LUNAR OCCULTATION OBSERVATIONS OF MILLIMETER CO EMISSION IN S255

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Observations of millimeter wavelength emission lines at the highest possible angular resolution are necessary to reveal the energetics and dynamics in compact regions of star formation activity. Lunar occultations of molecular clouds provide a means for obtaining angular resolution that is much better than that possible with a single radio telescope, and make it possible to study in more distant sources features at the same linear scale as those in Orion. We have recently used lunar occultations of the region around two infrared sources embedded in the S255 molecular cloud to determine the angular structure of the CO emission of the surrounding gas, and we have found that this region closely resembles the core of the Orion molecular cloud (Schloerb and Scoville 1980).

During 1978 and 1979 we used the Five College Radio Astronomy Observatory's 14-m antenna to observe three lunar occultations of the S255 molecular cloud in the CO J=1-0 transition. The resolution obtained by the observations was between 4 and 7 arcsec, and enabled us to resolve features that were much smaller than the 44 arcsec telescope beam. In addition to the large-scale structure seen in previous maps of this cloud, the occultation observations reveal two high temperature emission regions in the cloud core that are associated with two compact infrared sources separated by about 20 arcsec. The first of these high temperature regions, which is clearly present in all three occultations, is well modeled by a 40 arcsec (FWHM) gaussian with a peak temperature of about 65 K. The position of this component is close to that of S255 IRS2. The most recent occultation revealed evidence of a smaller (<7 arcsec) and hotter (>200 K) source at the position of S255 IRS1. Due in part to the better signal-to-noise then, this small feature has been observed unambiguously only during the most recent occultation, although there is some evidence for it in the previous two occultations as well. Further observations of this region will be necessary to confirm its existence and clarify its properties.

Overall, there exists a remarkable similarity between the scale and characteristics of the phenomena in S255 and those in the Orion molecular cloud. In both cases a grouping of two dominant infrared sources is found in a neutral molecular cloud at the edge of young HII regions. The

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sources are separated by $\lesssim 10^{17}$ cm. One of the sources in each region (S255 IRS1; and the Becklin-Neugebauer object, BN in Orion) has a relatively high color temperature ($T_C \sim$ 500-600 K) and dominates the near infrared emission, while the other, cooler source (S255 IRS2; and the Kleinmann-Low Nebula, KL) becomes bright only at $\lambda \gtrsim 10\mu$. The total infrared luminosities for these regions are also comparable to each other (8×10^4 $L_\odot$ for S255 IR, Beichman et al. 1979; and 1.2×10^5 $L_\odot$ for KL and BN, Werner et al. 1976). We find that these similarities persist when one compares the millimeter line characteristics. Both the peak temperature (65 K) and half intensity size of 0.5 parsec of the 40 arcsec CO source are in close agreement with the peak intensity and half power size of the Orion cloud core.

Since the infrared characteristics of the two regions are so similar, the similarity of the CO emission properties in the S255 and Orion clouds is easily accounted for if the H_2 gas (and CO) is heated by thermal collisions with the warm dust grains which surround the infrared sources. In such a model (Goldreich and Kwan 1974; Scoville and Kwan 1976), when the grains and gas are in thermal equilibrium, the gas temperature surrounding an embedded infrared source should depend mostly on $(L/r^2)^{1/5 \to 1/6}$. Since the luminosities are so nearly equal for these two regions, we then expect that the temperature structures should also be the same.

In seeking a counterpart to the small, hot CO source associated with S255 IRS1, one might look to the high velocity emission in Orion (Zuckerman et al. 1976; Kwan and Scoville 1976). Solomon et al. (1979) have recently determined that the center of this CO emission is close to BN (the counterpart of S255 IRS1) and its size is similar to that of the unresolved source ($\lesssim 2 \times 10^{17}$ cm). A sensitive search for high velocity CO emission at the position of S255 IRS1 would indicate whether the similarity to BN extends to the kinematic properties of the gas.

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REFERENCES

Beichman, C.A., Becklin, E.E., and Wynn-Williams, C.G.: 1979, Astrophys. J. (Letters) 232, L47.
Goldreich, P., and Kwan, J.: 1974, Astrophys. J. 217, 448.
Kwan, J., and Scoville, N.Z.: 1976, Astrophys. J. 210, L39.
Schloerb, F.P., and Scoville, N.Z.: 1980, Astrophys. J. (Letters) 235, L33.
Scoville, N.Z., and Kwan, J.: 1976, Astrophys. J. 206, 718.
Solomon, P.M., Huguenin, G.R., and Scoville, N.Z.: 1979, in preparation.
Werner, M.W., Gatley, I., Harper, D.A., Becklin, E.E., Loewenstein, R.F., Telesco, C.M., and Thronson, H.A.: 1976, Astrophys. J. 204, 420.
Zuckerman, B., Kuiper, T.B.H., and Kuiper, E.N.R.: 1976, Astrophys. J. 209, L137.