The SF-AGN connection from the CALIFA survey perspective

A. Morales[1★], F. F. Rosales-Ortega[2], J. P. Torres-Papaqui[1], S. F. Sánchez[3], M. Chow-Martínez[1], R. A. Ortega-Minakata[4], F. J. Romero-Cruz[1], J. J. Trejo-Alonso[5], D. M. Neri-Larios[6], A. Robleto-Orús[1] & the CALIFA collaboration[7]

[1]Universidad de Guanajuato [2]Instituto Nacional de Astrofísica, Óptica y Electrónica [3]Instituto de Astronomía, UNAM [4]Observatório do Valongo, Universidade Federal do Rio de Janeiro [5]Instituto Enrique Díaz de León [6]The University of Melbourne [7]http://califa.caha.es/

Introduction

Gravitational instabilities and gas dynamics are fundamental to comprehend galactic formation and evolution. Flows of gas are common to two intrinsic phenomena of galaxies: star formation (SF) and AGN. Besides both using gas as fuel, another accepted evidence connecting them is the M_{BH}-σ relation, which is believed to emerge at either or both of:

a) *scenario A*: BHs and bulges grow at the same time due to sequences of SF bursts taking place in the center of galaxies during their formation,

b) *scenario B*: BHs regulate bulge evolution through feedback mechanisms which gradually reduce SF as AGNs reach their peak activity.

Are the SF and AGN phenomena connected? If so, what is the nature of such a connection?

Main Goals

1. To confirm the influence of SMBHs on the SFHs of galaxies (or vice versa).
2. To measure the influence of environment: do SMBHs/bulges grow due to environmentally induced nuclear/circumnuclear SF?
3. To give insight on what the AGN feedback role is in all AGN types. Does it quench, trigger or even enhance SF?

Current instances

On the basis of the theory of tidal perturbation[1,2,3] and with CALIFA survey[4] data, *isolated* and *non-isolated* galaxy samples are studied considering morphology and environment. On the SF side, we are characterizing whether the highest burst intensities ($\boldsymbol{\Sigma}_{SFR}$) are nuclear or external. They seem to be what produces the chemical differences among galaxies[5]. We also want to verify if such intensities are enhanced by perturbers.

Methods

- Adjusting stellar population models to CALIFA survey spectra (STARLIGHT[6]).
- Fitting gaussian profiles to the emission-line residuals.
- Imposing an Hα EW cut-off ($\geq$6 Å) characteristic of ELGs (Hβ S/N $\geq$3) and SFGs (emission line S/N $\geq$3)[7], and also characteristic of H II regions with significant fractions of young stellar populations (SPs)[8].
- Selection of reliable SF pixels by means of diagnostic diagrams (DDs)[9,10] and several H II region/Starburst instantaneous and evolving models[11,12,13].
- Estimating the average $\boldsymbol{\Sigma}_{SFR}$ (using the extinction-corrected Hα line flux) and the average SP age at different annuli.

Preliminary conclusions

1. In the *non-isolated* sample, the median maximum $\boldsymbol{\Sigma}_{SFR}$ is $\sim$1.9 times greater. Agreeing enhanced values are also found by[14]. Inside the SDSS fiber aperture ($\sim$3 arcsec, dark-red circles and bars, Fig. 1), the median is $\sim$1.3 greater.
2. The average $\boldsymbol{\Sigma}_{SFR}$ by annuli seems to behave the same: the maximum is found most of the times in central regions decreasing then gradually outwards even though more softly in the *non-isolated* sample. It is also this one which more often hosts no SF pixels inside the SDSS aperture.
3. Hα EW histograms (see Fig. 2) rouhgly indicate similar percentages ($\sim$70% and $\sim$80% for *non-isolated* and *isolated* samples respectively) of H II Nucleus Galaxies[15]. H II regions are then conformed of SPs of similar age which supports interactions as to be the cause of the intensity differences.

References

[1] G. Byrd, M. J. Valtonen, L. Valtaoja, and *et al.* *A&A*, 166:75–82, 1986.
[2] J. Varela, M. Moles, I. Márquez, and *et al.* *A&A*, 420:873–879, 2004.
[3] C. J. Walcher, L. Wisotzki, S. Bekeraité, and *et al.* *A&A*, 569:18, 2014.
[4] S. F. Sánchez, R. C. Kennicutt, A. Gil de Paz, and *et al.* *A&A*, 538:31, 2012.
[5] J. P. Torres-Papaqui, R. Coziol, R. A. Ortega-Minakata, and *et al.* *ApJ*, 754:24, 2012.
[6] R. Cid Fernandes, A. Mateus, L. Sodré, and *et al.* *MNRAS*, 358:363–378, 2005.
[7] R. Cid Fernandes, G. Stasińska, M. S. Schlickmann, and *et al.* *MNRAS*, 403:17, 2010.
[8] S. F. Sánchez, F. F. Rosales-Ortega, J. Iglesias-Páramo, and *et al.* *A&A*, 563:25, 2014.
[9] J. A. Baldwin, M. M. Phillips, and R. Terlevich. *PASP*, 93:5, 1981.
[10] R. Coziol, R. E. Reyes, S. Considère, and *et al.* *A&A*, 345:13, 1999.
[11] L. J. Kewley, M. A. Dopita, R. S. Sutherland, and *et al.* *ApJ*, 556:19, 2001.
[12] M. A. Dopita, J. Fischera, R. S. Sutherland, and *et al.* *ApJS*, 167:23, 2006.
[13] E. M. Levesque, L. J. Kewley, and K. L. Larson. *AJ*, 139:15, 2010.
[14] J. H. Knapen, M. Cisternas, and M. Querejeta. *MNRAS*, 454:8, 2015.
[15] R. Coziol. *A&A*, 309:12, 1996.

Preliminary results

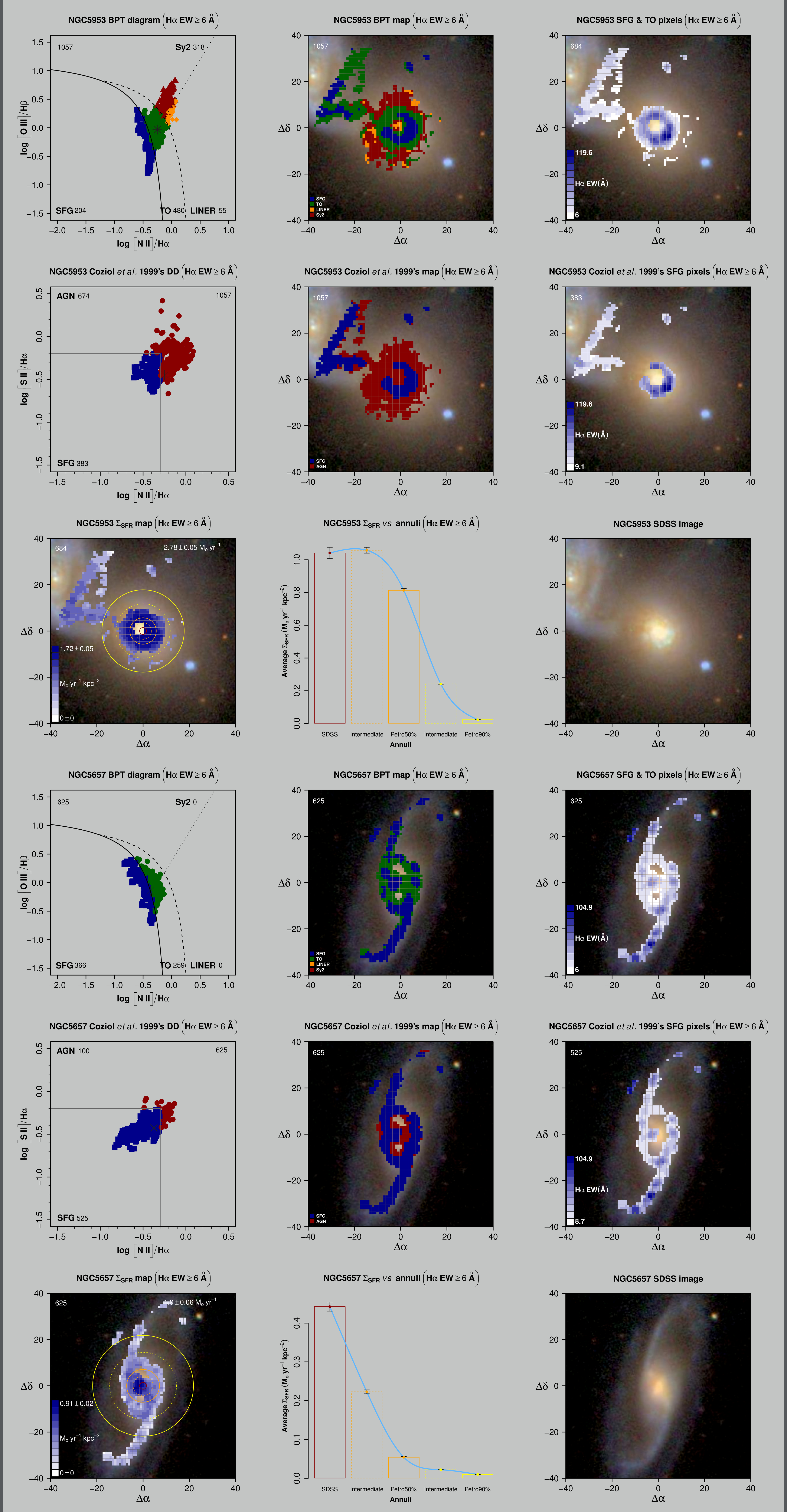

Figure 1: Properties of *non-isolated* and *isolated* galaxies NGC5953 and NGC5657 respectively.

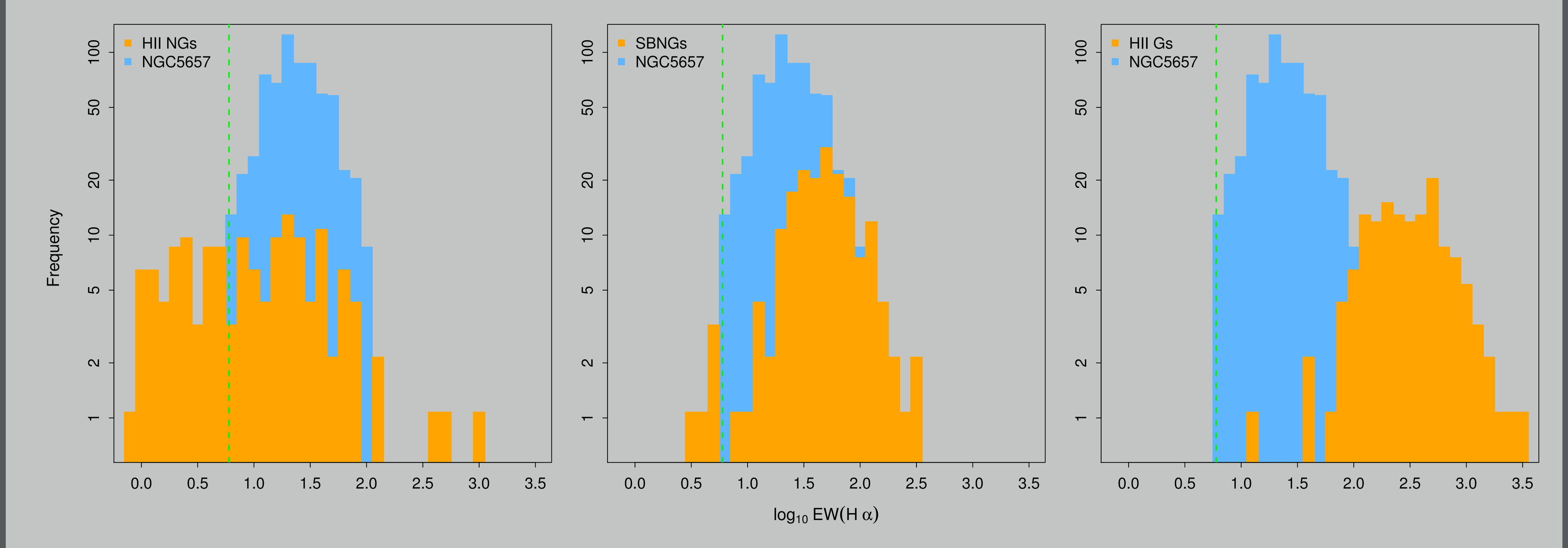

Figure 2: Coziol *et al.* 1996's classification for galaxy NGC5657. The dashed green line indicates the cut-off value.

http://www.astro.ugto.mx/webda/

★amorales@astro.ugto.mx