Is there L_{FIR}-L_{HCN} correlation for low L_{FIR} isolated galaxies?

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ABSTRACT

We observed HCN(1-0) in 15 well isolated galaxies where 9 galaxies were clearly detected. The aim of these observations is to confirm the relationship between the (dense) molecular gas and star formation (SF) activity through the correlation found by [3][4] between the FIR and HCN luminosity. We find that the detected galaxies in HCN(1-0) have a lower HCN luminosity than the expected from the FIR-HCN correlation. This departure from the correlation may be due to an extended emission of the HCN(1-0) line in the galaxies. To prove this we mapped 4 galaxies that were clearly detected in HCN(1-0) at the center of the galaxy to measure their spatial extension and to get a more precise measurement of the total HCN(1-0) luminosity. The HCN(1-0) luminosity was compared to the CO(1-0) luminosity finding a ratio that implies that the galaxies in the sample have a low level of activity.

INTRODUCTION

The molecular ISM in galaxies has been extensively studied through the CO transitions at millimeter wavelengths. These transitions are good tracers of the molecular gas mass and represent the general distribution of molecular hydrogen ([16] [17]). High-density tracers, like HCN, add relevant information concerning the densest gas. Observational evidence accumulated in recent years ([9][10][6][7]) suggests a close relationship between dense molecular gas and massive SF in the center of galaxies. Indeed, in the center of starbursts, HCN is tightly correlated with the radio-continuum emission and the total L_{HCN} seems to be very well correlated with the L_{FIR} according to [11]. Recently [3][4] presented the results of a sensitive HCN(1-0) survey of IR-luminous galaxies were they concluded that the L_{IR} and L_{HCN} correltates linearly indicating a tight relationship between the SF and the dense molecular gas and that they also found a strong correlation between the L_{CO} and the L_{HCN}. The relation was confirmed at lower luminosity by [15] in the Giant Molecular Clouds of our galaxy. Nevertheless such important study is missing a genuine control sample for studying the behavior of the HCN emission in galaxies without interactions and with low L_{FIR}. For such purpose, the AMIGA project was created (see [14], [8], [13]). Moreover a recent study ([5]) has casted doubts on the use of HCN as an unbiased quantitative tracer of the dense molecular gas content in LIRGs and ULIRGs, mainly because of the X-rays coming from an embedded AGN which may play a dominant role in the chemistry of the molecules.

Fig. 1

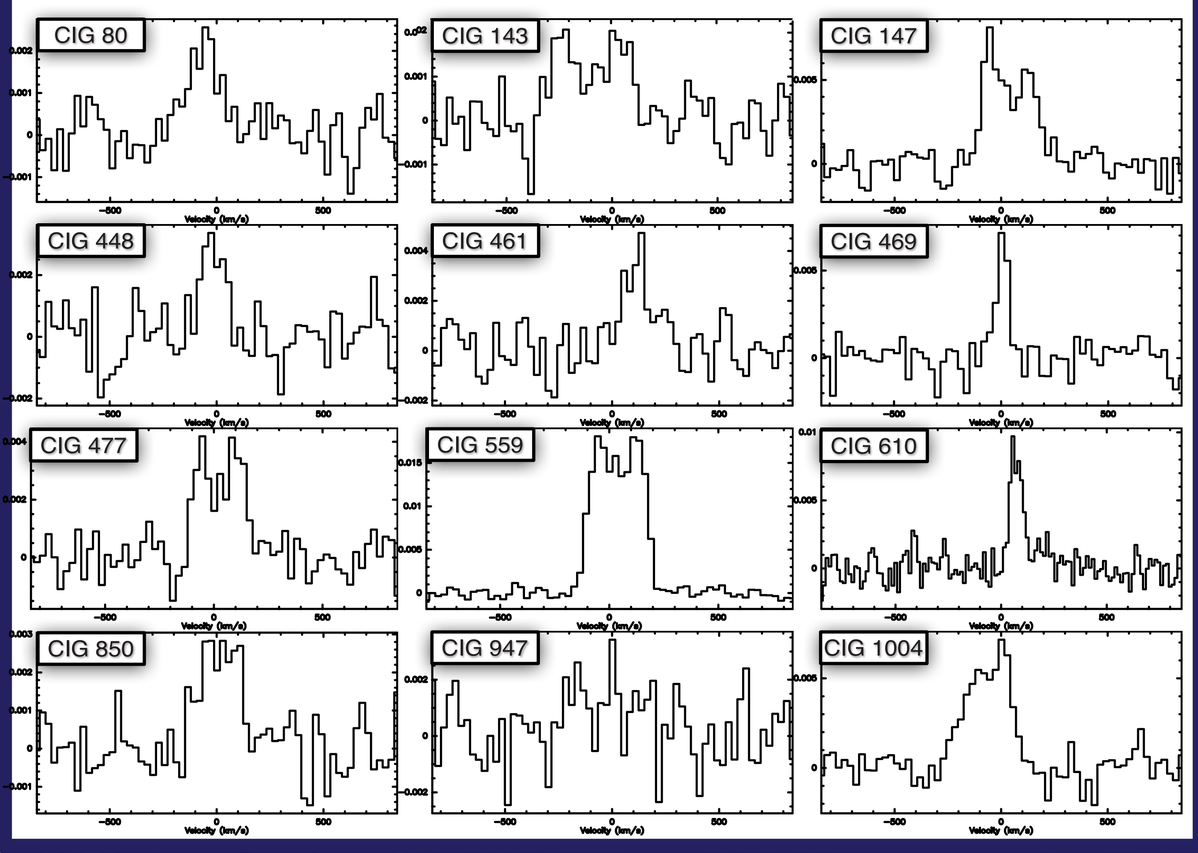


Fig. 3

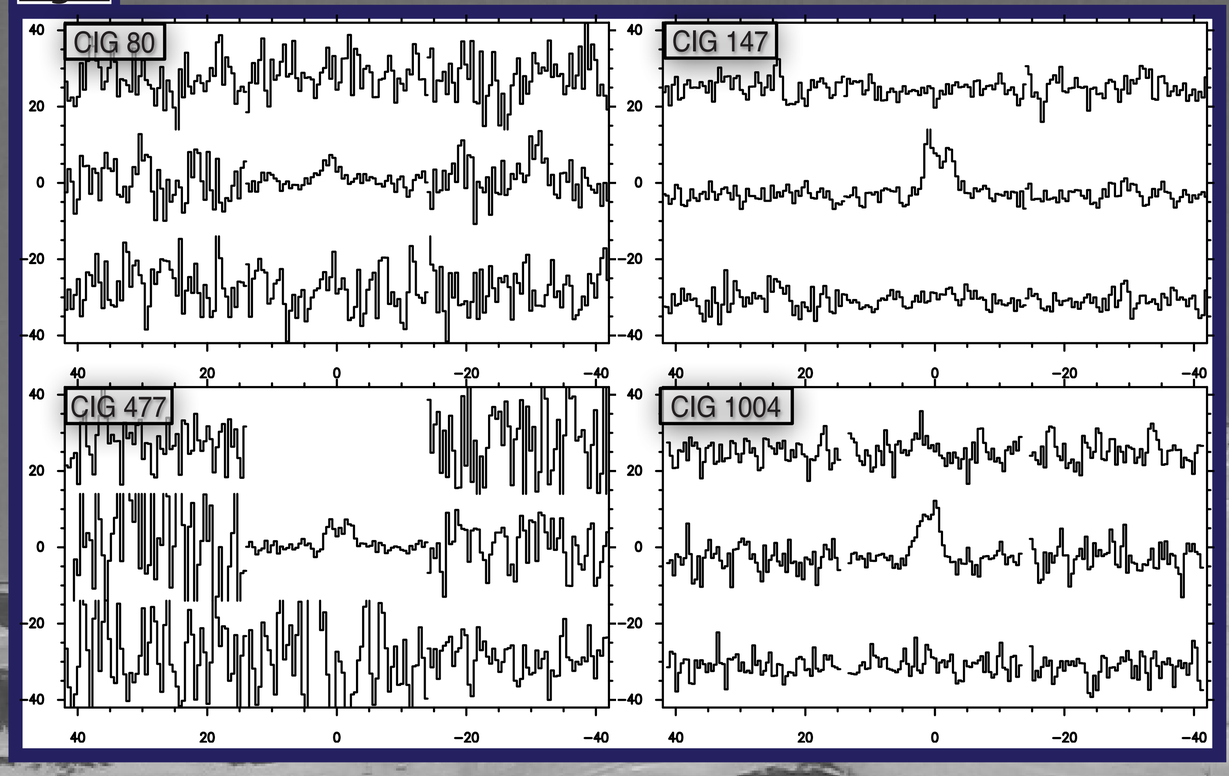
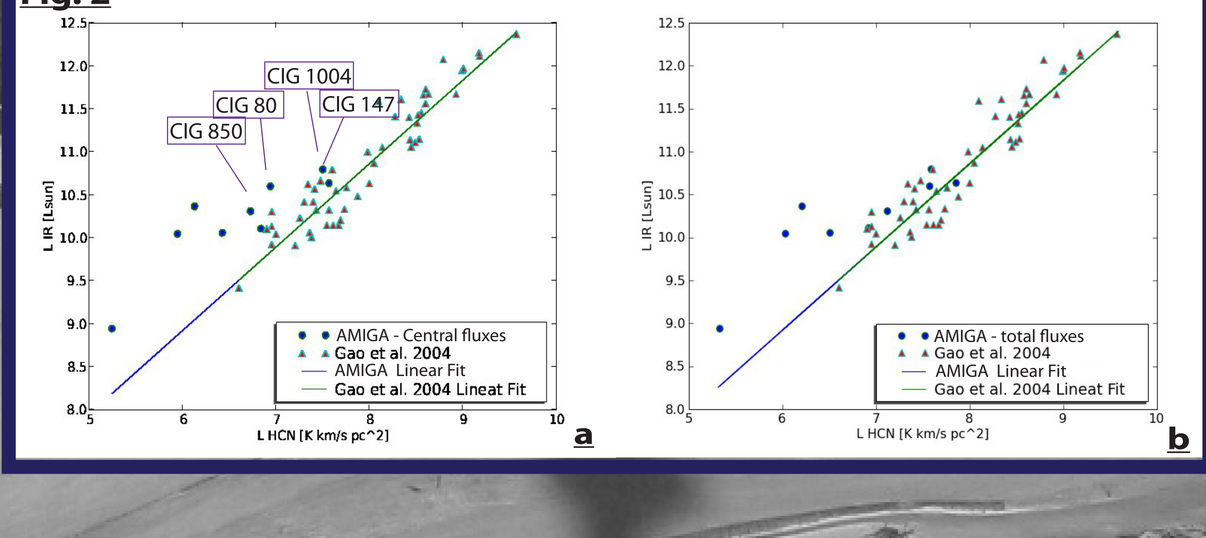


Fig. 2



HCN-FIR RELATIONSHIP IN ISOLATED GALAXIES

If the L_{HCN} is a dense gas tracer and the L_{FIR} a high-mass SF indicator, then the SFR/mass of dense gas would be the same for normal spirals and IR-luminous interacting galaxies ([12]). In this project we have clearly detected 12 galaxies (Fig. 1) at the center and we find a lower L_{HCN} than expected from the relation with the L_{FIR} (Fig. 2 a). One interpretation could be that we are only observing at the center of the galaxy, and we are missing some of the HCN(1-0) emission spread around the center. Indeed, the $L_{HCN(1-0)}$ is much lower than the predicted for the largest galaxies. According to [1][2] and [3] a substantial fraction of the HCN emission originates from their inner disks outside the central ~1 Kpc, even though the dense molecular gas is strongly concentrated in the central regions. We mapped some of galaxies to observe whether the HCN emission is concentrated only at the center or spread around the galaxy. Most of the dense gas seems to be concentrated at the center of each galaxy only that we are not reaching the total amount expected according to Gao and Solomon relation (GSR). From the maps (Fig. 3) it seems that the HCN emission is mainly concentrated at the center, but with some emission spread outside the center. Fig. 2b represents the total flux for the galaxies after mapping them and were we can see that the HCN flux is closer to what we expected on the galaxies with detections outsede the central part. We compare the HCN that we expected, calculated from the GSR, with the actual HCN from the IRAM-30m telescope for both, the flux at the center and the total flux . From the HCNexpected/HCNreal we know that we were expecting 2 times the amount of HCN that we actually got. If we compare only the galaxies were we detected HCN around the center, the ratio at the center is 1.26 and the ratio of the total HCN is 0.52, supporting the idea that the gas is not only at the center. HCN/CO ratio in our sample is 0.048, which according to [4] is a value for normal galaxies with low dense gas fraction.

CONCLUSIONS

* Relation HCN-FIR from [3] extends as well in isolated CIG galaxies with lower FIR luminosities.
* The HCN is mainly concentrated in the center but with some emission outside the center.
* HCN/CO for this sample is low , indicating that the galaxies are normal with a low level of activity.

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