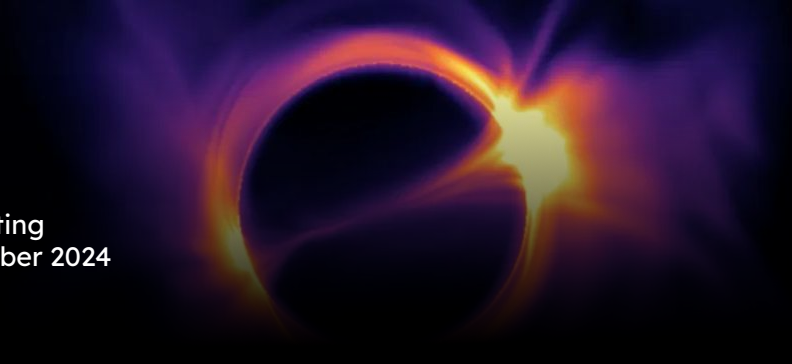
TITANs Meeting
11th - 13th December 2024



Do SMBH mass estimates *agree* one to each other?

A study on the systematics of indirect MBH estimators in the **ETHER** database

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TITANS Nucleo Milenio

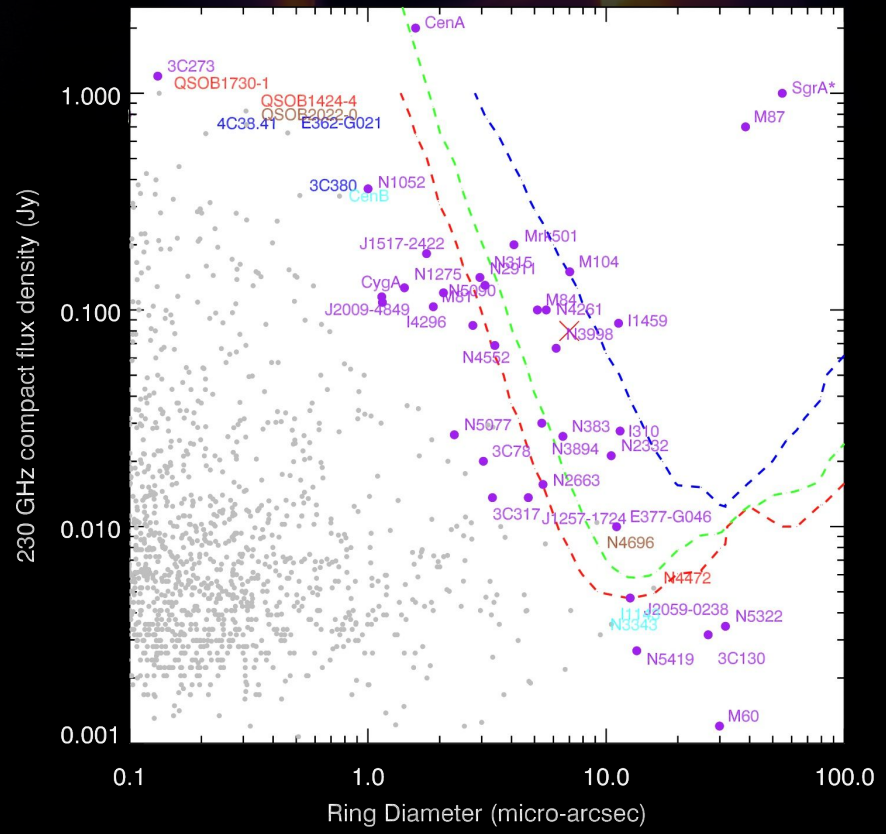
Supermassive Black Holes (SMBH)

- Supermassive black holes (SMBH), ranging from 10^5 to 10^{10} $M_\odot$, are present in galactic nuclei (Graham+2016), influencing the evolution and structure of host galaxies (Rees 1984, Kormendy+2013).

Left: Image of the shadow of M87* and its emission at 230 GHz.
Right: Same, but for Sgr A* (EHTC+2019, 2022)

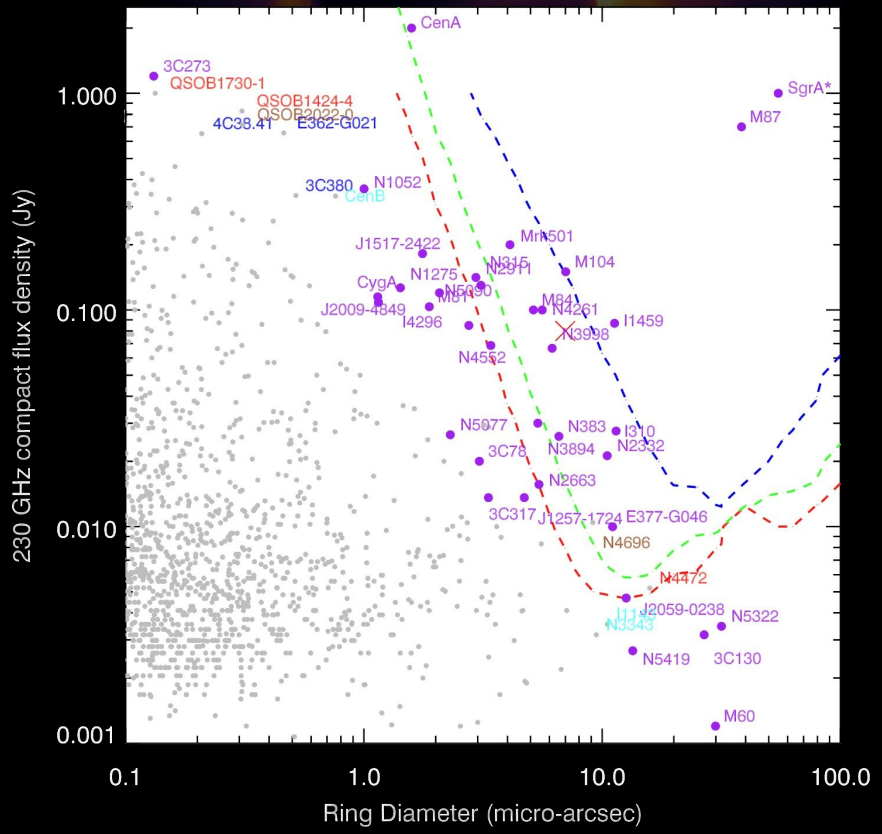
Event Horizon and Environs (ETHER) sample

- A curated database for EHT and ngEHT target selection
- ~3.6 million SMBH masses (181 measurements, **~3.1 million estimates**)
- More details will be available in **Silpa+in prep** (presented in **Ramakrishnan+2023**, updated in **Hernández-Yévenes+2024, Nair+2024**).
- For more info, see presentations by **Dhanya, Silpa, Vicente and Bidisha** (all coming next!)



MBH estimates in ETHER

- Compilations from M-sigma, e.g, Portsmouth (pPXF) or Wisconsin (PCA). Around 1.5M estimates.
- Single-epoch spectra (or single-epoch RM) from Rakshit+2020 (500k estimates)
- WISE2MBH (3M estimates+uplimits,~75% disponibility)

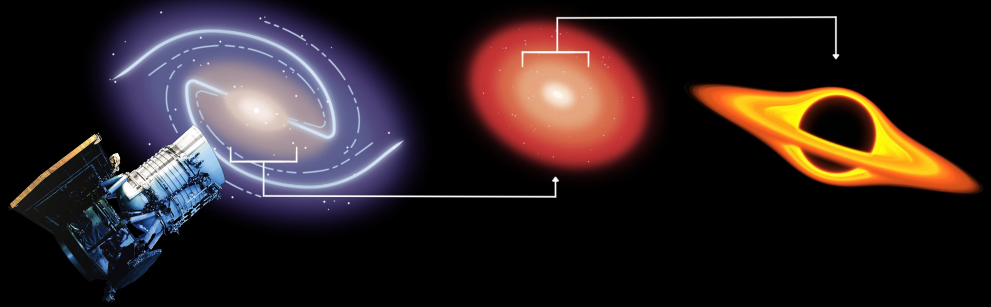


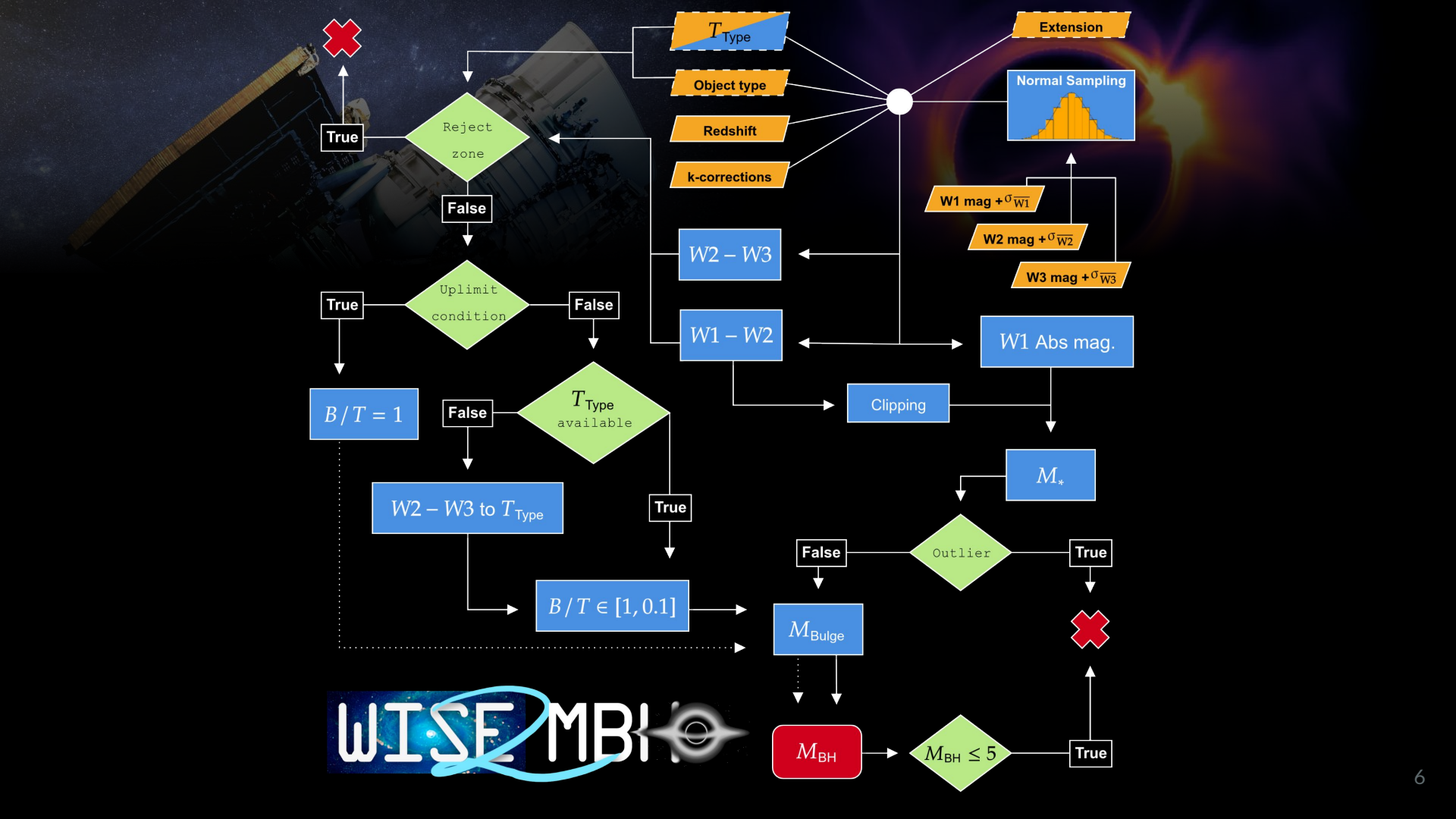
WISE2MBH: Scaling from mid-IR photometry
(Hernández-Yévenes+2024)

- Uses WISE bands for total stellar mass and SFR estimation, AGN selection, morphology estimation, etc **(mainly work from Jarrett & Cluver)**.

- Bulge-to-total ratios are used to get bulge masses and then scaled down to black hole mass **(Schutte+2019, Hernández-Yévenes+2024)**.

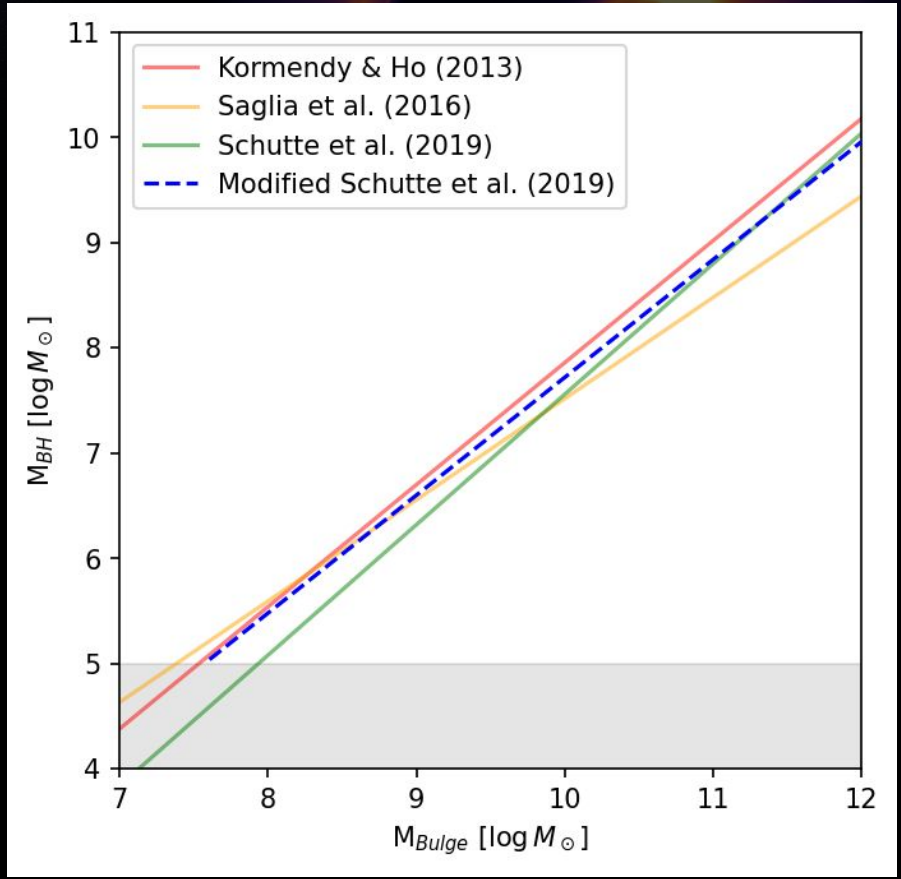
- Empirical AGN compensation is applied in updated version **(Hernández-Yévenes+in prep)**.




T_{Type}
Extension
Object type
Normal Sampling
Redshift
k-corrections
Reject zone
True
False
W1 mag +σ_{W1}
W2 mag +σ_{W2}
W3 mag +σ_{W3}
$W2 - W3$
Uplimit condition
True
False
$W1 - W2$
$W1$ Abs mag.
$B/T = 1$
False
T_{Type} available
Clipping
M_*
$W2 - W3$ to T_{Type}
True
False
Outlier
True
$B/T \in [1, 0.1]$
M_{Bulge}
WISE MBH
M_{BH}
$M_{BH} \leq 5$
True

WISE2MBH: Scaling from mid-IR photometry

Figure: Comparison of different M_{BH}-M_{Bulge} scaling relations from the literature, including Kormendy+2013, Saglia+2016, Schutte+2019 and the modified scaling presented in this work. Grey area represents the limit of the WISE2MBH algorithm for log M_{BH}<5, where it drops all estimates.



$$\log M_{\mathrm{BH}} = 1.12 \log \left(\frac{M_{\mathrm{Bulge}}}{10^{11}} \right) + 8.84$$

WISE2MBH: Scaling from mid-IR photometry

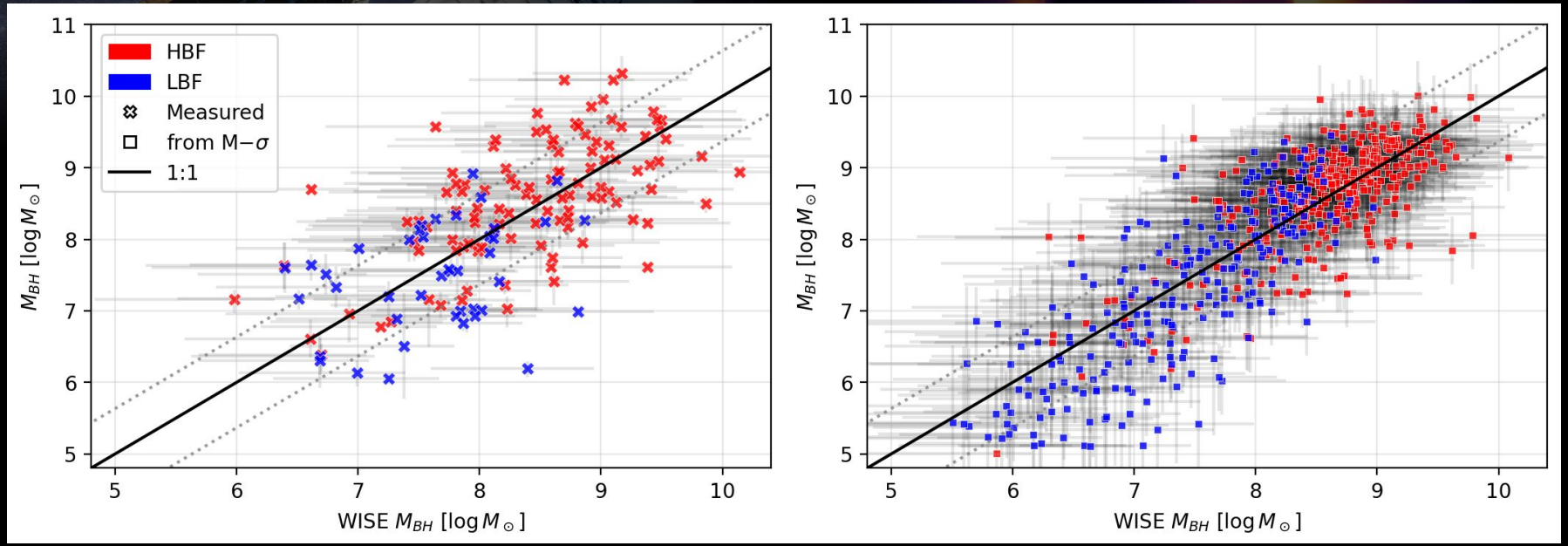
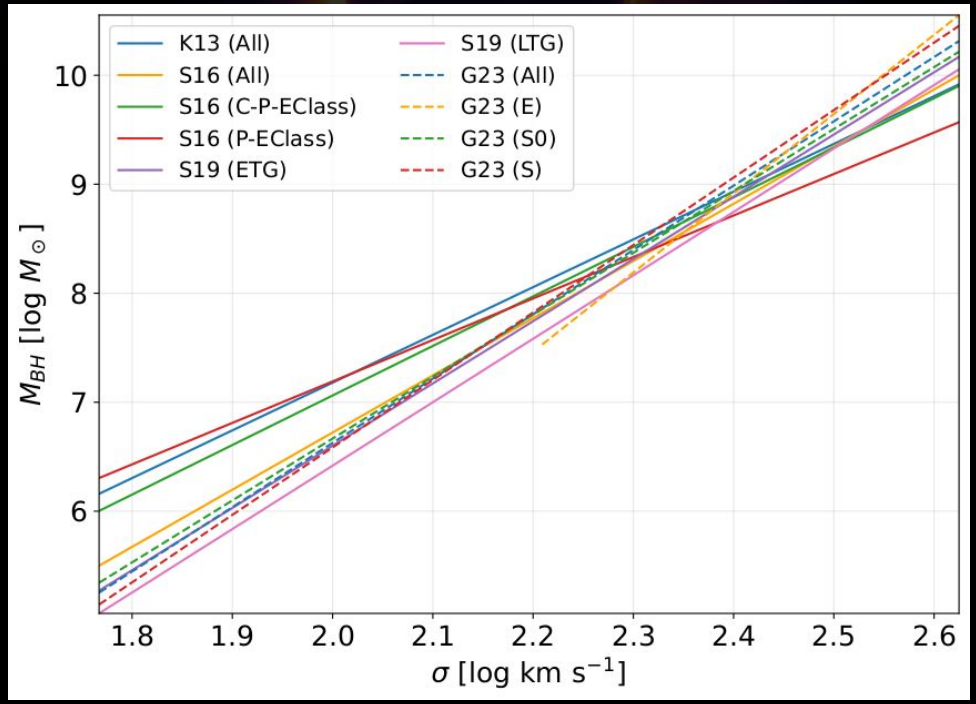


Figure: Comparison diagram of control sample MBH (measurements in right and estimates in left) vs. WISE2MBH estimates. When measurements and estimates are both compared against WISE2MBH a 0.73 correlation score (Spearman) is obtained with a scatter of 0.63 dex

Other indirect MBH estimators

- M-sigma scaling relations **(e.g., Kormendy+13, Saglia+16, Graham23)**.
- Single-epoch spectra with RM scalings **(Rakshit+20, Shen+24)**.
- Using MASSIVE total stellar masses **(Veale+17)** with scaling from WISE2MBH.
- WISE2MBH with WXSC photometry **(Jarrett+19, Cluver+ in prep)**.



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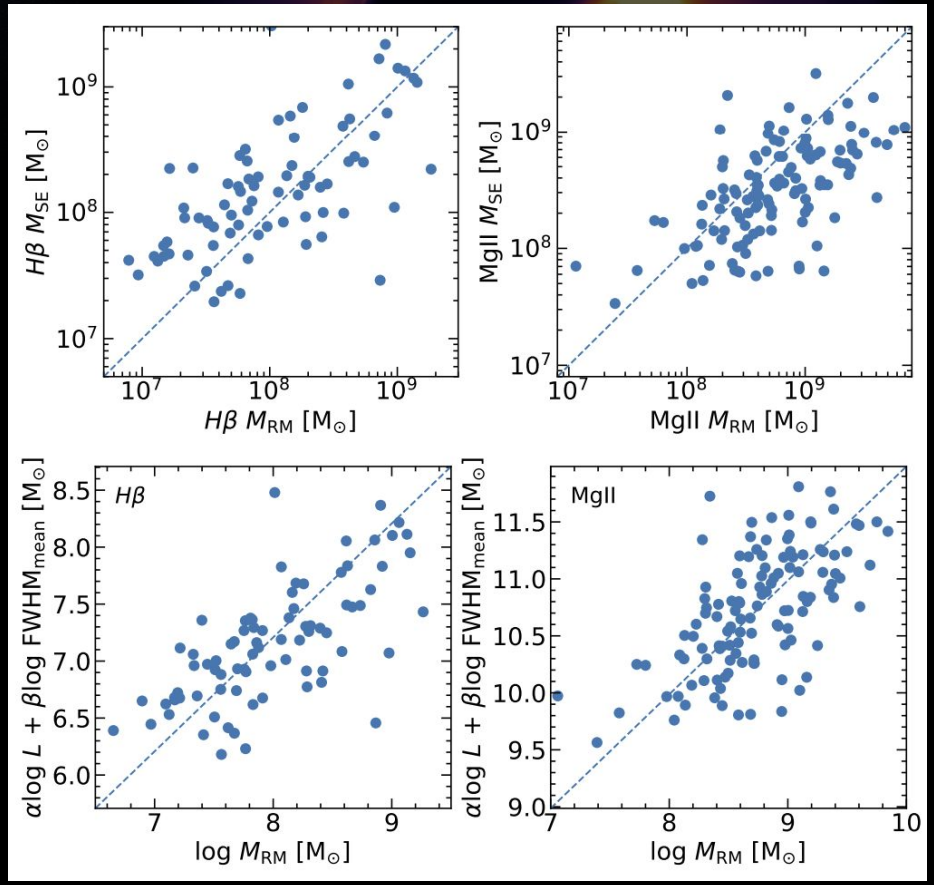

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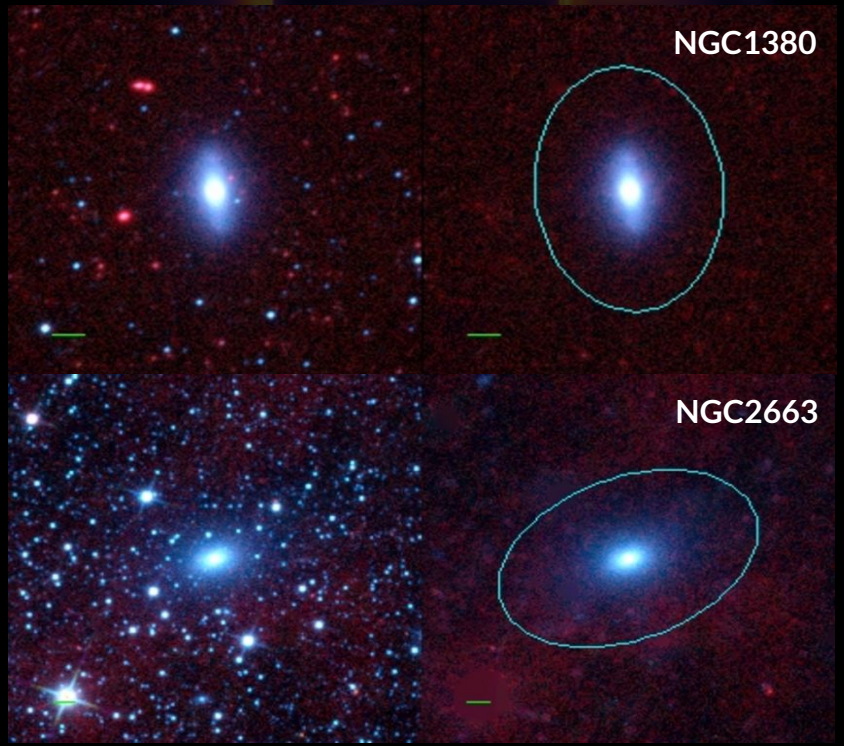

Do they *agree*?

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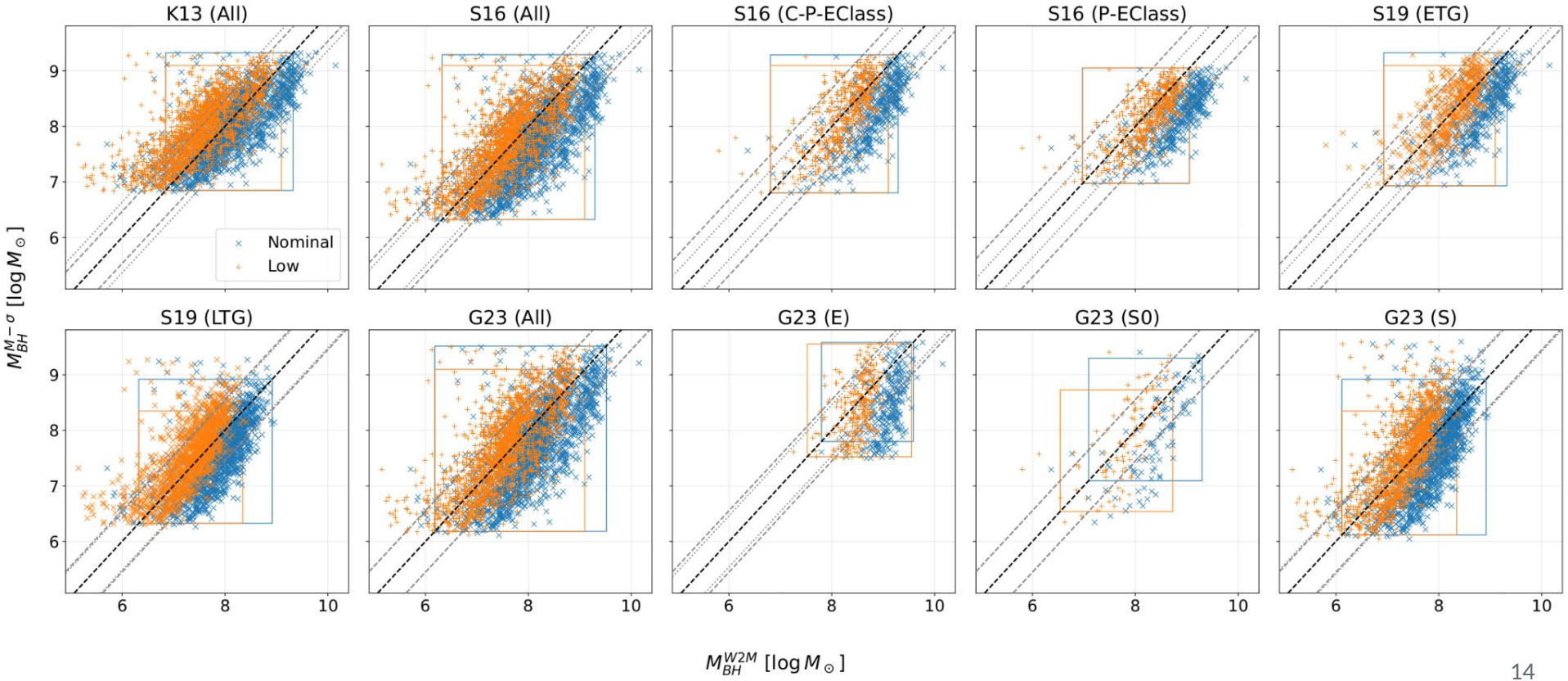
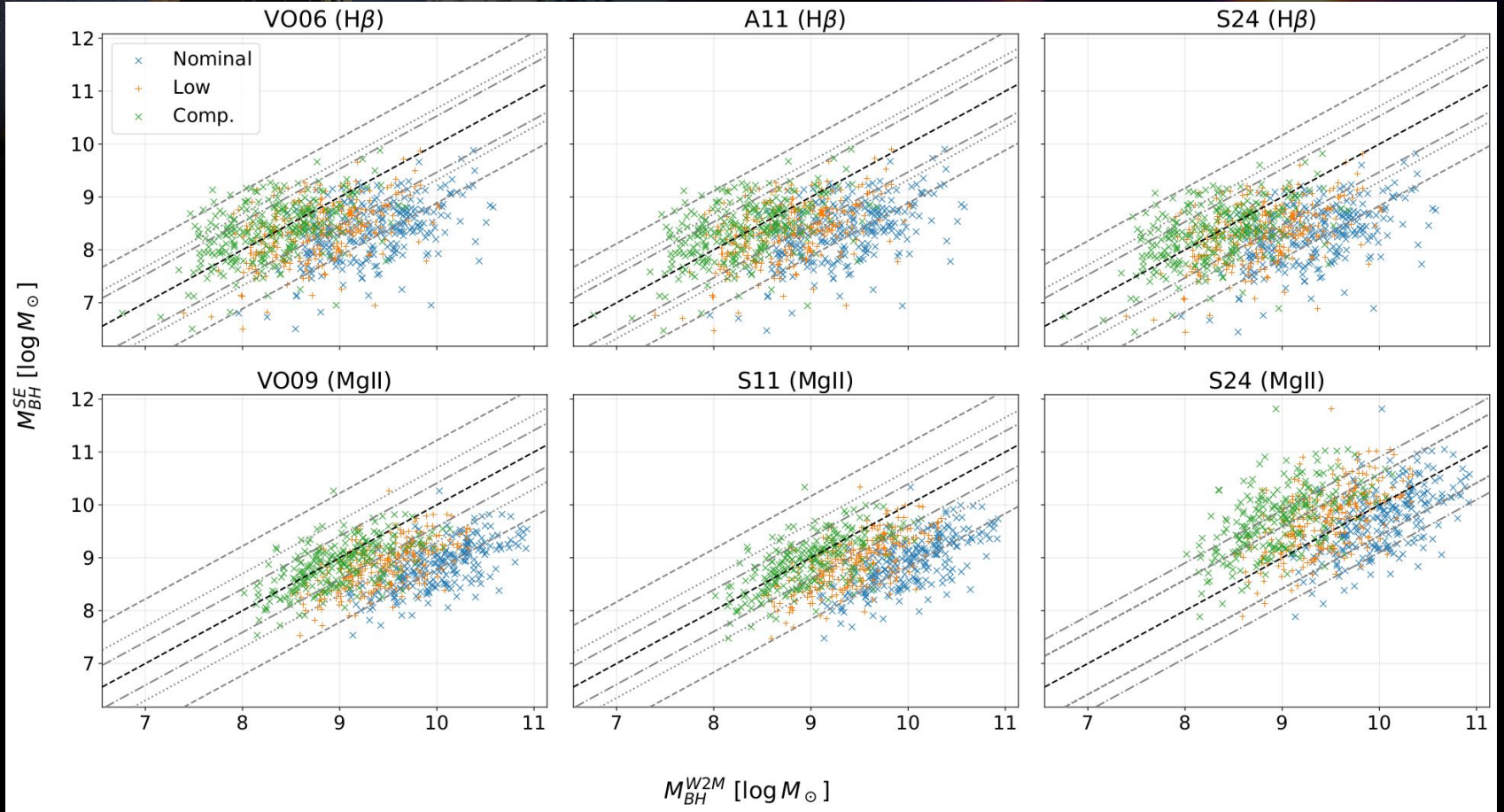
Yes!

kinda...

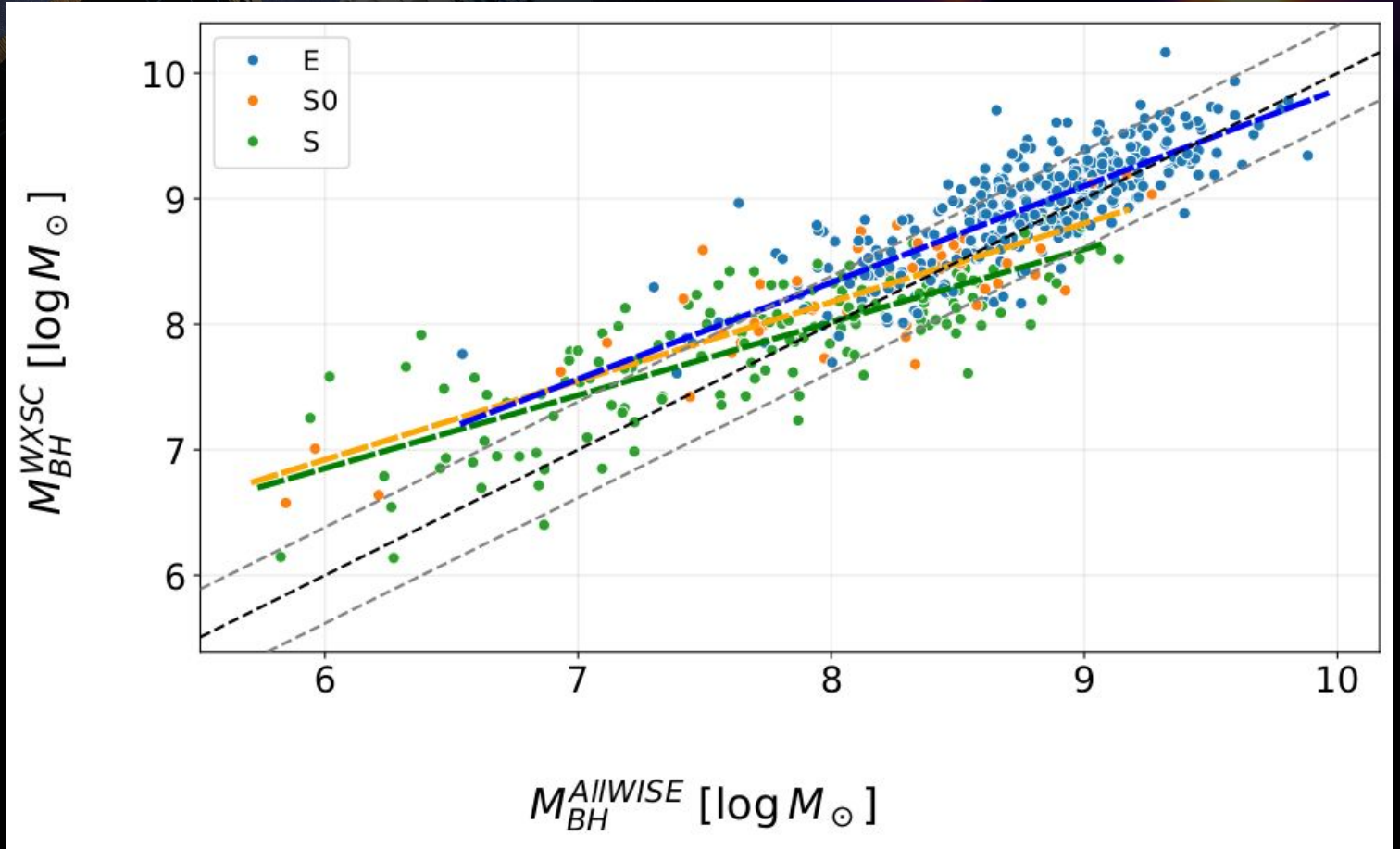
M-sigma vs WISE2MBH



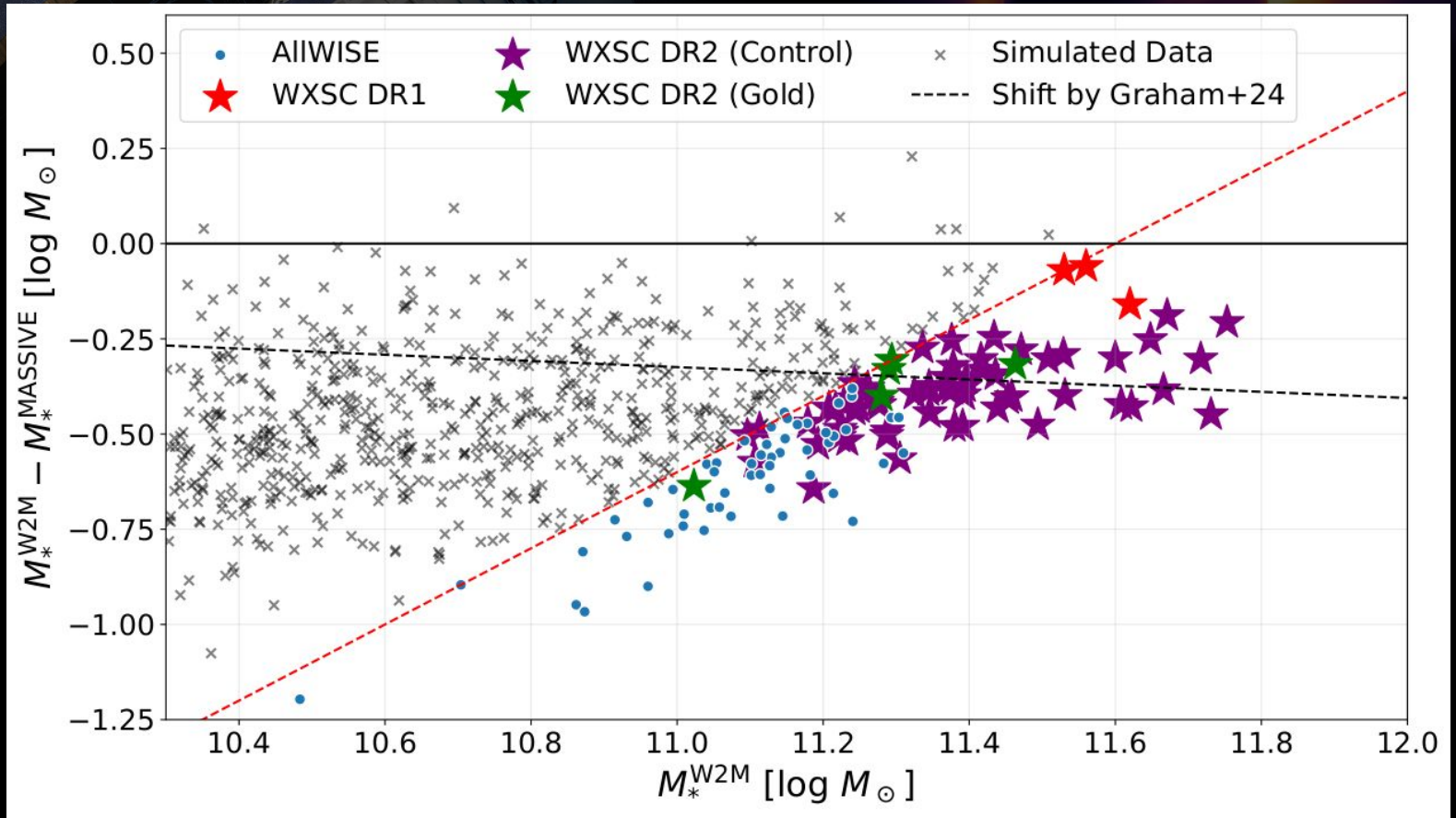
Single-epoch vs WISE2MBH



AllWISE vs WXSC using WISE2MBH



MASSIVE vs WISE as a prior estimate in WISE2MBH



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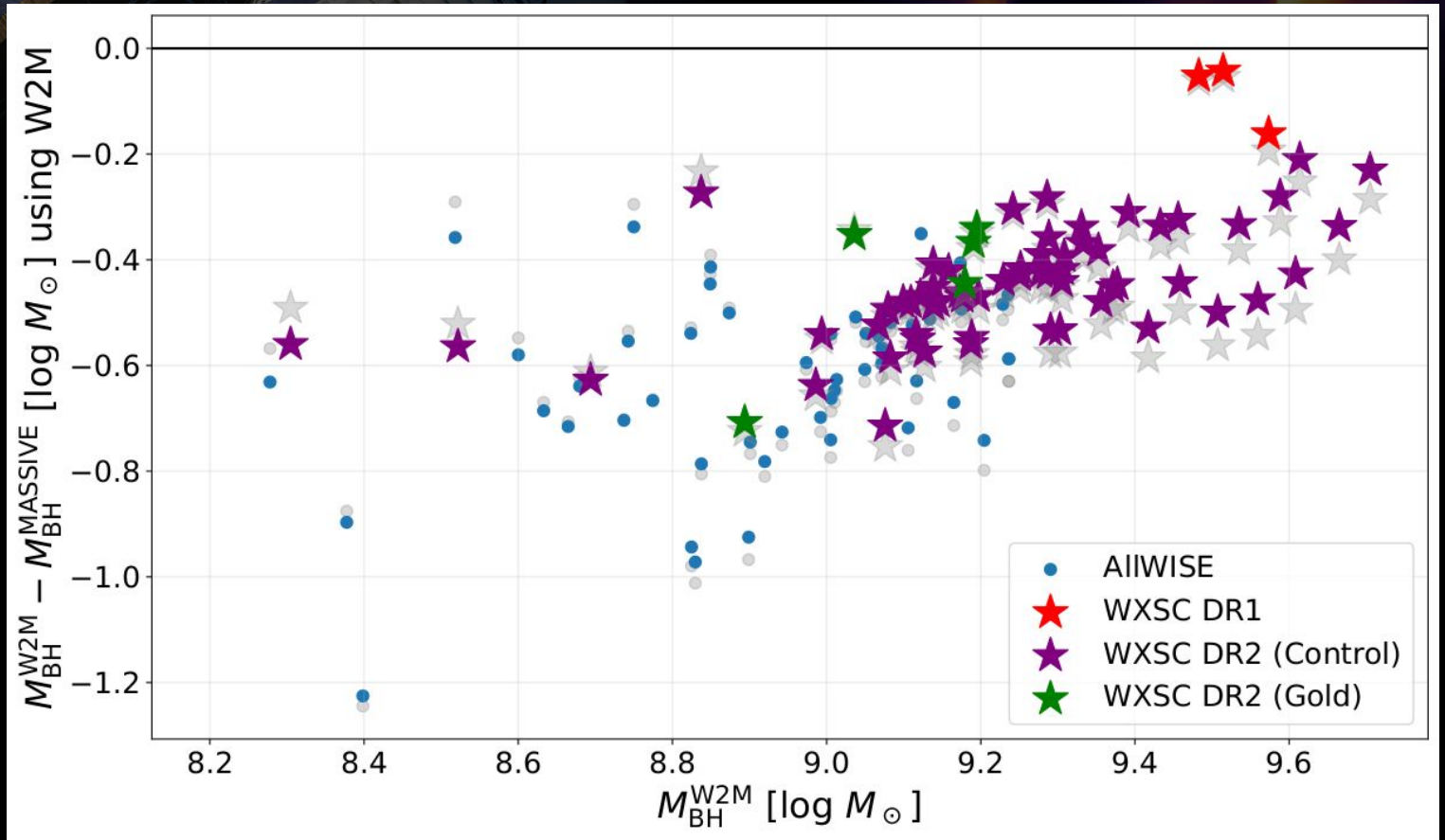

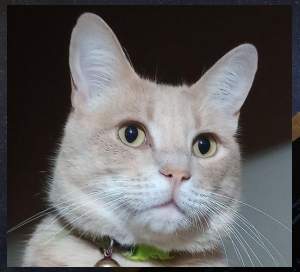

Publications

(MNRAS + A&A in prep.)

Code

(Pipeline in GitHub)

WISE2MBH: a scaling-based algorithm for probing supermassive black hole masses through *WISE* catalogues

J. Hernández-Yévenes[1★], N. Nagar[1], V. Arratia[1] and T. H. Jarrett[2,3,4]

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[2]*Department of Astronomy, University of Cape Town, Rondebosch 7700, South Africa*
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Evaluating and harmonizing systematics of diverse indirect M_{BH} estimators for SMBHs

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Welcome to the WISE2MBH repository! 👋

DOI 10.1093/mnras/stae1372 arXiv arXiv:2405.18336 version 0.8.1.2

Instalation

To install `wise2mbh-0.8.1.2` you will need to have `git` installed. If you don't have it, you can install it in **Linux** with the following command:

```
sudo apt install git
```

To install `wise2mbh-0.8.1.2`, use the following command:

```
pip install git+https://github.com/joacoh/wise2mbh.git
```

THANKS FOR YOUR ATTENTION!