Molecular gas properties of the most isolated galaxies

U. Lisenfeld[(1,*)], D. Espada[(2)], L. Verdes-Montenegro[(3)], N. Kuno[(4)] & AMIGA team

(1) Universidad de Granada, Spain, (2) Instituto de Astrofísica de Andalucía-CSIC, Spain, (3) Center for Astrophysics, Cambridge, USA, (4) Nobeyama Astronomical Observatory, Japón

(*) Email: ute@ugr.es

Summary

- **The AMIGA project**: The role of nature vs. nurture for the properties and evolution of galaxies is still an open question. In order to find answers, it is crucial to have a well-selected sample of isolated galaxies as a baseline and comparison. We built, refined and analised such a sample in the project AMIGA ("Analysis of the Interstellar Medium of Isolated GAlaxies", http://www.iaa.es/AMIGA.html). The sample is based on the Catalogue of Isolated Galaxies (CIG) by Karanchenseva (1978) and the database (containing optical magnitude, Hα, far-infrared, radio continuum, HI and CO) enables us to characterize the properties of the star formation and interstellar medium.
- **The CO data:** We present CO data for 276 AMIGA galaxies, obtained to a large extent (189 galaxies) from own observations in addition to data from the literature. This sample enables us to characterize the molecular gas content of isolated galaxies.
- **Comparison to other wavelengths:** We show the comparison of the total molecular gas mass to the blue luminosity and the atomic gas mass. The molecular gas mass and the blue luminosity show a good correlation which can serve as a baseline to define the extected molecular gas content in a galaxy in the absence of interaction. The atomic gas mass is higher than the molecular gas mass for all Hubble types, and the ratio of the molecular-to-atomic mass ratio decreases towards late Hubble type.

The CO database for isolated galaxies

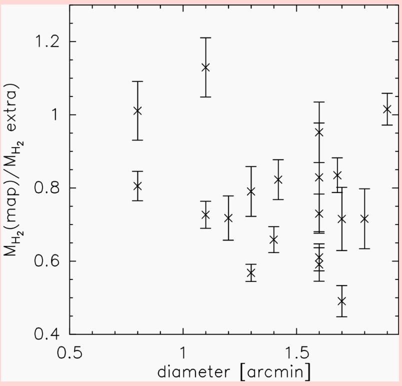


Fig. 1: Ratio between the molecular gas mass obtained from a mapping along the major axis and the mass extrapolated from the central pointing assuming an exponential distribution of the CO emission with r_e = 0.2 r_{25}. The data points are the 19 galaxies that were mapped with the IRAM 30m telescope.

We observed a total of 189 galaxies:

- 102 galaxies, with d_{25} > 100'', with the 14m Five College Radio Observatory
- 102 galaxies, with d_{25} between 45'' and 100'', with the IRAM 30m telescope. 19 of these galaxies were mapped along their major axis.
- 9 galaxies, with d_{25}< 45'', with the 45m Nobeyama telescope

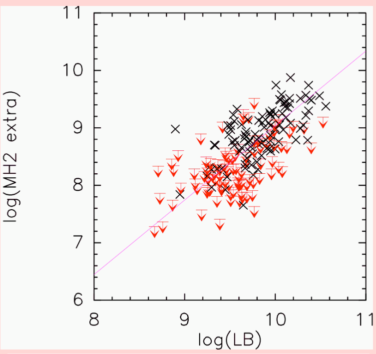
Some galaxies were observed at different telescopes in order to check the calibration.

Data from the literature was found for 87 additional objects.

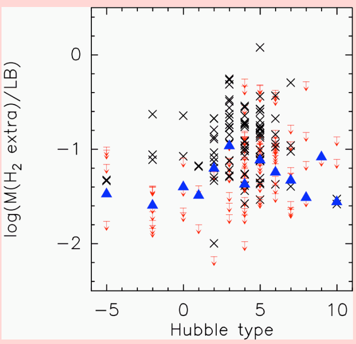
The molecular gas mass was caluclated assuming $N(H_2)/I_{CO}$ = 2.0 10^{20} $cm^{-2}(K\ kms^{-1})^{-1}$.

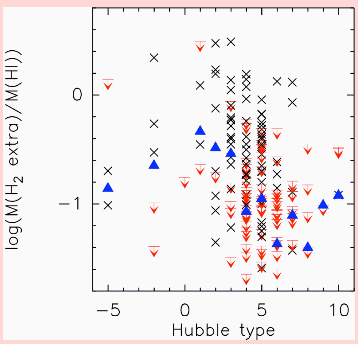
The total molecular gas mass, $M(H_2$ extra), in a galaxy was estimated by extrapolation, assuming that the CO distribution is exponential with a scale length r_e = 0.2 r_{25} (Leroy et al. 2008, AJ, 136, 2782; Regan et al. 2001, ApJ, 561, 218; Nishiyama et al. 2001, PASJ, 53, 757). This extrapolated molecular gas mass is in reasonable agreement with the total molecular gas mass obtained from the mapping along the major axis (Fig. 1) .

$M(H_2)$, M(HI) and L_B



The total (extrapolated) molecular gas mass and the blue luminosity show a good correlation. The line represent the best-fit line derived as a bisector fit taking into account the upper limits (using the package ASURV).





The ratio between the total (extrapolated) molecular gas mass and the blue luminosity (middle), respectively atomic gas mass (right). The mean value for each Hubble type, indicated as a blue triangle, is calculated with ASURV and takes the upper limits into account.

Whereas $M(H_2$ extra$)/L_B$ shows no obvious relation with Hubble type, $M(H_2$ extra)/M(HI) decreases towards later Hubble types. The latter is in agrement with previous findings (Young & Knezek 1989, ApJ 347, L55; Casoli et al. 1998, A&A, 331, 451). $M(H_2$ extra)/M(HI) is below 1 for all Hubble types, showing that the atomic hydrogen domiantes over molecular hydrogen.