ACTIVE GALAXIES IN A COMPLETE SAMPLE OF ISOLATED GALAXIES


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INTRODUCTION

Galaxy evolution depends strongly on the environment, in particular, galaxy-galaxy interaction can induce nuclear activity by removing angular momentum from the gas feeding the central black hole. Hence a higher fraction of nuclear activity is expected in interacting galaxies. Different studies of this topic lead to contradictory results. Some works conclude that galaxies hosting an active galactic nucleus (AGN) have a higher rate of companions than non-active ones (Petrosian 1982, Dahn 1985, MacKenty 1989, MacKenty 1990, Flannery 1995). On the other hand other studies do not find this effect of interacting companion on the AGN activity (Bushouse 1986, Fuentes-Wilkins 1988, Lehnert 1995). Most recent works find a different result depending on the type of Seyfert galaxy (Dubois-Hayman 1999, Krongold 2003).

To understand the role of the environment in evolution and galaxy properties like the interstellar medium (ISM) and formation and, in particular, nuclear activity we need a statistically significant sample of isolated galaxies. This sample is provided by the AMIGA project (Analysis of the interstellar Medium of Isolated Galaxies: Verdes-Montenegro et al. 2005). The sample is based on the CIG catalog (Karcheshtine 1973) and the data base includes blue luminosity, near-infrared luminosity, far-infrared (FIR) emission, atomic gas (HI) emission, radio continuum, and, for a red-shift limited sample of 200 galaxies and CO emission.

One of our main goals is the study of the triggering of nuclear activity in non-interacting galaxies using different methods. We will focus on the well known radiocontinuum-FIR correlation in order to find radio-excess galaxies (radio-excess selection) which are candidates to host an active galactic nucleus (AGN). We also use the FIR color (IRAS color selection) to find obscured AGN candidates. We have looked for the existing information on nuclear activity in the Véron-Cetty catalogue and in the NASA Extragalactic Database (NED) (literature data). Finally we have produce a final catalogue of AGN candidate galaxies which will provide a baseline for the study of the nuclear activity depending on the galaxy-galaxy interaction.

THE DATA & THE SAMPLE

Far Infrared (FIR) is the thermal emission re-radiated by dust grains warmed up by radiation from young stars and the AGN. The FIR emission is also the energy reservoir from which the ISM grains warmed up by radiation from young stars and the AGN.

Radiocontinuum data come from three different sources: a) Wesley Johnson Northern Sky Survey (WMSS, 325 and 522 MHz), b) NRAO VLA Sky Survey (NVSS, 1.4 GHz) and Green Bank 8 (GB8, 4.8 GHz). Leon et al. 2006 (in prep). We use NVSS data because it has the best detection rate and sensitivity and this survey contains all the galaxies belonging to our sample. The frequency of the observations is 1.4 GHz.

Completeness of the sample: We have used a completeness test (q<0.95) as explained in (Verdes-Montenegro et al. 2005). We adopted q=0.5 as the cutoff magnitude necessary to have a reasonably complete sample. The complete sample contains 738 galaxies.

RAS COLOR SELECTION

In the work of de Grijp et al. 1985 is shown a method to identify AGN candidates using FIR properties. Galaxies hosting an AGN have, in general, a flatter spectrum in FIR. This is due to the hotter temperatures of the dust warmed by the central engine. The advantage of the method is that it can find obscured AGNs that can not be observed using other wavelength or methods. The success rate of the method is about 72%. We select the galaxies with an spectral index between 25 µm and 60 µm of -1.958. We plot in the figure log [L FIR/L EM] versus log [L 60 µm/L EM]. The spectral index of -1.958 is plotted in a black line. Galaxies above the line can be identified as AGN candidates. The crosses denote the galaxies detected data and the arrows are the upper limits. Finally we find 110 galaxies located above the line which are the AGN candidates of the complete sample. There are 22 AGN candidates for the final catalogue. This is 12.3 % of the sample.

RADIO-EXCESS SELECTION

Radiocontinuum-Far Infrared correlation

One of the tightest correlations in astrophysics is the one between the FIR and the radiocontinuum emission. This correlation is produced by the stellar formation (Condon 1991). This correlation is broken if a strong radio emission exist from an radio-active nucleus.

We use survival analysis methods to compute the correlation. The Schmidt method (Schmidt 1985) allow us to use the information carried by the upper limits.

There are 8 radio-excess galaxies in the complete sample (n=738) which amount 1.1% of the sample. This is a very low rate.

q parameter

The parameter (Helou 1985) is a good estimator of the deviation from the radio-FIR correlation. It has been found to be independent of the starburst strength (Lehnert 1995) and distance (Yun et al. 2001) it is defined as:

q = log [L FIR/1.75L 60 µm] + log [L 60µm/5L EM] - 1.958

We have computed the q parameter with the galaxies detected either in FIR and in radiocontinuum (n=288). In the figure is shown a histogram of the q parameter. The mean value is 2.34 with a sigma of 0.24. Radio-excess galaxies are located in the left tail of the histogram with lower q values. There are 4 over 288 which are 1.4 % of the galaxies studied. This result is consistent with the study of the luminosities using upper limits.

FINAL CATALOGUE AND CONCLUSIONS

In this work we have produced a catalogue of AGN candidates for the CIG sample. Therefore we can study nuclear activity in a complete low density well defined sample of isolated galaxies. This catalogue will be the baseline for forthcoming studies about nuclear activity-environment relation.

The final catalogue is composed by the active galaxies found in the NED and the Véron-Cetty catalogue (n=29), the radio-excess galaxies selected using the FIR-radiocontinuum correlation (n=110) and the AGN candidates selected using the IRAS color criteria (n=10) . The catalogue will be available in the AMIGA project web page.

The activity rate derived from the radio-FIR correlation is very low (1.1 %) in comparison with denser environments. This shows us how environment is fundamental for the nuclear activity.