blue star-forming isolated elliptical galaxies

Ivan Lacerna[1,2,3], H. Hernández-Toledo[4], V. Avila-Reese[4], J. Abonza-Sane[4], A. del Olmo[5]

ABSTRACT

The isolated environment seems to favor the formation of blue, star-forming galaxies that are not observed in a high-density environment such as the Coma supercluster. These galaxies, with masses between 7×10^9 and 2×10^{10} h^{-2} $M_\odot$, are also the youngest galaxies from a sample of isolated elliptical galaxies with light-weighted stellar ages <1 Gyr and exhibit bluer colors toward the galaxy center. Around 30–60% of their present-day luminosity, but only <5% of their present-day mass, is due to star formation in the last 1 Gyr. The color and star-formation activity in these galaxies could be explained by rejuvenation of ellipticals by recent cold gas accretion.

Introduction

Our aim is to probe the role of environment on the morphological transformation and quenching of elliptical (E) galaxies as a function of mass. We study a relatively complete sample of isolated ellipticals from the catalog of local isolated galaxies by Hernández-Toledo et al. (2010) in a large mass range and compare some of their properties to those ellipticals located in a high-density environment, the Coma supercluster.

Properties and mass dependences of ellipticals

In Fig.1, we see that the fraction of blue galaxies is higher in the isolated environment (20%) than in the Coma supercluster (8%). On the other hand, the distribution of isolated and Coma ellipticals in Fig. 2 seems to be not too different, except for a small fraction of isolated ellipticals with relevant signs of star formation activity.

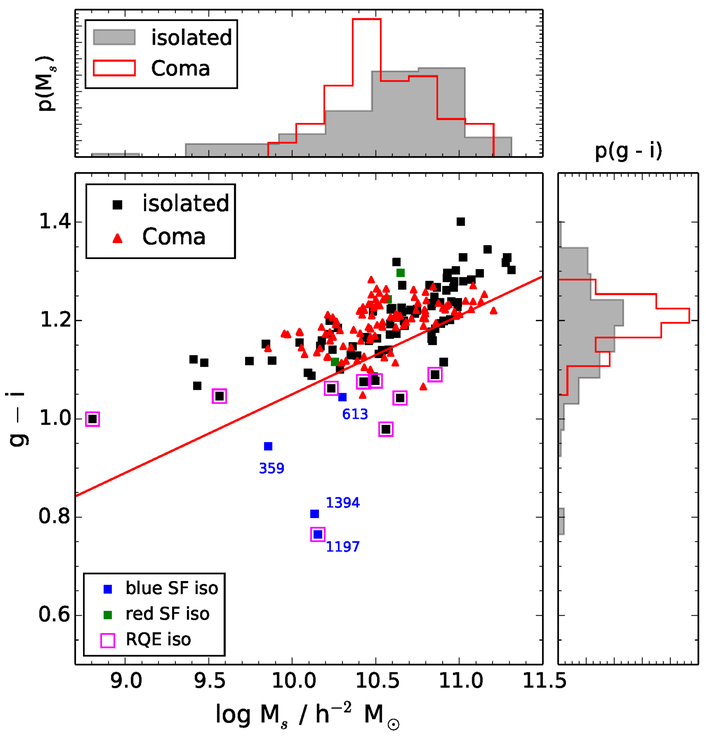

Figure 1. As a function of stellar mass, $g - i$ color for our sample of isolated elliptical galaxies (filled squares). In addition, we include a sample of elliptical galaxies located in the Coma supercluster (red filled triangles). The red line is used to separate red/blue galaxies (Lacerna et al. 2014). Blue filled squares and green filled squares show the blue and red isolated ellipticals, which are also star-forming galaxies (see Fig. 2), respectively. The numbers are the ID in the UNAM-KIAS catalog for the former. Magenta open squares correspond to the recently quenched elliptical (RQE) galaxies following the color-color criterion of McIntosh et al. (2014). Top and right panels: normalized density distributions of stellar mass and $g - i$ color for isolated elliptical galaxies (gray solid histogram) and elliptical galaxies located in the Coma supercluster (red open histogram), respectively.

Figure 2. Specific star formation rate (sSFR) as a function of the stellar mass. The symbols for the galaxies are the same as Fig. 1. The red line separates star-forming and passive galaxies (above and below the line, respectively. See Lacerna et al. 2014). Right panel: normalized density distribution of sSFR for isolated elliptical galaxies (gray solid histogram) and elliptical galaxies located in the Coma supercluster (red open histogram).

BPT diagram

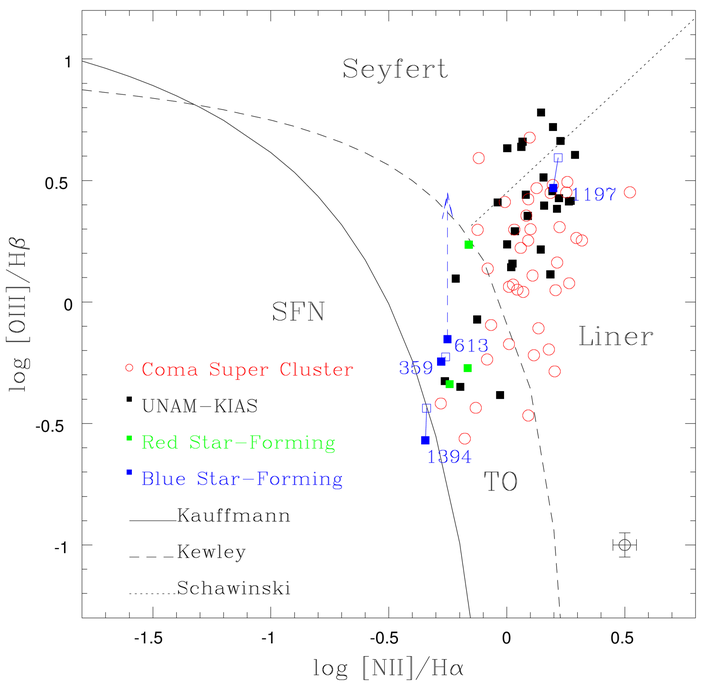

Figure 3. BPT diagram for the isolated elliptical galaxies (black filled squares) and E galaxies in the Coma supercluster (red open circles). Blue points represent the blue SF isolated E galaxies. Galaxies are classified as star-forming nuclei (SFN), transition objects (TO), or AGN (Seyfert/LINER) according to the relations of Kauffmann et al. (2003, solid line), Kewley et al. (2001, dashed line), and Schawinski et al. (2007, dotted line). The dashed arrow indicates that UNAM-KIAS 613 is rather a Seyfert 1.8 because of its broad components in Hα and Hβ.

Star formation history

Figure 4 shows that 30–60% of the present-day luminosity of the blue star-forming (SF) isolated ellipticals is due to star formation in the last 1 Gyr, whereas the mass-weighted SFH show that they formed <5% (<20%) out of their present-day stellar masses in the last 1 (3) Gyrs. These results suggest that the blue SF isolated ellipticals formed most of their stars early, but in the last ∼1 Gyr they had a period of enhanced star formation.

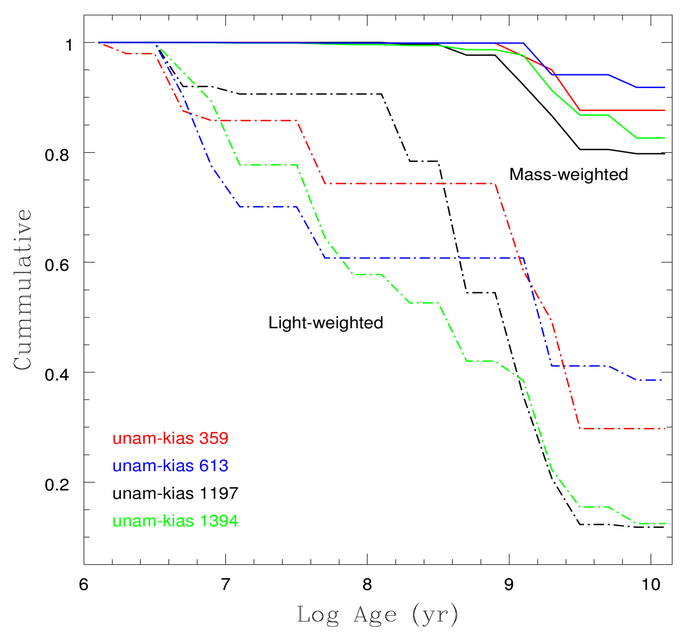

Figure 4. Cumulative stellar population synthesis distributions as a function of the lookback time for light-weighted ages (dot-dashed lines) and mass-weighted ages (solid lines) of the blue SF isolated elliptical galaxies.

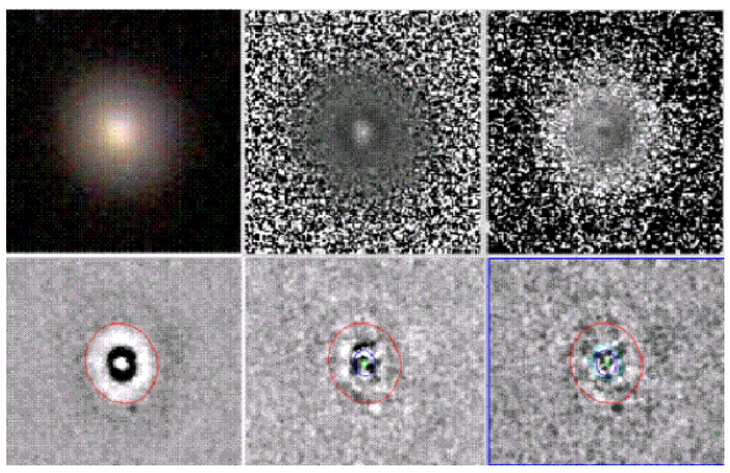

Figure 5. Example of the photometric analysis for the blue star-forming galaxy UNAM-KIAS 359. First row shows (from left to right) the SDSS gri-band color image, filter-enhanced r-band image, and g−i color map. Second row shows the residual r-band images from Sérsic models.

Conclusions

It is more plausible that the blue SF isolated E galaxies assembled early as other ellipticals, but they were rejuvenated by recent (<1 Gyr) accretion events of cold gas. Further work with Integral Field Spectroscopy is needed to investigate the kinematic and stellar population properties resolved in space. These galaxies can be used to trace and estimate the fraction of recent gas cooling from the cosmic web.

Based on **Lacerna et al., 2016, A&A, 588, A79**

References

Hernández-Toledo H. M., et al., 2010, AJ, 139, 2525
Kauffmann G., et al., 2003, MNRAS, 346, 1055
Kewley L. J., et al., 2001, ApJ, 556, 121
Lacerna I., et al., 2014, ApJ, 788, 29
McIntosh D. H., et al., 2014, MNRAS, 442, 533
Schawinski K., et al., 2007, MNRAS, 382, 1415

[1] Instituto de Astrofísica, Pontificia Universidad Católica de Chile
[2] Centro de Astro-Ingeniería, Pontificia Universidad Católica de Chile
[3] Max Planck Institute for Astronomy, Heidelberg, Germany
[4] Instituto de Astronomía, Universidad Nacional Autónoma de México
[5] Instituto de Astrofísica de Andalucía IAA – CSIC, Granada, Spain

ialacern@astro.puc.cl