AN EXTREMELY LUMINOUS H_2 FLOW IN THE DR21 STAR FORMING REGION

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Previously, mapping of the spatial distribution and velocity structure of vibrational molecular hydrogen (H_2) line emission has necessarily been restricted to the central outflow region of the Orion Molecular Cloud (e.g. Beckwidth *et al.* 1983) where the line intensities are an order of magnitude larger than any other presently known H_2 emission source. However, an improved understanding of the role played by highly energetic gas flows in sustaining the observed H_2 line emission relies heavily on the collection of comparable data on other active star-forming regions. With this view in mind, we have undertaken a detailed H_2 line emission survey of the DR21/W75S molecular cloud complex. We considered this region to be one of the best candidates because it was already known to possess a luminosity (Harvey *et al.* 1977), CO wind velocities (Dickel *et al.* 1978, Fischer *et al.* 1985) and extended H_2 emission (Fischer *et al.* 1981) similar to those seen in Orion.

A map of the spatial distribution of the H_2 v = 1-0 S(1) integrated emission line intensity in the DR21 molecular cloud is illustrated in Figure 1; the map is fully sampled using a 10 arcsec beam. The near-infrared emission clearly delineates a highly collimated, bipolar structure extending over a projected distance of $\sim$ (D/3000) 5 pc, centered on the DR21 H II region/molecular cloud core (Harris 1973, Werner 1975). CVF spectra, taken at the peaks of line emission in both lobes, exhibit vibrational line ratios, v = 1-0 S(1): v = 2-1 S(1) $\sim$10:1, characteristic of shock excitation, i.e. the level populations are well modeled by a Boltzmann distribution at T $\sim$ 2000°K. Furthermore, the ratios of the integrated Q branch to v = 1-0 S(1) line fluxes indicate significant foreground extinction at 2.12 microns (3±1 mag). Consequently, we estimate that the dereddened luminosity in all H_2 lines, integrated over the entire emission region, is $\sim$ $(D/3000)^2$ 2000 $L_\odot$ (one order of magnitude more luminous than the Orion H_2 source). This places DR21 as one of the largest, most massive and certainly most luminous (in shocked molecular gas) of the currently known sample of galactic H_2 emission line sources (Shull and Beckwith 1982).

To compliment the mapping observations, we have also measured v = 1-0 S(1) line profiles, at 35 km s^{-1} resolution, at several positions along the outflow axis in both lobes (Figures 2 and 3). The profiles at

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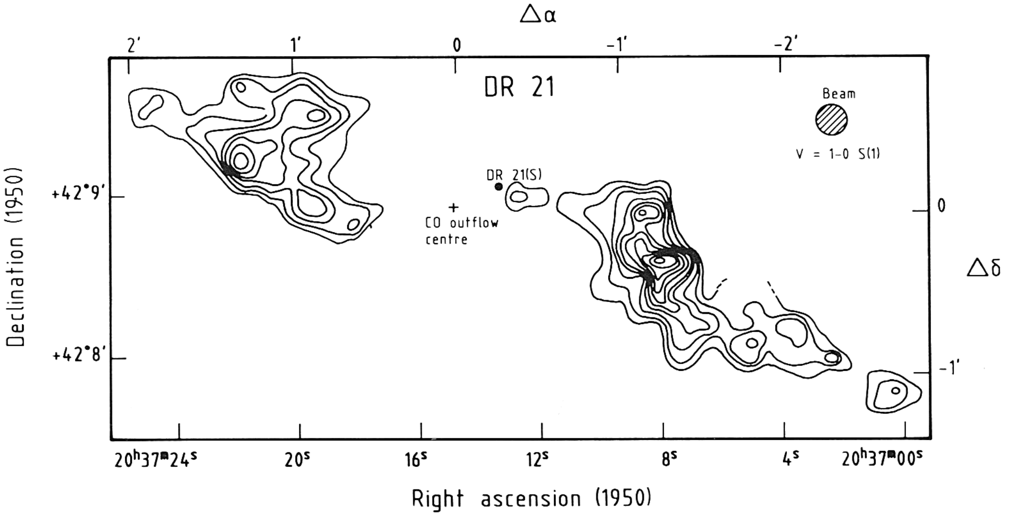
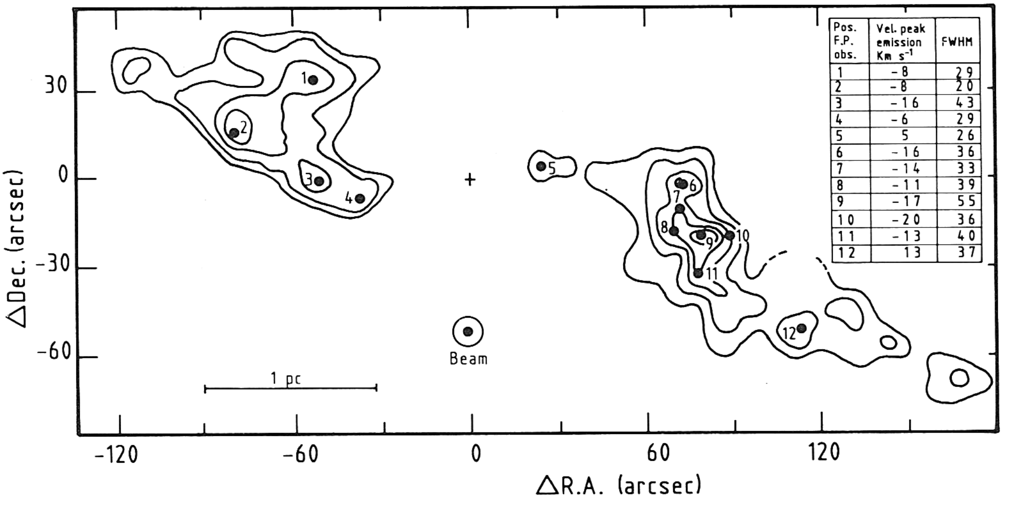


Fig. 1. Contour map of the DR21 H_2 source in the v = 1-0 S(1) line.



Pos. F.P. obs.	Vel. peak emission Km s^{-1}	FWHM
1	-8	29
2	-8	20
3	-16	43
4	-6	29
5	5	26
6	-16	36
7	-14	33
8	-11	39
9	-17	55
10	-20	36
11	-13	40
12	13	37

Fig. 2. Shows the location at which Fabry-Perot spectra were taken.

different locations in the flow show distinct differences in velocity at line peak and width at half maximum; indeed, some positions show velocity widths comparable to those observed in the Orion outflow source. The deconvolved emission in the high-velocity wings (> 50 km s^{-1}) greatly exceeds current theoretical dissociation limits (Draine *et al.* 1983) and most probably arises from shocked cloudlets moving at velocities comparable to the flow; the intense low-velocity line cores probably arise from the shocked ambient cloud gas, swept up to form a dense shell surrounding the high velocity expansion region. Non-radial motions (e.g. jet boundary oscillation, turbulence, etc.) within the outflow may account for some of the observed velocity widths.

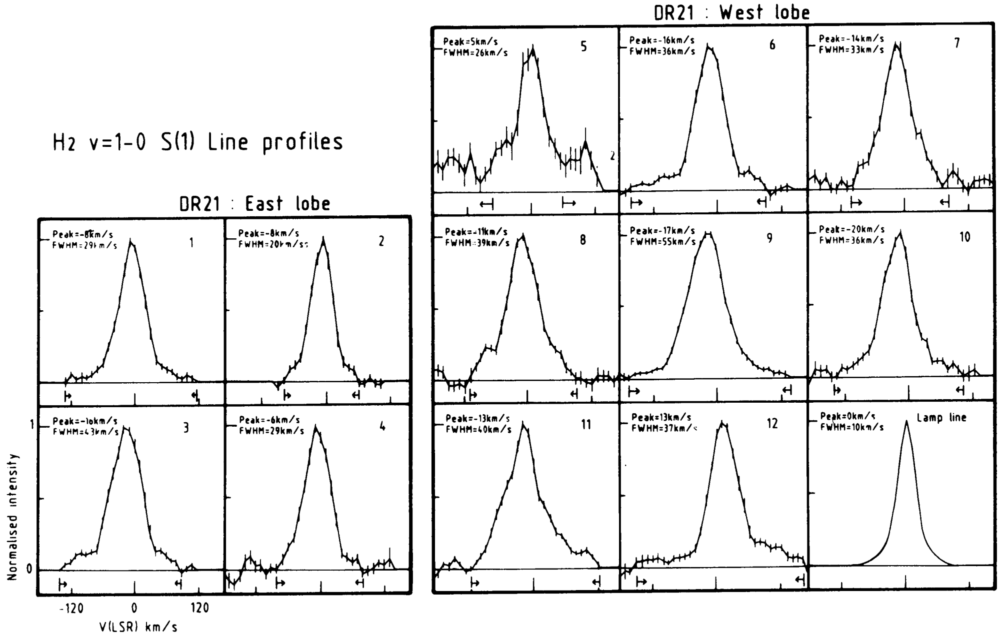


Fig. 3. Velocity resolved profiles of v = 1-0 S(1) line emission measured at each of the positions indicated in Figure 3. A warm, scanning Fabry-Perot interferometer of measured spectral resolution 35 km s^{-1}, and beam size 10", was employed.

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HIGH VELOCITY CO WINGS IN NGC 2071 AND GL 490 OBSERVED WITH THE 45-m TELESCOPE

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We have used the 45-m telescope for mapping two CO broad wing sources NGC 2071 and GL490 with a 15" beam in the J = 1-0 line. We obtained 250 CO and 130 ^{13}CO spectra for NGC 2071 and 150 CO spectra for GL490. The observations were made with the highest angular resolution for the CO line and, as well, cover the whole extent of the outflows. The results reveal significant details of the angular distribution of the CO wings.

The main points can be summarized as follows:
(1) The outflow consists of the high velocity component ($|\Delta v| \gtrsim 10$ km/s), and the intermediate velocity component ($|\Delta v| < 10$ km/s).
(2) The high velocity component appears well collimated and is being accelerated.
(3) The intermediate velocity component is mildly collimated and shows the signs of deceleration.
(4) The intermediate velocity component delineates a cavity, and the high velocity component is located in the central hole of the cavity.
(5) The ^{13}CO data are used to derive the filling factor in NGC 2071. We found that the outflow is growing in mass at $r \lesssim 0.1$. pc and the mass flux is nearly constant at $r > 0.1$ pc. Therefore, we suggest that the interaction of the disk or stellar wind with the ambient cloud is occurring mostly at $r \lesssim 0.1$ pc.

Based on these results, we suggest that the CO outflow consists of two components: the highly collimated velocity one, which is not interacting with the ambient gas, and the mildly collimated intermediate velocity one, which is significantly interacting with the ambient gas and is loosing momentum.