

# A Herschel Spectroscopic Survey of Warm Molecular Gas in Local Infrared Luminous Galaxies

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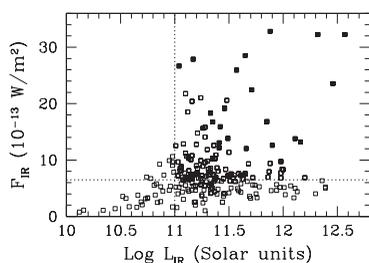
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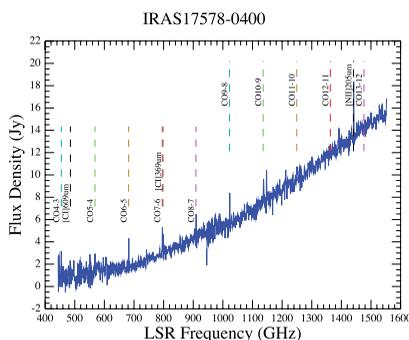
**Abstract.** We describe an on-going 194-671  $\mu\text{m}$  spectroscopic survey of a flux-limited sample of 125 local luminous infrared galaxies (LIRGs) with *Herschel* SPIRE Fourier Transform Spectrometer (FTS). The survey targets primarily the CO spectral line energy distribution (SLED), from  $J = 4-3$  up to  $J = 13-12$ , to probe dense and warm molecular gas that should play an intimate role in star formation and/or active galactic nuclear activities in these galaxies. The program is about 75% finished. At  $S/N > 5$ , besides the CO lines, we also detected [N II] 205  $\mu\text{m}$  and [C I] 370  $\mu\text{m}$  ( $^3P_2 - ^3P_1$ ) lines in every target observed. In about half of the observed targets, we also detected [C I] 609  $\mu\text{m}$  ( $^3P_1 - ^3P_0$ ).

**Keywords.** galaxies: ISM — galaxies: starburst — infrared: galaxies — infrared: ISM

Our sample is a flux-limited subset of the Great Observatories All-Sky LIRGs Survey sample (GOALS; Armus *et al.* 2009, *PASP*, 121, 559). Fig. 1 illustrates our SPIRE/FTS sample selection of 125 galaxies with  $L_{\text{IR}} > 10^{11} L_{\odot}$  and an IR flux  $F_{\text{IR}} > 6.5 \times 10^{-13} \text{ W m}^{-2}$ , of which 32 are covered by other existing SPIRE/FTS programs. Each of the remaining 93 targets, which represent more typical LIRGs, is being observed by us in a single telescope pointing that targets the nuclear position, with an integration time long enough to detect the CO( $J=6-5$ ) line at  $S/N > 5$ . Our SPIRE/FTS program should be completed by early 2013. Fig. 2 shows a typical spectrum observed, with expected or detected lines marked.



**Figure 1.** Plot of IR flux vs. IR luminosity for the full GOALS sample of 202 individual galaxies. The two dotted lines indicate the selection criteria for our SPIRE/FTS sample of 125 galaxies located in the right upper quadrant. The filled squares are 32 sample galaxies covered by other existing SPIRE/FTS programs.



**Figure 2.** The observed SPIRE/FTS spectrum of *IRAS* 17578-0400 with the expected lines marked.