JCMT OBSERVATIONS OF CO(3-2) FROM M82

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INTRODUCTION AND OBSERVATIONS

The inner 500 pc of M82 is a nearby proto-typical starburst region. A starburst requires at least three conditions: (i) an adequate supply of gas, (ii) gathering of the gas within the starburst region, typically ≤ 1 kpc in extent in the nuclear region, and (iii) a triggering mechanism for the onset of star formation throughout the region. It is clearly important to understand the physical conditions of molecular gas in such regions.

By necessity so far, observations of extragalactic molecular gas have relied principally on the CO(1-0) transition alone. Inferences on the H\textsubscript{2} column density depend entirely on the assumption that molecular gas properties are identical to those found in the disk of our Galaxy. In starburst regions, the physical conditions are clearly different. For example, throughout the starburst region in M82, the far-UV flux is ~10\textsuperscript{5} L\textsubscript{\odot}/pc\textsuperscript{2}, comparable to that at 0.25 pc from the Trapezium stars in Orion. This may be quite typical in all starburst regions.

Thus, direct determination of the gas properties in external galaxies is necessary. Ideally, this requires observations of more than one transition from a variety of molecules at resolutions sufficient to resolve individual molecular clouds. J=2-1 and J=1-0 transitions of CO from M82 have been observed at high resolution.\textsuperscript{2, 3, 4}

We have used the 15-m James Clerk Maxwell Telescope to observe CO(3-2) transitions from the inner region of M82, in order to obtain further constraints on the gas properties in the starburst region. The telescope beam at A0.87" is ~14", with \( \eta_{mb} = -0.6 \) and \( \eta_{fs} = -0.7 \). The receiver used is a Schottky diode receiver with a carcinotron as local oscillator, and had a typical DSB T\textsubscript{R} \leq 1000 K. During the observations (Feb., 1988), the zenith opacity at 346 GHz was < 0.3.

RESULTS AND DISCUSSION

We obtained spectra at 18 locations sampling incompletely the central 1' x 0.5' region. The general profile shapes of the CO(3-2) emission and the integrated intensity distribution are similar to those of the 1-0 and 2-1 transitions of CO obtained at similar resolution.\textsuperscript{3, 4} The T\textsubscript{R} of the CO(3-2) emission within the region mapped is \( \leq 5 \) K, where T\textsubscript{R} = T\textsubscript{A} / \( \eta_{fs} \).\textsuperscript{6}

Figure 1: CO(3-2) emission at -12" to the west of the M82 nucleus along the major axis.

In determining line ratios, there are a few practical difficulties, such as calibration errors and differences in angular resolutions. Also, different J transitions may be sampling gas at different excitations at varying locations within the beam, and have different amount of self-absorption. To obtain constraints on the mean properties of the gas, we have chosen to compare the temperatures of the different J transitions at a point 12" to the west of the nucleus along the major axis. We use the 1-0 measurements from the Nobeyama 45-m (17" resolution) and the 2-1 measurements from IRAM 30-m (13" resolution). The 2-1/1-0 ratio of $T_R^*$ is -3, whereas the 3-2/1-0 ratio is -1. If we assume that all the J-transitions have the same distribution within the beam, then the 3-2/1-0 ratio indicates that the CO(3-2) emission cannot be optically thin, since the expected ratio of $T_R$ then is $9 \exp(-16.5/T_{ex})$. This would imply that the mean $T_{ex}$ of the gas within the beam of is not very high and that the filling factor of the CO(3-2) emission may be smaller than that of the lower J transitions. This research is partially supported by the U.S. National Science Foundation.

REFERENCES