CO NEAR THE PLEIADES: ENCOUNTER OF A STAR CLUSTER WITH A SMALL MOLECULAR CLOUD

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Although there is a large amount of interstellar matter near the Pleiades star cluster, the observed dust and gas is not a remnant of the placental molecular cloud from which the star cluster was formed. Carbon monoxide (CO) associated with the visible reflection nebulae was discovered by Cohen (1975). Its radial velocity ($V_{LSR}=+10$ kms^{-1}) differs from that of the cluster ($V_{LSR}=-4$ kms^{-1}) by many times the cluster escape velocity, which implies that the cloud-cluster association is the result of a chance encounter. This circumstance and the proximity of the Pleiades to the sun creates an unique opportunity for study of interstellar processes at high spatial resolution. (At 125 pc, 1' corresponds to 0.036 pc.)

To study the molecular component of the gas, we mapped a 1.7 square degree field with the AT&T Bell Laboratories 7-meter antenna (1.7' beam) on a 1' grid in the J=1-0 ^{12}CO line, obtaining over 6,000 spectra with 50 kHz (0.13 km s^{-1}) resolution. The cloud core was mapped in the J=1-0 line of ^{13}CO. Further observations include an unsuccessful search for CS (J=2-1) at AT&T BL, and some ^{12}CO J=2-1 spectra obtained at the Millimeter Wave Observatory of the University of Texas.

Figure 1 shows a contour map of the ^{12}CO emission and the location of the 17 brightest cluster stars. Distinctive features of the Pleiades molecular cloud include the following.

1. The Pleiades molecular cloud resembles the small clouds detected at large galactic latitudes. There is no evidence for any ongoing star formation. The statistics of Magnani, Lada, and Blitz (1986) imply an *a posteriori* probability of order 10^{-3} for the observed encounter between the CO cloud and the cluster.
2. The cloud has a warm (T = 30 K), dense ($n_{H_2} \approx 1 \times 10^4$cm^{-3}) core a few tenths of a parsec in diameter, containing 10 $M_\odot$ of gas. The total cloud mass is about 20 $M_\odot$. The absence of detectable CS emission from such a dense core suggests that self-shielding of CS against ultraviolet radiation is negligible .
3. The portion of the cloud nearest to the bright cluster stars η Tau (B8 III, 2600 $L_\odot$ at a projected separation of 30' or 1 pc from the cloud core) and 23 Tau (Merope, B6 IV, 1100 $L_\odot$, 15,' or 0.5 pc) exhibits a precipitous edge in its CO brightness, suggesting a dissociation front. The CO "cliff" coincides spatially with visible reflection nebulosity and the far infrared peak observed by IRAS.
4. The molecular cloud has a "wind-swept" or cometary morphology. The CO radial velocities and the "wings" located on either side of the cloud core suggests that the low density portions of the cloud have been decelerated as they approach the cluster. Possible acceleration mechanisms include ram pressure of a low density heated ambient medium, radiation pressure, and the rocket effect on the cloud created by the ablation of heated gas escaping from the cloud surface.

5. The wing of the cloud near 17 Tau (B6 III, 1600 $L_\odot$, 30′ or 1 pc from the cloud core) clearly shows a bay in the CO emission contours, indicating the importance of photodissociation on the CO morphology.

6. The "tail" of the cloud presents a complex array of clumps and filaments. The clumps have radial velocities ranging from 7.5 to 10.5 km s^{-1} and masses less than 1 $M_\odot$. Clumps at the same velocity frequently lie along lines which point to the luminous stars, suggesting that mutual shielding by the clumps from the dissociating radiation effects the spatial structure of the molecular gas in the cloud tail.

References

Magnani, L., Lada, E. A., and Blitz, L. 1986, *Ap. J., 301,* 395.

Cohen, R. S. 1975, unpublished.

Figure 1: An ^{12}CO map showing the molecular cloud near the Pleiades. The contours show the antenna temperature (corrected to above the atmosphere) integrated from V_{LSR}=7kms to V_{LSR}= 12km s^{-1}. Contour intervals are in steps of 1 Kkm s^{-1}. The positions of several of the brighter members of the Pleiades star cluster are indicated in the map. The (0,0) co-ordinates are $\alpha(1950) = 03^h43^m21^s$ and $\delta(1950) = 23°\ 27'\ 00''$.