg^2) and in particular shows a strong source to the East of OMC1.

Observations and Results

The observations were made using the 3.6 m Anglo Australian Telescope using an InSb hot-electron bolometer receiver mounted at the Coudé focus. The details of the observing procedures are given in Gillespie et al. (1977) but can be summarized as follows: the system noise temperature was 400 K and the beamwidth was 3.′2. The receiver has a single channel of bandwidth 1 MHz (equivalent to 2.6 km s^{-1}) and the map was made by scanning the telescope whilst switching the channel frequency between $v_{\rm lsr}=+9$ km s^{-1} and a reference frequency 20 km s^{-1} away. The data were taken as a set of 1° long scans sampled at 1′ intervals with constant declination. Each scan took 30 s and the telescope was then moved 2′ north for the next scan, taken in the reverse direction, for 30 scans. In this way a complete map was built up over a period of 15 min, and 17 such maps were made in two periods on successive days. This method of observing gives complete angular coverage and also smooths any short-term fluctuations in the atmospheric transparency over the whole map, giving good relative calibration across the map. Atmospheric absorption of $\tau=0.3$ was measured immediately after the observations by means of sky dips. The final map (Fig. 1) was made by adding together the declination scans after weighting the individual scans by the appropriate zenith distance and then smoothing the final set of 17 scans to a 4′ beam. It has a 1σ noise level of 1.2 K. The zero level of the map was confirmed by comparisons with spectra taken at the central peak. A 59 km s^{-1} wide spectrum was also taken of a peak discussed below at a position $\alpha_{1950}=05^{\rm h}34^{\rm m}22^{\rm s}$, $\delta_{1950}=-05°27.'6$ and gave a value of $T_A^*=22$ K and $v_{\rm lsr}=9$ km s^{-1} with half-power line-width 3.9 km s^{-1} (compared with $T_A^*=55$ K, $v_{\rm lsr}=9$ km s^{-1} for the main molecular peak). A 230 GHz spectrum taken at this position using

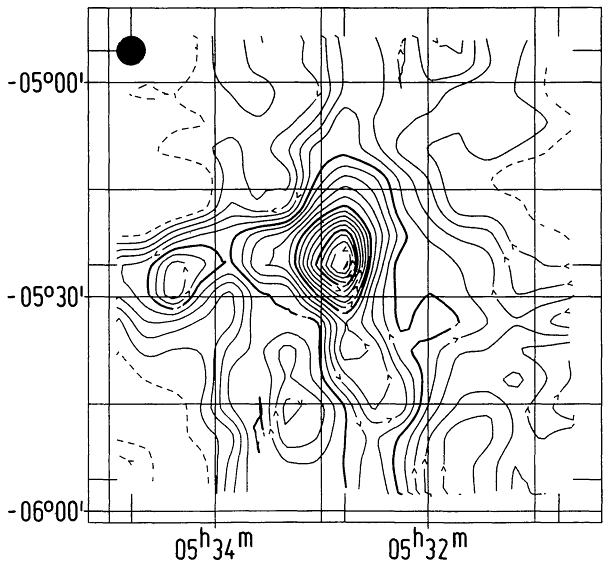

Fig. 1. CO emission observed around the Orion Nebula in a 2.6 km s^{-1} bandwidth centred on $v_{\rm lsr}=9$ km s^{-1}. The contour interval is 2.8 K, the zero contour is dashed and negative contours have been omitted. The smoothed beam size of 4′ is shown by the circle in the north-east corner

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an InSb detector of the Max-Planck-Institut at the ESO 3.6 m telescope gave $T_A^* = 20$ K showing that the CO is optically thick. The 115 GHz observations were made at the end of a period of daytime use of an optical telescope to study southern hemisphere sources and hence time did not allow maps to be made at other velocities, which would have been desirable as the emission covers a much larger velocity range than that covered in this map.

Discussion

The map shows the well known north-south extension of the Orion cloud. The main new feature is the source 24′ to the east of the main peak which is itself extended to this direction. There is also a ridge to the south east of the main peak and a large plateau to the west without any prominent peaks. A smoothing of the data to an 8′ beam gives a map in agreement with that of Kutner et al. allowing for our limited velocity coverage and the velocity gradients they observe. They see an extension to the east, but their large beam size and the position of their data points, which lay around the new source, smoothed the structure in the east into a simple ridge. The data are also consistent with the higher resolution map from Liszt et al. of the central source. Comparison with the work of Loren in the central part of our map shows good agreement to the east of the KL nebula, but we fail to see his source 10′ to the north west with no obvious reason for this discrepancy, although we do see a small extension of the main peak in this direction.

The new eastern source must be associated with the Orion complex as it has $v_{lrs} = 9\,\mathrm{km\,s^{-1}}$ and it can either be an independent site of star formation occurring in the molecular cloud or it can be caused by a shock. With the former explanations there would also be an infrared source at this position, but unfortunately there is no far-infrared data here and examination of a near infra-red plate from the UK Schmidt telescope shows that the source is within the nebula observed at those frequencies. The ridge to the south east is the one discussed by Loren, but these observations show that it is much larger than in his map with a minimum length of 3.5 pc and merges into the general CO emission to the south of the KL nebula. This suggests that it is part of the main CO cloud and is difficult to explain by a model with a 2–3 $\mathrm{km\,s^{-1}}$ ionization/shock front moving away from the Trapezium stars, as postulated by Loren.

Conclusion

The Orion Nebula area has been mapped at 115 GHz. The main features of the map are a peak 24′ to the east of the KL nebula and a long ridge of emission to the south and east which gradually merges into the general CO cloud to the south of the nebula.

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