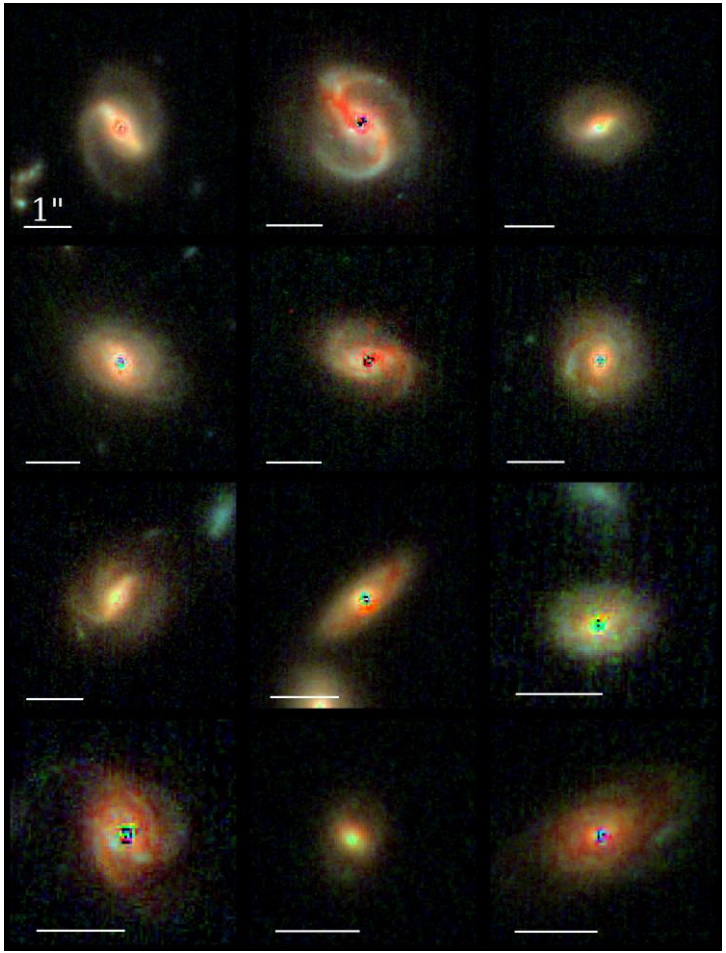


JWST COSMOS-Web 画像データから探る AGN 母銀河の性質

Tanaka et al. (2024), arXiv:2401.13742

Takumi Tanaka (U.Tokyo/Kavli IPMU)
John D. Silverman (Kavli IPMU)
Knud Jahnke (MPIA)

Feb. 28, 2024
ブラックホール大研究会 @ 御殿場

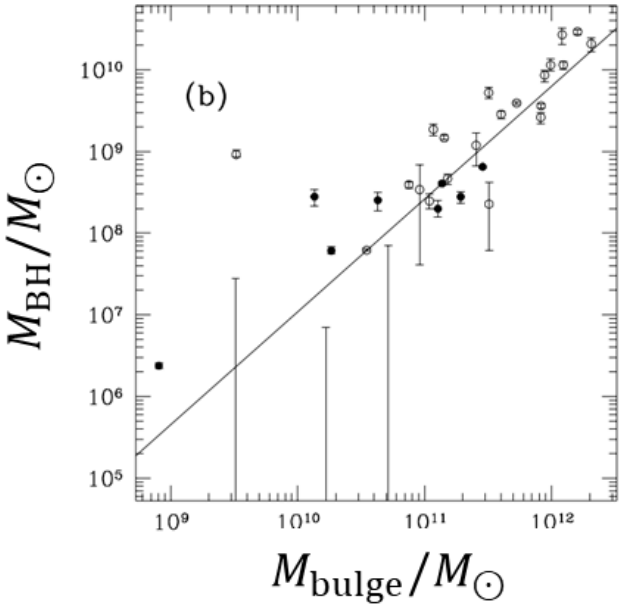
Today's Topics

1. Introduction: $M_{\mathrm{BH}} - M_{*}$ relation
2. Model-case study: Tanaka et al. (2024)
3. Prospects for Euclid/UNIONS

$M_* - M_{\rm BH}$ Relation

Tight Correlation between $M_{\rm BH}$ and M_* (or $\sigma_*, M_{\rm bulge}$) @ local Universe

(e.g. Magorrian et al. 1998; Ferrarase&Merritt 2000; Marconi&Hunt 2003; Kormendy&Ho 2013)



Magorrian et al. 1998

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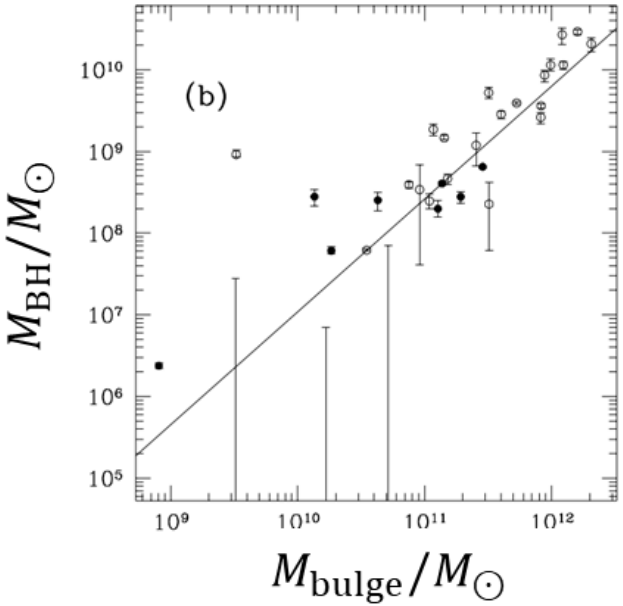


Magorrian et al. 1998

Key questions:

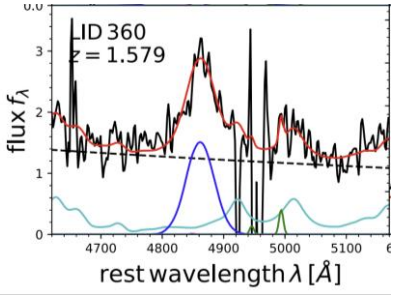
"How was the relation formed?"

"What process(es) connect galaxy and BH?"

- For insight: **check the redshift evolution!**

How to investigate $M_* - M_{\rm BH}$ relation

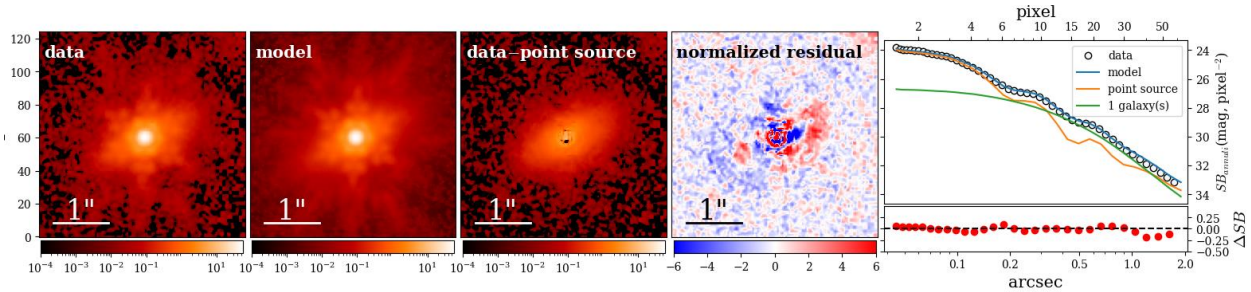
- Fitting broad emission line → $M_{\rm BH}$ from single epoch method

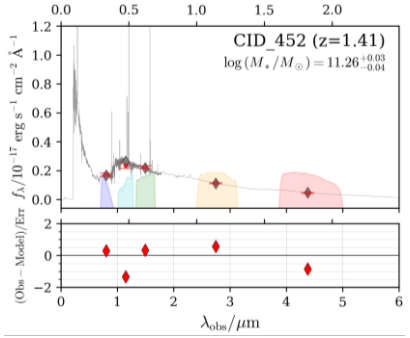


Schulze et al. 2018

$$M_{\rm BH}\,({\rm H}\beta) = 10^{6.91}\left(\frac{L_{5100}}{10^{44}\ {\rm erg\ s^{-1}}}\right)^{0.5}\left(\frac{{\rm FWHM_{H\beta}}}{1000\ {\rm km\ s^{-1}}}\right)^{2} M_\odot$$

- Fitting image with PSF + Sersic component(s)
  → host galaxy photometry (+morph) → M_* from SED fitting





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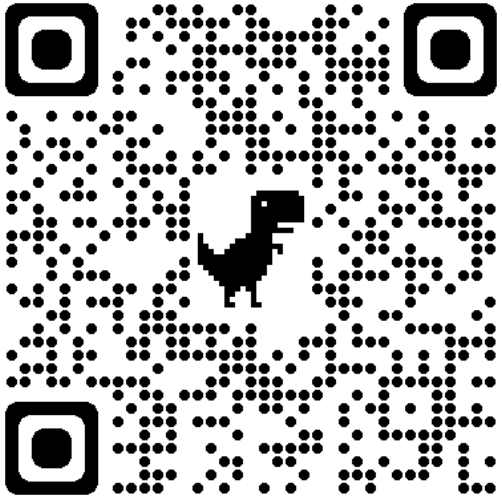
2. **Model-case study: Tanaka et al. (2024)**
3. Prospects for Euclid/UNIONS



Tanaka et al. (2024), arXiv:2401.13742

Data

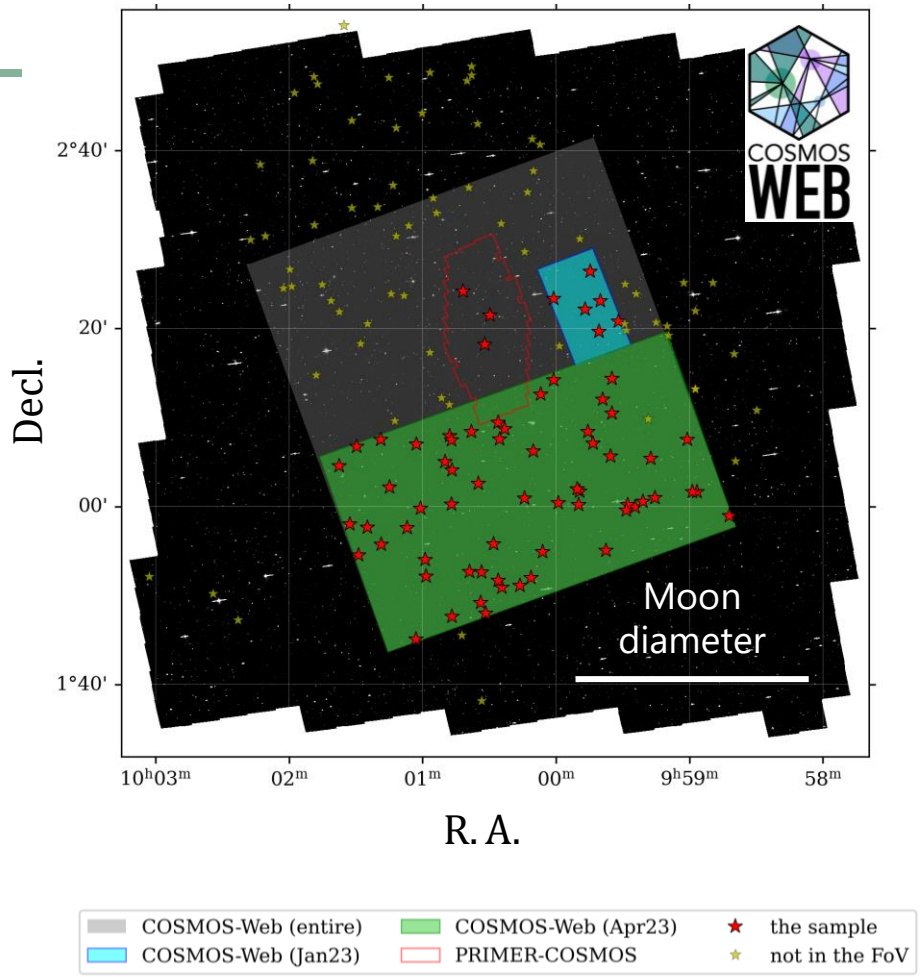
COSMOS-Web (~0.6 deg^2)

- Jan23+Apr23
  (~half of entire COSMOS-Web)
- 5 filters
  (HST/ACS F814W), F115W, F150W, F277W, F444W

- X-ray detected type-I AGN
  from Schulze+15;18
  All have SE M_{BH} (Ha, Hb, MgII)
  N=61

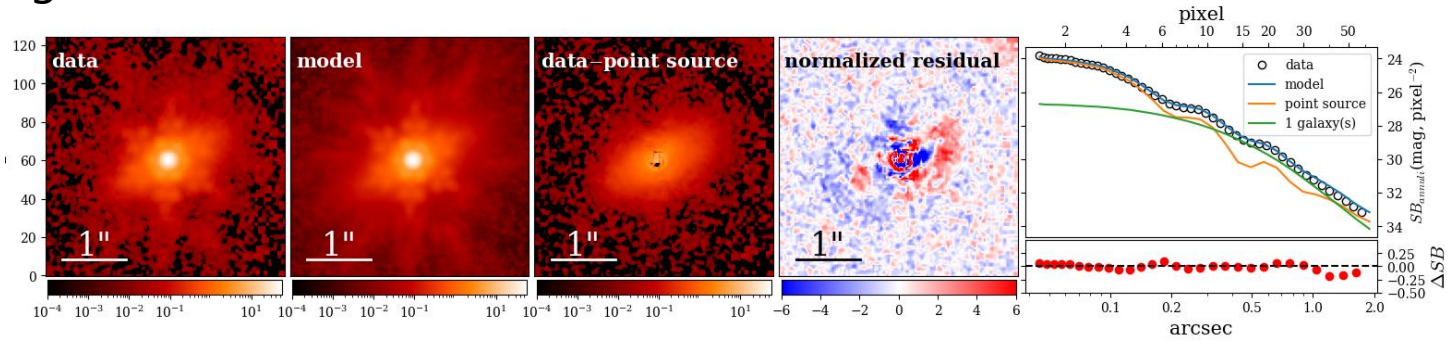
Pixel scale : 0.03″/pix

※ After the completion of COSMOS-Web (Jan24), we will have N~100 sample!!

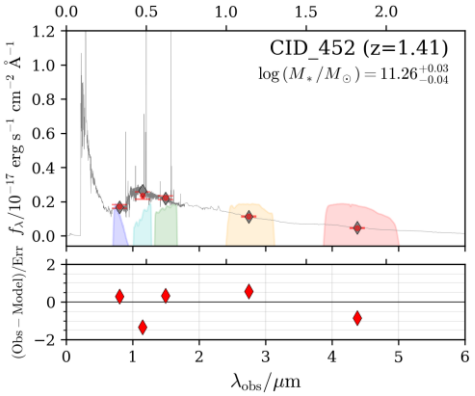


2D Decomposition Analysis

- Fitting data with PSF + Sersic component(s) → host galaxy information
  galight (Ding+20)

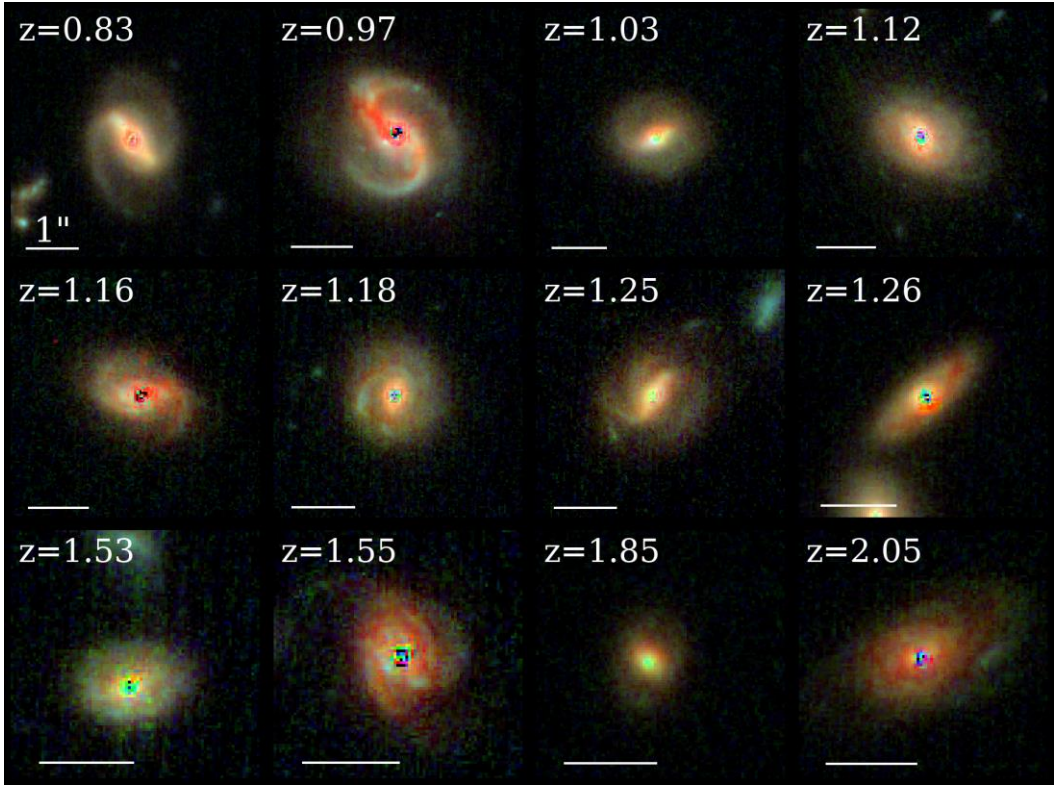


- Estimate M* from SED fitting
  CIGALE (Boquien+19; Yang+22)



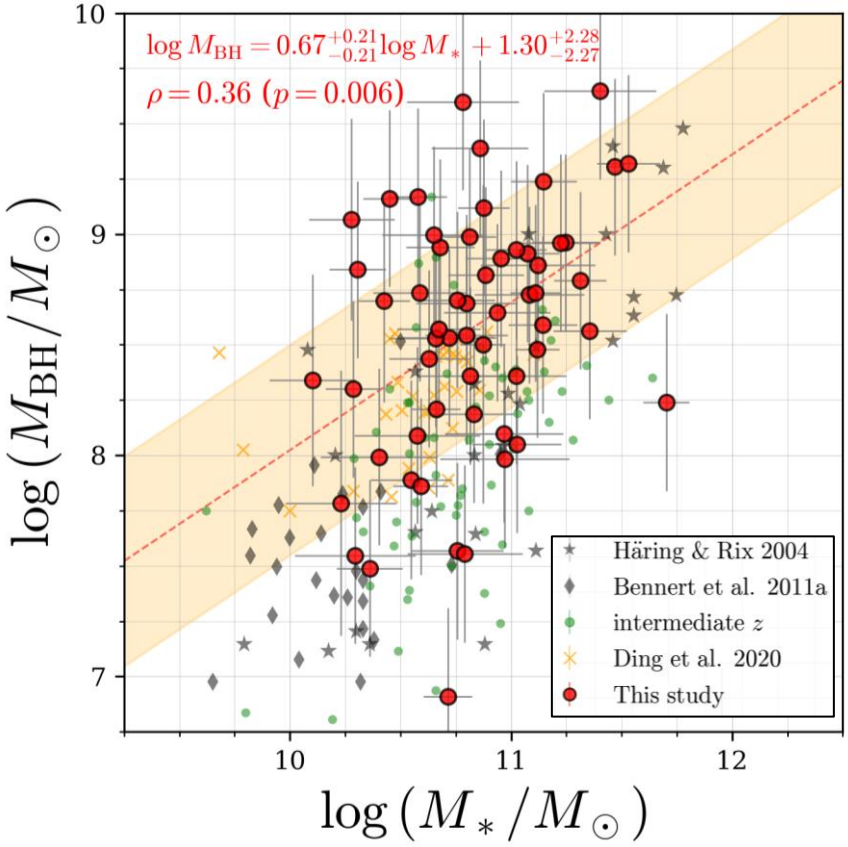
Power of JWST

F277-150-115W PSF-subtracted images



Clearly identify substructures even at z~2 AGN!

$M_* - M_{\rm BH}$ Relation

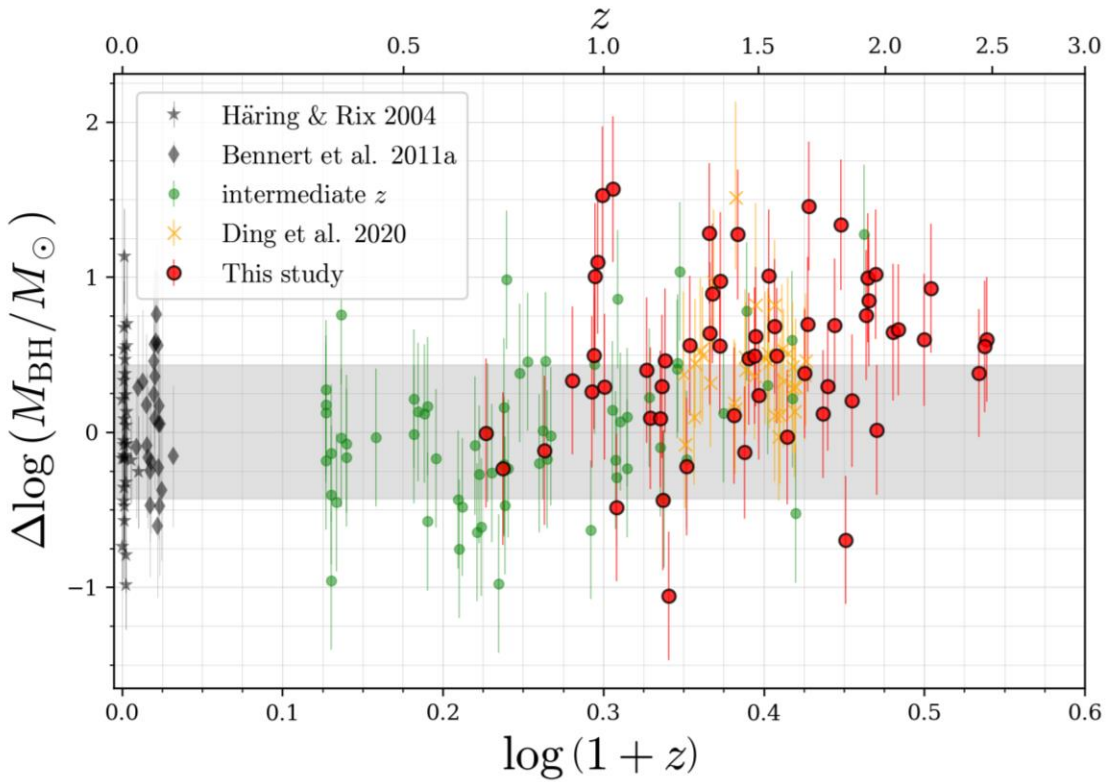


- **Calculate the difference from the local relation**

$$\Delta \log (M_{\rm BH}/M_\odot) = M_{\rm BH} - \alpha_{\rm local} \log (M_*/M_\odot) - \beta_{\rm local}$$

$M_* - M_{\rm BH}$ Relation

Redshift vs $\Delta\log M_{\rm BH}$



Δ~0: no evolution
Δ>0: mild evolution

Little evolution?

Need to consider the selection bias!

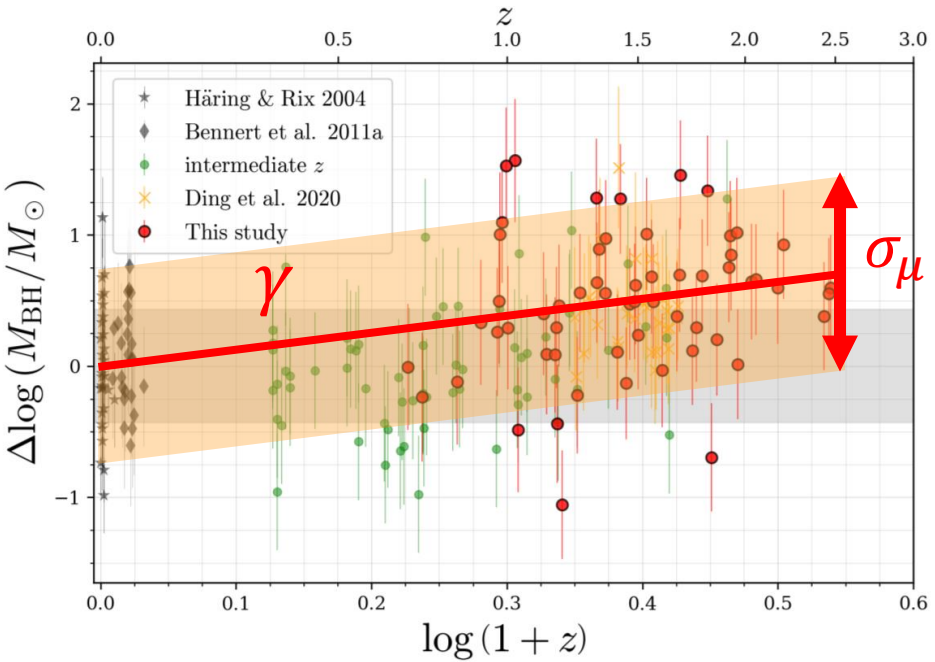
Statistical Analysis: Evolution or No Evolution?

Model the redshift evolution

$$\Delta M_{BH} = N\left(\gamma \log(1+z), \sigma_\mu\right)$$

Generate mock observation using ΔM_{BH}

Compare with the results
to **estimate PDF of γ and σ_μ**



Assumption in genarating mock data:
- COSMOS2020 SMF (Weaver+23)
- ERDF (Schulze+15)
- Luminosity-dependent bias of SE M_{BH} with $\beta = 0.6$
- Observational error and bias

Statistical Analysis: Evolution or No Evolution?

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$$\Delta M_{BH} = N\left(\gamma \log(1+z), \sigma_\mu\right)$$

Generate mock observation using ΔM_{BH}

Compare with the results
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→ No-to-mild evolution at z<2.5!

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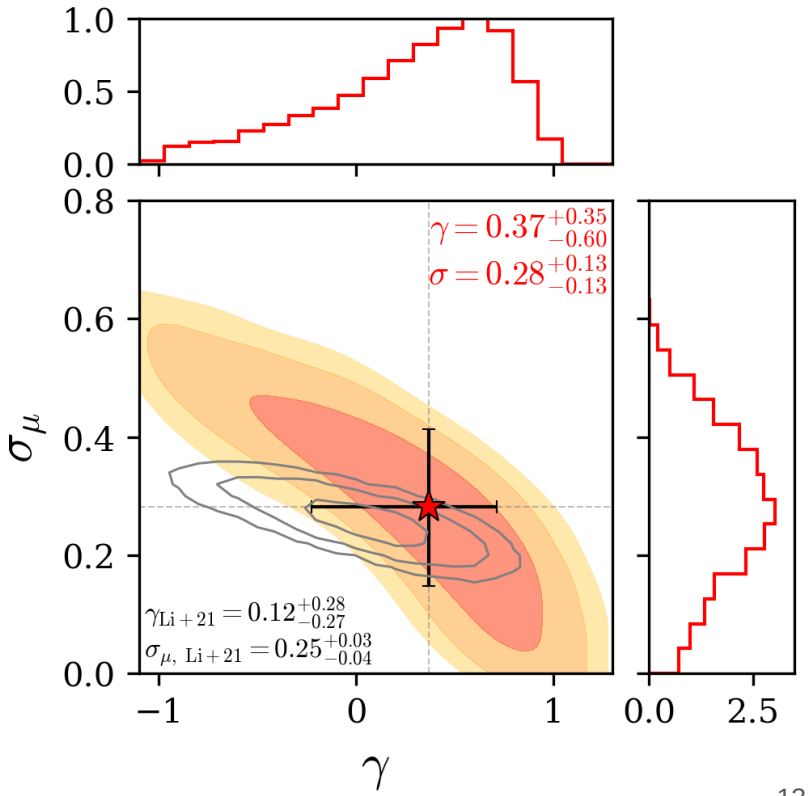
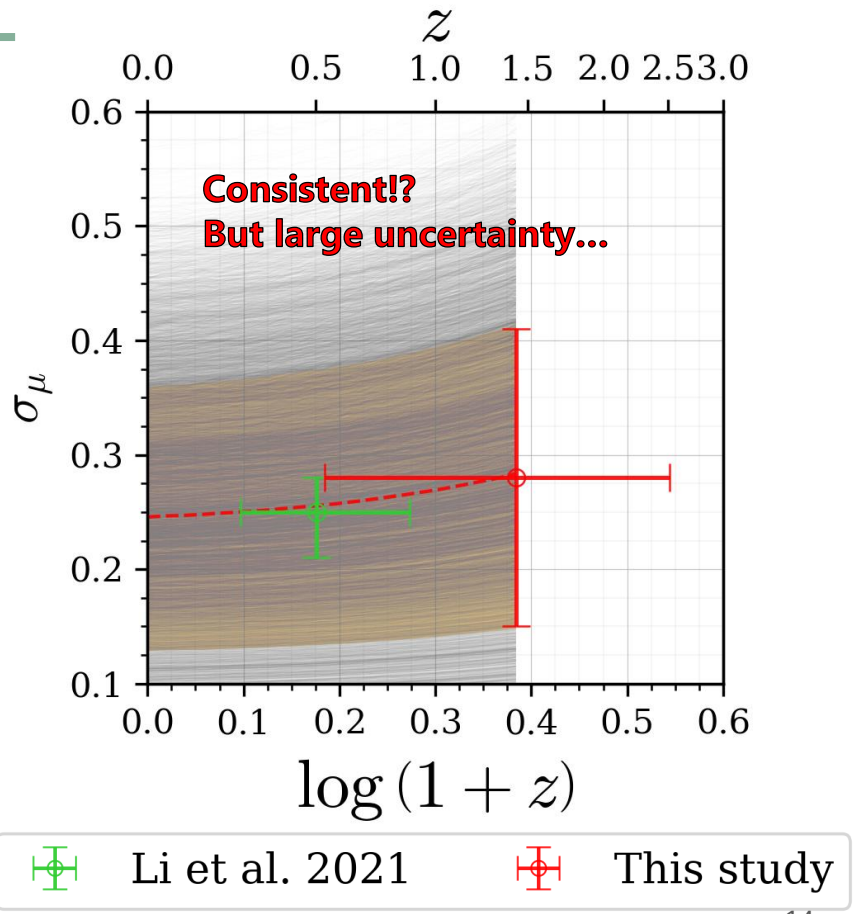


σ_μ evolution

- Easy simulation of Cosmic Averaging scenario
  - Start from the fitted mock sample
  - Only assuming major merger
    - (merger rate: Rodriguez-Gomez+15)
  - Without feedback & their growth

- **Too large uncertainty on σ_μ**
  - Due to small sample and high redshift.
  - Also difficult to constrain the EoR population.

- **We need much larger sample ($N \sim 10^3$)**
  - We will use **Euclid/UNIONS** data!



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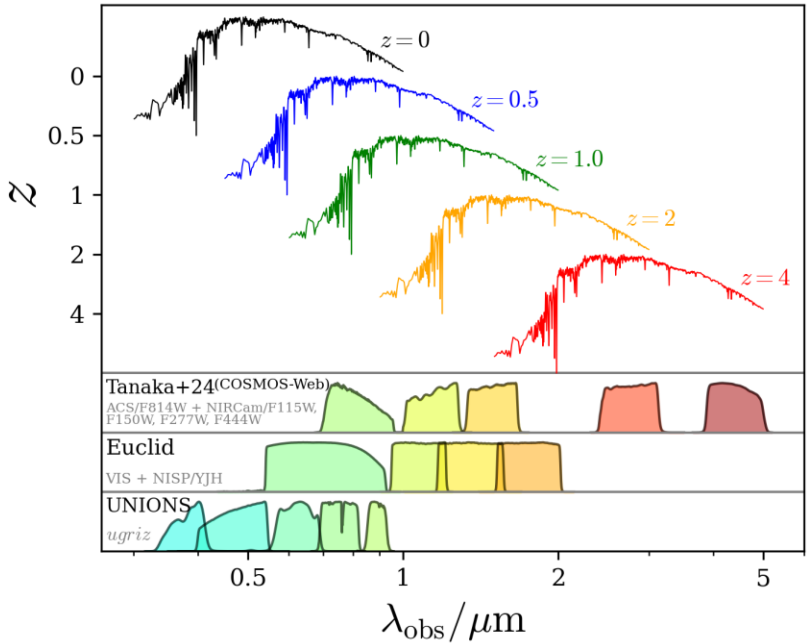
Power of Euclid/UNIONS



- Euclid/UNIONS covers Balmer break around z~0-2

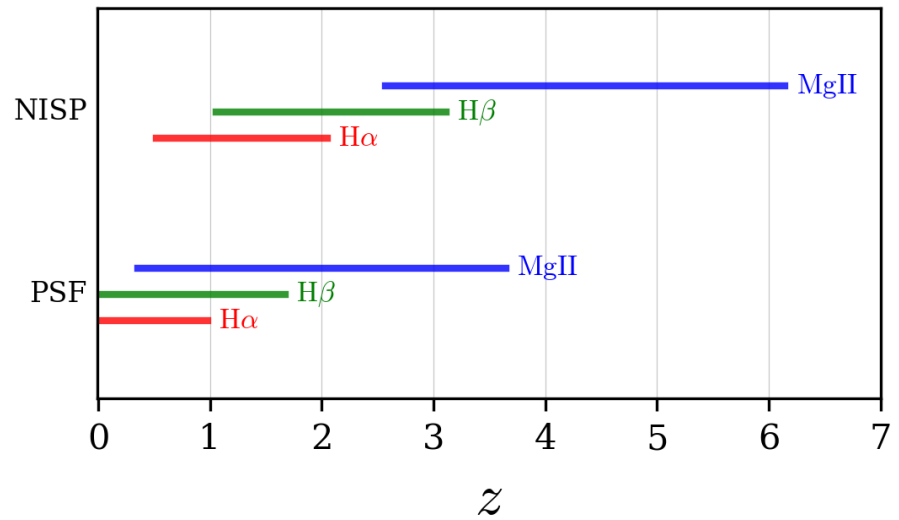
  → accurate M* estimation

Strategies for AGN-host studies in next yrs

- **Spectroscopy:**

  Making catalog, M_{BH}, σ_*

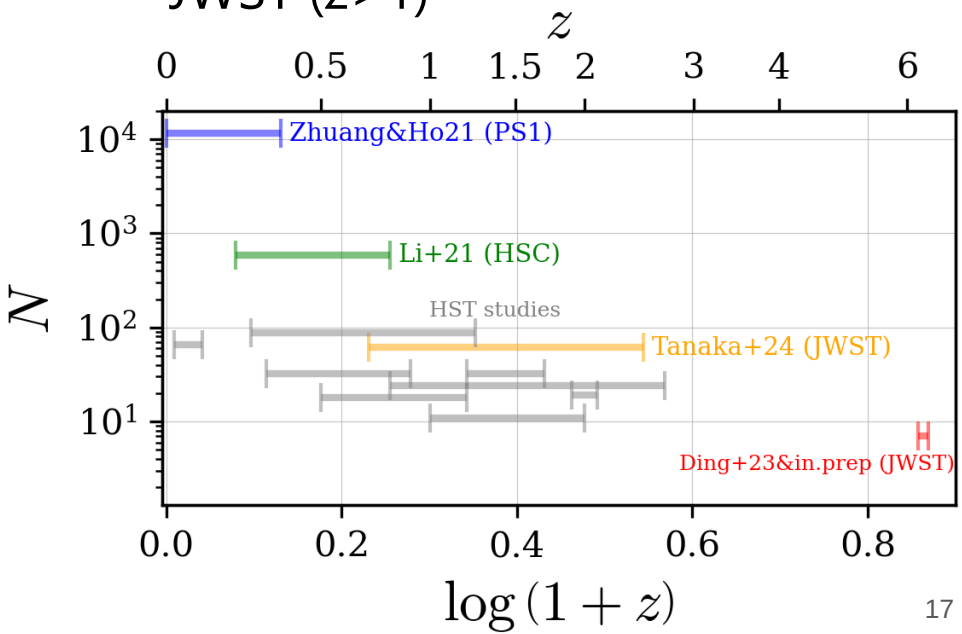
  - Euclid/NISP
  - Subaru/PFS



- **Imaging**

  M_* , host morph, environment

  - Euclid & UNIONS (z<1.5)
  - JWST (z>1)



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▪ Spectroscopy:

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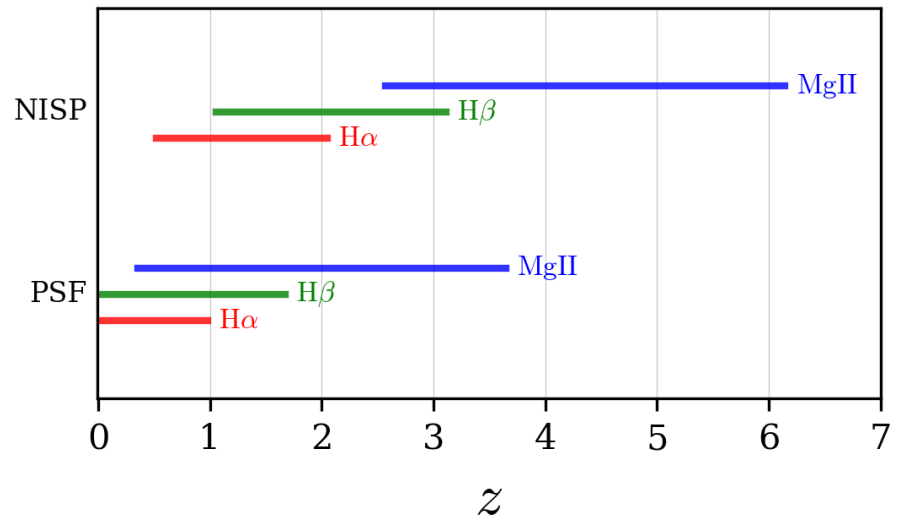

▪ Imaging

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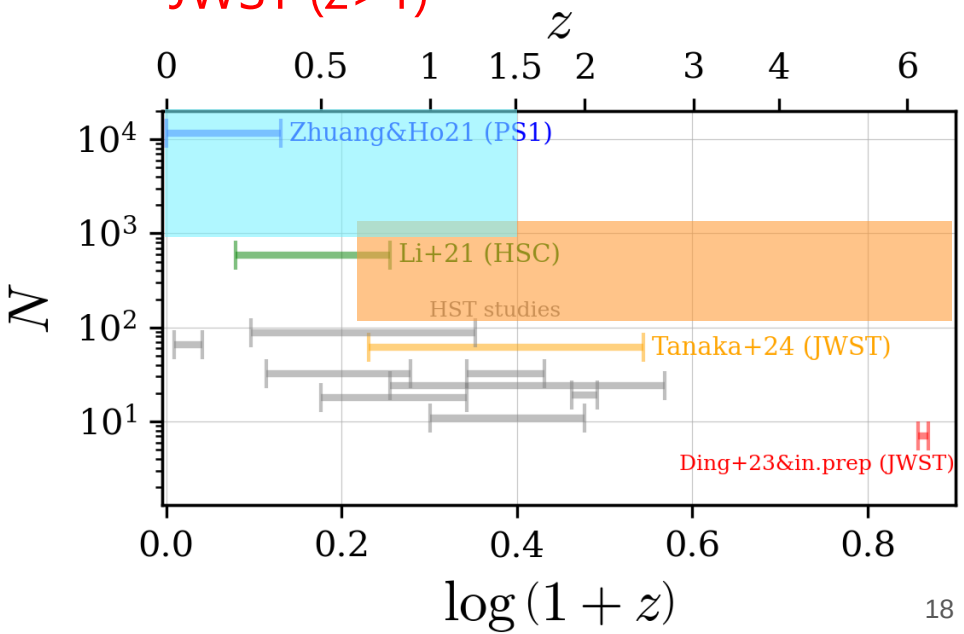

Summary & Prospects

We have found:

- **No-to-mild evolution in mass relation at z~0.7-2.5**
- Still large uncertainty with the N~60 sample

- **Euclid can detect z~0.9 AGN-host galaxy (at least)**

Prospects:

- Plan to discuss host morphology with the CW sample
- Large spectroscopic surveys;
  Euclid/NISP, Subaru/PFS
- Complementary strategy for image-based host analysis;
  Euclid-UNIONS (z<1.5) & JWST (z>1)

- **We can constrain evolution parameters more strongly with larger, higher-z, and wider-z range sample**

Tanaka et al. (2024),
arXiv:2401.13742