PROPERTIES OF A SAMPLE OF THE MOST ISOLATED GALAXIES

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Abstract

We are studying properties of the interstellar medium and star formation in isolated galaxies. Our source is the Catalog of Isolated Galaxies and our sample contains 754 galaxies with redshifts and far infrared (IRAS) data. We collected old and new unpublished optical and far infrared data which enabled us to study source luminosities and global properties of the sample. Fifteen galaxies from our sample were observed with ISOCAM and we used this data to supplement a database composed of optical, infrared and radio observations. We compare the distribution of warm dust with cold (HI) and warm (Hα) gas in the ISOCAM observed galaxies.

Key words: Galaxies: evolution – Galaxies: structure – Missions: ISO

1. Introduction

The evolutionary history of galaxies, and perhaps especially star formation, is strongly conditioned by the environment. Therefore a definition of "normal galaxy" is needed before one can properly assess the history and properties of peculiar ones. This motivated us to build a large and well-defined sample of isolated galaxies to serve as a comparison template in the study of galaxies in denser environments. Our goal is to characterize the interstellar medium (ISM) properties (and level of star formation) in this template sample. We report here on: a) the isolated reference sample and its global characteristics, as well as, b) a subset observed by ISOCAM whose ISM properties are characterized by means of multiwavelength imaging.

2. The reference sample

Our reference sample is drawn from the Catalogue of Isolated Galaxies (CIG; Karachentseva 1973) which originally included 1052 galaxies, reduced to 893 after the revision by Karachentseva (1980), see also Xu & Sulentic (1991) and Hernandez-Toledo (1999). We obtained the best available redshift from NED[1]/ZCAT (Huchra et al 1992 for 766 galaxies (increasing the CIG based sample by 298 relative to Hernandez-Toledo 1999). IRAS PSC data for 303 and coadded data for 451 (446 more than in previous papers) were also compiled. We were able to derive optical and FIR luminosities for a total of 754 galaxies. The detection rate in the 12, 25, 60 and 100μ IRAS bands was 0.25, 0.27, 0.79 and 0.55, respectively.

Advantages of our CIG-based sample include: a) selection using well-defined isolation criteria, b) the large number of galaxies with available optical and FIR data, c) completeness at $<V/V_m> = 0.42$ level down to $m_B = 15.7$, and d) the large variety of morphological types included. We plan to reevaluate a and d using the new IIIa-F based northern sky survey (DPOSS2). Figure 1 shows the correlation between far-infrared (L_{FIR}) versus optical (L_B) luminosities for our sample, where arrows represent upper limits (mostly due to non-detection at 100μ) where galactic cirrus is a problem. We see a range of optical luminosities from $\log(L_B/L_\odot) = 8 - 11.2$ with most galaxies concentrated at values larger than 9.8. We see a fairly sharp cutoff at luminosities above $\log(L_{FIR}) \sim 10.4$. The break in the correlation at about $L_{FIR}{\sim}9.0$ most likely reflects the onset of Malmquist bias, assuming that the relationship below this level is well enough defined. Data for 38 strongly interacting pairs (Solomon & Sage 1988, Young & Scoville 1991, Perea et al. 1997) was also plotted in Figure 1 for comparison. Pair luminosities cover a similar optical range as the bulk of the isolated sample but have much higher L_{FIR} values, as is well documented (Sanders et al. 1986; Solomon & Sage 1988; Young & Scoville 1991; Perea et al. 1997),

3. Isolated galaxies observed by ISOCAM

Among the 753 galaxies in our CIG-based sample of isolated galaxies, about 600 were detected by IRAS but only 15 were imaged by ISOCAM. Late types are favored in this subset where optical luminosities span a range from $\log(L_B/L_\odot)= 9.0$–11.0. The ISOCAM subsample covers essentially the full optical luminosity range of the total sample (Fig. 2). We extracted and analyzed the CAM images from the ISO archive for comparison with multiwavelength data. We have completed 80% of the imaging for

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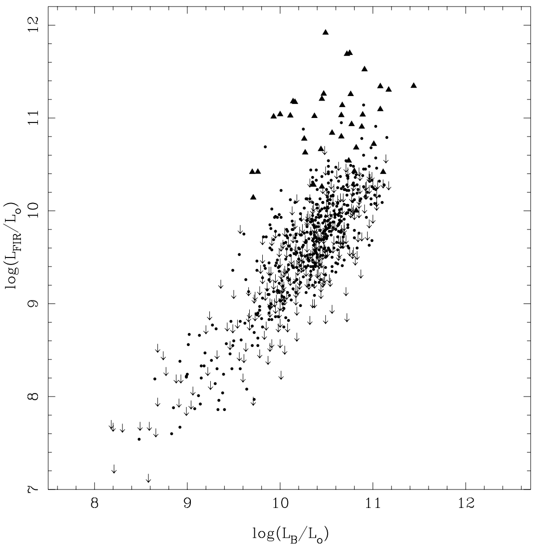

Figure 1. Far-infrared versus optical luminosity for the isolated galaxy sample (circles represent detections and arrows upper limits) and for strongly interacting pairs (triangles).

these 15 galaxies at B, V, R, I, Hα, J, H, K, HI, CO and 21 cm continuum,with part of the data obtained by ourselves and the rest taken from the literature as well as from the ING-La Palma, HST, VLA, 2MASS, NED and WHISP archives. Detailed analysis of the full data set is in preparation.

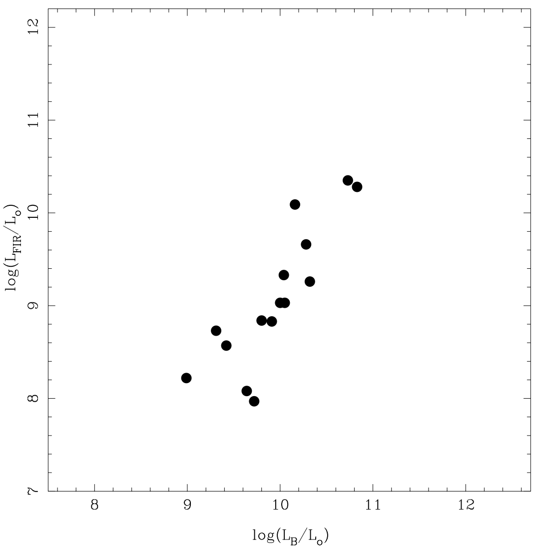

Figure 2. Far-infrared versus optical luminosity for the 15 isolated galaxies of our CIG-based sample imaged by ISOCAM.

Figure 3 shows an example of our comparison data at optical, MIR and radio wavelengths. The top left panel of Figure 3 shows a V band image for CIG 121 classified as IB(s)m in the RC3. The galaxy, with $\log(L_B/L_\odot) = 9.3$ and $\log(L_{FIR}/L_\odot) = 8.7$ comes from the low luminsity tail of the CIG distribution shown in Figure 1. The galaxy shows several bright blue stellar concentrations and is in an active star formation stage as indicated by its Wolf-Rayet spectrum (Larsen 1999). The star formation activity is evident in the Hα image which is shown in grey-scale in the top right panel. Most of the numerous Hα knots coincide with mid-infrared (MIR; LW..) emission, plotted as contours on the same panel. Atomic gas (bottom left panel) is more extended than the optical light (the MIR field is slightly smaller than the HI image). No detailed correlation between MIR and HI emission is found at the observed resolution. Some MIR luminous areas correlate with high HI column densities, while others do not. The origin of these differences in the HI to MIR emission is not clear but may relect more complete HI consumption in some regions of the galaxy. Observations of the distribution of molecular gas would be helpful, but no CO data are available for this galaxy. CIG121 is a good example of an isolated galaxy where active star formation is ongoing but is unlikely to be influenced by the external environment.

4. Concluding remarks and future work

A large and reasonably complete sample of isolated galaxies has been assembled with complete optical and far-infrared luminosity information. We plan to refine the sample including reevaluation of isolation and morphology properties using the POSS2 images. We are also particularly interested in the CIG galaxies with FIR luminosities above 10.5. Are they really isolated galaxies with high levels of star formation. Are some of them isolated AGN? The faint end of the CIG luminosity function is also unusual because it contains an early type dwarf population that is not found in pairs (Hernandez-Toledo 1999). The multiwavelength information available for a growing subset of the sample will allow a more detailed comparison of the different components of the ISM. This will improve our understanding of the complex interplay between the different phases.

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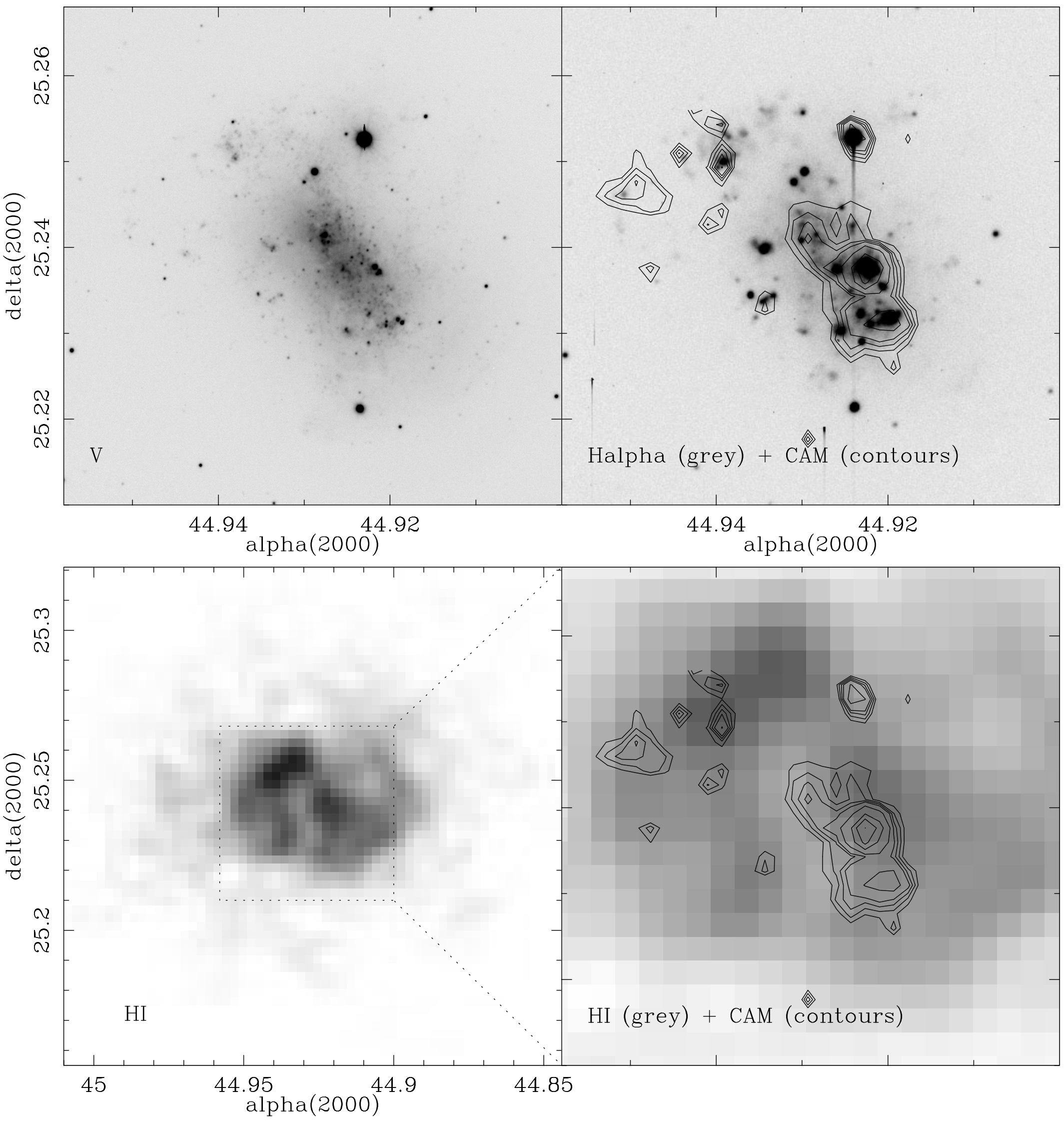

Figure 3. Multiwavelength images of isolated galaxy CIG 121. TOP-LEFT panel: optical V band, TOP RIGHT: optical Hα shown in greyscale with ISOCAM MIR contours superimposed, BOTTOM LEFT: radio HI integrated emission and BOTTOM RIGHT: central part of the HI map with MIR contours superpimposed.

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