Evolution of star-forming galaxies in the Hercules cluster: new observational clues of the mass-metallicity relation

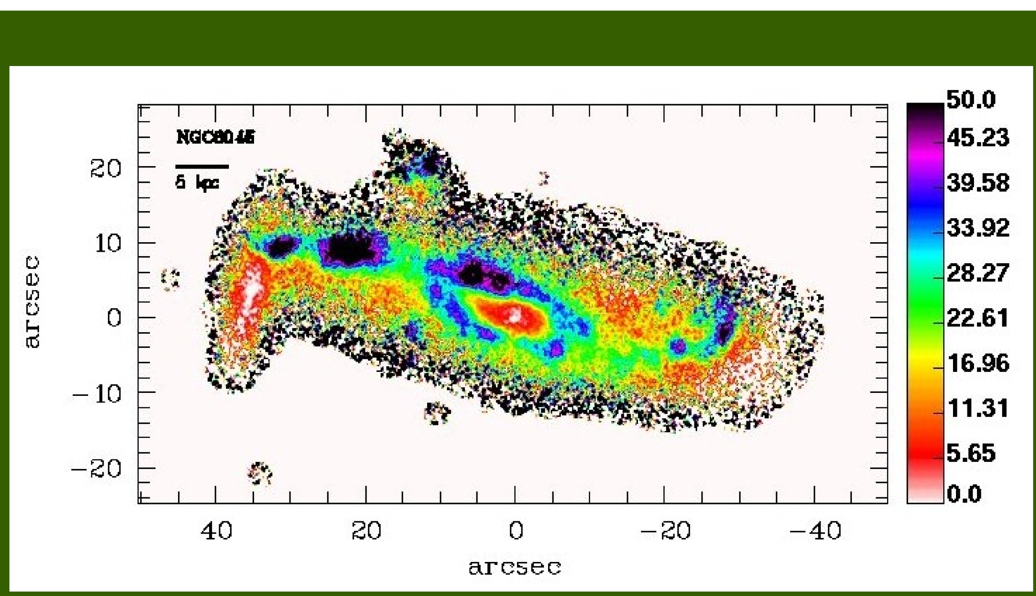
Petropoulou Vasiliki, Vílchez José-Manuel, Iglesias-Páramo Jorge, Papaderos Polis

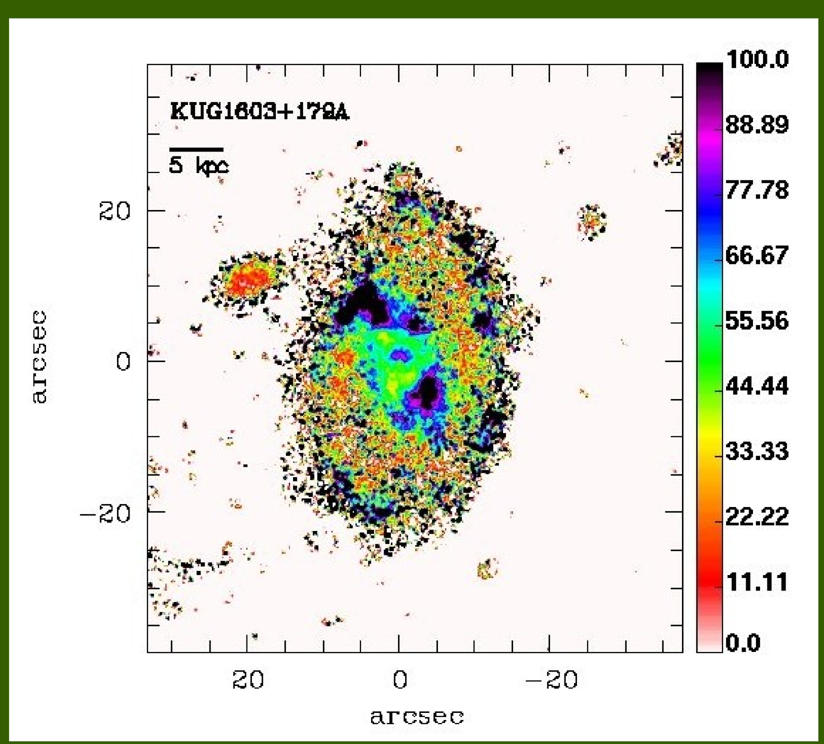
Instituto de Astrofísica de Andalucía (CSIC)

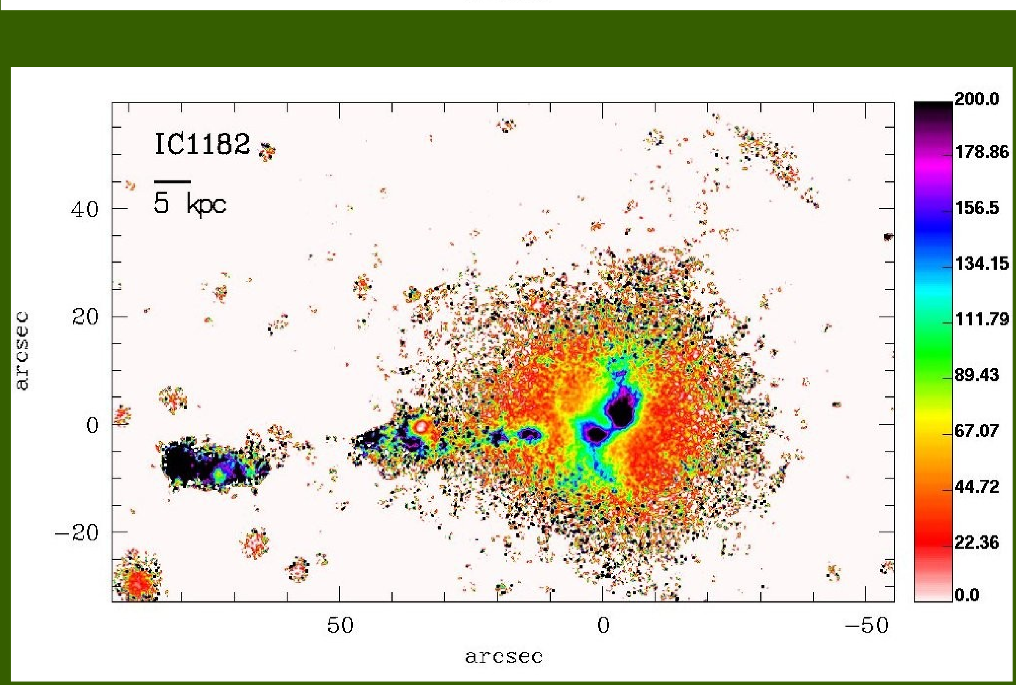
ABSTRACT: The star formation history, gas-content and the mass interchange with the environment (infall of metal-poor gas and/or outflow of enriched material) are the fundamental variables controlling the chemical evolution of a galaxy. Observational hints which constrain the galaxy evolution scenarios in dense environments have lately started to be investigated (Mouhcine et al. 2007, Ellison et al. 2009, Cooper et al. 2008). In this work we study the relation between metallicity and environment for a sample of star-forming galaxies in the Hercules cluster. Spatially resolved spectroscopy has been obtained for 28 galaxies selected from our deep Hα survey of the Hercules cluster. We apply spectral synthesis models to all our emission-line spectra using the evolutionary code STARLIGHT and we obtain fundamental parameters of the underlying stellar component, as the mean metallicity and age. By the emission-line spectra corrected from the stellar population continuum we derive gas chemical abundances using empirical strong-line calibrations. We calculate galaxies' physical properties as masses and total luminosities using SDSS broadband photometry. All the information obtained has provided us with new observable imprints of the cluster environment effect on the chemical evolution of galaxies and the mass-metallicity relation.

Hα imaging

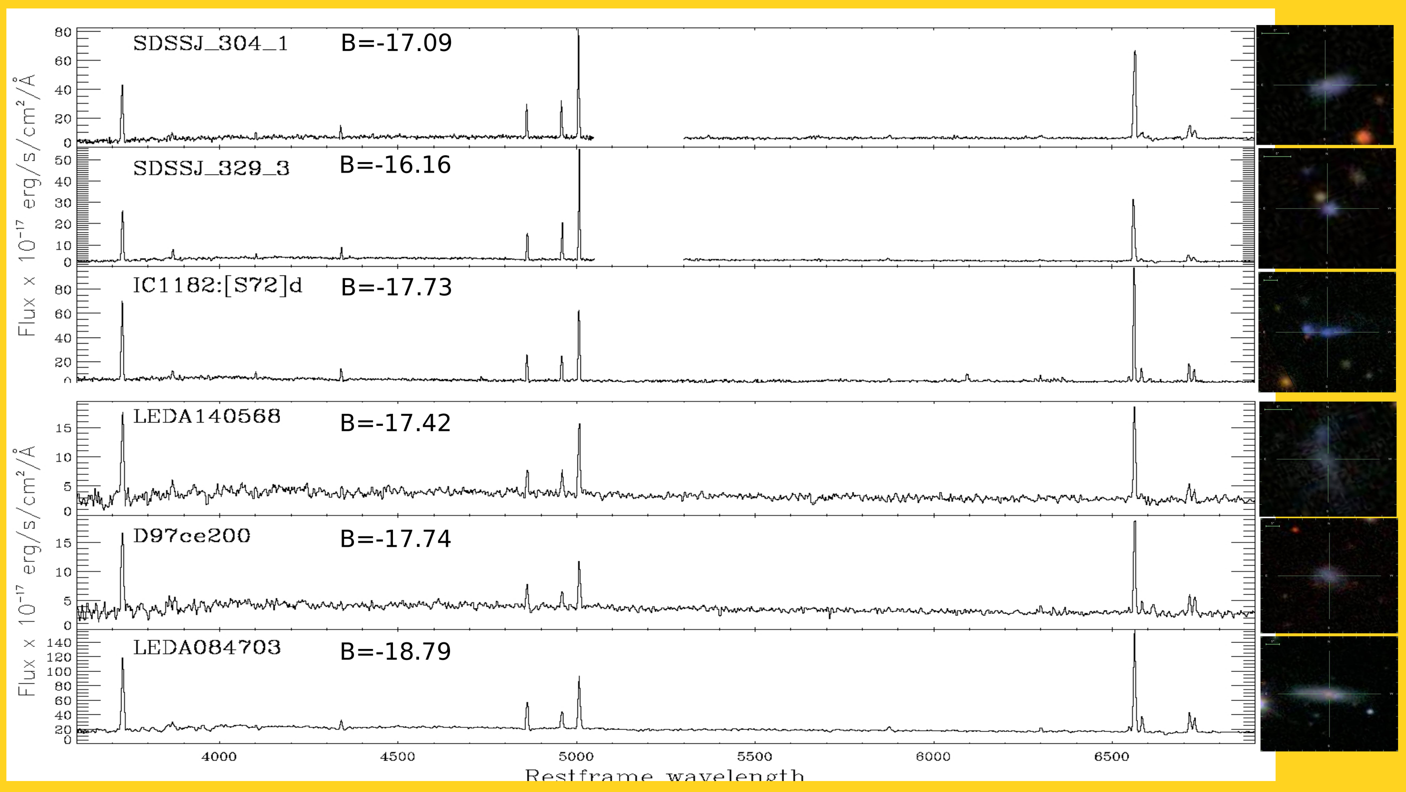
We used images from our deep Hα-survey (NOT & WHT) of the Hercules cluster (Cedres et al. 2009) in order to design carefully our spectroscopic follow-up. Our Hα equivalent width maps reveal a wealth of morphological features of the Hercules star-forming spirals. The long-slit spectra of galaxies showing rich spatial structure, were divided into different 1D spectra corresponding to their different sub-regions.







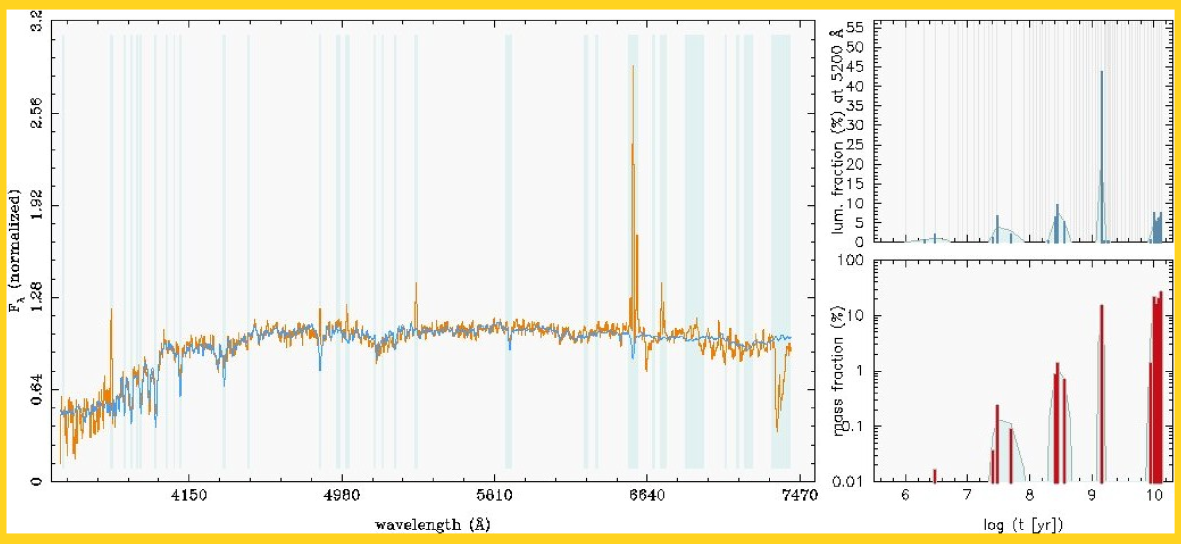
Long-slit Spectroscopy



Hercules star-forming galaxies were observed with WHT/ISIS and INT/IDS at ORM, La Palma, Spain. Our spectroscopic sample contains from grand design spirals to blue compacts and tidal dwarfs.

Star-forming dwarf cluster galaxies show different behavior with respect to field galaxies (Duc et al. 2001, Iglesias-Páramo et al. 2003, Vílchez & Iglesias-Páramo 2003, Vaduvescu et al. 2007). Examine the mass-metallicity and luminosity-metallicity relation specially of dwarf cluster galaxies provides observable imprints of the cluster environment on these galaxies.

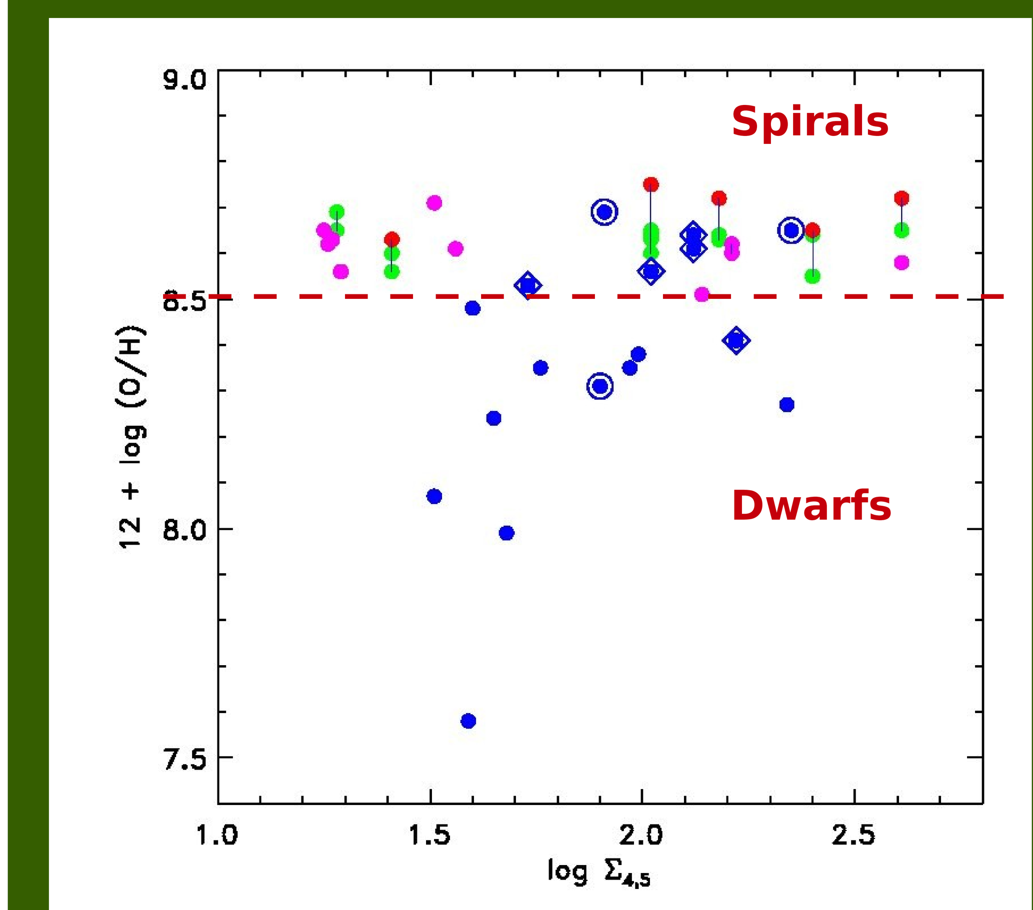
Model fitting



We apply to all our emission-line spectra the evolutionary code STARLIGHT (Cid Fernandes et al. 2004, 2005a,b, Garcia-Rissmann et al. 2005) and we obtain fundamental parameters of the underlying stellar component, as the mean metallicity and age (Asari et al. 2007). These fundamental physical parameters provide us with new tools to study the galaxy evolution.

By the emission-line spectra corrected from the stellar population continuum we derive gas chemical abundances using empirical strong-line calibrations (Pilyugin et al. 2010, Pérez-Montero & Contini 2009).

Metallicity vs Local Density

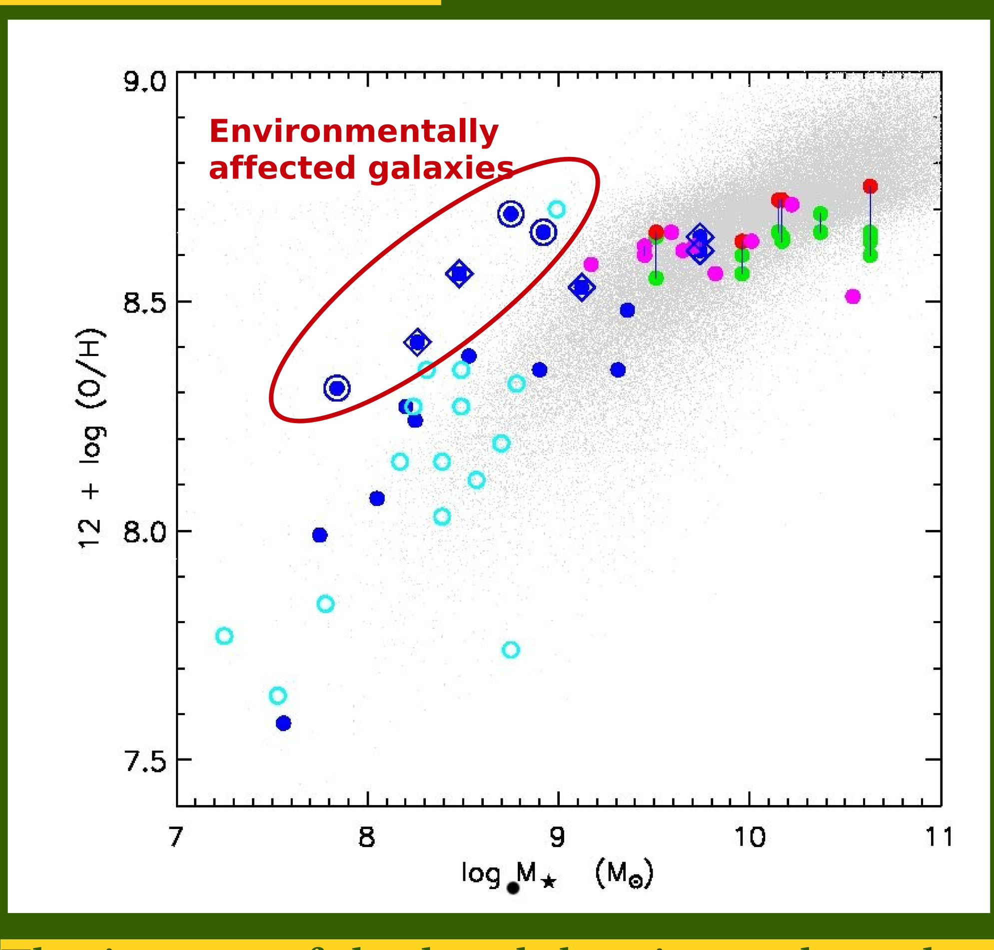


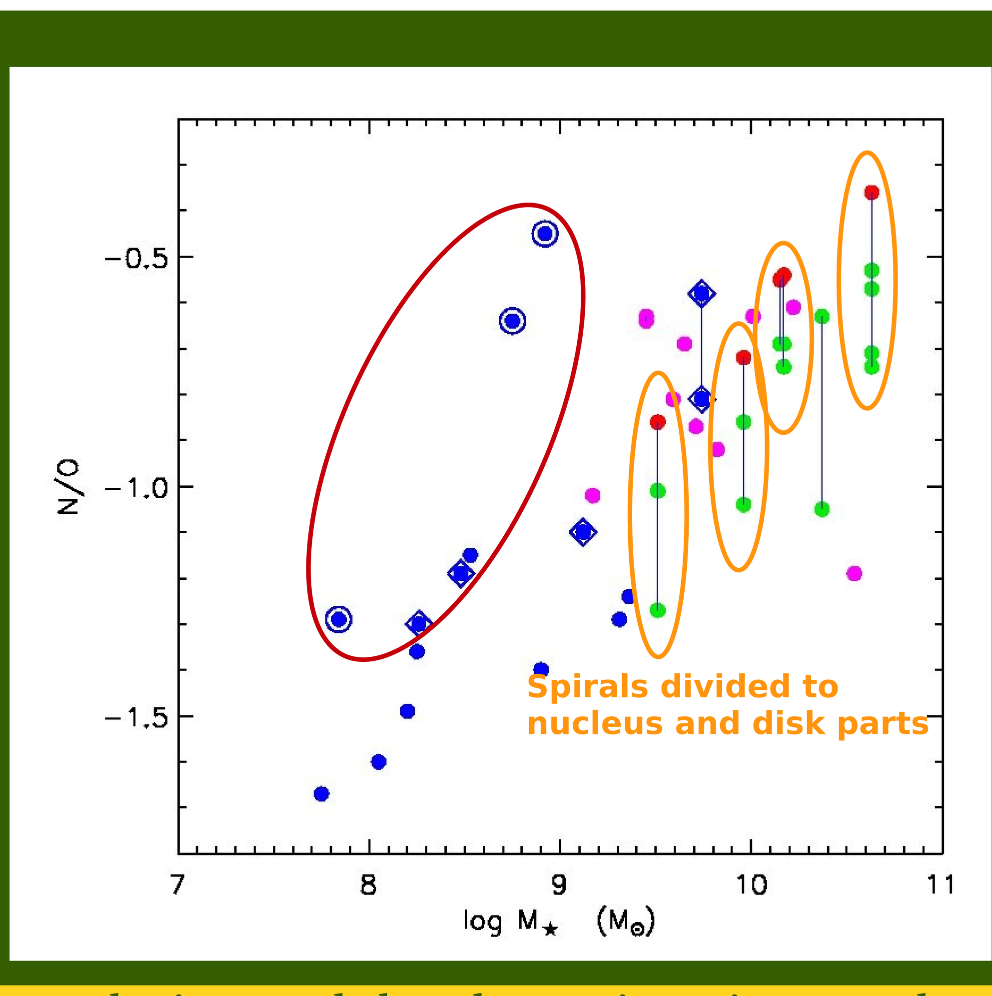
$\Sigma_{4,5}$ is the local galaxy number density to the average of the projected distances to the fourth and fifth nearest neighbor.

Blue points stand for dwarf/irregular galaxies (B > -19), magenta for spirals (B < -19) with integrated spectra, red for the nuclei of 6 spirals that we divide into different parts and green for their corresponding disk components (nuclei and disks are connected with lines). We use distinctive marks (circles and diamonds) for galaxies showing clear morphological/ structural evidences of being environmentally affected.

In the range of local number density of a cluster core, dwarf galaxies seem to be affected by their local environment, when massive galaxies show no signs of correlation with local density.

Metallicity vs Mass





The correlation between gas-phase oxygen abundance and stellar mass follows the one of the MPA/JHU SF galaxies: grey points (as used by Amorin et a. 2009) and of Virgo dIs and BCDs: cyan circles (Vaduvescu et al. 2007).

Environmentally affected galaxies go out from this correlation providing observable imprints of the cluster environment on the mass-metallicity relation.

N/O vs stellar mass reinforce the correlation.

Special note on the N/O abundance gradients shown by spirals that we divide into different parts.

The impact of the local density to the galaxy evolution and the cluster imprints on the mass- metallicity and luminosity-metallicity relation are studied further by Petropoulou et al., 2010 (to be submitted).

•References

- -Amorin R., et al., 2010, ApJ, 715, L128
- -Asari N.V., et al., 2007, MNRAS, 381, 263
- -Cedrés B. et al., 2009, AJ, 138,873
- -Cid Fernandes R.,et al. 2005, MNRAS, 358,363
- -Cid Fernandes R., et al. 2005, MNRAS, 356,270
- -Cid Fernandes R., et al. 2004, MNRAS, 355,273
- -Cooper M. et al., 2008, MNRAS, 390, 245
- -Duc P.-A.et al., 2001, A&A, 369, 763
- -Ellison S., et al., 2009, MNRAS, 396, 1257
- -Garcia-Grissmann A. et al., 2005,MNRAS, 359,765
- -Iglesias-Páramo J. et al., 2003,A&A,406,453
- -Mouhcine M. et al., 2007, MNRAS, 382, 801
- -Pérez-Montero E. & Contini T., 2009, MNRAS, 398, 949
- -Pilyugin L.S. et al., 2010, AJ, 720,1738
- -Vaduvescu O. et al., 2007, AJ, 134, 604
- -Vílchez J.M.& Iglesias-Páramo J., 2003,ApJS, 145,225