

CO Observations and the Tully-Fisher Relation at High Redshift

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Abstract. We performed deep CO-line observations of spiral galaxies at intermediate redshifts using the NRO 45-m telescope and obtained the CO linewidths of 16 luminous IR galaxies at redshifts $cz = 10,000 - 50,000$ km/s. The observed galaxies were selected by high FIR flux density and optically normal morphology to investigate the CO Tully-Fisher relation. When compared to other CO observations of intermediate redshift galaxies we find that our observations are more sensitive and reach larger dust-to-gas mass ratios.

1. Introduction

Previous CO observations of luminous IR galaxies at intermediate redshift ($cz \sim 10,000 - 50,000$ km/s) have focussed mainly on galaxies which are irregular or are merging (e.g. Mirabel et al.(1990), Sanders et al.(1991), Solomon et al.(1997), Lavezzi & Dickey (1998)), with the exception of the sample studied by Lavezzi & Dickey(1998). Here we present CO observations of such galaxies which have normal morphologies using long integrations with the NRO 45-m telescope and obtained CO linewidths of 16 galaxies up to $cz \sim 50,000$ km/s (Sofue et al. 1996, Tutui et al. 1999)

2. CO Observations

The CO luminosities and the redshifts cz of our sample are plotted in Fig. 1. Our observations are more sensitive than other surveys and are of normal galaxies. Comparisons of molecular gas masses derived from the CO intensities and dust masses derived from IRAS fluxes show that the galaxies in our sample have larger dust-to-gas mass ratios (see Tutui et al. 1999 for details).

We also observed one of the CO-detected galaxies in our sample (IRAS 02185+0642, $cz \sim 29,000$ km/s) using the Nobeyama Millimeter Array (NMA). The velocity field shows that the rotation is not disturbed. It supports the idea that our sample may be used to investigate the CO Tully-Fisher relation.

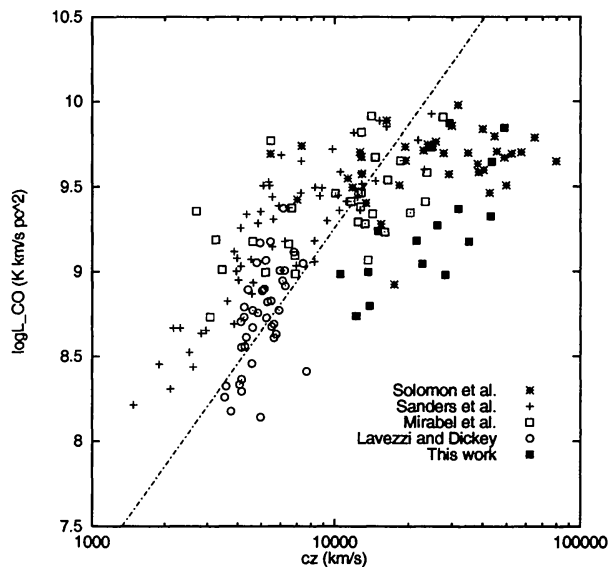
3. The CO Tully-Fisher Relation

One of our goals is to use our CO data together with the CO Tully-Fisher relation to measure the distances to galaxies and estimate the Hubble constant. We obtained photometric observations of our sample with the CFHT 3.6-m telescope and the Okayama Astrophysical Observatory (OAO) 1.88-m telescope. From these we estimated the individual Hubble constants, or Hubble ratios, for each galaxy (Sofue et al. 1996, Tutui et al. 1999).

4. Discussion

Our sample contains the largest number of faint CO-galaxies of normal type which are at intermediate redshifts. We compared their CO gas and dust masses, and found that our galaxies are dustier, or perhaps less luminous in CO than those of the other surveys. Further observations of our sample with an interferometer might reveal the CO / dust mass relation.

Fig. 1: Redshift cz vs CO luminosities for intermediate redshift galaxies. Filled squares are our sample. The dotted line means iso-flux density. Our observations are more sensitive than other surveys.



References

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