Several processes can affect a galaxy over its lifetime. If effects of interaction with companions are minimized, it is possible to focus on secular evolutionary processes. We present a study of the SDSS (g-r) colors of isolated galaxies in the AMIGA project (Analysis of the Interstellar Medium of Isolated Galaxies; http://www.amiga.iaa.es). Assuming that color is an indicator of the star formation history, this work further records the signature of passive star formation via pure secular evolution. We focused on median values for the main morphological subtypes found in the AMIGA sample (66% Sb-Sc and 14% E/S0) and compared them with equivalent measures of galaxies in denser environments.

The main results of this study include: 1) a tendency for AMIGA spiral galaxies to be redder than similar type galaxies in close pairs, but 2) no clear difference when we compare with galaxies in other (e.g. group) environments; 3) a Gaussian distribution of the (g-r) color of isolated galaxies, as might be expected in the case of pure secular evolution; and 4) a smaller median absolute deviation in colors for isolated galaxies compared to both wide and close pairs.

(g-r) color as a function of morphological type

We used the model magnitudes of SDSS-DR8 for deriving colors in our sample. A careful revision of the morphologies was performed by Sulentic et al. (2006) for the whole CIG sample based on POSS II imaging. We recently revised those morphologies using CCD images available either from SDSS or our own data for 843 galaxies, including those studied here.

The reddest median values of (g-r) are found for early-type galaxies (Fig. 1), although median (g-r) values remain essentially constant out to Tn (Sb). Beginning with type Sb we see a decrease in median (g-r) as expected if this sequence reflects a uniform decreasing contribution from an old stellar population. The objects suspected on being involved in interactions (red circles) are outside the normal trend of the median values, but the colors of the AMIGA galaxies that present asymmetries (blue triangles) agree with the colors of symmetric galaxies.

We found a higher color dispersion for spiral subtypes in the AMIGA sample than that expected for this sample, minimally affected by environmental effects, which are apparently responsible of inducing color dispersion.

Data and sample selection

Color dependence on environment

Effects of environment in the star formation of galaxies are expected to influence their colors. In this sense, the isolated galaxies are likely to show passive star formation, and then redder colors than galaxies in denser environments.

We have compared (g-r) median colors of AMIGA sample with - Nair & Abraham (2010) sample & EFOGI catalog (Balasini et al. 2011), both including galaxies in a wide range of the catalog of isolated pairs (CPG, Karachentsev 1972), separated into close (CLO) and wide interacting (WID) pairs for different morphological bins (see the table below).

Conclusions

- The AMIGA project is producing and analyzing a multiwavelength database for a refinement of the Catalog of Isolated Galaxies (CIG: Karachentsev 1973, n=1050 galaxies). A complete revision of distances, magnitudes and velocities from updated versions of HyperLEDA catalog has been performed with the help of scientific workflows developed in the frame of the WHEVeR project. These data may be accessed through a Virtual Observatory compliant interface and a CernesceVO service.

- For this work we have used a subsample of 657 AMIGA galaxies that fulfill: a) the selection criteria detailed in Verley et al. (2007b, b) Vm=1500 km/s, and c) completeness limit as decided in Verdes-Montenegro et al. (2005). These conditions imply that the evolution of all galaxies in our starting sample is dominated by their intrinsic properties. Crossmatch of this sample with the SDSS-III (Data Release 8, DR8 Aharah et al. 2011) and further cleaning lead to a final studied sample of 468 isolated galaxies.

- While a good agreement has been found for the colors of early-type galaxies in all samples, the median values for the AMIGA sample are slightly bluer (but within the errors) than the other samples in the range T=5 to T=0.

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- We found a higher color dispersion for spiral subtypes in the AMIGA sample than that expected for this sample, minimally affected by environmental effects, which are apparently responsible of inducing color dispersion.

- The color-magnitude diagram of the AMIGA sample is shown in Fig. 2, where it is compared with the Nair & Abraham (2010). Our Sc galaxies (left) follow the blue sequence, showing that the major source of color dispersion is connected with the color-luminosity trend. We find a tendency for galaxies of fixed absolute magnitude to be (g-r)~0.8 redder at lower recession velocities, implying that the color measures in our sample could be increasingly affected by bulge light at lower recession velocities. In the case of the AMIGA early-type (E/S0) galaxies, there is no color trend with recession velocity, and we notice only a slight trend between color and luminosity.

- We found little evidence for a green valley in our sample, with most spirals redder than (g-r)~0.7 having spurious colors (~80%) caused by effects such as a star projected onto or very close to the galaxy, a high degree of asymmetry, or a high uncertainty in the extinction correction due to their high inclination.

- The median values of colors for the Nair & Abraham (2010) and close pair samples for the (Sb-Sc) spirals are consistent but slightly bluer than our sample. For the comparison with Nair & Abraham (2010), the differences in color may be due to their morphologies classifications used in both samples. We find their morphologies to be earlier than ours, with a mean deviation of ~1.5 for each Hubble type. The differences increase for late-type galaxies, with the large uncertainties and the classification in this range due to the large scatter in the data.

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References

See the reference page for a detailed list of references.

Fig. 1. Distribution of the rest-frame (g-r) color as a function of Hubble type.

Fig. 2. (g-r) color-magnitude diagram for the Sc (left) and E/S0 (right) galaxies in the AMIGA sample.

Fig. 3. Distribution of absolute magnitudes in the g (left) band, g-r color (middle), and r (right) color (bottom) for all galaxies in the AMIGA sample.