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### THE PROJECT

- A definition of "isolated galaxy" is needed before one can properly assess the history and properties of peculiar ones.
- We are constructing the first complete unbiased control sample of the most isolated galaxies of the northern sky (Verdes-Montenegro et al 2001, 2002) to serve as a template in the study of star formation and galaxy evolution in denser environments.
- Our goal is to compare and quantify the properties of different phases of the interstellar medium in this sample, as well as the level of star formation, both relevant parameters in the internal evolution of galaxies and strongly conditioned by the environment.
- To achieve this goal we are building a multiwavelength database for this sample to compare and quantify the properties of different phases of the ISM. Our source list is based on the Catalog of Isolated Galaxies (CIG; 1051 galaxies) and our sample contains ~800 galaxies.

### THE CIG REFINED SAMPLE

Our reference sample is drawn from the Catalogue of Isolated Galaxies (CIG; Karachentseva 1973). Advantages of our CIG-based sample include isolation, morphological diversity, depth and completeness (reasonably complete out to  $V_0 = 10000$  km/s). We cover a range of optical luminosities of  $\log(L_B/L_{\odot}) = 8 - 11.2$ .

• We are currently refining:

✓ **Positions:** We revised positions for the 1051 CIG galaxies. Original measurements come from different sources (Simbad) and we have calculated the new positions in a uniform way. We have applied SExtractor to the Digitized Sky Survey CIG fields with a spatial resolution of 1.2", and an accuracy of 0.05". We have visually checked the resulting positions and for 143 galaxies we had to recompute the assigned positions due to irregular morphologies (e.g. distorted isophotes, undefined nuclei, knotty galaxies) or the presence of bright stars. We have found differences between the older and newer coordinates of up to 44.5" arcsec with a mean value of 1.8".

✓ **Velocities:** We obtained the best available redshifts for 926 CIGs from different surveys in the bibliography increasing by 458 those used in previous CIG based papers.

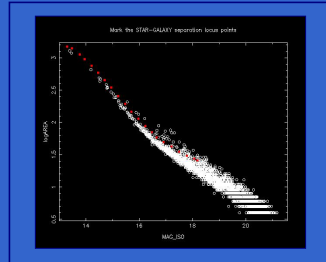
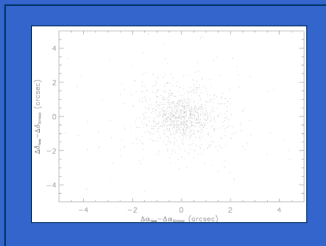
✓ **Isolation: done for 80% of the galaxies.** We are using the publicly available images of POSS-I E plates (as well as POSS-II F plates for some fields) in order to revise the isolation degree of CIG galaxies. These images are reduced using AIMTOOL in LMORPHO, and GUI-driven star-galaxy separation procedure is used to classify detected sources as: STAR, GALAXY, or UNKNOWN.

We have decided to use the logAREA vs. MAG\_ISO SExtractor parameter space to separate star-galaxy images measured on the images (middle right fig.). As a secondary check, the GUI allows the user to view the image catalog produced by CIGWORK (lower right fig.)

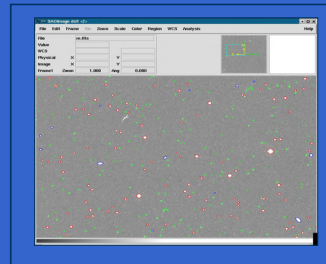
• <http://www.public.asu.edu/~gsiscs/documents/morpho/projects/cig/index.htm>

✓ **Morphologies: starting.** We will obtain automatic classifications of all CIGs detected in the POSS-II survey with  $g \leq 16.5$  and an isophotal diameter larger than 25", based on the method by Odewahn et al. (2002) which will provide us with Hubble type, family and a variety of properties. This quantitative classification allows to detect tidal tails and can be of much utility in relation with the degree of isolation of CIGs.

We started to perform a 2D Fourier analysis of the POSS II images in order to decompose the light distribution in the different modes for the extraction of the density wave patterns following the method in Del Río et al. (1998, 1999). Among others information on the opening of the spiral arms and deviation from a logarithmic spiral will be derived.

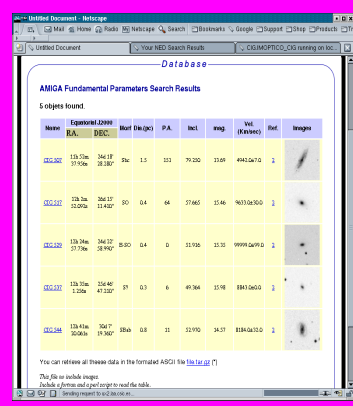
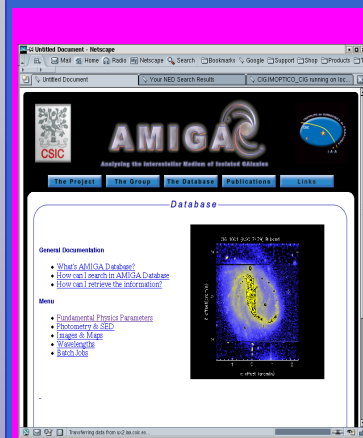


A typical star-galaxy separation parameter space from a POSS-I E image (CIG 714). All points that lie above the curve defined by the red points will be classified as GALAXY. The points below this curve (which is described with a cubic spline) are classified as STAR.



The distribution of galaxies around CIG 714 as viewed with CIGWORK.

### PUBLIC DATABASE



A Web interface is being prepared to make the survey database available to the community.

#### QUERY EXAMPLE

Both numerical data and images will be available and the search will allow "a-la-carta" subsamples construction.

## MULTIWAVELENGTH CHARACTERIZATION OF THE ISM

### HI: tracer of interaction

The goals of our HI study are

• To establish a statistically meaningful template for the HI content as a function of  $L_B$ ,  $\phi$  and morphology extending the earlier valuable HI survey for  $n=324$  galaxies (Haynes & Giovanelli 1984). We will both double the sample size and improve the quality of the lower sensitivity measures used in the earlier work, allowing a better quantification of properties for all subsamples.

• To characterize the degree of symmetry in the HI spectra of well isolated galaxies. Previous works based on smaller samples of isolated galaxies ( $n=104$  in Haynes et al 1998;  $n=30$  galaxies in Matthews et al 1998) suggest that 50-75% of them have asymmetric profiles. Other samples of galaxies in different environments (e.g. Swaters et al 2002, Richter & Sancisi 1994, Sulentic & Arp 1983) give similar rates of asymmetric profiles. This is a striking result that will be clarified in our study. Perhaps some of the "isolated" galaxies in previous studies were not so isolated.

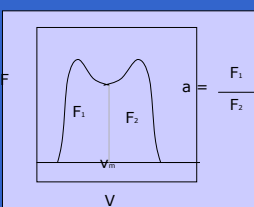
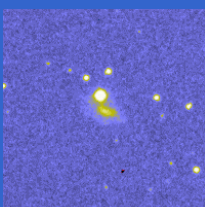
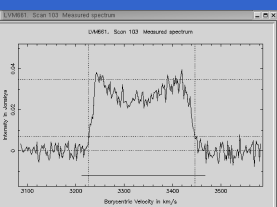
• To study the origin of the cold gas of isolated galaxies with types earlier than Sa. We detect 40% of them in HI. Many are also FIR detections indicating some level of star formation. The presence of gas in early type galaxies is usually attributed to accretion from a nearby companion (cf. Huchtmeier, 1994) or to minor/major merger events (e.g. Morganti et al. 1997; Balcells et al. 2001). Since the here proposed galaxies are selected based on isolation criteria the above interpretation is not straightforward. Are they really early type galaxies? Are they the definition of a primordial early-type?

We have completed 80% of the sample:

• We found data for 407 CIGs in the bibliography, most of them in Haynes & Giovanelli (1984) and Huchtmeier & Richter (1989). We have completed the search in NED selecting the best available data.

• The remaining galaxies have been observed with:

Green Bank (72), Arecibo (34), Nancy (80) and Effelsberg (157) with some overlap in order to allow a better calibration of relative errors. We have allocated time at Nancy during this semester.



Example of HI spectrum (left) taken at Green Bank corresponding to the Sm galaxy Cig 661 (center). We show a scheme of the asymmetry index to be used for the profiles characterization (right).

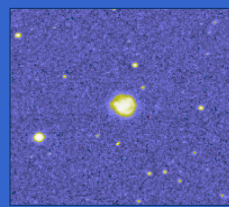
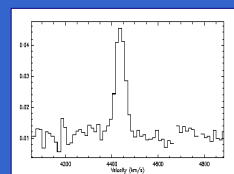
### CO: tracer of molecular gas

The CO will allow us to study

- The total gas content (HI and H<sub>2</sub>) and the molecular gas fraction as a function of Hubble type and luminosity.
- The star formation efficiency.
- The influence of morphology (type, bars) on the molecular gas content.

#### DATA:

We have found CO data for 7 galaxies of our sample in the bibliography and observed 132 galaxies at Nobeyama, IRAM 30m and FCRAO. These account for a 70% of the total sub-sample and we have scheduled observations at the IRAM 30m radiotelescope this fall.



Example of CO spectrum taken at FCRAO (up) corresponding to the SB(s)m galaxy CIG 444 (bottom).

### FIR AND RADIOCONTINUUM

• PSC-IRAS data were available for 303 galaxies and we coadded data for the whole CIG sample in order to get the best possible snr.

• IRAS data for extended sources were processed with FRESKO

• We have reprocessed radiocontinuum fluxes from the WENSS (Westerbork Northern Sky Survey), NVSS (NRAO VLA Sky Survey) and GB6 (Green Bank) surveys to significantly increase the detection rate relative to the respective public catalogue. In the table we show the data obtained so far.

Survey	Frequency	Resolution	CIG found
WENSS	320 MHz	55"	139
NVSS	1.4 GHz	50"	622
GB6	4.8 GHz	7"	100

### H $\alpha$ : tracer of recent SF

We aim to

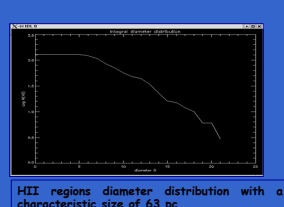
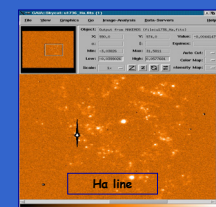
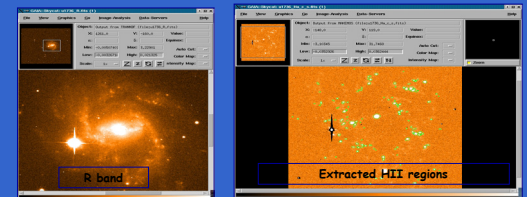
• Revise reported SF enhancements in strongly interacting systems and unexpected SF inhibition in compact groups of galaxies (e.g. Kennicutt et al. 1987, 1994, Hummel et al 1990, Gavazzi et al 1991, 1998, 2002, Young et al 1996, Boselli et al 2002, Iglesias-Páramo et al 1999, 2002ab) all of them depending upon small/unhomogeneous control samples.

• Investigate the dependence of H $\alpha$  derived SF rates with HI, H $\alpha$  and/or HI+H $\alpha$  for isolated galaxies. This connection is not well defined yet for other samples (Kennicutt 1988, 1989, 1998).

• Quantify H $\alpha$  morphologies following our previous studies of interacting pairs (e.g. Combes et al. 1994) that revealed at least 3-4 fundamentally different morphologies in H $\alpha$  light (discrete emission: nuclear dominated and/or disk dominated, as well as diffuse emission).

We have compiled H $\alpha$  images for 21 galaxies from ING/La Palma Archive and James's database (priv. comm.) and observed 100 galaxies at the 1.5m in Sierra Nevada Obs., 2.2m & 1.52m of Calar Alto Obs. and 2.5m of San Pedro Martir and have 4 weeks scheduled for the next semester.

Below we show an example of extraction of HII regions catalogue with SExtractor for CIG96 (James's data).



HII regions diameter distribution with a characteristic size of 63 pc.