ATOMIC AND MOLECULAR GAS IN LUMINOUS FAR-INFRARED GALAXIES

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We present the results from an HI survey of 160 IRAS galaxies with luminosities larger than 10^{10} $L_\odot$. The observations were made with the Nançay Radiotelescope and the overall detection rate is about 75%.

A distance limited sample ($V \leq 11000$ km s^{-1}) has been extracted from the above one for statistical studies. It contains 88 galaxies with HI detected in emission, which represents a 85% detection rate independant of distance. Inspection of the sky surveys shows that 37 of them are confused or interacting galaxies (the Nançay beam is 4' x 22') while 51 appear to be isolated. The F_{IR} luminosities span the range from 10^{10} to 2.5 10^{11} $L_\odot$. Higher luminosity galaxies are missing because their HI is mostly seen in absorption.

The overall properties of the "isolated" galaxies are compared to those of a reference sample of "classical" galaxies (Bottinelli, Gouguenheim, Paturel, 1980, 1982). The "isolated" galaxies have been binned into two classes : early type ones (type 0 to 2, that is So to Sa-b) and late type ones (type 3 to 5, that is Sb to Sc). The main results are the following :

- the galaxies are more luminous (L_B) than the reference sample, specially late type ones
- their diameter (Ao) is also larger, again with emphasis on late types;
- there is no systematic difference between HI and optical velocities;
- their indicative mass (Mi) is larger than in the reference sample by about a factor of 2.

These objects are therefore "giant" ones. This gigantism could be intrinsic or due to the merging of two or more "normal" galaxies, as suggested by the peculiar HI profiles.

Properties of the Atomic Gas

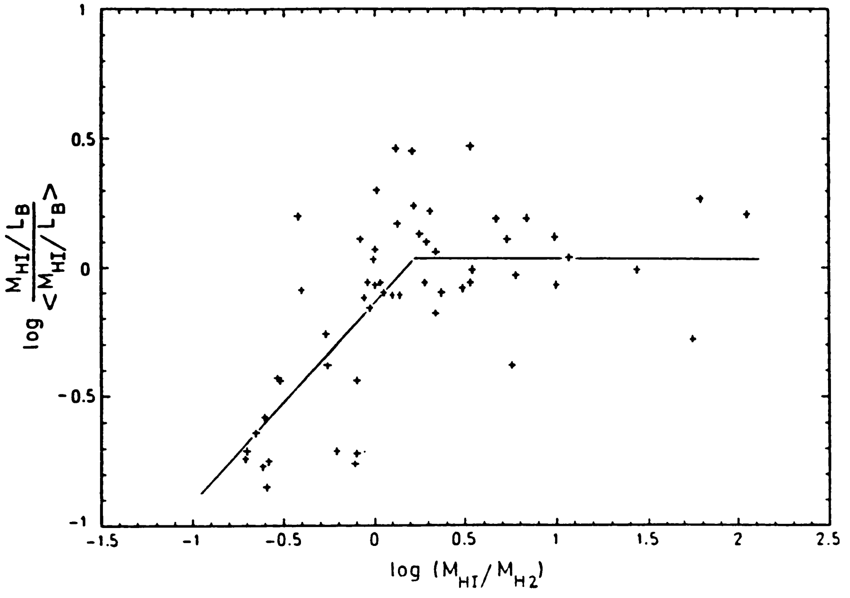
- The mean value of the HI mass is log M_{HI} = 9.72±0.04 for the whole sample, thus much larger than the mean value for reference spiral galaxies (9.54±0.02).
  Restricting to "isolated" galaxies, there is still an overabundance of about a factor of 2 for late type galaxies.
- There is a clear increase of M_{HI} with L_{IR}.
- However, the relative HI content (compared to L_B, M_I or diameter) is much lower than for the reference galaxies. In particular, the HI surface density is down by a factor of 1.5 to 2 compared to the reference galaxies. This deficiency is increasing with L_{IR}, and thus with the star formation rate.

  A straightforward interpretation would be that the gas has been used to form stars. However, we have first to take into account the molecular gas also !

F. Combes and F. Casoli (eds.), Dynamics of Galaxies and Their Molecular Cloud Distributions, 448–449.

Properties of the Molecular Gas

Waiting for the results of now scheduled CO observations, the molecular gas has been estimated in a first step from the L_{IR}-L_{CO} relation derived by Solomon and Sage (1988) followed by a standard $L_{CO} - M_{H_2}$ transformation. It appears that, at high IR luminosities, the proportion of molecular gas increases. This tendancy was independently found by Mirabel and Sanders (1989).



To illustrate this we show in the figure the relative HI deficiency (normalised to the average M_{HI}/L_B value for the reference galaxies) versus the HI/H_2 mass ratio, for galaxies with CO measurements in the sample of Young et al. (1989) which extends to lower F_{IR} luminosities. At the higher IR luminosities, where the HI deficiency is the largest, and only there, the molecular gas becomes clearly dominant. If we plot instead the total (normalised) HI + H_2 mass, the deficiency disappears (but a large scatter remains), suggesting that the HI gas has been transformed into molecular gas.

References

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