Are active galaxies more rotationally supported?

Ignacio del Moral-Castro – IAC, ULL (PHD student)

Collaborators: **B. Garcia-Lorenzo, C. Ramos Almeida**, T. Ruiz-Lara, J.Falcon-Barroso, S.F.Sanchez, P.Sanchez-Blazquez, I. Marquez, J.Masegosa

We present a comparison of the spin parameter λ_R, measured in a region dominated by the galaxy disc, between 20 pairs of nearby ($0.005 < z < 0.03$) seemingly isolated twin galaxies differing in nuclear activity. We find that 80-82% of the active galaxies show higher values of λ_R than their corresponding non-active twin(s), indicating larger rotational support in the active galactic nuclei (AGN) discs. This result is driven by the 11 pairs of unbarred galaxies, for which 100% of the AGN show larger λR than their twins. These results can be explained by a more efficient angular momentum transfer from the inflowing gas to the disc baryonic matter in the case of the active galaxies. This gas inflow could have been induced by disc or bar instabilities, although we cannot rule out minor mergers if these are prevalent in our active galaxies. This result represents the first evidence of galaxy-scale differences between the dynamics of active and non-active isolated spiral galaxies of intermediate stellar masses $(10^{10} < M_* < 10^{11}\ M_\odot)$ in the Universe.

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LETTER TO THE EDITOR

Larger λ_R in the disc of isolated active spiral galaxies than in their non-active twins

arxiv:2006.12654

del Moral-Castro et. Al (2020)
A&A Letters

Context

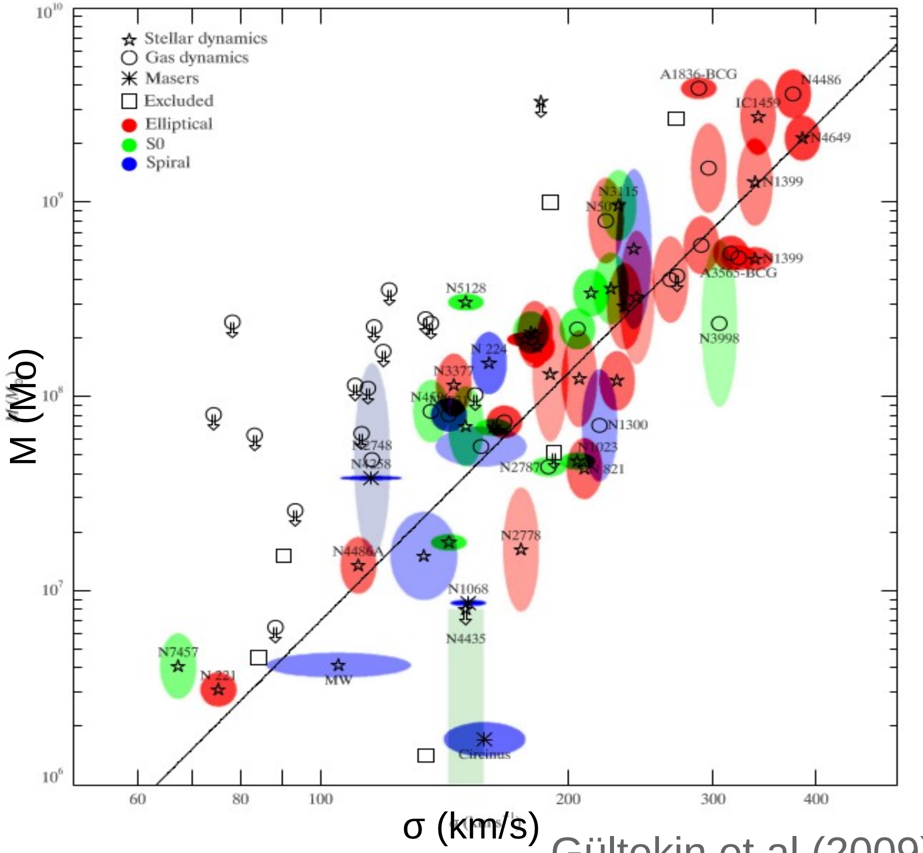
- Observational evidence suggests a **co-evolution** of the **central supermassive black holes** and their **host galaxies**

- Unveiling the **mechanism(s)** controlling this **co-evolution** is crucial to improve our understanding of the **formation and evolution of galaxies.**

- **Active galactic nuclei** (AGN) feedback has been proposed as the **main mechanism regulating SMBH** and **galaxy growth** in massive galaxies, and it can act in different ways.

- Understanding how nuclear activity is triggered and **whether all massive galaxies go through an active phase** is then of great importance.

Bulge velocity dispersion – Black hole mass relationship



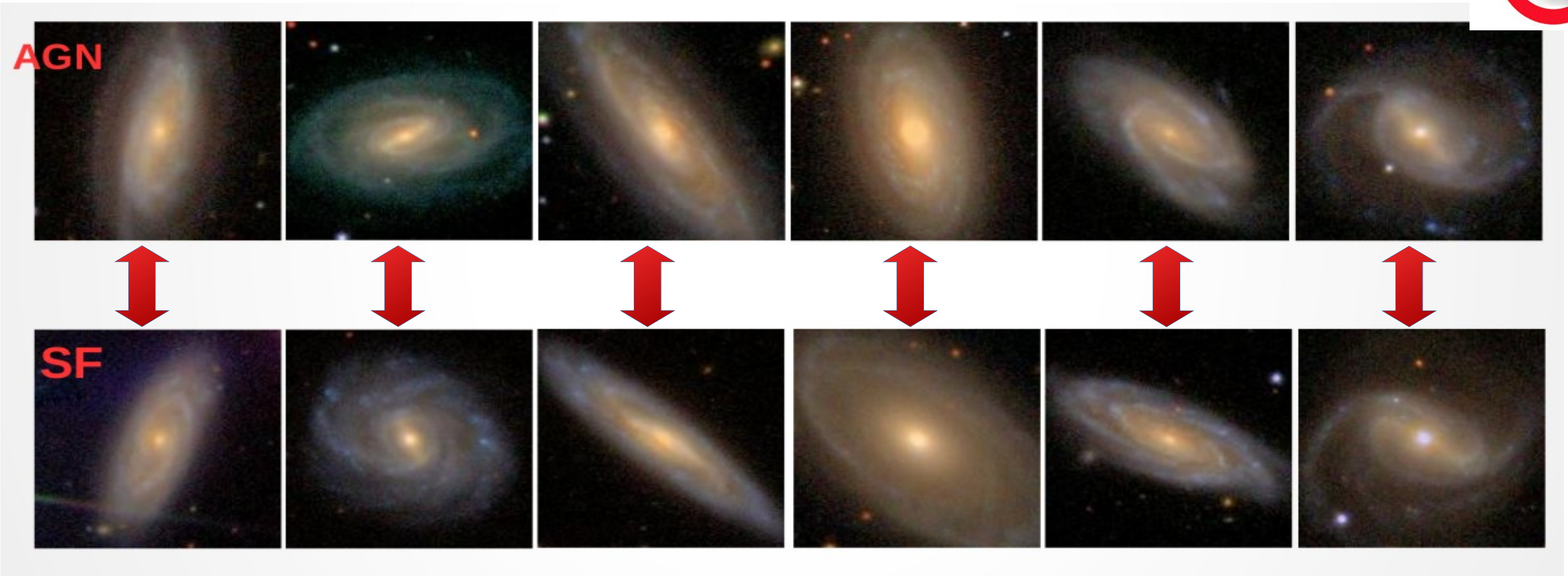
Gültekin et al (2009)

The definition of **non-active samples** is essential to search for **properties** that might be **unique to AGN**

Description of the work

- We identify large-scale almost identical **pairs of isolated galaxies** differing only in nuclear activity, using data from **CALIFA Survey**

Twin galaxies



Some AGN have two or more non-active twins

Matched:

- Mass
- Magnitude
- Inclination
- Redshift
- Bar length
- Hubble type
- Morphology

- We study the **differences in stellar λ_R**, in a region dominated by the **galaxy disc**, between **active and non-active galaxies matched in galaxy properties** and based on one-to-one comparisons.

λ_R quantifies the rotational support of a system

Results

- 16/20 (**80%**) pairs and 9/11 (**82%**) best twins have **AGN with larger λ_R**
- The **only type 1 AGN** in our sample has considerably **lower λ_R than its two twins.**
- 11/11 (**100%**) **unbarred pairs** have AGN with larger λ_R
- 5/9 (**56%**) **barred pairs** have AGN with larger λ_R

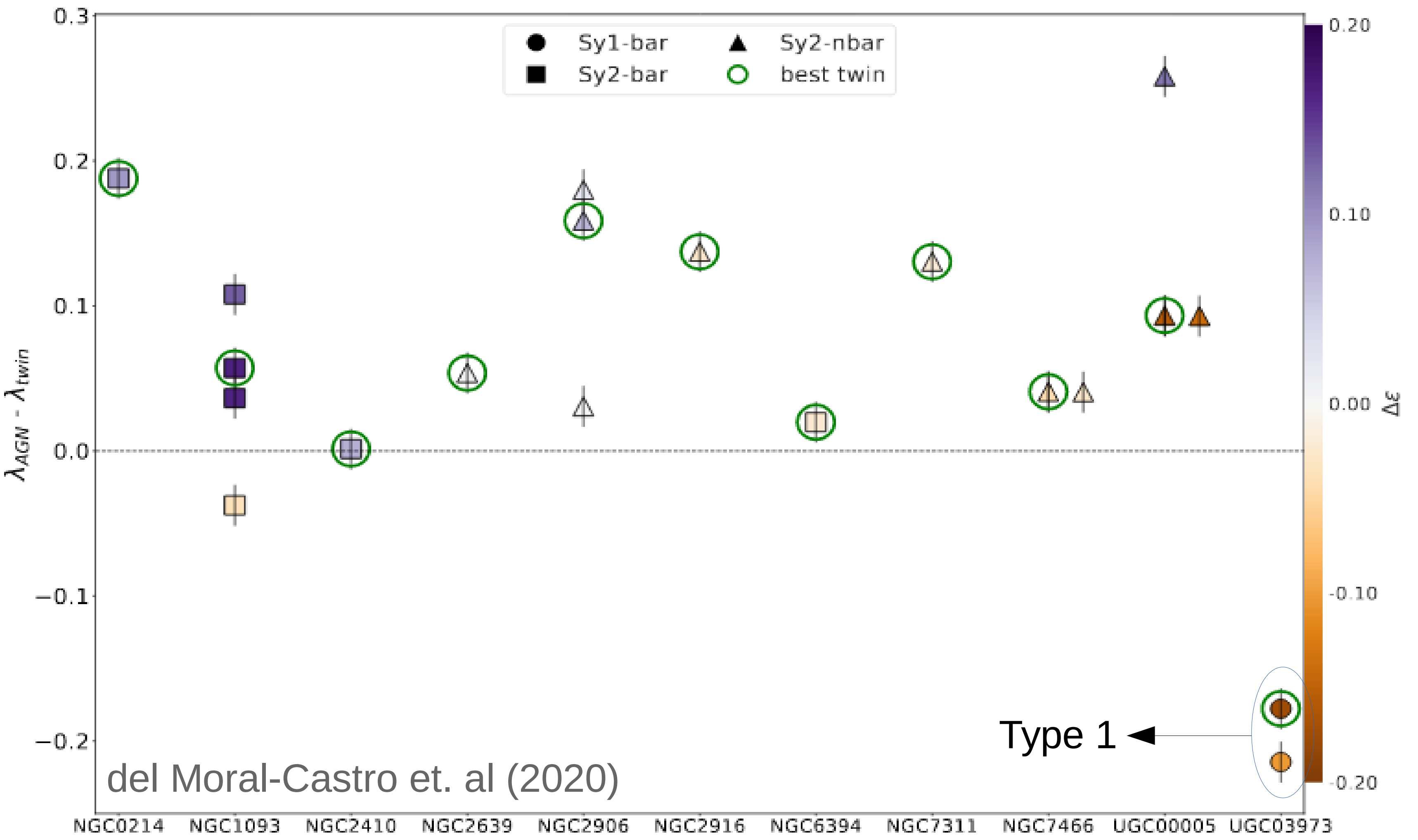


Fig. 2. Differences in stellar λ_R between the pairs of twin galaxies. The best twin of each AGN is indicated with a green circle. Each column corresponds to an active galaxy and each symbol to the difference in λ_R with each of its twins. The colour code indicates the difference in ellipticity ($\epsilon_{AGN} - \epsilon_{twin}$, see Table 1). Error bars correspond to propagation of the individual uncertainties (see Sect. 3).

The results are **no driving** by the **ellipticity, stellar ages, bulge fraction, effective radius or stellar mass**

Interpretations

- 2 possible interpretations:

  - An **imprint of the angular momentum transfer** from the **inflowing gas** to the baryonic matter in the disc (Kormendy 2013; Saha & Jog 2014). A large-scale disc or bar instability would have induced gas to move from the disc to the central region, triggering nuclear activity. As a consequence of this internal angular momentum redistribution, the galactic disc got dynamically colder (i.e. higher λ_R).

  - The gas has an **external origin** (i.e.minor mergers) in the case of the active galaxies. Thus, **gas-rich minor mergers** constitute another possible explanation if they are prevalent in AGN: not only do these minor mergers **promote spiral structure** (Purcell et al. 2011), **therefore increasing the disc λ_R**, but they also provide gas supply that can potentially trigger nuclear activity (e.g. Neistein & Netzer 2014; Tadhunter et al. 2014).

Impact and prospects for the future

- This result represents the **first evidence of galaxy-scale differences between the dynamics of active and non-active isolated spiral galaxies** of intermediate stellar masses $(10^{10} < M_* < 10^{11}\ M_\odot)$ in the Local Universe.

- **Finding galaxy-scale differences** between the active galaxies and their non-active twins appears **puzzling** because **AGN** are now understood as a short and likely **episodic phase of galaxy evolution**.

This could then imply that **not every galaxy goes through an active fase**, at least in the redshift and mass range considered here.

- This result needs to be **further explored and confirmed for a larger sample** of active and non-active galaxies, preferably using integral field data of higher angular and spectral resolution and larger spatial coverage.

More information and details in del Moral-Castro et. al (2020)

https://arxiv.org/abs/2006.12654

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