Study of scaling relations and host galaxy properties of AGNs using the SHARKS survey

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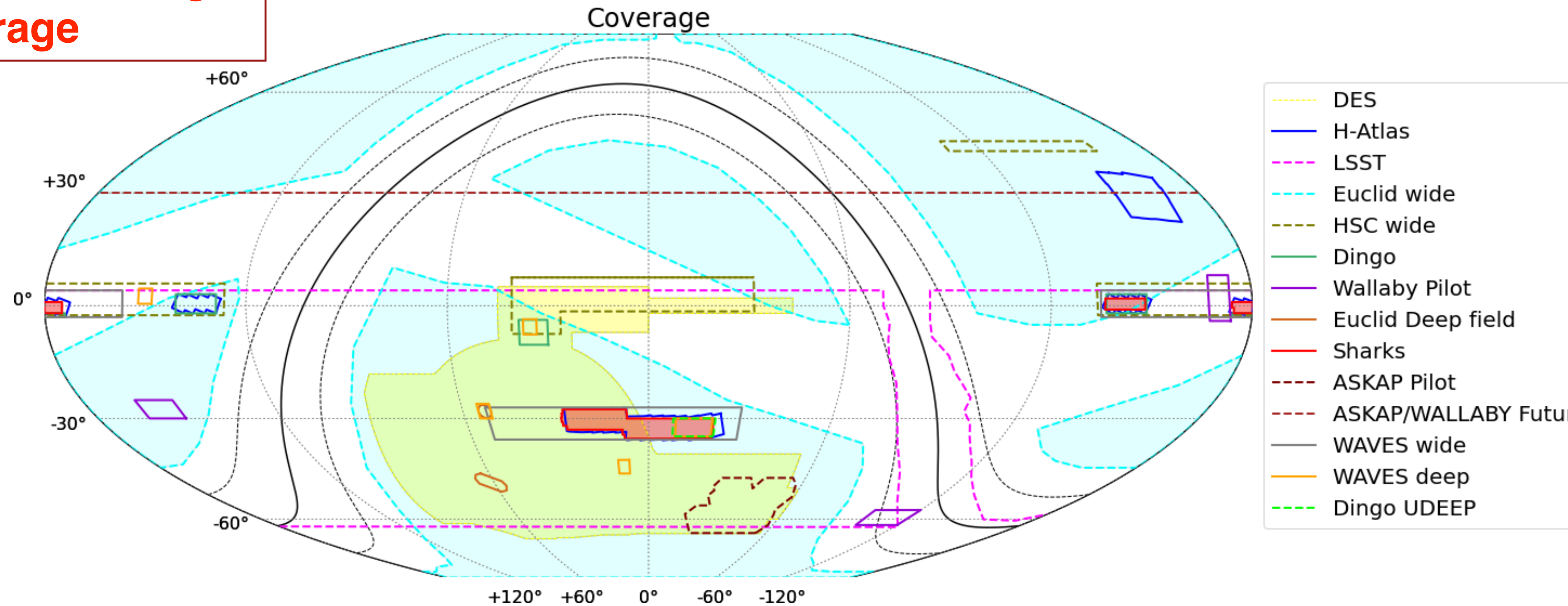
SHARKS: *Southern H-Atlas Regions Ks-band Survey*

Excellent multi-wavelength coverage

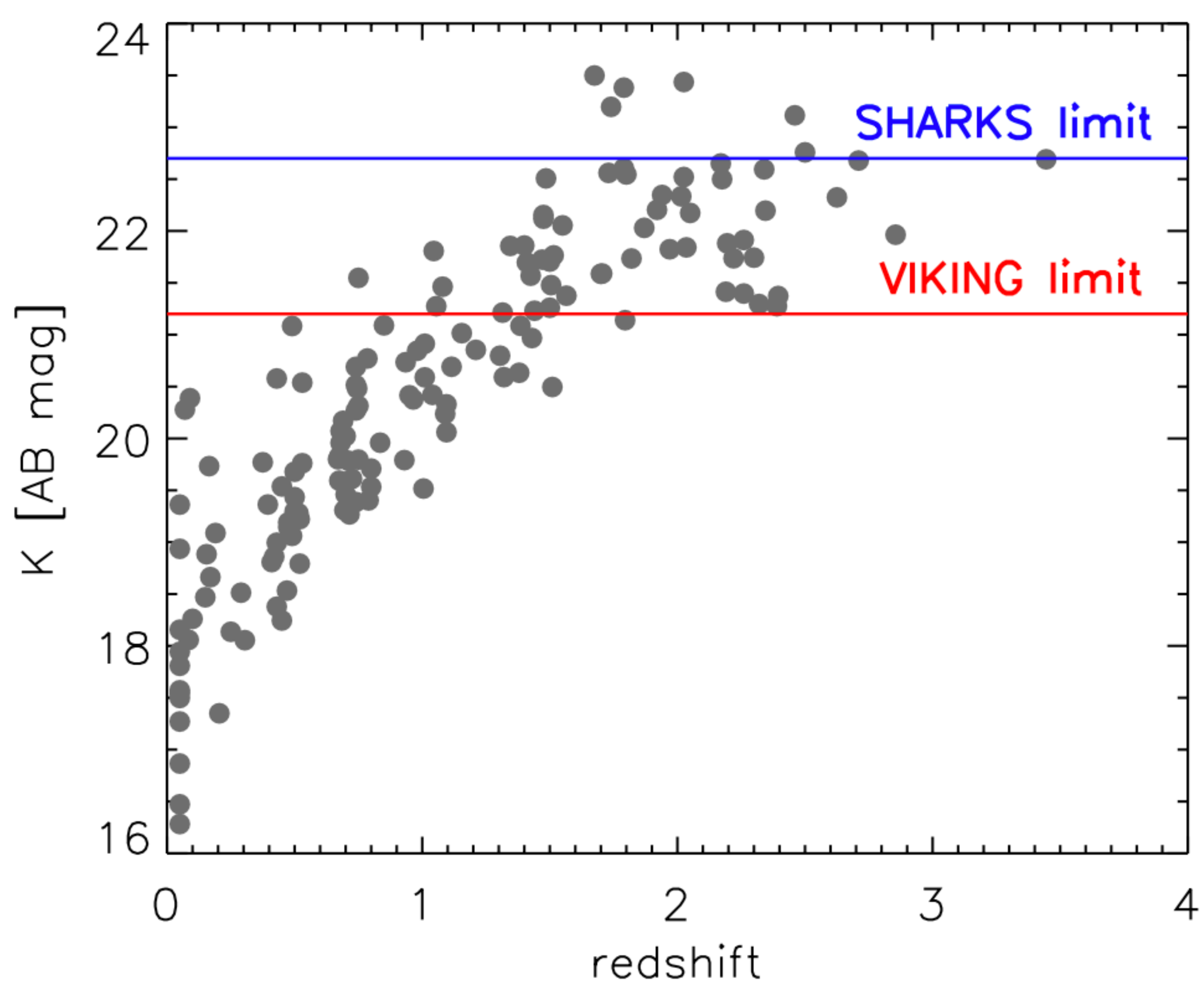


SHARKS in a nutshell

- **K_s-band survey of ~300 sq. degrees** in the **SGP, G12 and G15 fields** from H-ATLAS reaching a 5σ depth of **K_s~22.7 mag (AB) with a mean seeing of ~1´´** with VIRCAM at ESO VISTA 4m telescope.
- **Legacy value >>** Overlap with several past, present and future surveys (e.g., Euclid, WISE, LOFAR, ASKAP).
- **First data release** of **SHARKS on last January:** comprises calibrated **K_s-band images and source catalogues for ~20 sq. degrees divided in 10 mosaics of ~2 sq.** degrees each.
- 86% of tiles have been reduced.

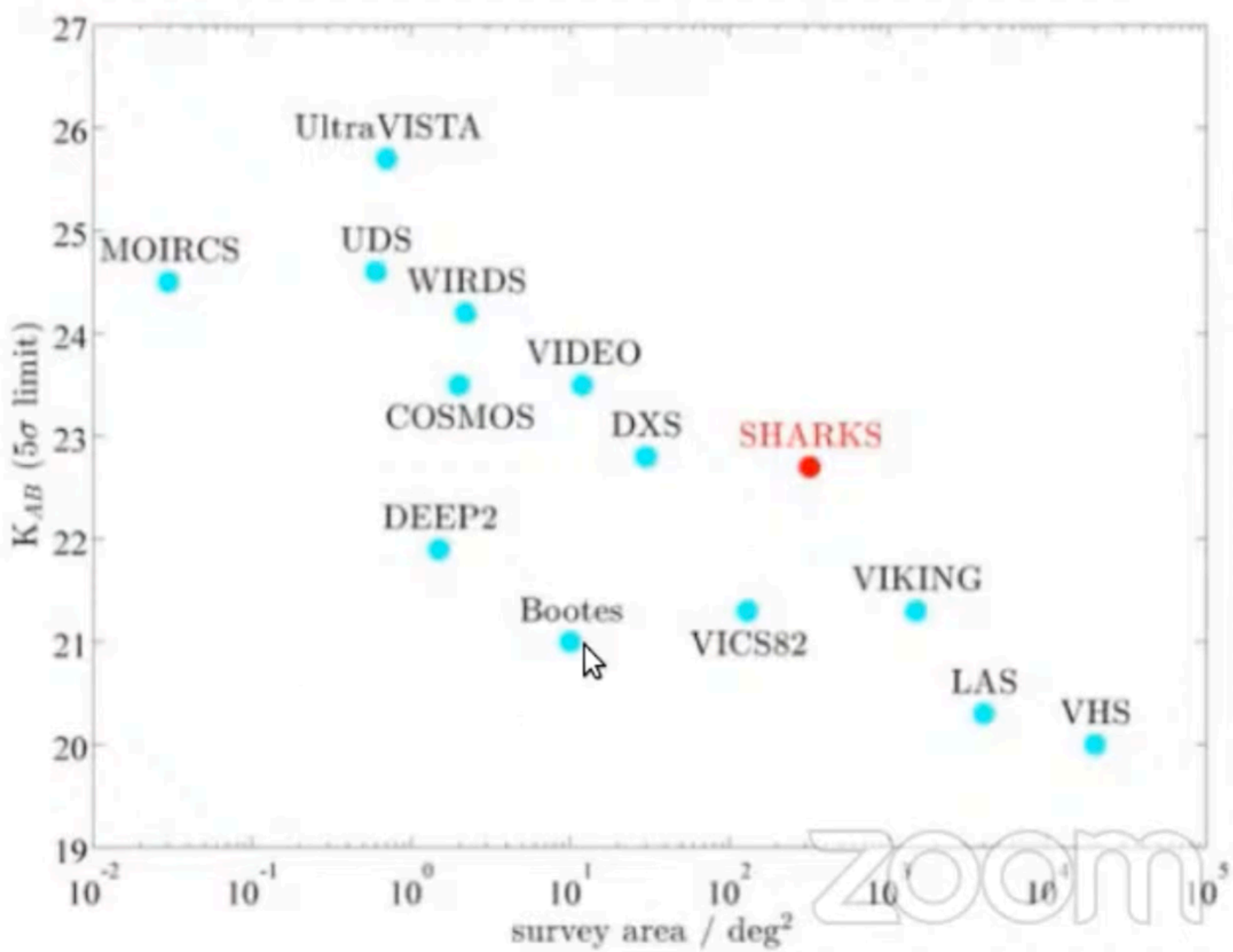
SHARKS Aims

- Increase the depth of VIKING survey from *Ks*= 21.2 to 22.7 mag over the SGP and GAMA fields (300 sq. deg.) with VISTA/VIRCAM.
- *Identification of (high-z) sources by providing the best possible counterpart for ~90% of the sources detected by H-ATLAS up to z~3.*
- Study the evolution of the most massive structures in the Universe.



Ks-band magnitude as a function of redshift for H-ATLAS sources with VLA counterparts in the SXDF and COSMOS fields.

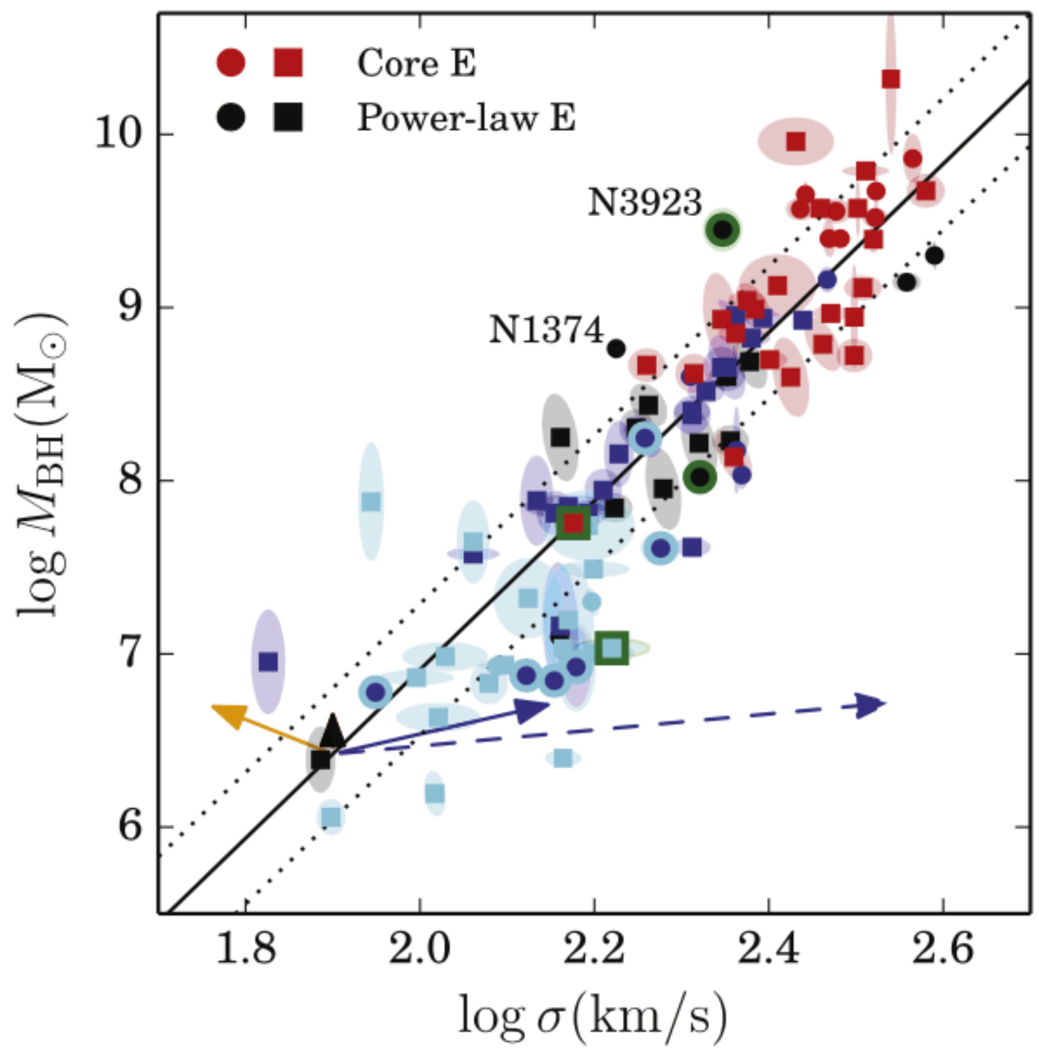
SHARKS fill the gap between wide/shallow and small/deep surveys



Scaling Relations

- Galaxies follow remarkably tight scaling relations between different physical properties such as luminosities, sizes, masses, among others.
- Scaling relations constitute benchmarks for any theoretical model of galaxy formation and evolution.

Tight correlations between the mass of SMBHs and host galaxy properties, e.g. bulge mass, stellar velocity dispersion (e.g., Magorrian et al. 1998, Kormendy & Ho 2013) suggest that the growth of galaxies is linked to that of their SMBHs.



- Saglia et al., (2016)

Bulge types

Bulges growth linked to mechanisms of formation and evolution of galaxies.

Classical bulges: *pressure-supported and formed mainly in major mergers as ellipticals.*

Pseudobulges: *rotational-supported and evolve continually and slowly via secular processes related to disc of galaxies.*

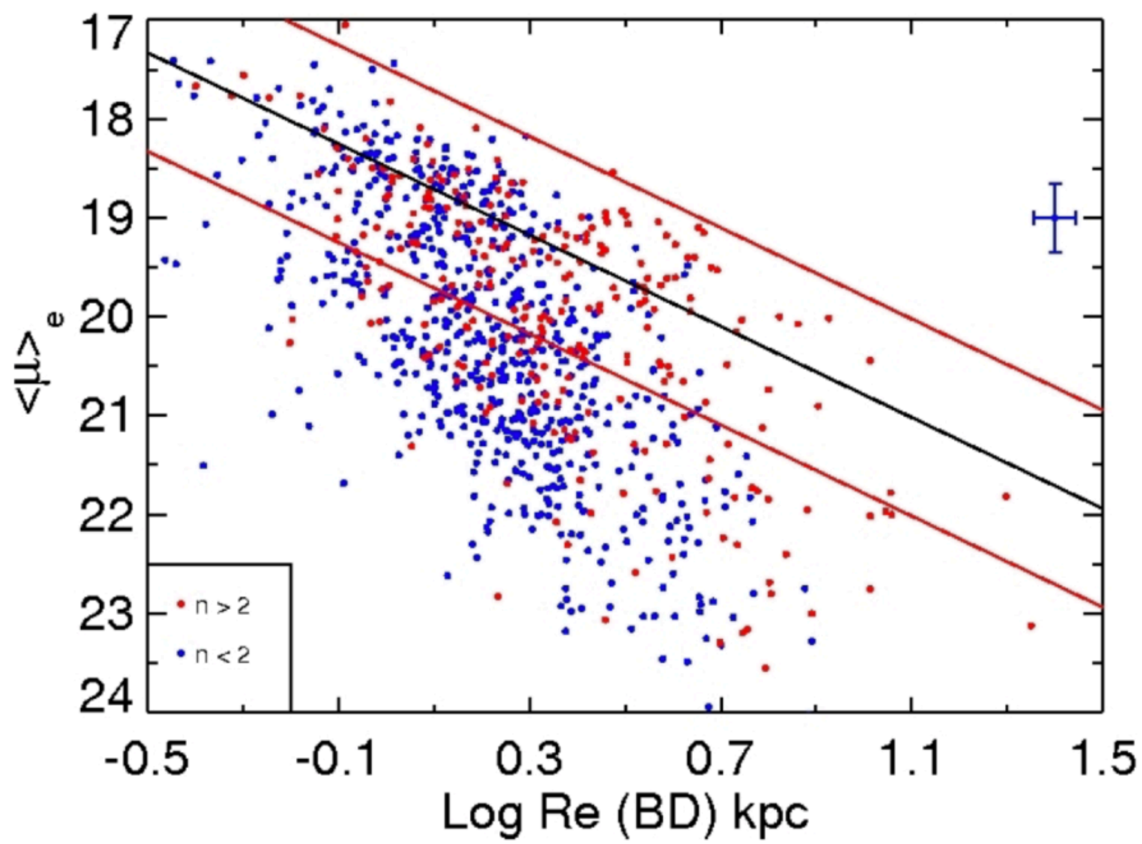
Indicators proposed to identify bulges (e.g., Kormendy & Kennicutt, 2004; Athanassoula, 2005; Fisher & Drory, 2008; Gadotti, 2009; Costantin et al. 2018):

-Sérsic index: Classical bulges **—>** $n \geq 2$; otherwise, pseudobulges.

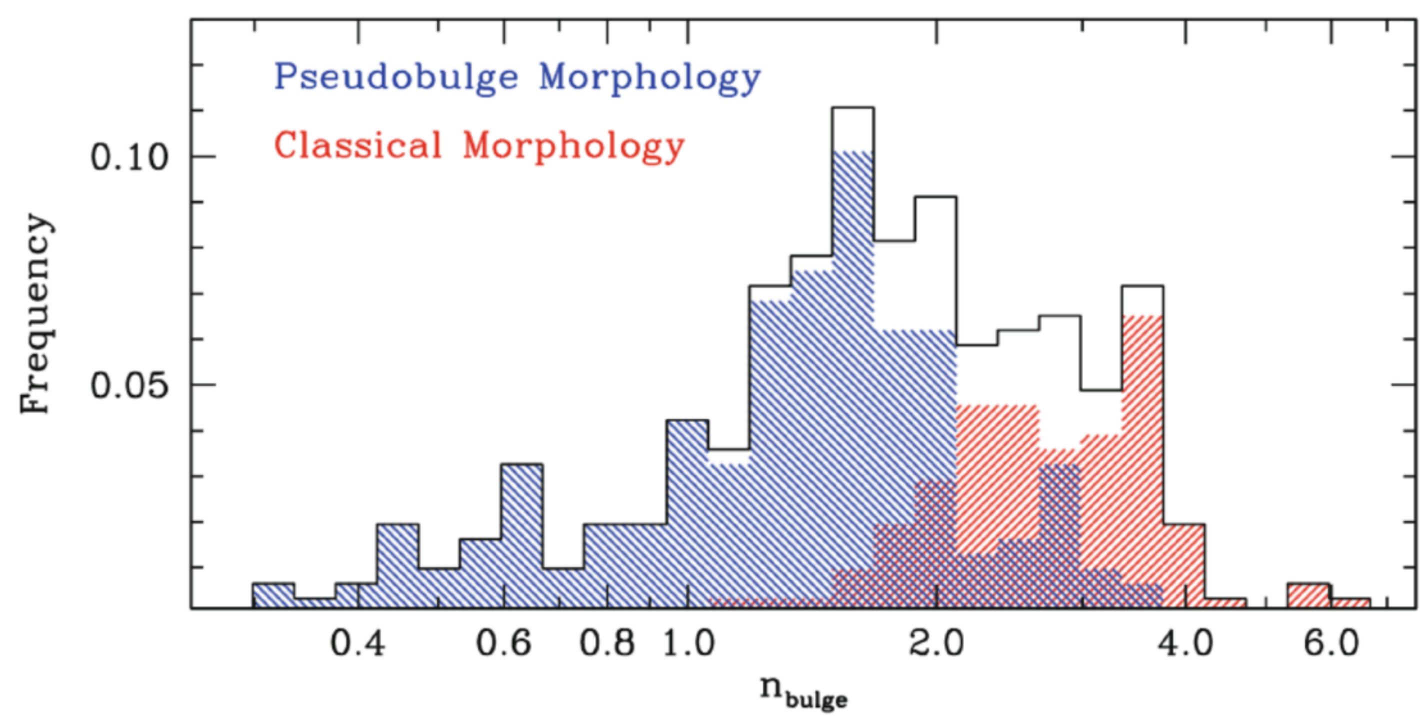
-Velocity dispersion: Classical bulges **—>** $\sigma > 130$ km/s; otherwise, pseudobulges.

-FP projections (e.g., *Kormendy*,Faber-Jackson *relations*) **—>** Pseudobulges are outliers of such correlations.

-Specific star formation rate: Pseudobulges present high sSFR $> 10^{-11}\,yr^{-1}$



Kormendy Relation (Añorve 2012).



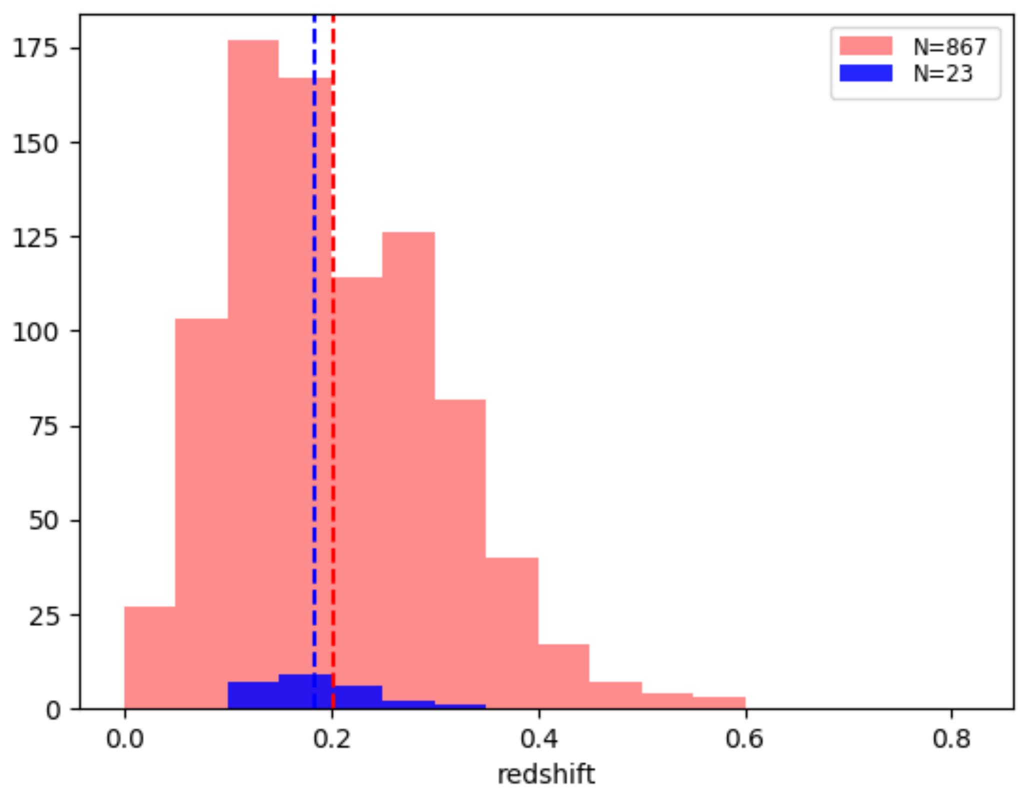
Sérsic index distribution for bulges (Laurikainen et al. 2016).

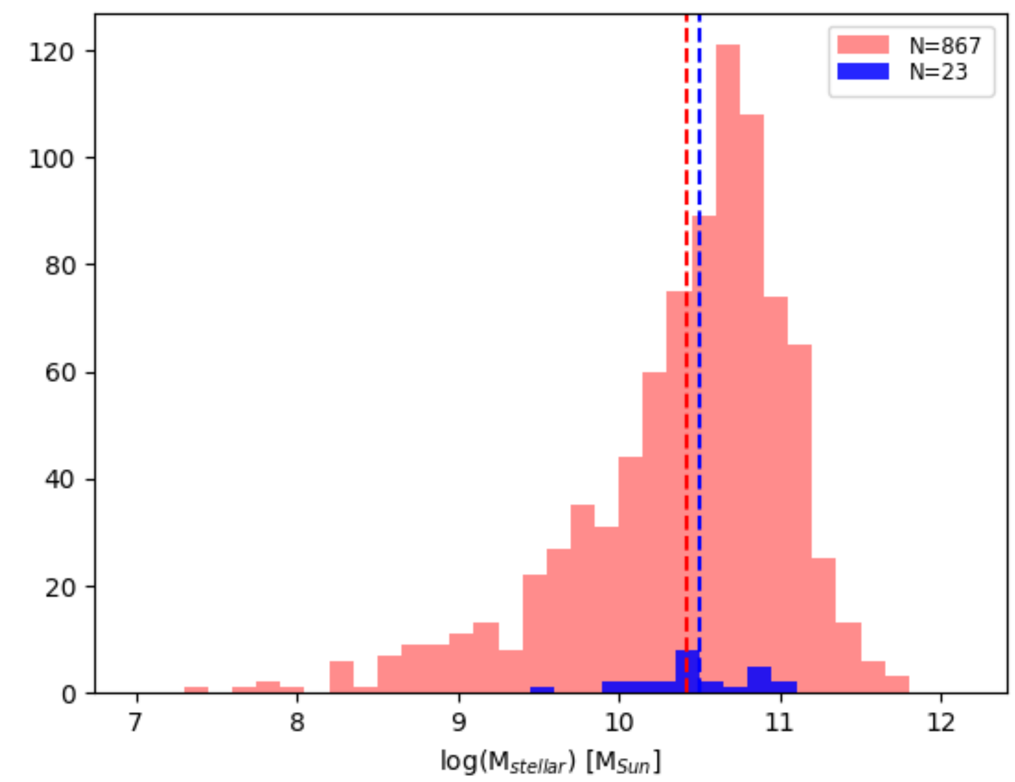
Objectives

- A pilot study using SHARKS images along with multi-wavelength data focusing on the AGN sources.
- Photometry of galaxies in the near infrared (NIR; Ks band) to estimate structural parameters of host galaxies of AGN.
- Combining spectroscopic and photometric data to perform a detailed mapping of BH Scaling Relations:

i) Increase the sample in size and redshift range; and ***ii)*** study the trends displayed by bulges (classical and pseudo).

Data

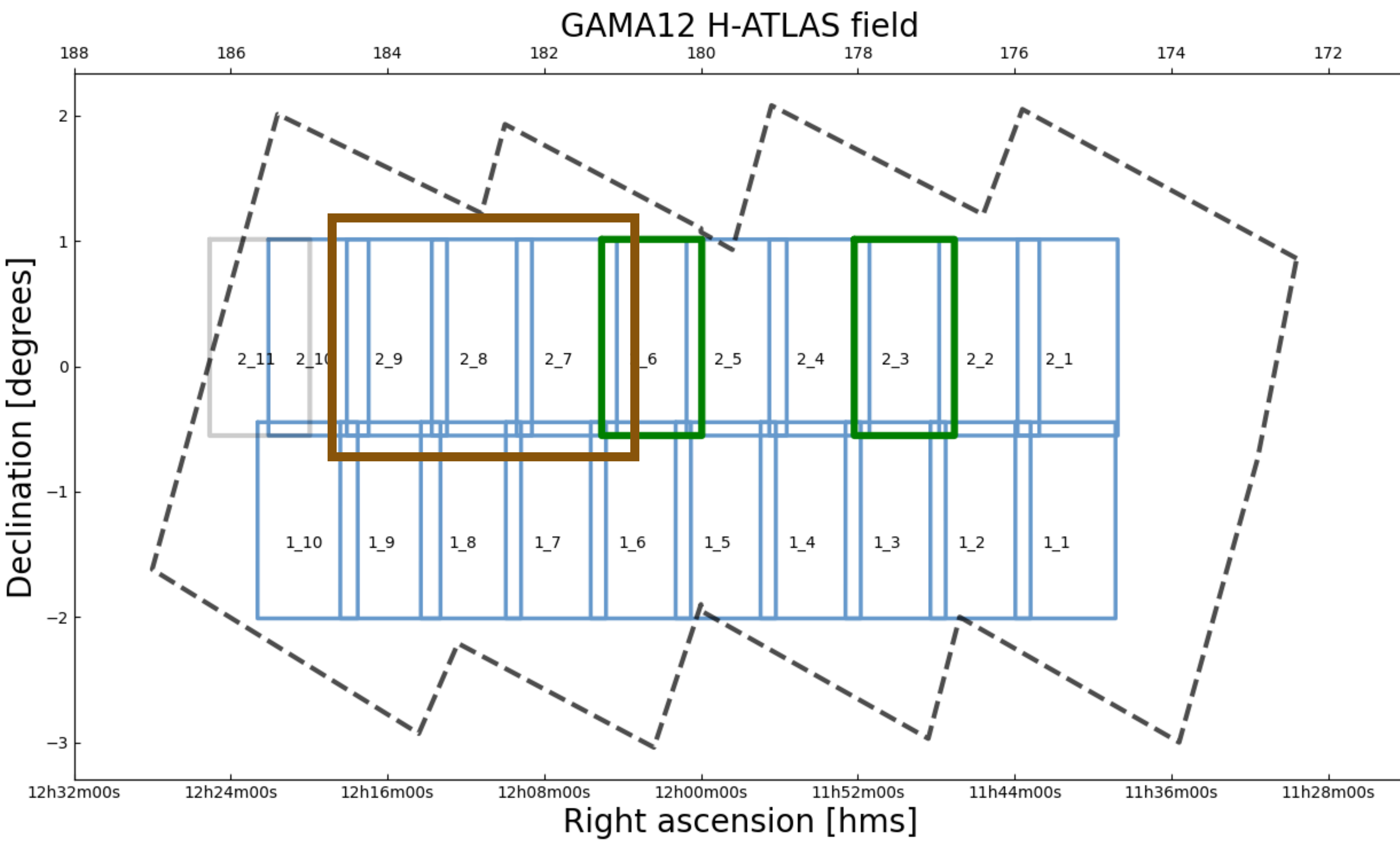




-For this pilot study we have used 3 mosaics (2_7, 2_8 and 2_9) from G12 field covered by SHARKS.

-Sample of galaxies with redshift $z < 0.6$.

-Our targets have counterparts in the GAMA and H-ATLAS surveys **>>** 867 sources found in these 3 mosaics.

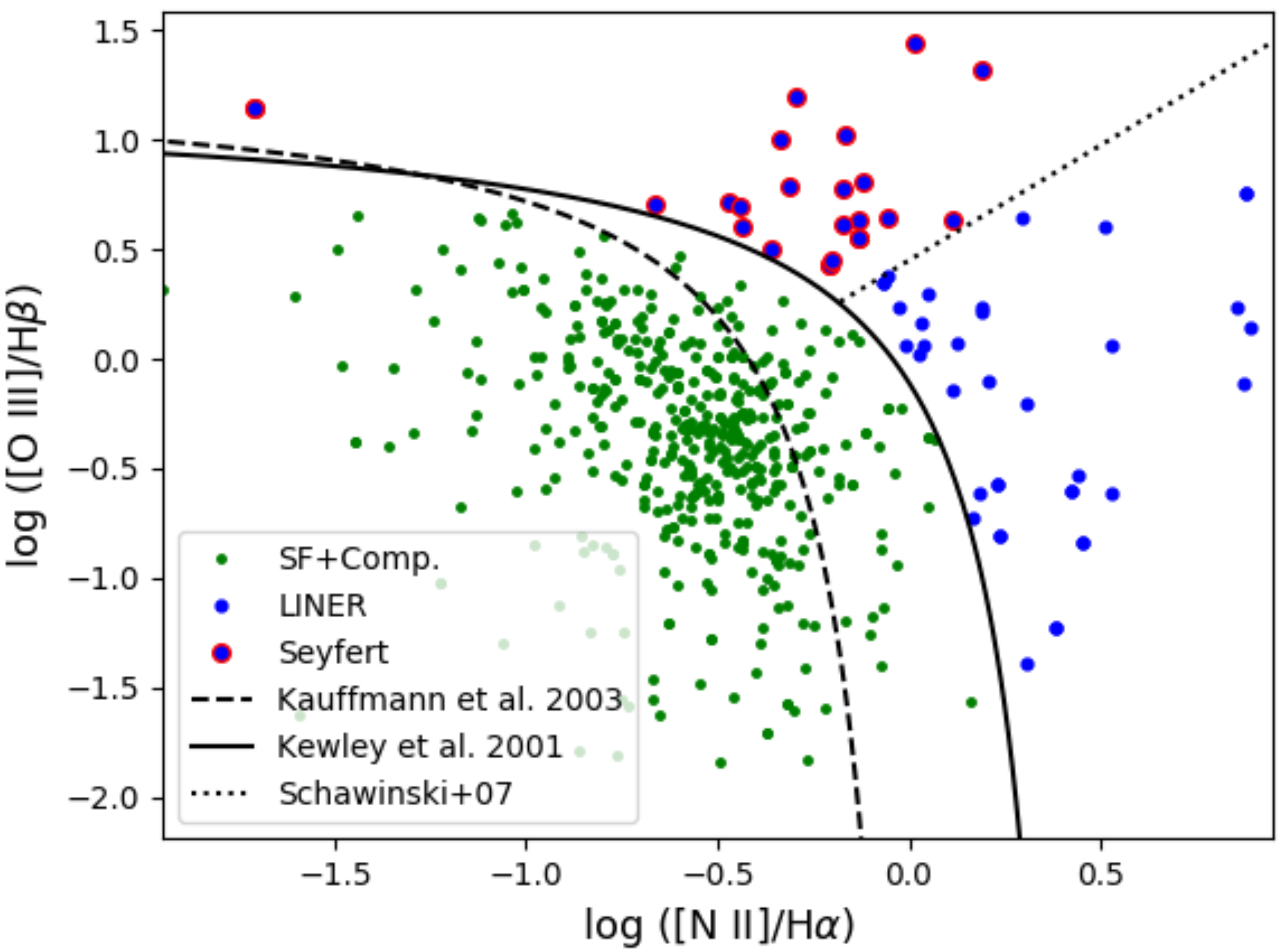

GAMA12 H-ATLAS field
Declination [degrees]
Right ascension [hms]
188
186
184
182
180
178
176
174
172
2
1
0
−1
−2
−3
12h32m00s
12h24m00s
12h16m00s
12h08m00s
12h00m00s
11h52m00s
11h44m00s
11h36m00s
11h28m00s
2_11
2_9
2_8
2_7
2_5
2_4
2_3
2_2
2_1
1_10
1_9
1_8
1_7
1_6
1_5
1_4
1_3
1_2
1_1

Methodology

-Classification of AGN and star-forming dominated sources by means of BPT diagram.

-Photometric analysis through a 2D photometric decomposition using GALFIT.

-Perform a bulge classification using the photometric decomposition along with other parameters.



-Spectroscopic data from GAMA catalogues (Taylor et al. 2011; Wright et al. 2016; da Cunha et al. 2008).

-From the 867 objects in these SHARKS mosaics **>>** *23 objects classified as Seyfert.*

2D Photometric Decomposition

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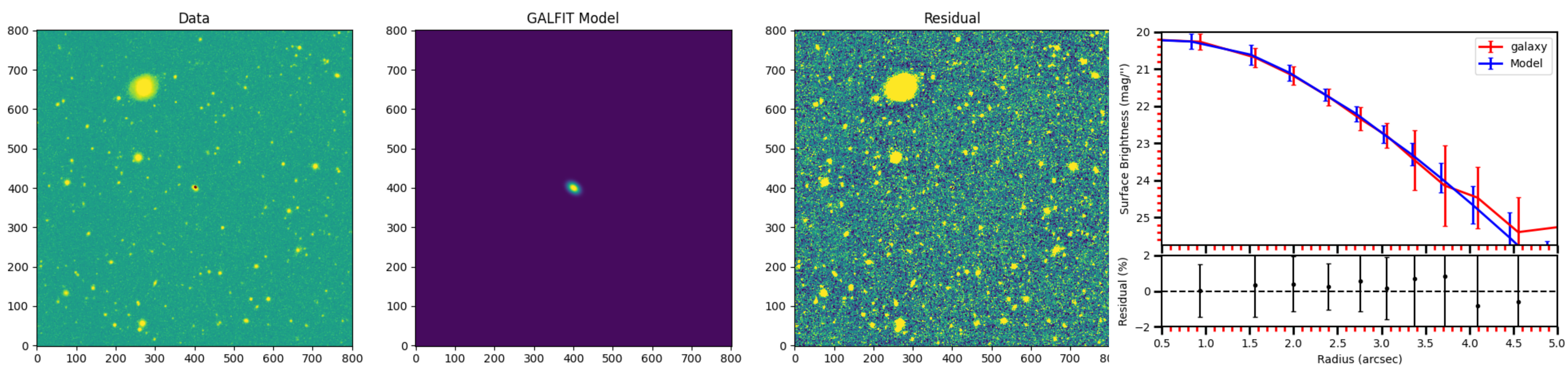
GALFIT (Peng et al. 2010) models surface brightness through radial functions for describeing the radia fall-off in flux, such as: Sérsic, Exponential Disc, among others.

Sérsic profile (Sérsic 1967):

$$\Sigma(r) = \Sigma_e exp\left[-\kappa\left(\left(\frac{r}{r_e}\right)^{1/n} - 1\right)\right]$$

where *re* is the effective radius, *Σe* is the surface brightness at *re*, *n* is the Sérsic Index.



Example of GALFIT's output using SHARKS data in the GAMA 12 field following the methodology in Ríos-López et al. 2021.

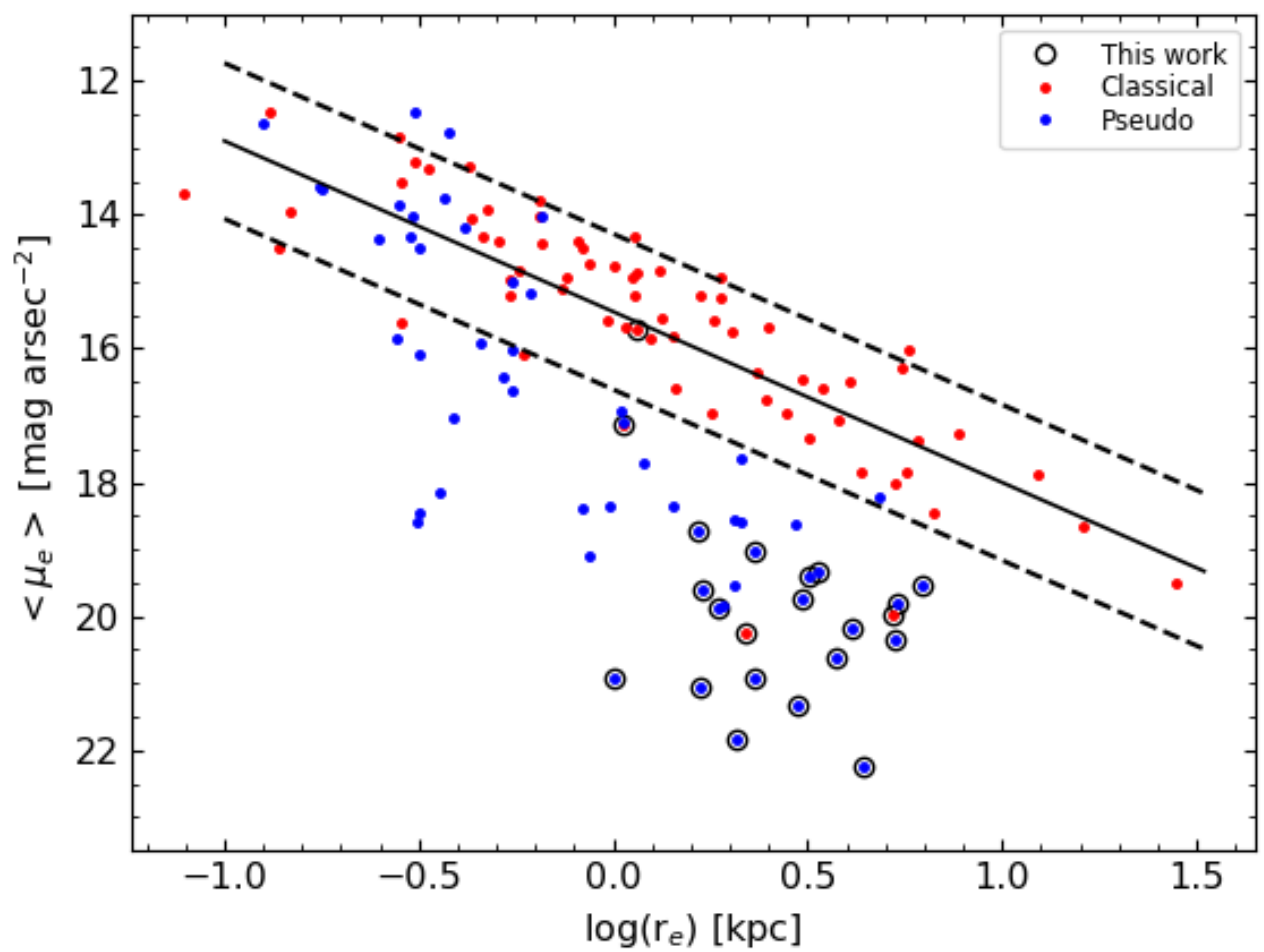
Scaling relations and bulge classification

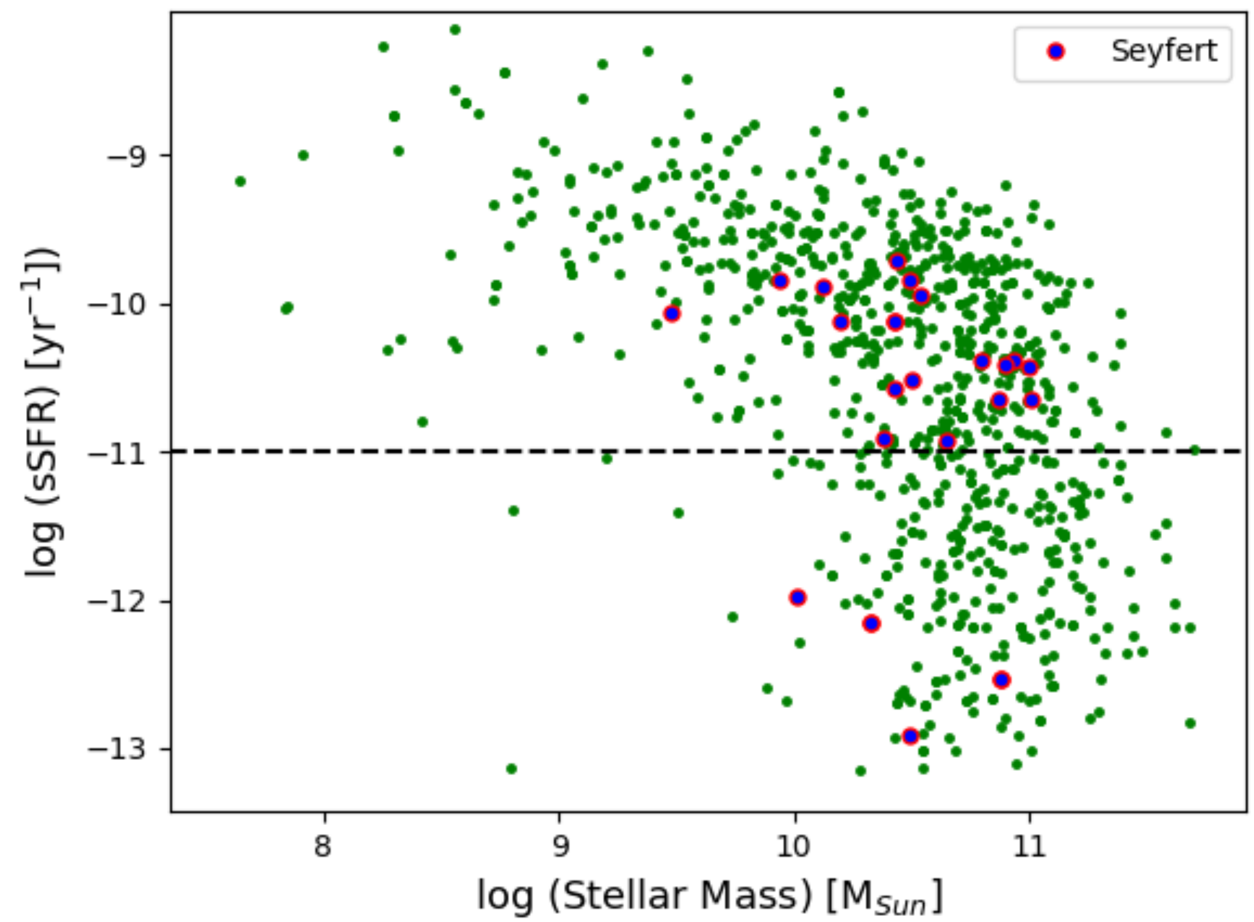
Preliminar results

For a more robust classification, 3 criteria used (e.g., Fisher & Drory 2008; Ríos-López et al. 2021):

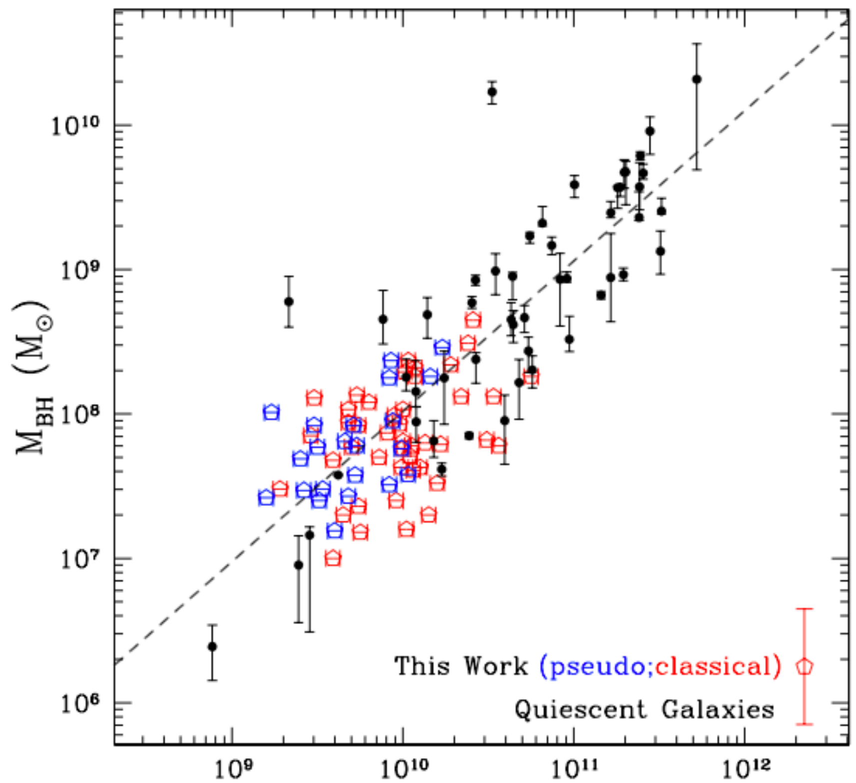
1) Kormendy Relation, **2)** Sérsic index and **3)** sSFR:

-We obtain for the 23 Seyferts galaxies **>>** _19 pseudobulges / 4 Classical bulges_

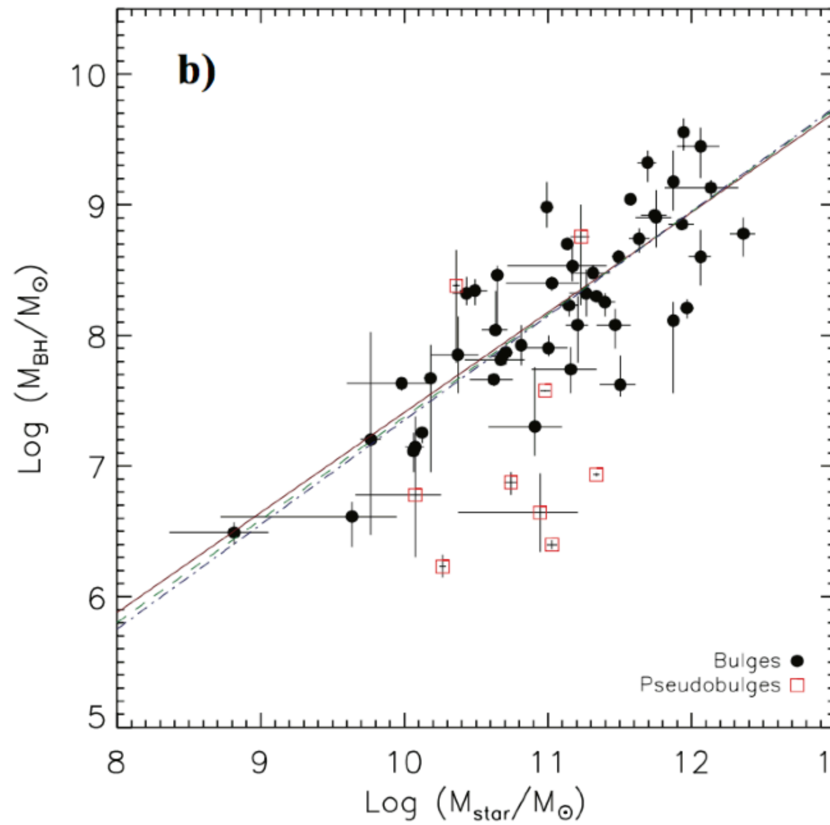




Why the study of bulges in these relations?

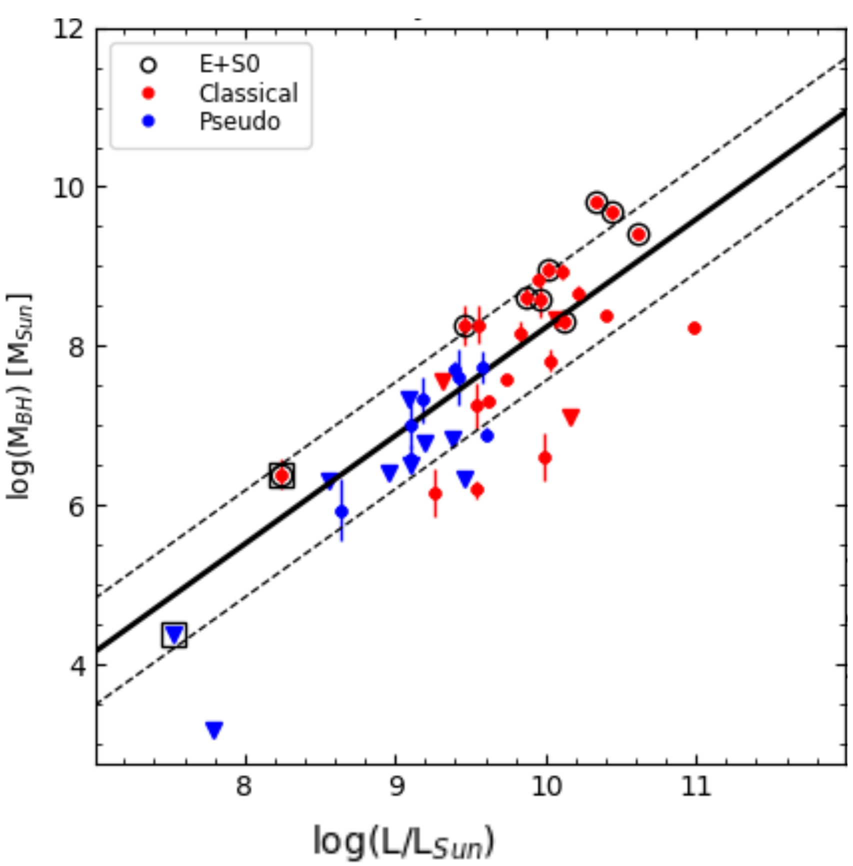


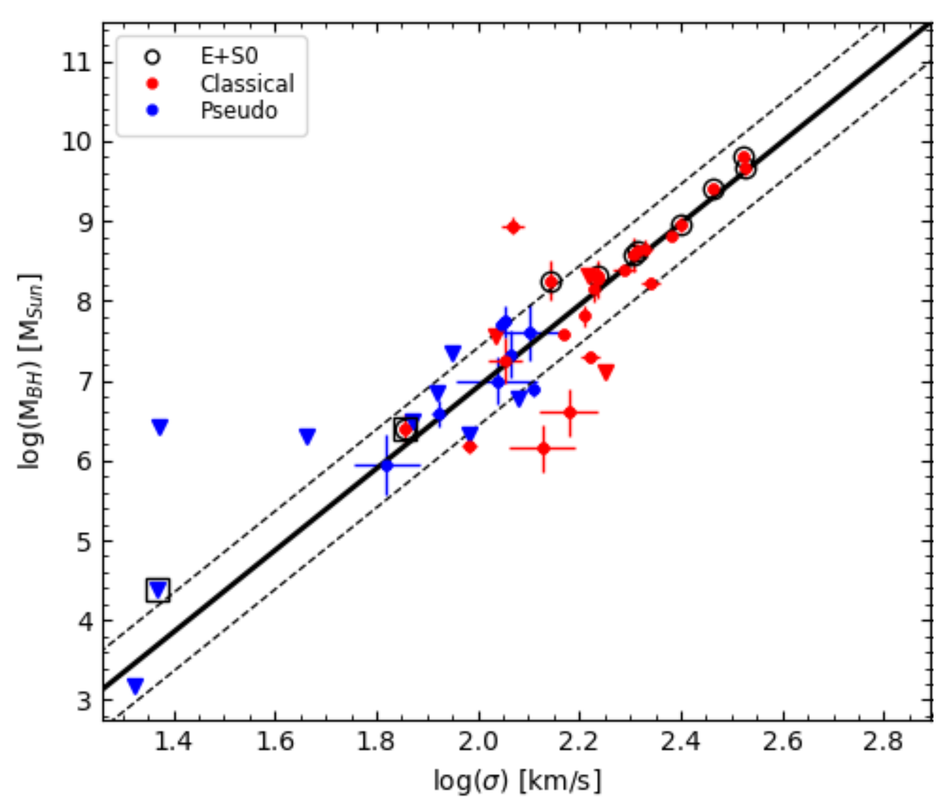
Bennert et al. (2021)



Sani et al. (2011)

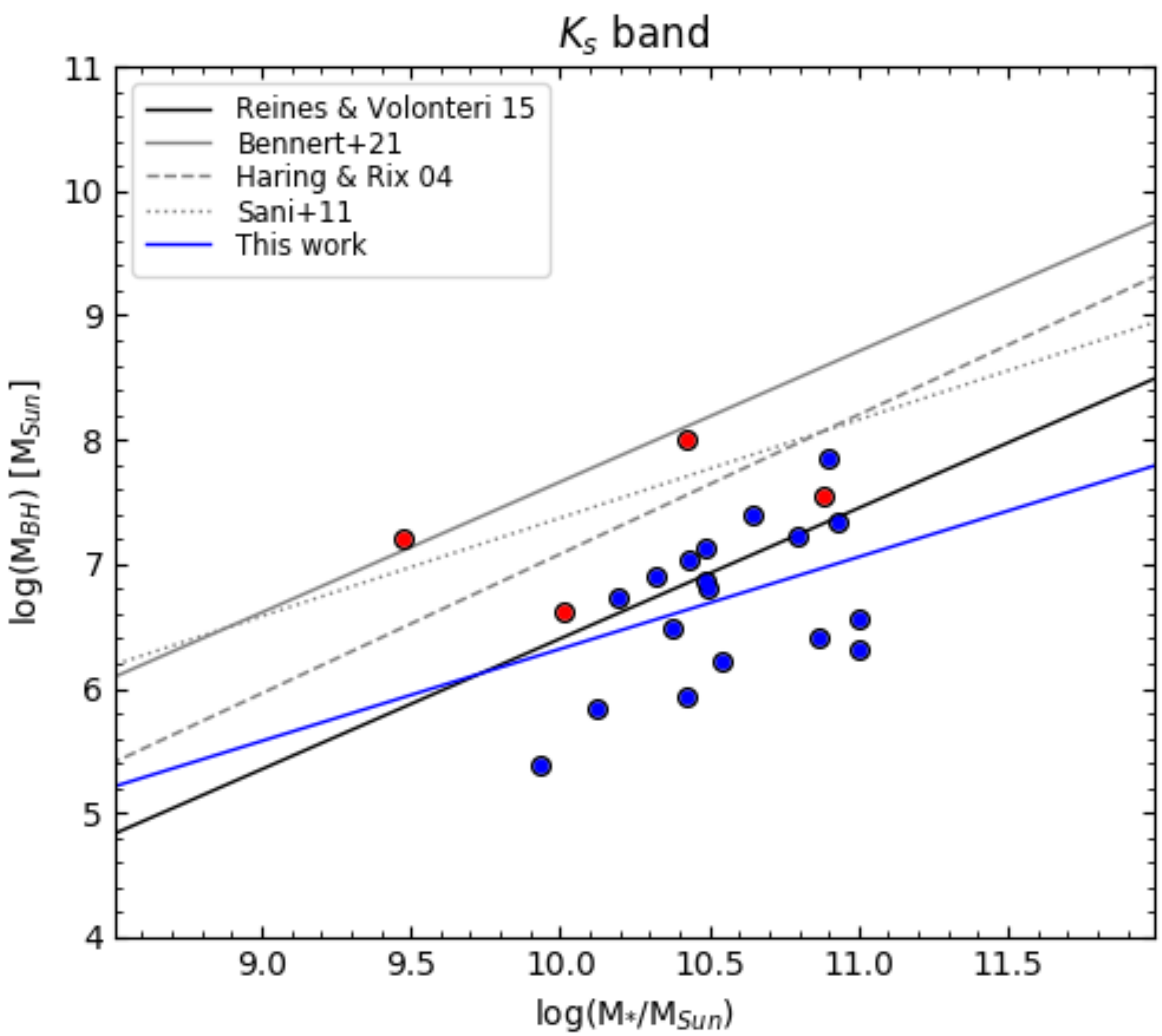
Pseudobulges are consistent with BH relations





- **M_{BH}-Lum and M_{BH}-σ Relations** (Ríos-López et al. in prep.)

Scaling relations: *Preliminar results*



BH Masses of SHARKS targets classified as Seyferts were estimated using M_{BH}-L_{tot} from Bennert+2021 $\log M_\bullet = a + b(\log L - 11)$

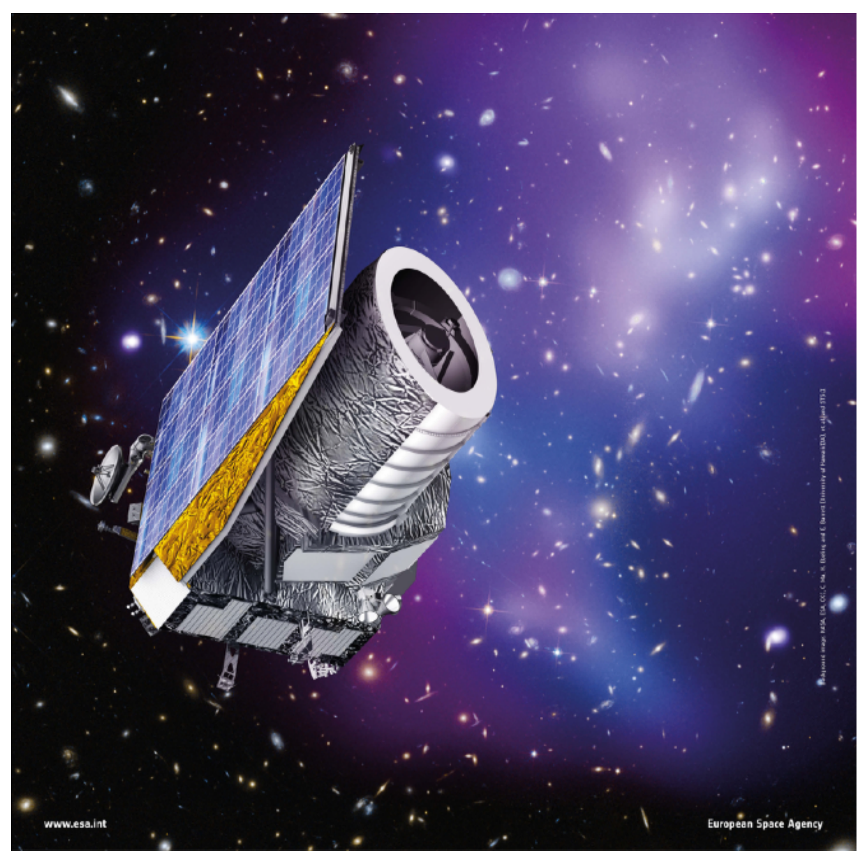
b=1.03 +/-0.07; a=9.06+/-0.73

- In agreement with Reines & Volonteri (2015) >> Sample of 262 AGNs
- Offset with previous studies, e.g., KH 2013; Haring & Rix (2004); Bennert et al. (2021) **>>** *Sample comprises quiescent galaxies + AGNs, redshift range; BH mass estimates*

- Using the G12 mosaics of SHARKS to increase the sample to study a better trend of pseudobulges wether they follow or not SRs

ESA Euclid Mission

- ***The SHARKS fields have a good coverage with several past, present and future surveys (e.g., Euclid, LSST, LOFAR, ASKAP).***
- EUCLID photometry in the *Y, J, H (not in Ks)* observations will overlap SHARKS, representing a perfect complementary datase.
- **An overlapping area of 100% in SGP observed by SHARKS.**
- **Euclid: 15,000 deg^2, high resolution, > 200 million of galaxies >>** Ideal for morphological studies of galaxies and their components such as bulges, bars, spiral arms, among other, as well as to test. the evolution of SRs as function of redshift.



Summary

- **SHARKS** is a **deep, wide survey in the K_s-band covering ~300 sq. degrees** with the ESO VISTA 4m telescope covering the **SGP (East and West), G12 and G15 fields** from the Herschel-ATLAS survey**.**

- **SHARKS-DR1** is the **first public data release** of **SHARKS survey** and comprises calibrated **K_s-band images and source catalogues for ~20 sq. degrees divided in 10 mosaics of ~2 sq.** degrees each.

- We have performed a 2D decomposition for galaxies classified as Seyfert via BPT diagram (23 out of 867) for 3 mosaics in G12 field covered by SHARKS.

- We performed a bulge classification for such Seyfert galaxies using next criteria: KR, Sérsic index and sSFR distribution **>> 19 pseudobulges and 4 classical bulges.**

- **MBH-M* relation for AGNs in this work from SHARKS :** In agreement with previous work (Reines & Volonteri 2015), however still discrepancies with other results —> ***Test in more detail this issue***

- SHARKS website:

  http://research.iac.es/proyecto/sharks/pages/en/team.php

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Thank you!

¡Gracias!

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