RECENT CO(2-1) OBSERVATIONS OF GALAXIES WITH THE CSO

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ABSTRACT CO(2→1) observations of a number of galaxies have recently been obtained with the CSO. Examples are presented here to illustrate the capabilities of the instrument.

1. Introduction

The newly-constructed Caltech Submillimeter Observatory (CSO) on Mauna Kea, Hawaii, has been used to acquire observations of several galaxies in the CO(2→1) transition at 230 GHz. Currently, the 10.4 m diameter Leighton telescope is equipped with an SIS receiver with double-sideband noise temperature $\sim$ 200 K, and an acousto-optic spectrometer of bandwidth 500 MHz. The high surface accuracy dish, 30 μm, and the excellent atmospheric transmission make it well-suited for sensitive measurements of galaxies. Observations presented here demonstrate the versatility of the system and its potential for studying distant galaxies.

2. Results

New CO(2→1) observations of Centaurus A (NGC 5128) have been made to compliment the initial 7-point map of Phillips *et al.* (1987). These confirm that the molecular gas is rotating at velocities of a few hundred km s^{-1} in a direction perpendicular to the ellipsoidal stellar component (*c.f.* Wilkinson *et al.* 1986), reflecting the separate dynamical systems in this highly disturbed merger. They also allow an examination of the kinematics of the central core, where HI VLA observations (van Gorkom 1987) are handicapped by self-absorption. The molecular gas and far infrared emission distributions (Joy *et al.* 1988) are remarkably similar.

NGC 3256, whose characteristic "tails" and chaotic nuclear appearance at optical wavelengths clearly identify it as a merging system (Toomre 1977; Schweizer 1986), has also been studied. Molecular gas extends over 7 – 10 kpc around the nucleus, as does 10 μm emission (Graham *et al.* 1987), indicating that the enhanced luminosity seen by IRAS, 3.2×10^{11} $L_\odot$, is plausibly accounted for by a burst of star formation. Although the total mass of gas, 2×10^{10} $M_\odot$, is a factor of two higher than that associated with Arp 220, the order of magnitude lower luminosity suggests that in NGC 3256 the merger is less advanced (*c.f.* Joseph and Wright 1985). Indeed, ESO photographic plates, kindly provided by J. Bergeron, show two central condensations separated by only 4″, which could reflect the presence of independent nuclei.

CO(2→1) observations of four more distant galaxies, NGC 1614 (cz $\approx$ 4800 km s^{-1}), NGC 2623 (cz $\approx$ 5500 km s^{-1}), NGC 6090 (cz $\approx$ 6090 km s^{-1}), and Markarian 231 (cz $\approx$ 12700 km

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s^{-1}), have also been made. For the nearer objects, typical integration times were about 25 minutes, while the spectrum of Mrk 231 shown in Figure 1 was acquired in an hour.

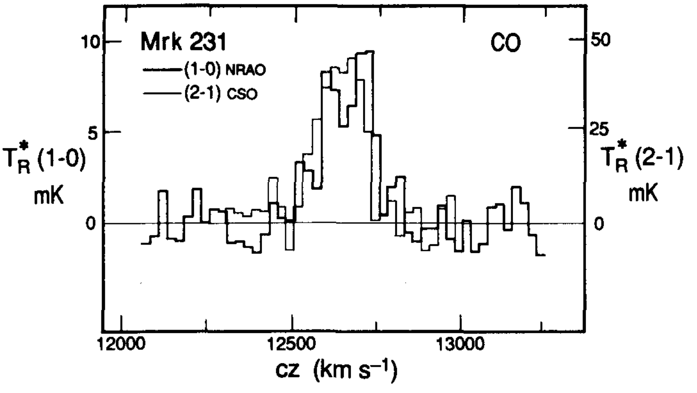

Figure 1. A spectrum of the CO(2→1) emission from Markarian 231 acquired at the CSO, superimposed on the CO(1→0) spectrum from NRAO

These CSO CO(2→ 1) spectra have been compared with CO(1→0) profiles obtained with the NRAO 12-meter telescope. The results for Mrk 231, displayed in Figure 1, are typical of galaxies unresolved by both instruments; the line shapes are very similar and the substantially higher values of T_R^* for the CO(2→1) line probably reflect only the ratio of telescope beam size. Thus we have as yet no evidence that the molecular gas, even in these distant galaxies, differs in its properties from molecular clouds in our Milky Way.

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