JADES census of broad line AGN and their hosts

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and the JADES collaboration

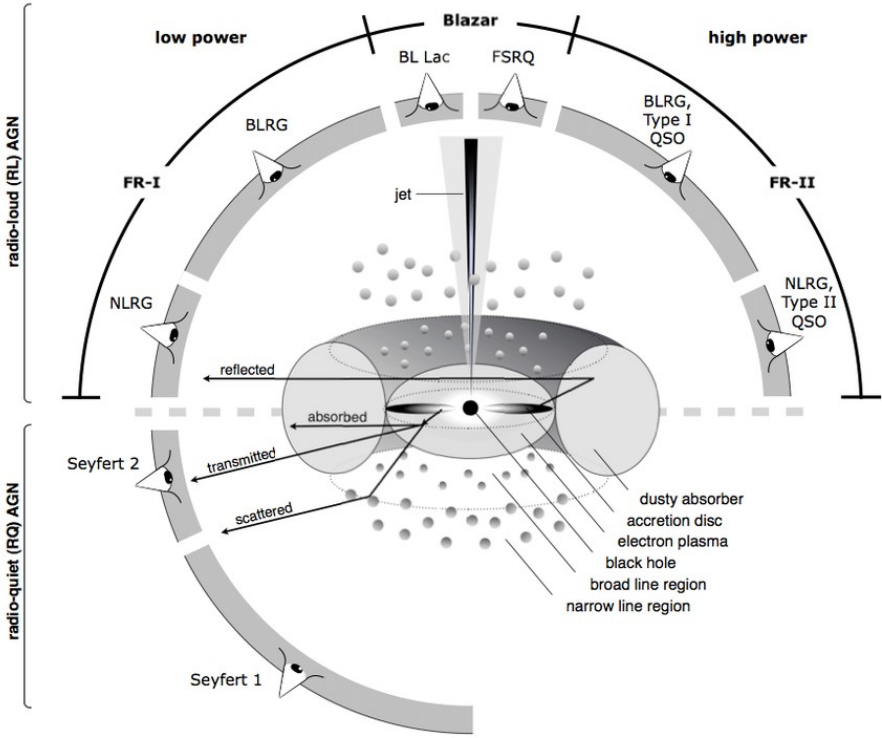
JADES JWST ADVANCED DEEP EXTRAGALACTIC SURVEY

KICC Kavli Institute for Cosmology Cambridge

UNIVERSITY OF CAMBRIDGE

Anatomy of an AGN (Active Galactic Nucleus)

- Accretion disk surrounding a black hole heated by viscous friction.
- Precise type of AGN determined by the angle at which the disk is viewed.

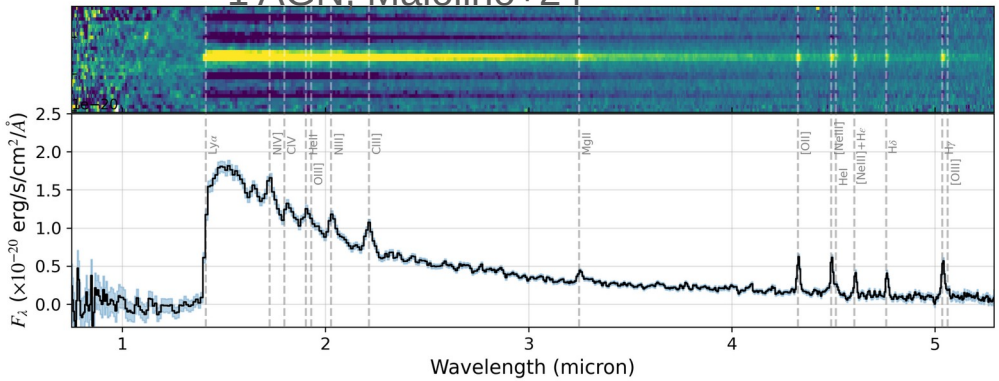


The unified AGN model, Beckmann & Shrader (2012)

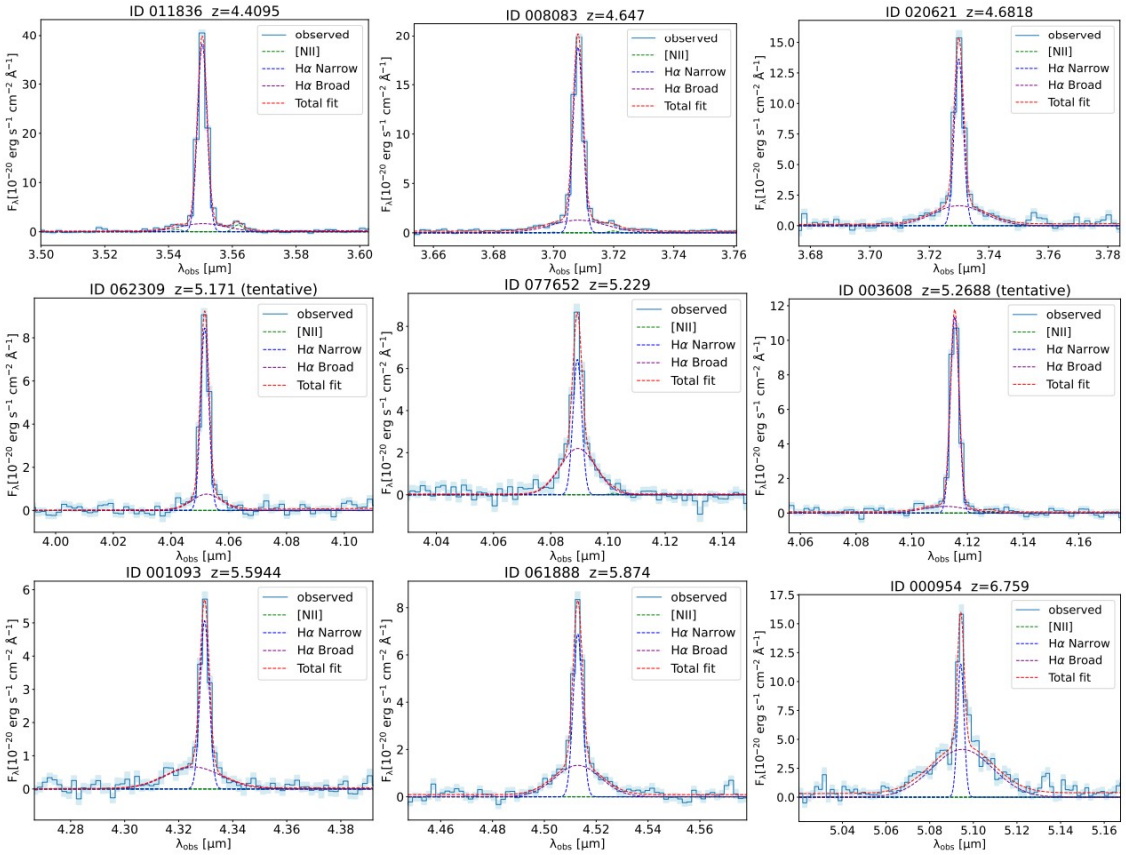
JADES spectroscopic sample

- The sample consists of ~5000 unique spectra spread across several tiers, differing in depth.
- First results exploring the presence of Type 1 broad line AGN in two of those tiers were presented in Maiolino+23b.
- Our current work consists of extending those methods across the entire survey.

Spectrum of GN-z11 - furthest type 1 AGN, Maiolino+24

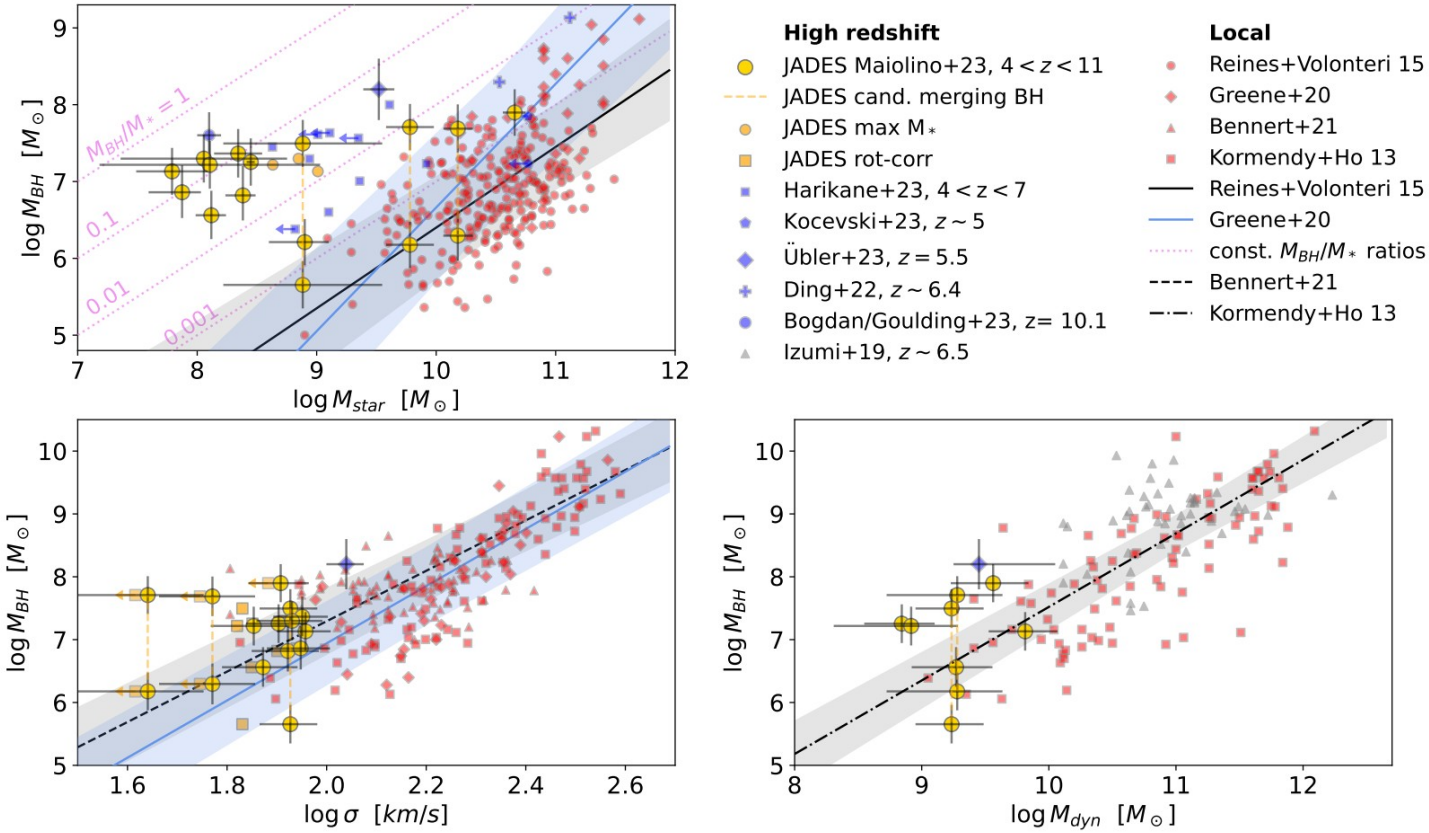


Examples of low luminosity (type 1) AGN at z > 4 discoverd by JADES



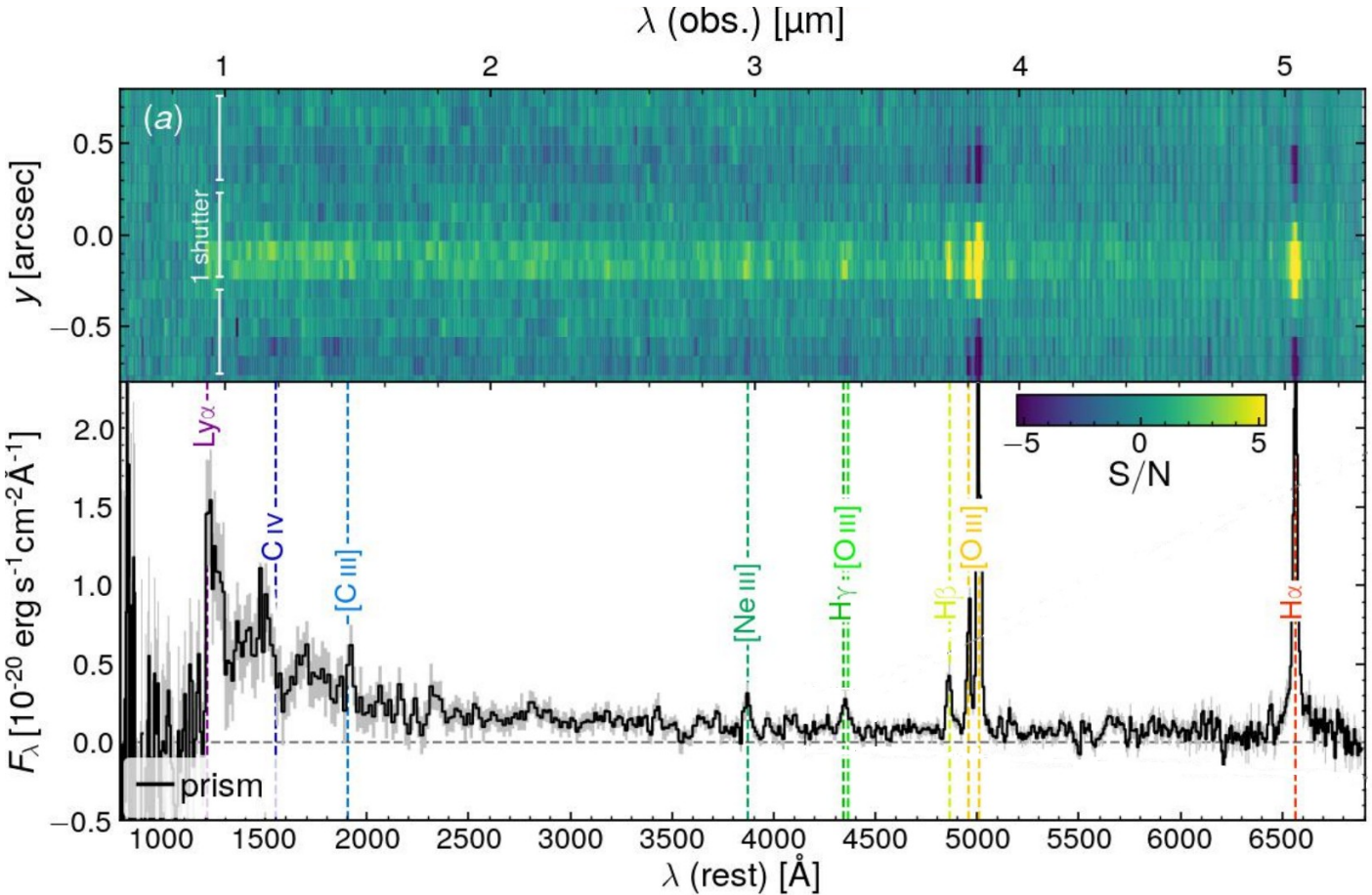
Maiolino+23b

Overmassive black holes at high redshift

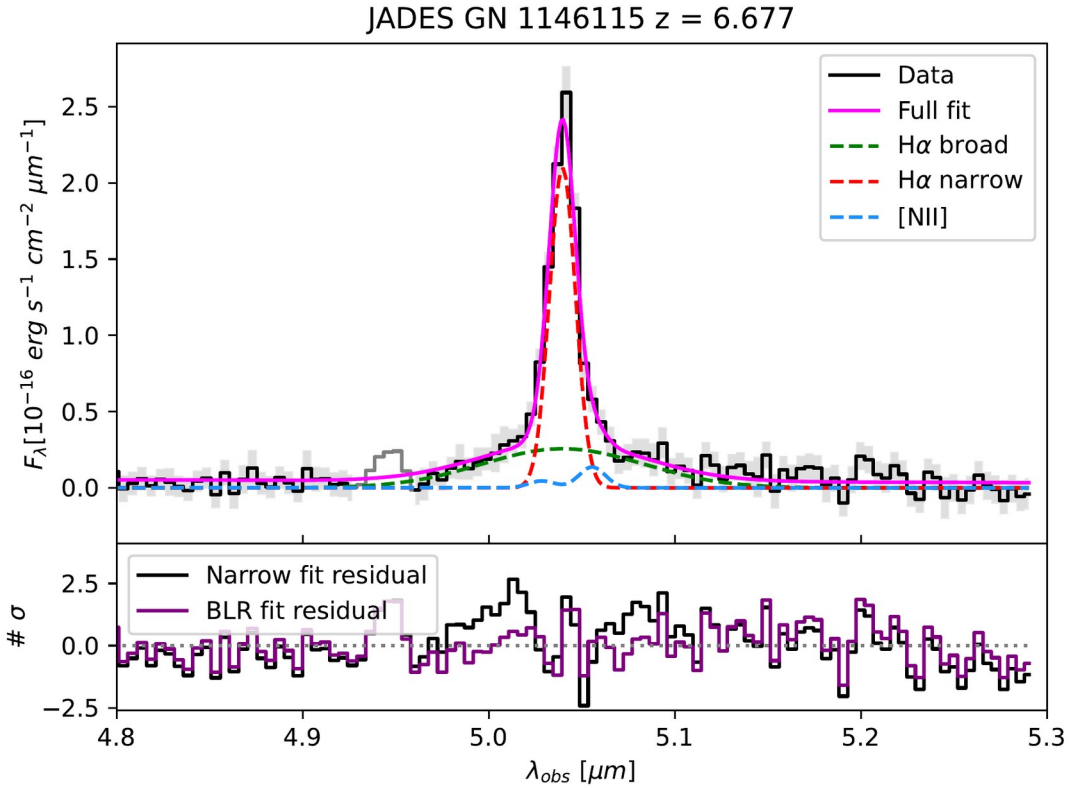


Maiolino+23b

Post Quasar galaxy at z = 6.7 - a case study



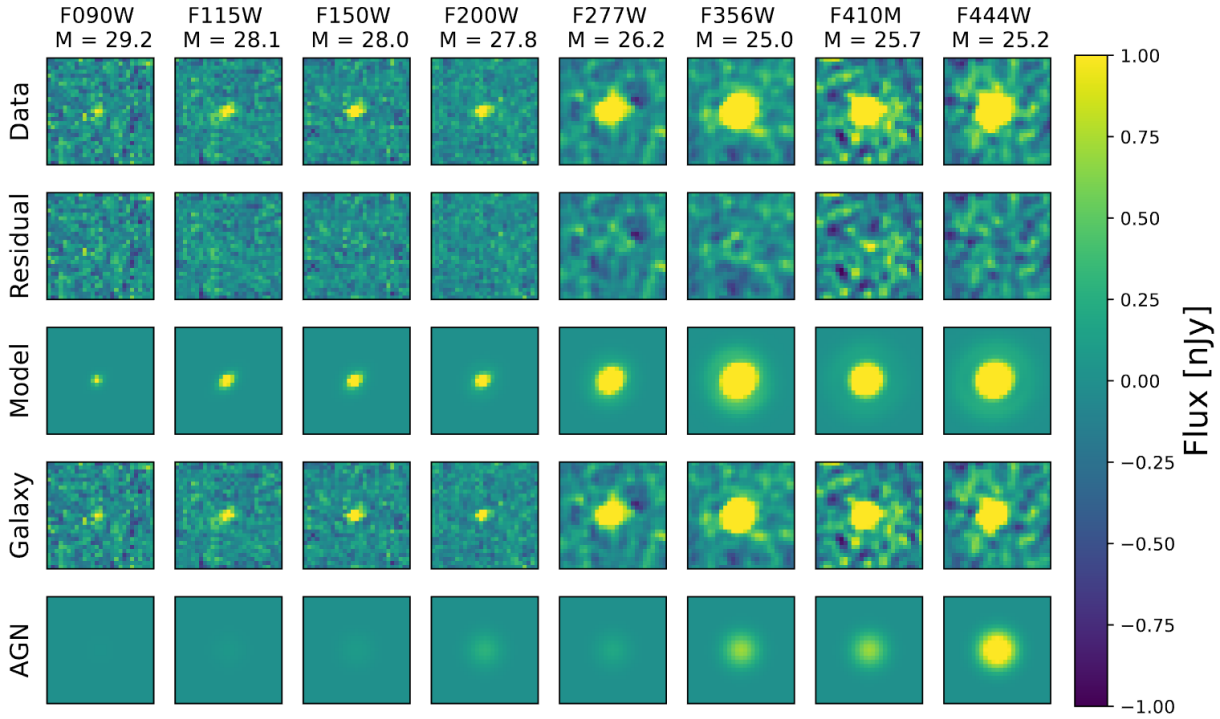
Faint broad Hα at z=6.67



Dust corrected (A_V ~ 2) BH properties:

- Log M_{BH} = 8.60 [$M_\odot$]
- L/L_{Edd} = 0.024

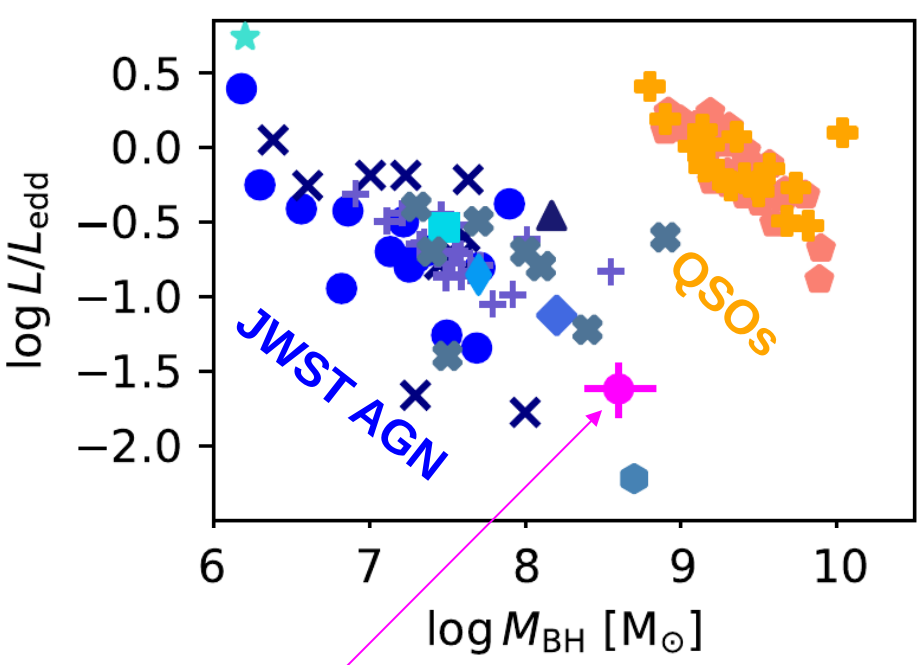
Being dormant (i.e. low luminosity), it is easier to identify and characterise the host



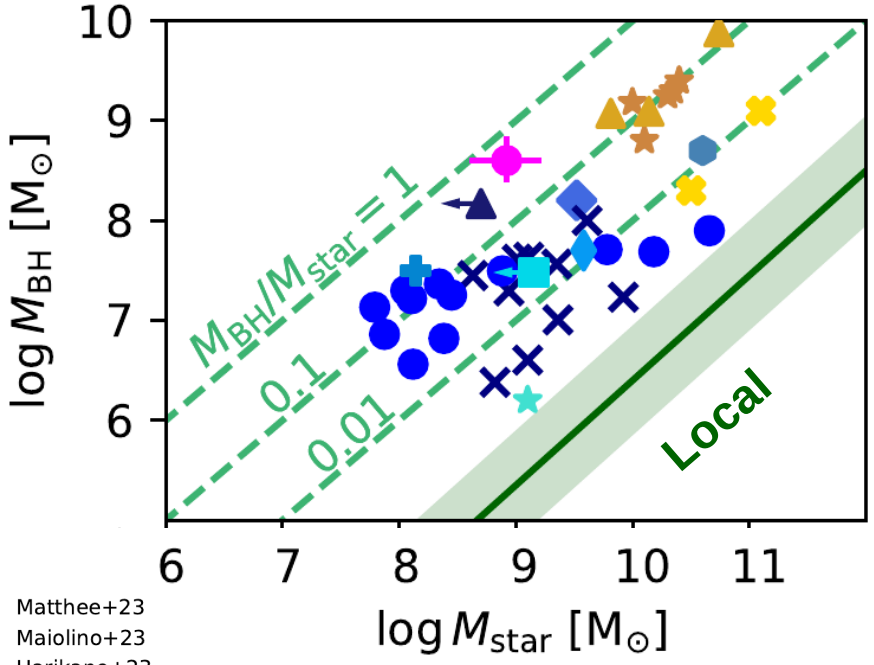
Host properties from ForcePho decomposition and photometry:

- $\log M_* = 8.92\ [M_\odot]$
- $\mathrm{SFR} = 1.38\ [M_\odot/\mathrm{yr}]$

Comparison with other observations

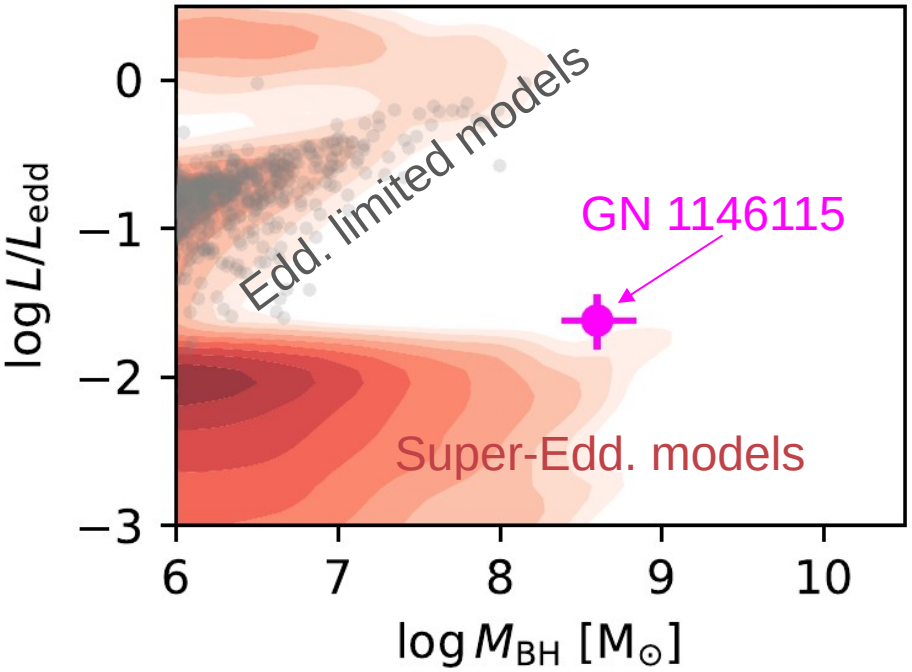


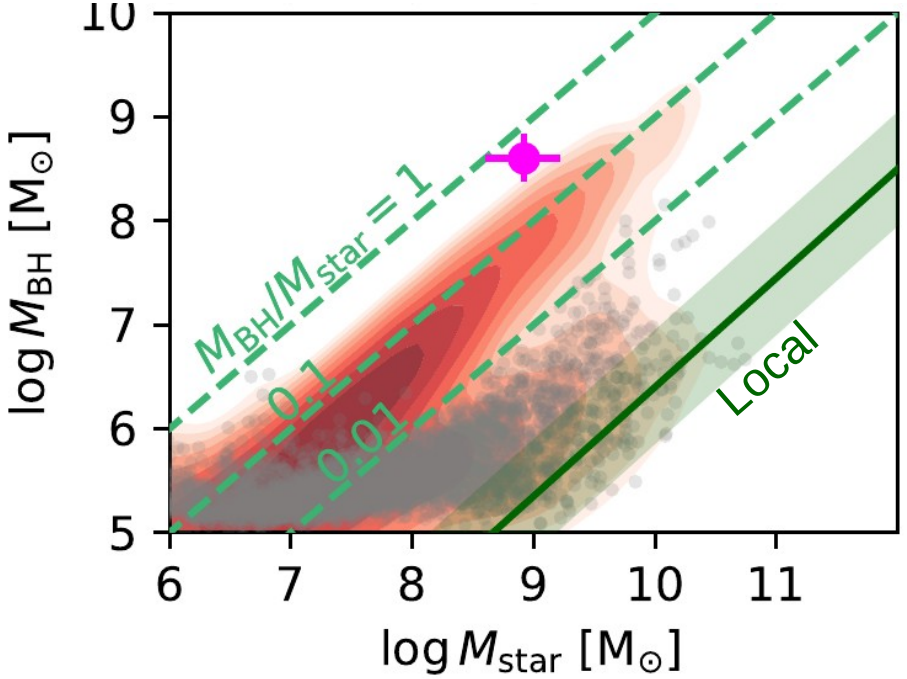
GN 1146115



Matthee+23
Maiolino+23
Harikane+23
Übler+23a
Übler+23b
Kokorev+23
Furtak+23
Greene+23
GN z11
Carnall+23
UHZ-1
XQR30
Hyperion
Stone+23
Ding+23
Yue+23

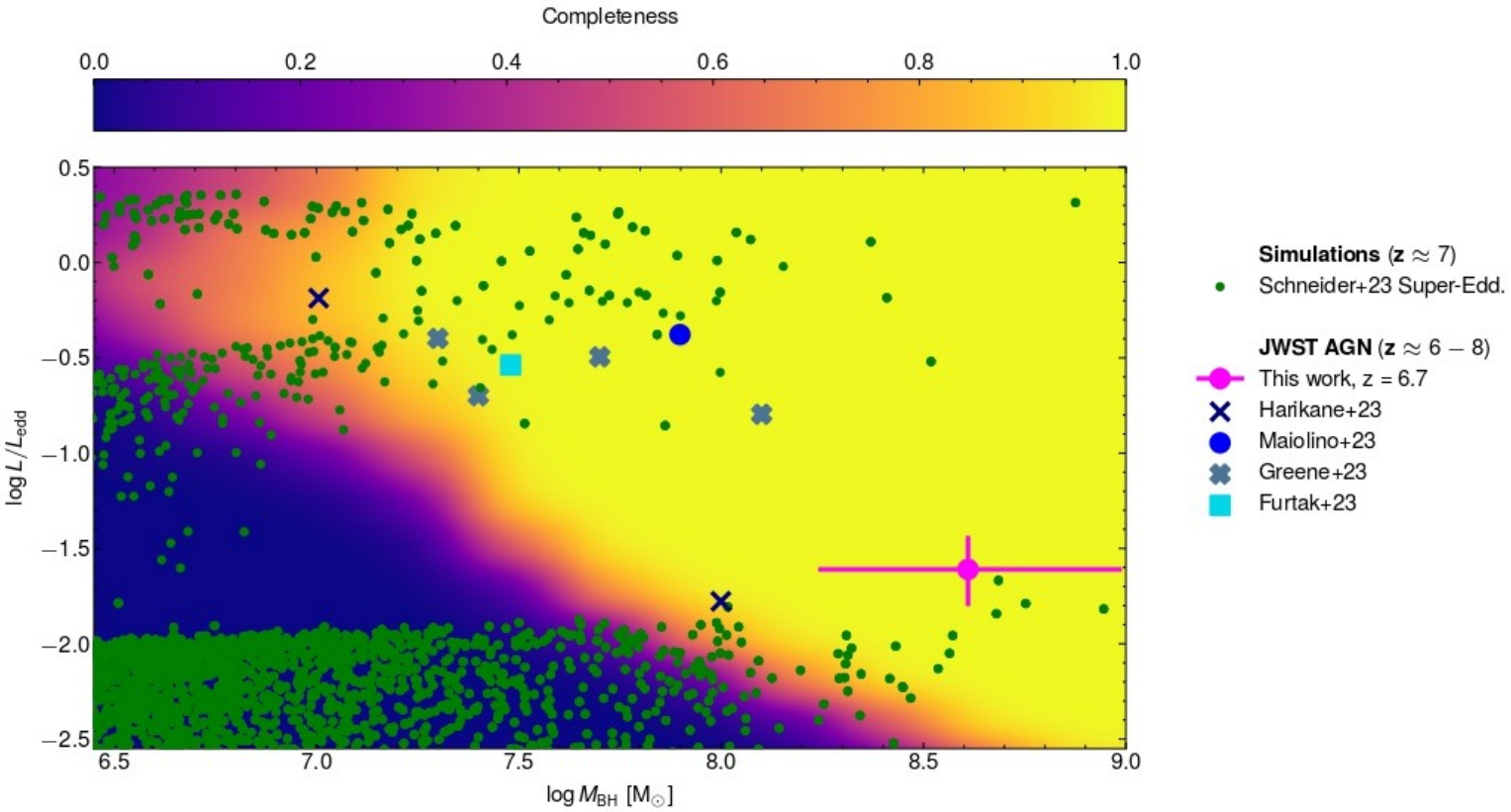
Properties are consistent with scenarios envisaging super-Eddington accretion bursts



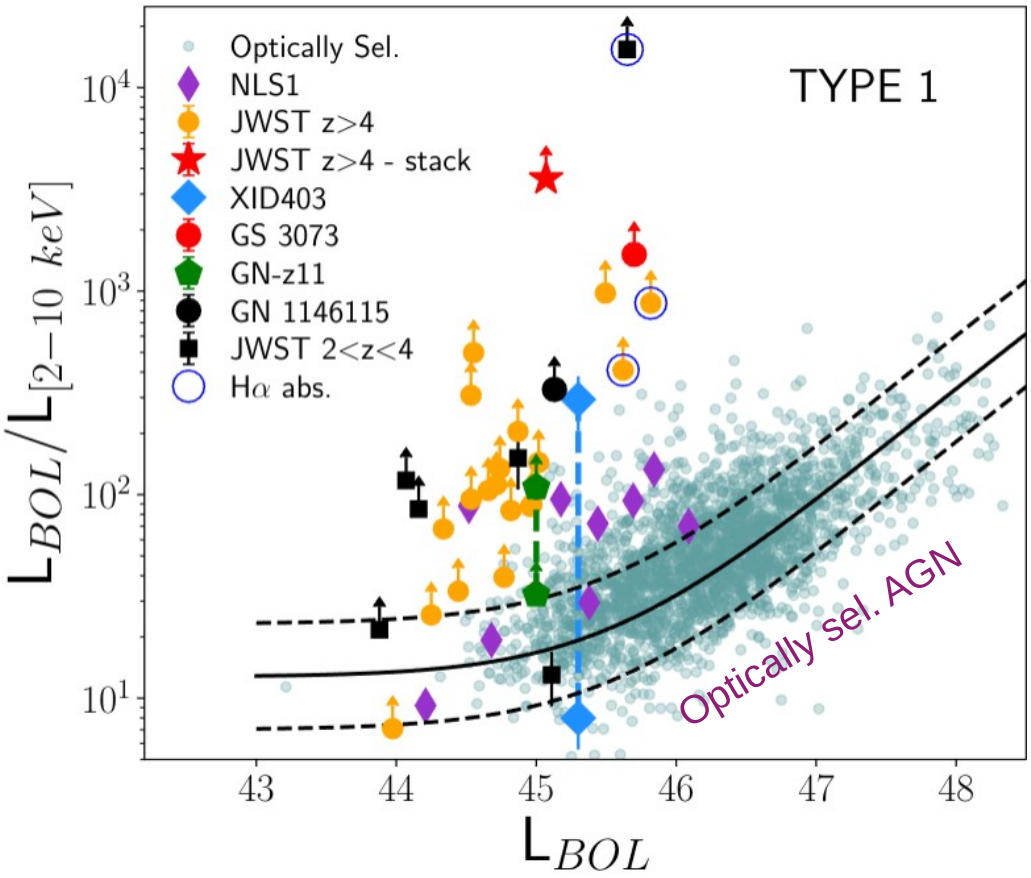


Super-Eddington bursts, despite being short and intermittent, make BH grow fast, while spending most of their life in a dormant state (hence more likely to be observed a such)

GN 1146115 is likely the tip of an iceberg

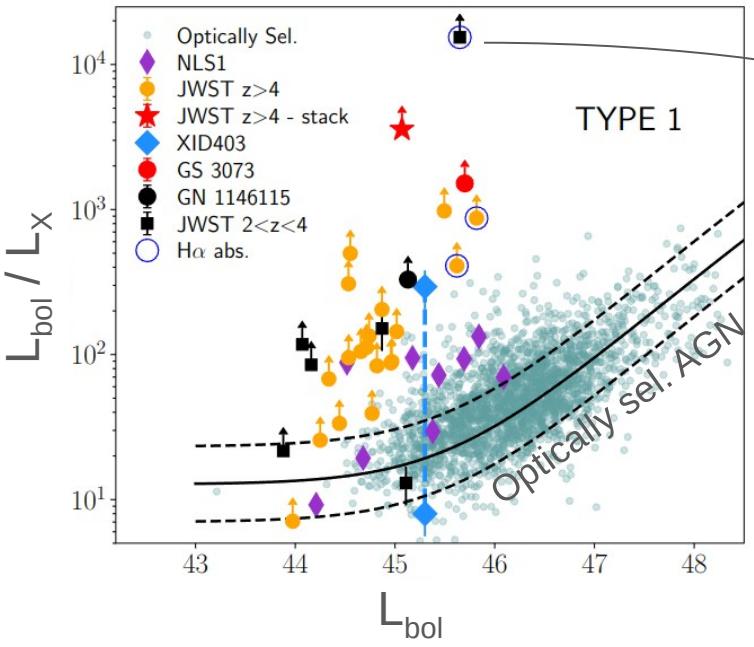


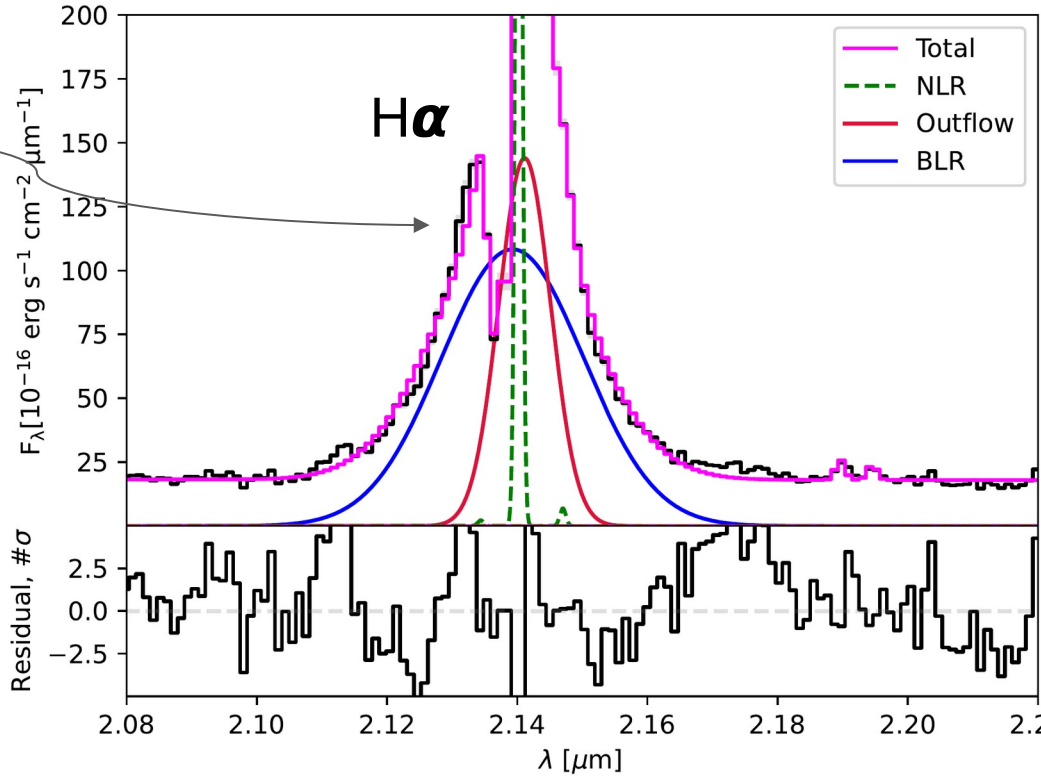
Lack of X-ray detection in JWST-selected sources

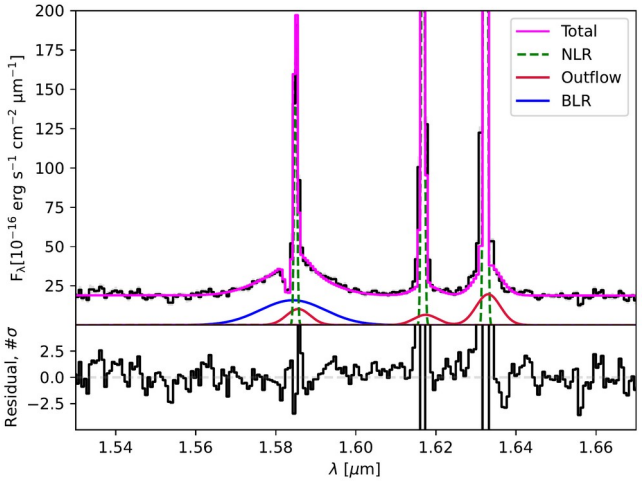


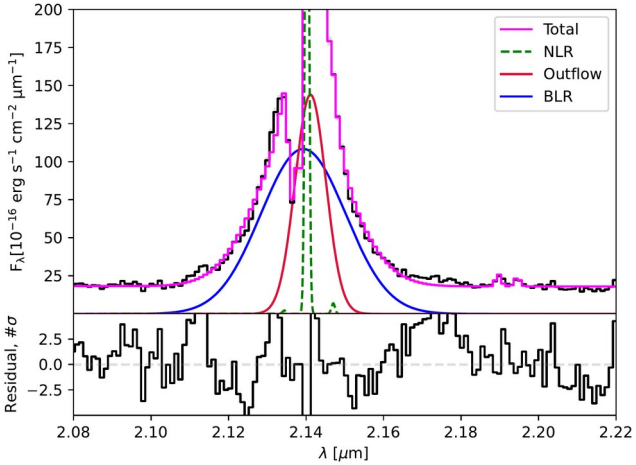
Maiolino+24

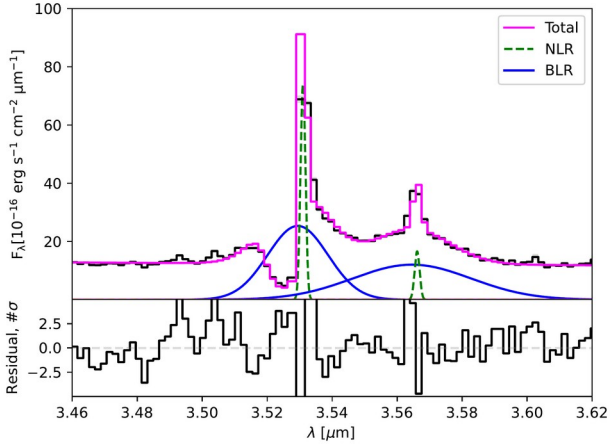
Blueshifted Hα absorption in a z = 2 quasar, GN-28074.











Hβ

Hα

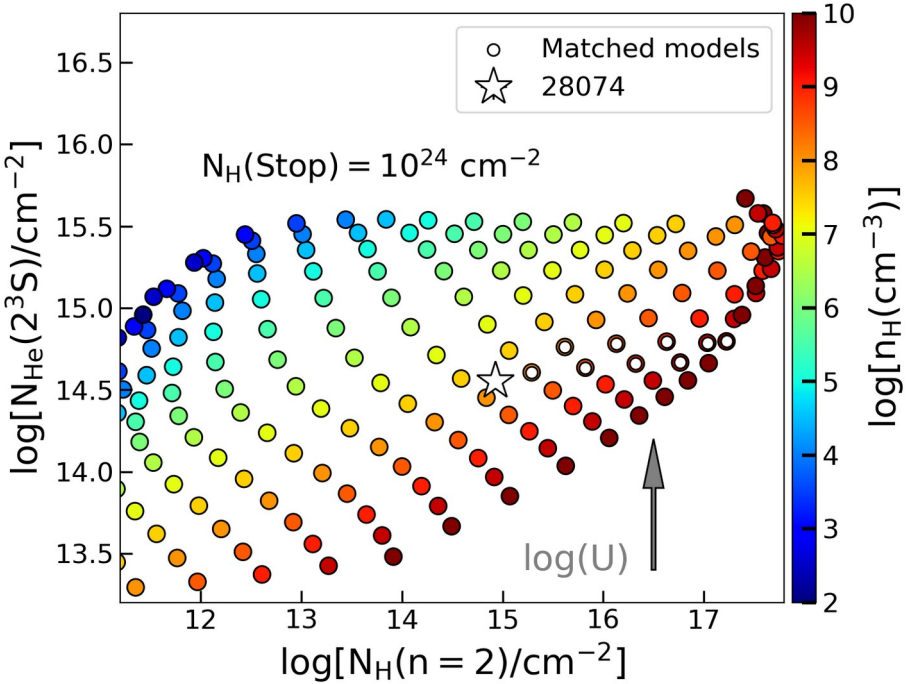
HeI10830

dv = -350 km/s
σ = 130 km/s
logN = 14.9 cm^{-2}

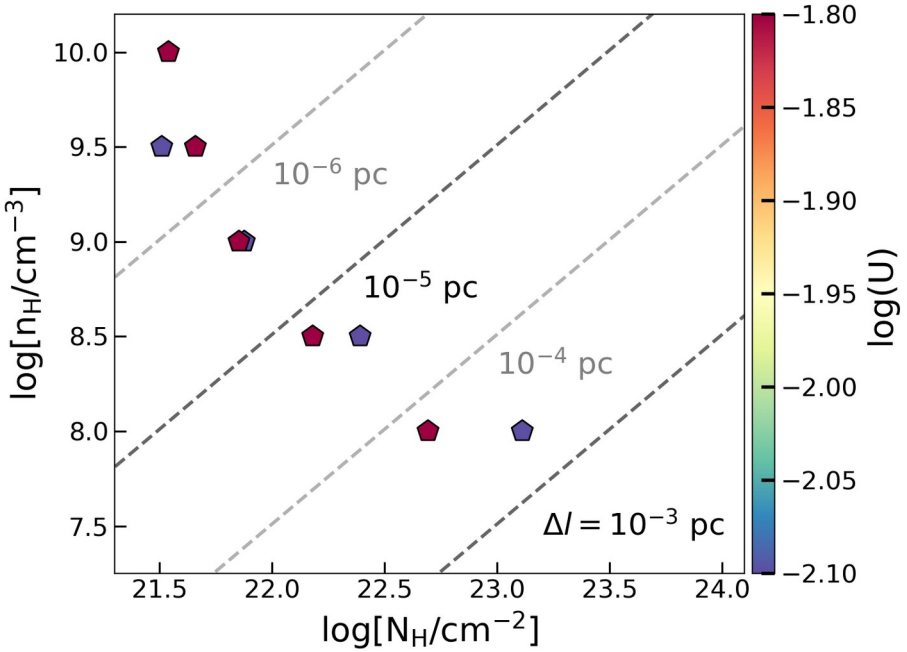
dv = -500 km/s
σ = 300 km/s
logN = 14.6 cm^{-2}

The multitude of absorption lines allows for tight constraints on the total hydrogen column density.

CLOUDY models consistent with absorption being produced by a single cloud in the BLR and a Compton-thick environment

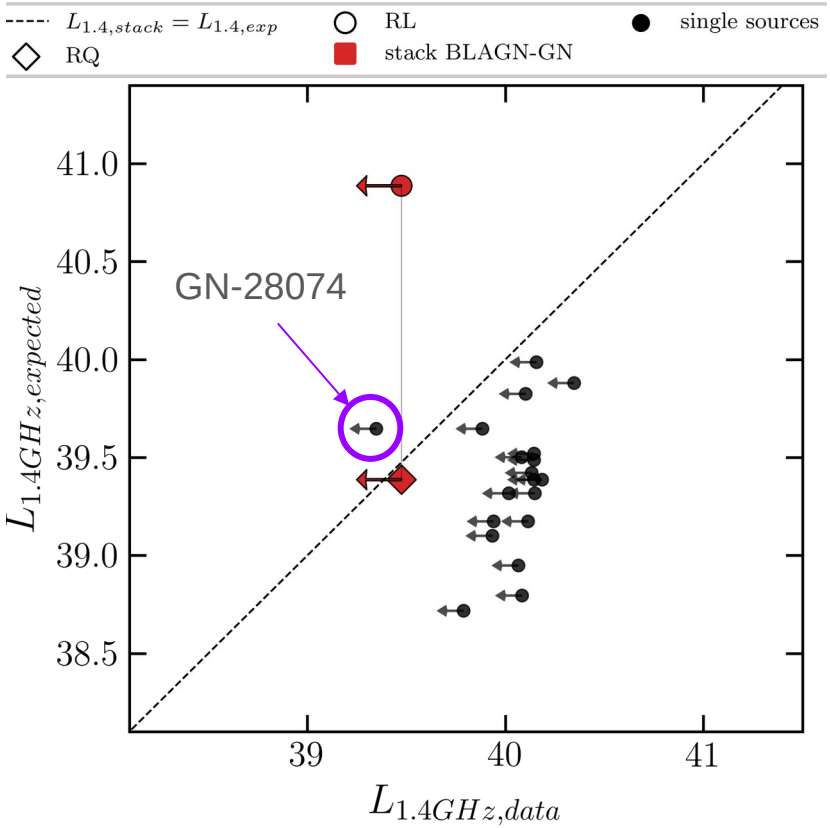


Matching of observed column densities with a model grid



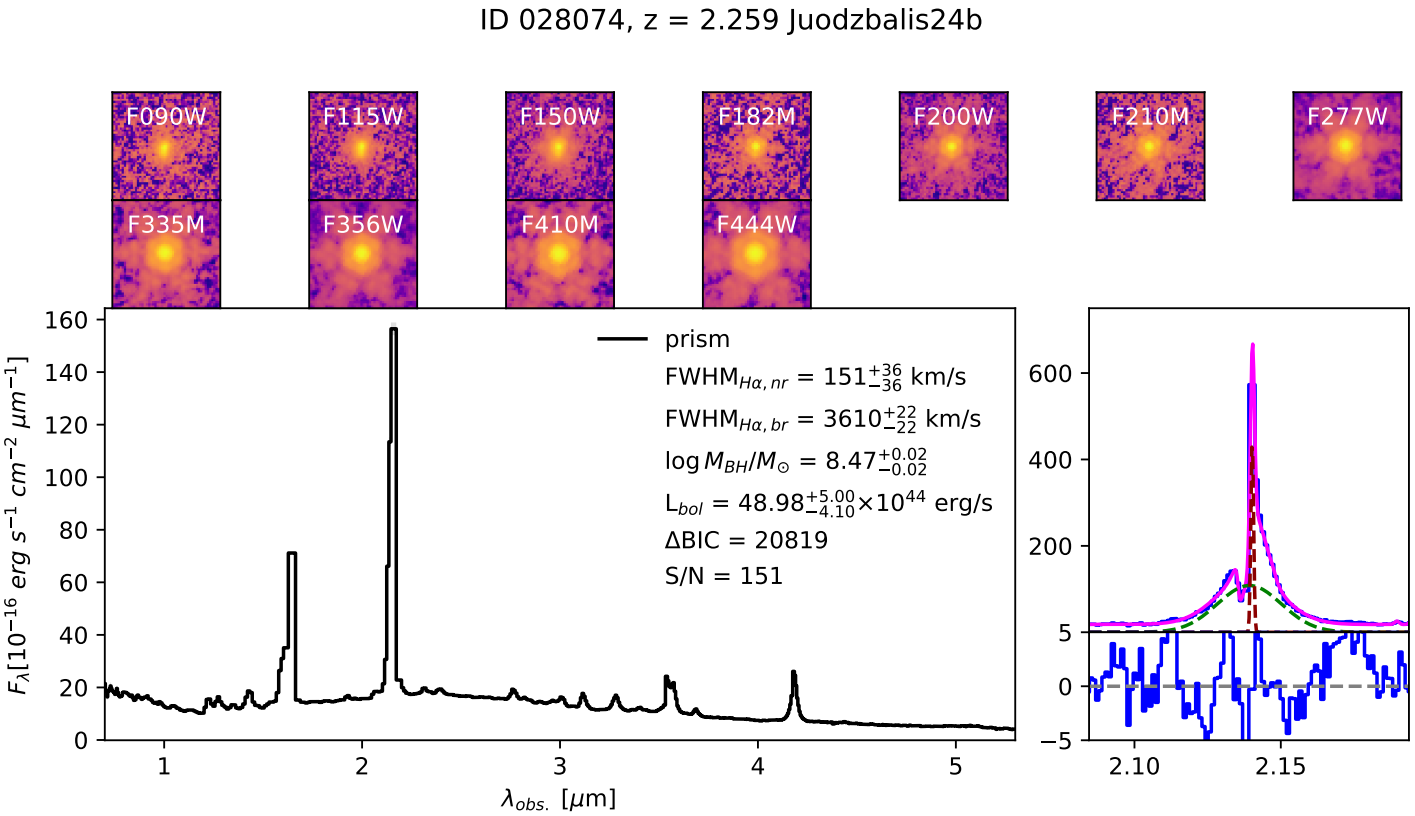
Implied small physical scale, high density and ionization parameter

- The extreme X-ray weakness of GN-28074 may be a consequence of its Compton thickness.
- However, it is also somewhat radio weak even for a radio quiet AGN
- Could point to a lack of a corona

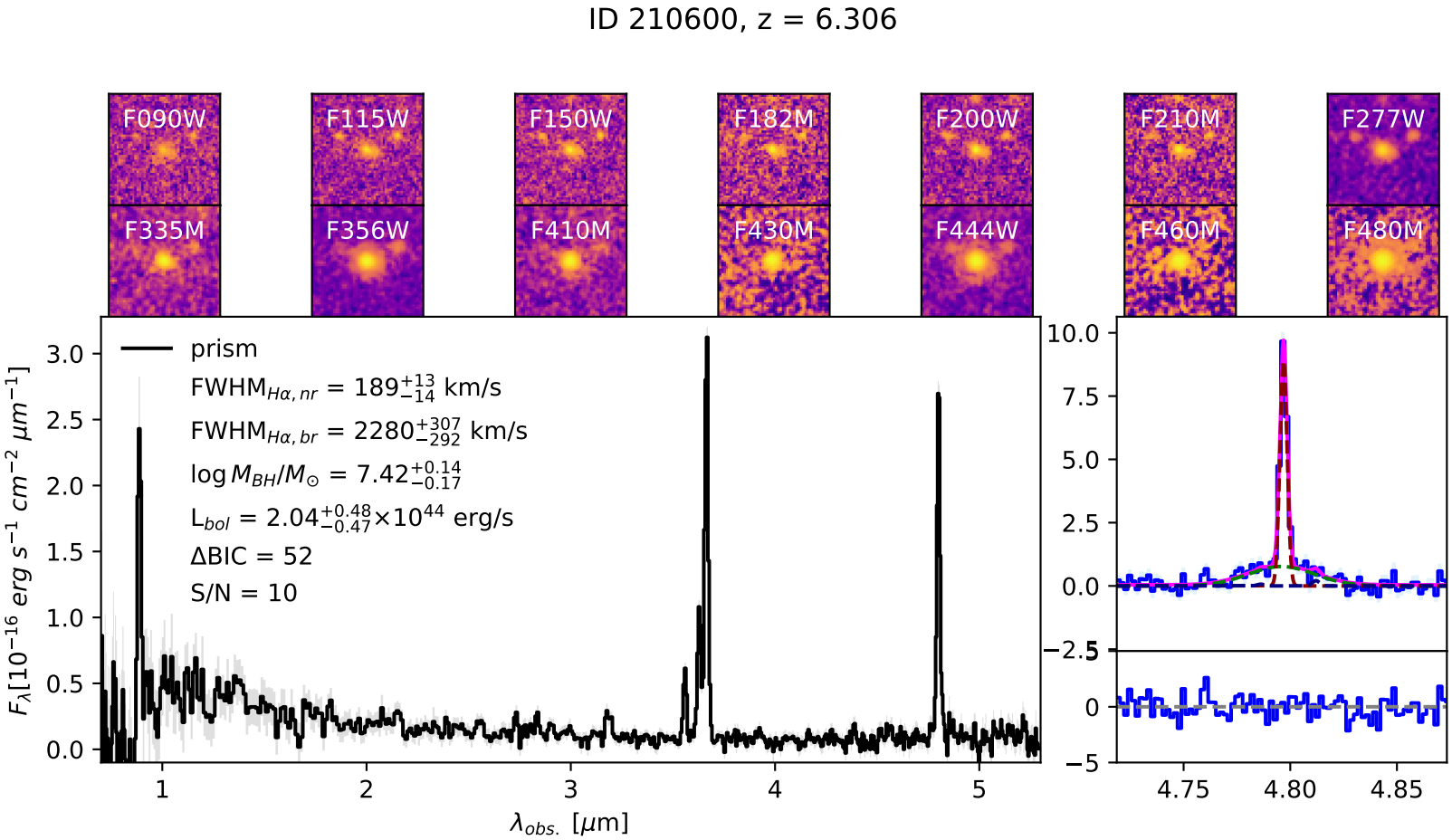


Mazzolari + 24

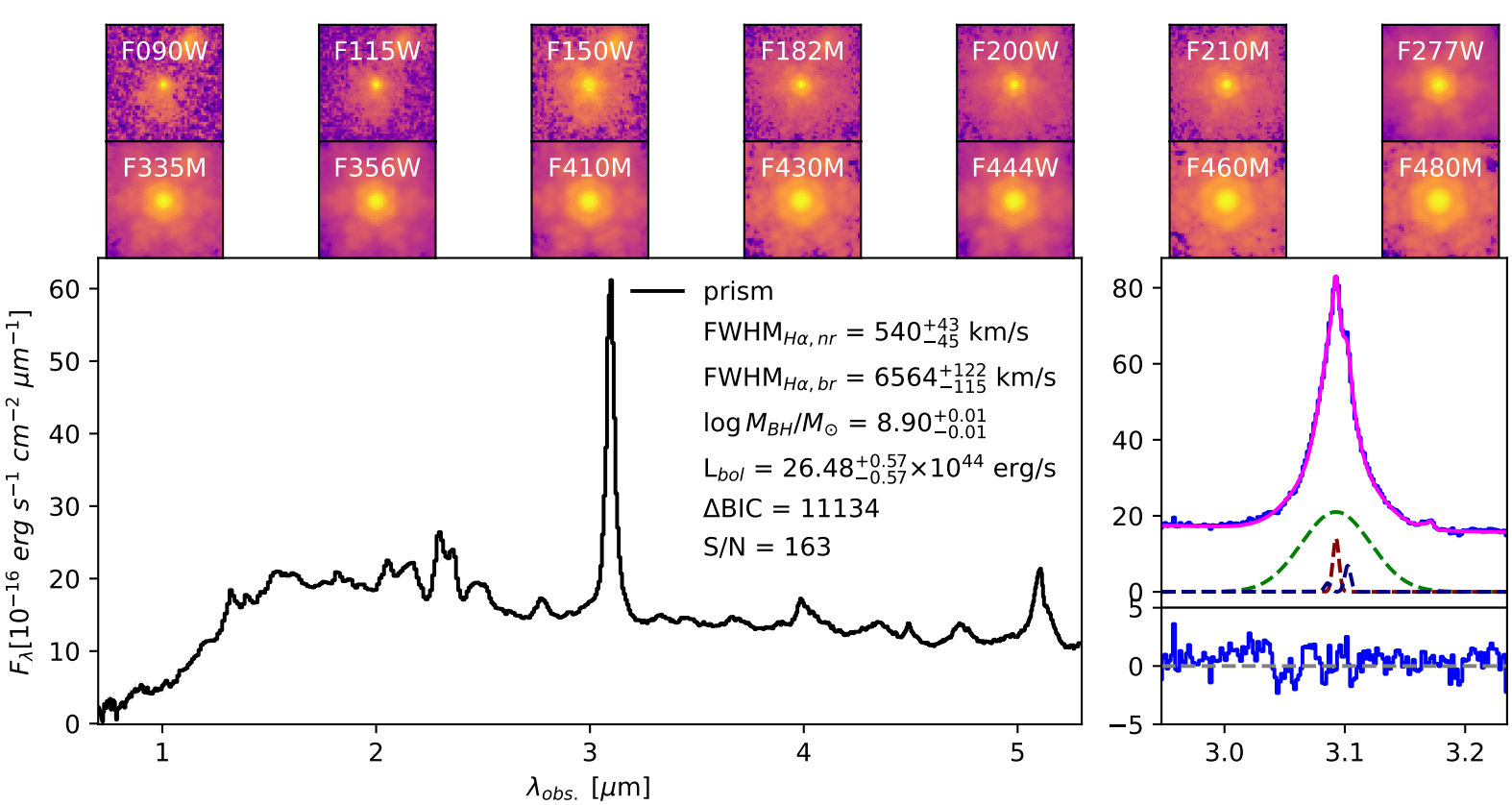
GN-28074 also posesses an unusual continuum shape, reminiscent of LRD sources



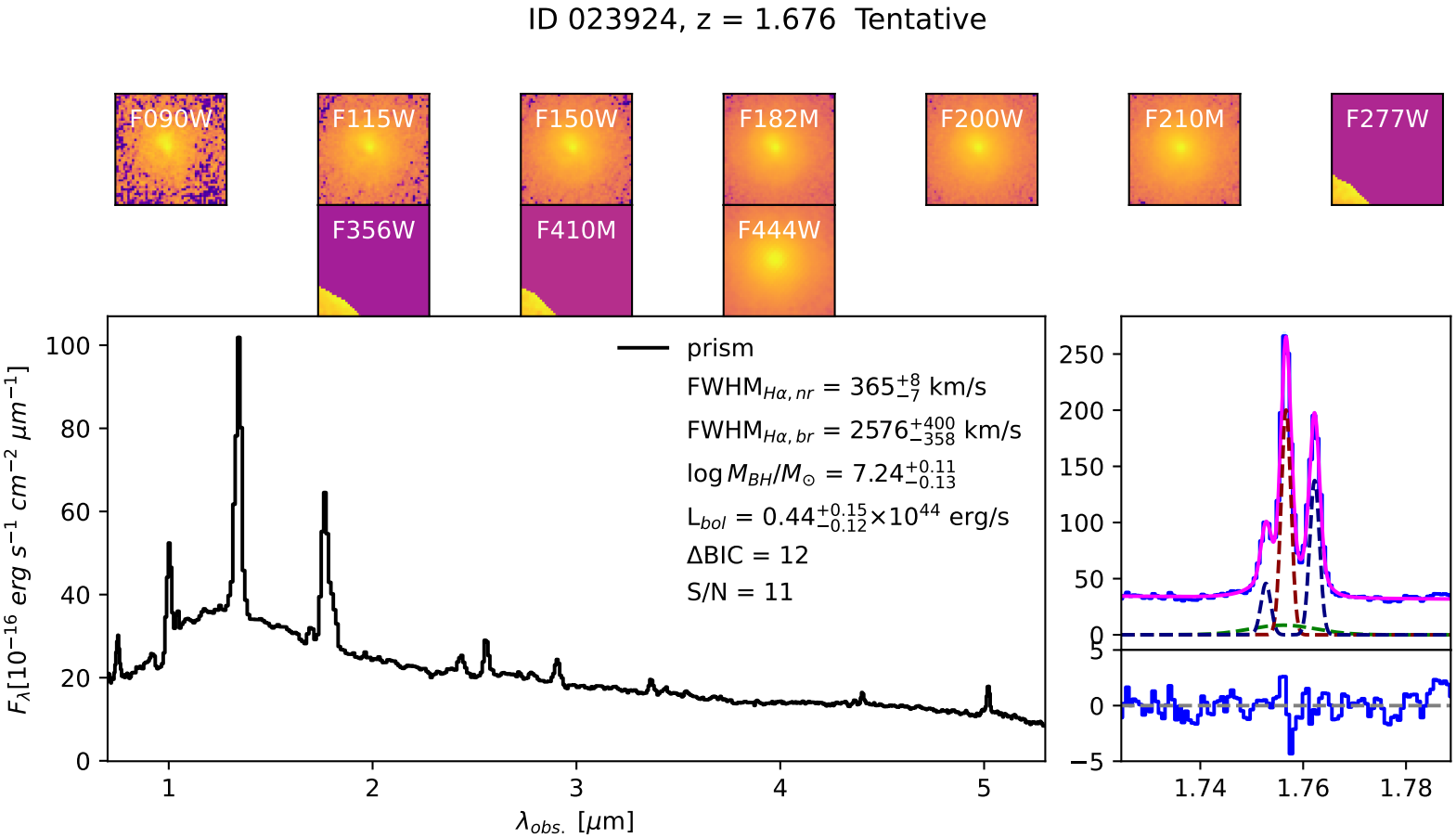
Full JADES sample of AGN: Compact sources near the end of reionization



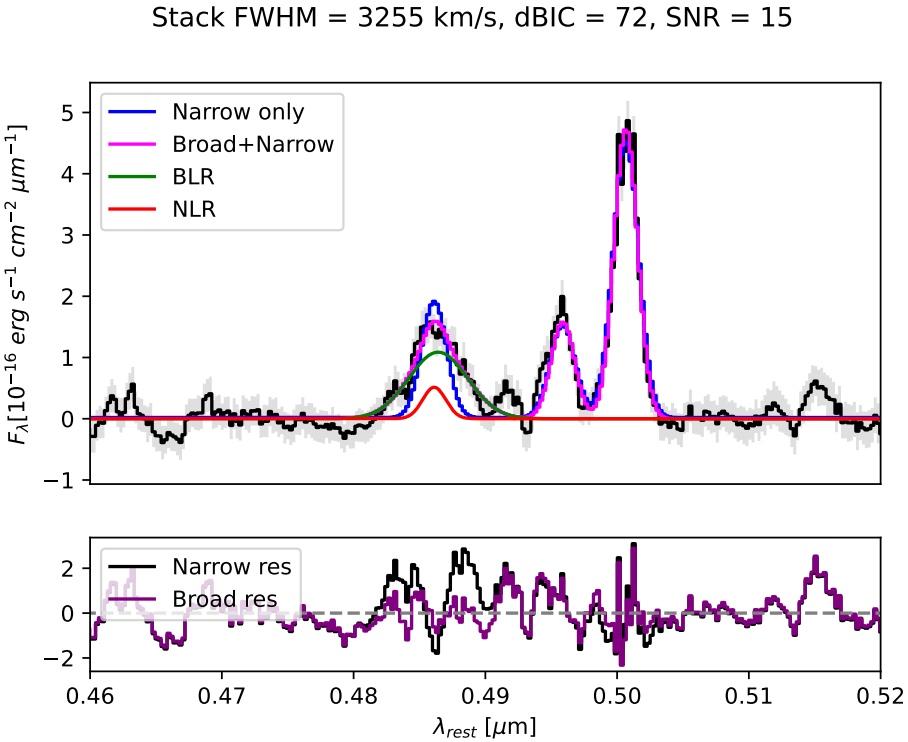
Full JADES sample of AGN: Cosmic morning quasars



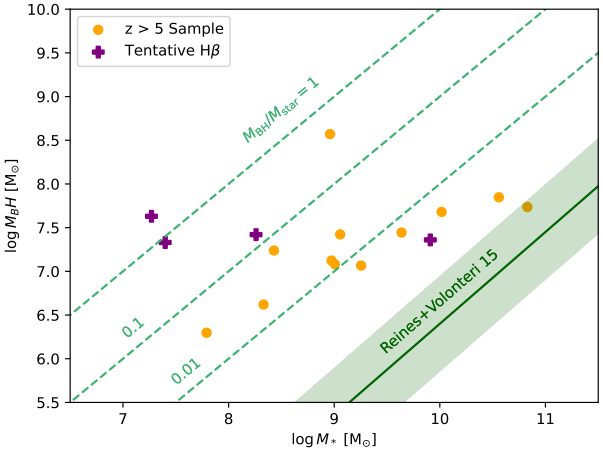
Full JADES sample of AGN: Extended hosts at cosmic noon

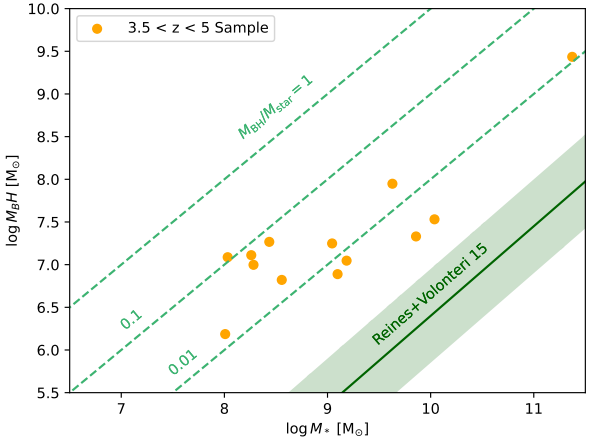


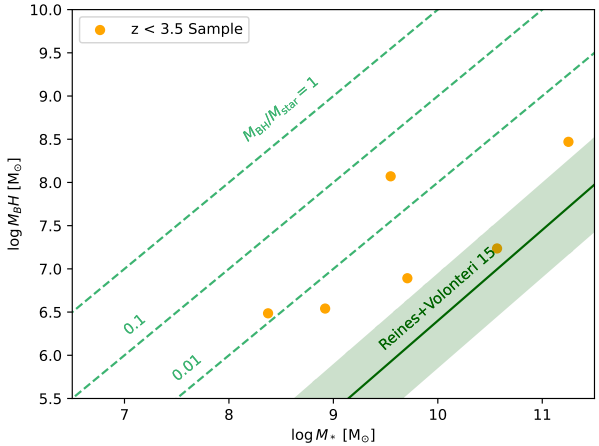
In addition to the main sample, spectral stacking reveals 4 tentative broad Hβ sources at z > 7.5



- Log M_{BH} = 7.40 [$M_\odot$]
- L/L_{Edd} = 0.054

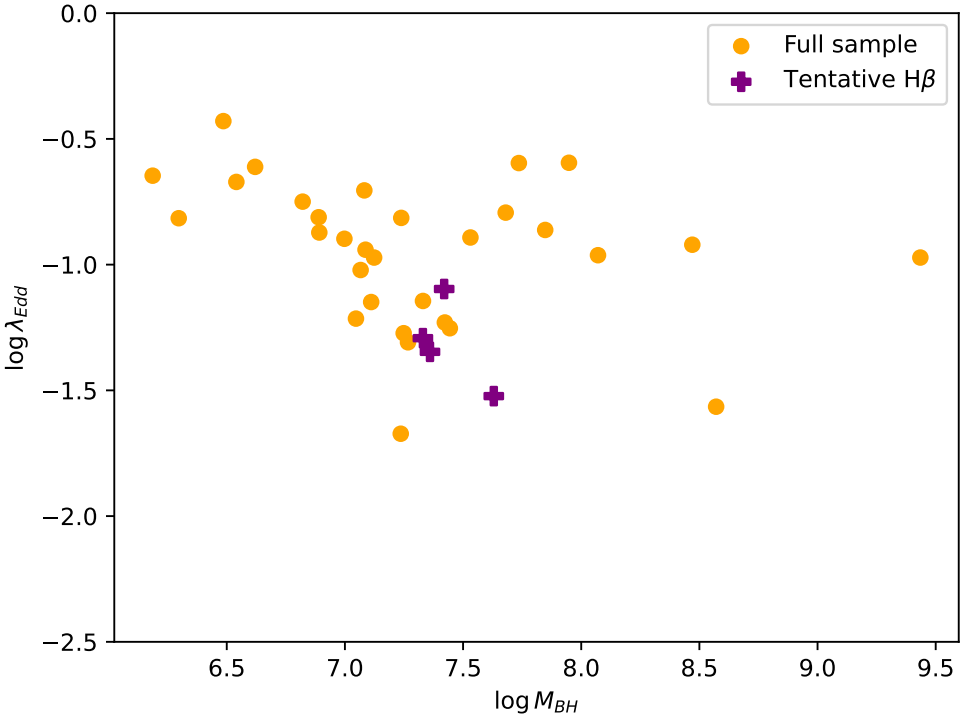




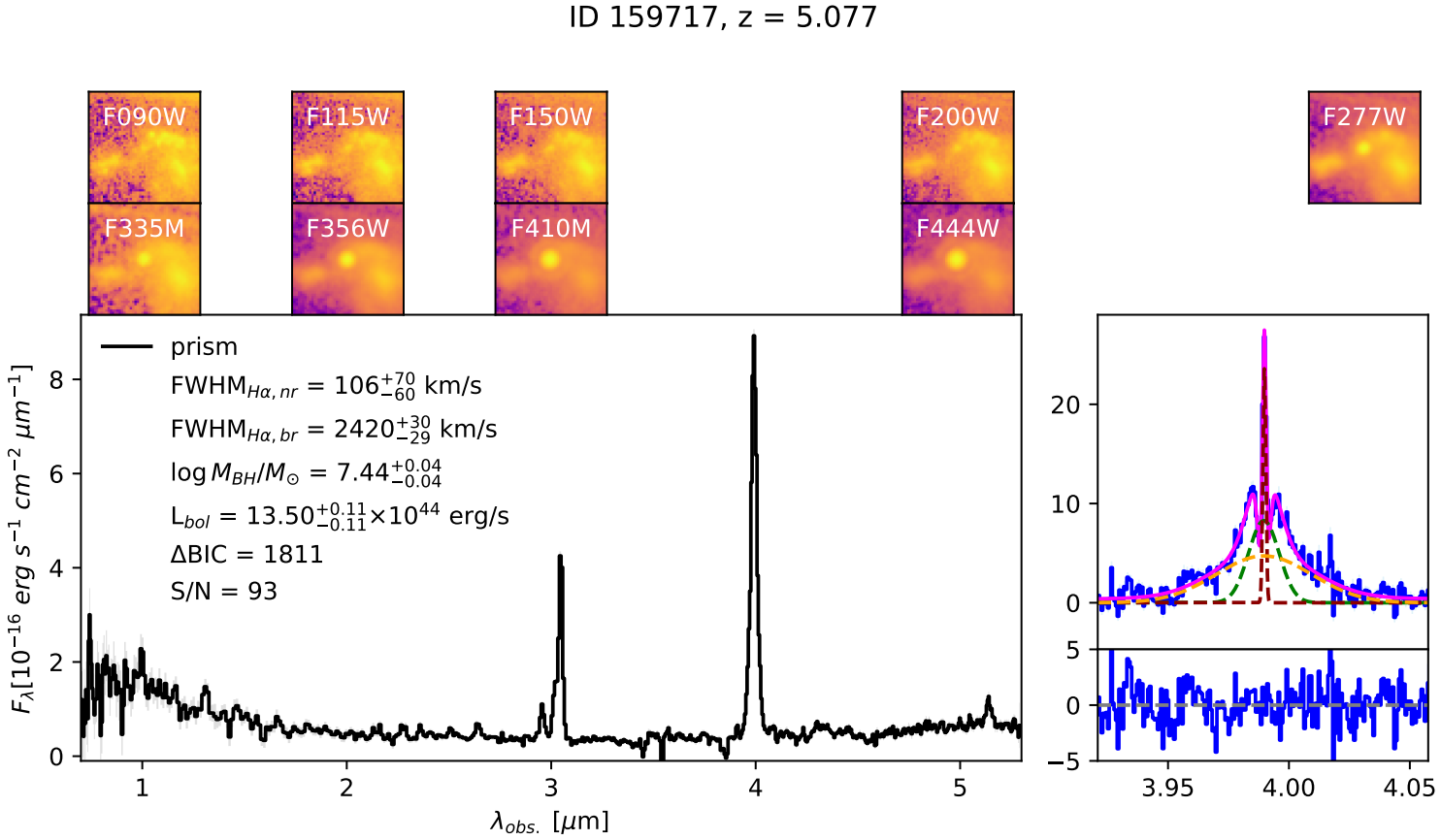


- BH – stellar mass relations across cosmic time:
  - No significant evolution between z = 5 and 3.5
  - Sources at lower z appear to be closer to the local scaling relations, however, statistics there are small

- Most of our Type 1 sources are heavily sub-Eddington.
- Potentially probing the dormant population predicted by super Eddington growth models.

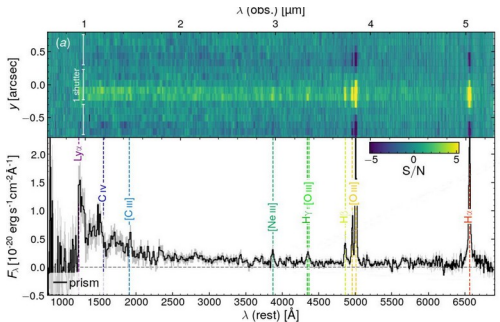


Additional object with Hα absorption



Summary

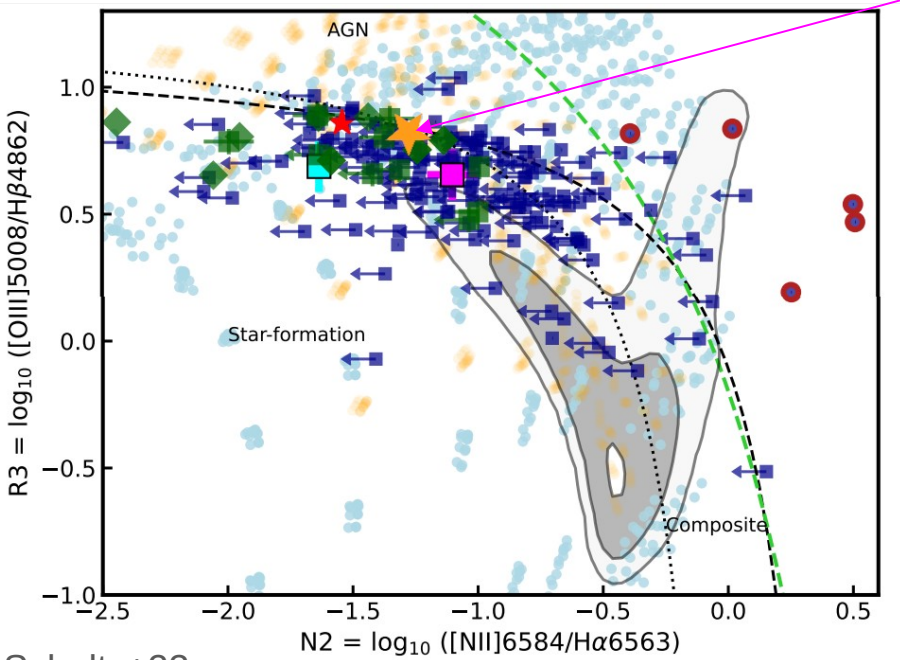
- There appears to be a significant population of (over-)massive yet dormant black holes in the early Universe
- This suggests an early BH growth driven by short bursts of super-Eddington accretion
- A significant fraction of low luminosity AGN appear to be Compton-thick
- The Balmer break like features seen in the continua of many low-luminosity AGN may be of non-stellar origin (Inayoshi & Maiolino 2024).



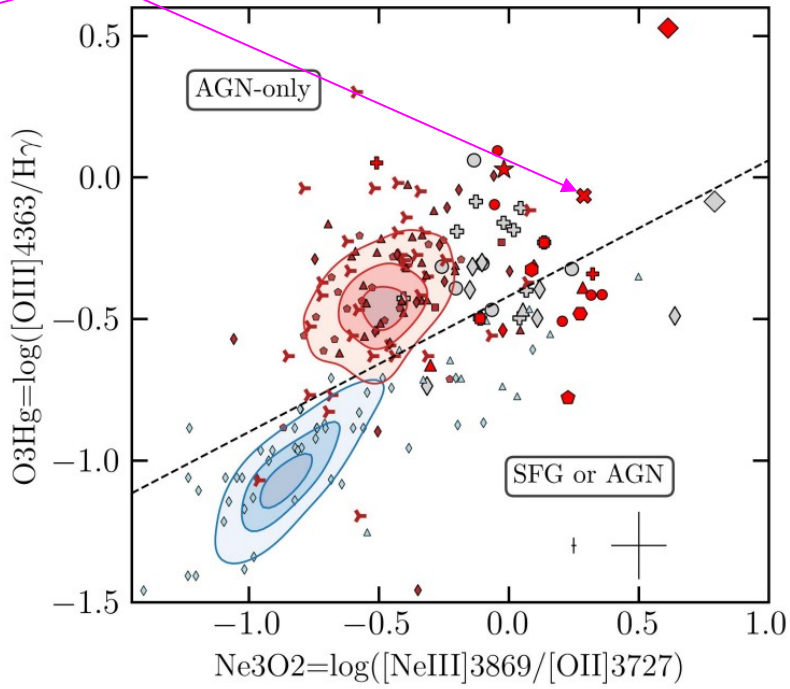
Supplemental material

AGN diagnostics at high redshift

GN 1146115

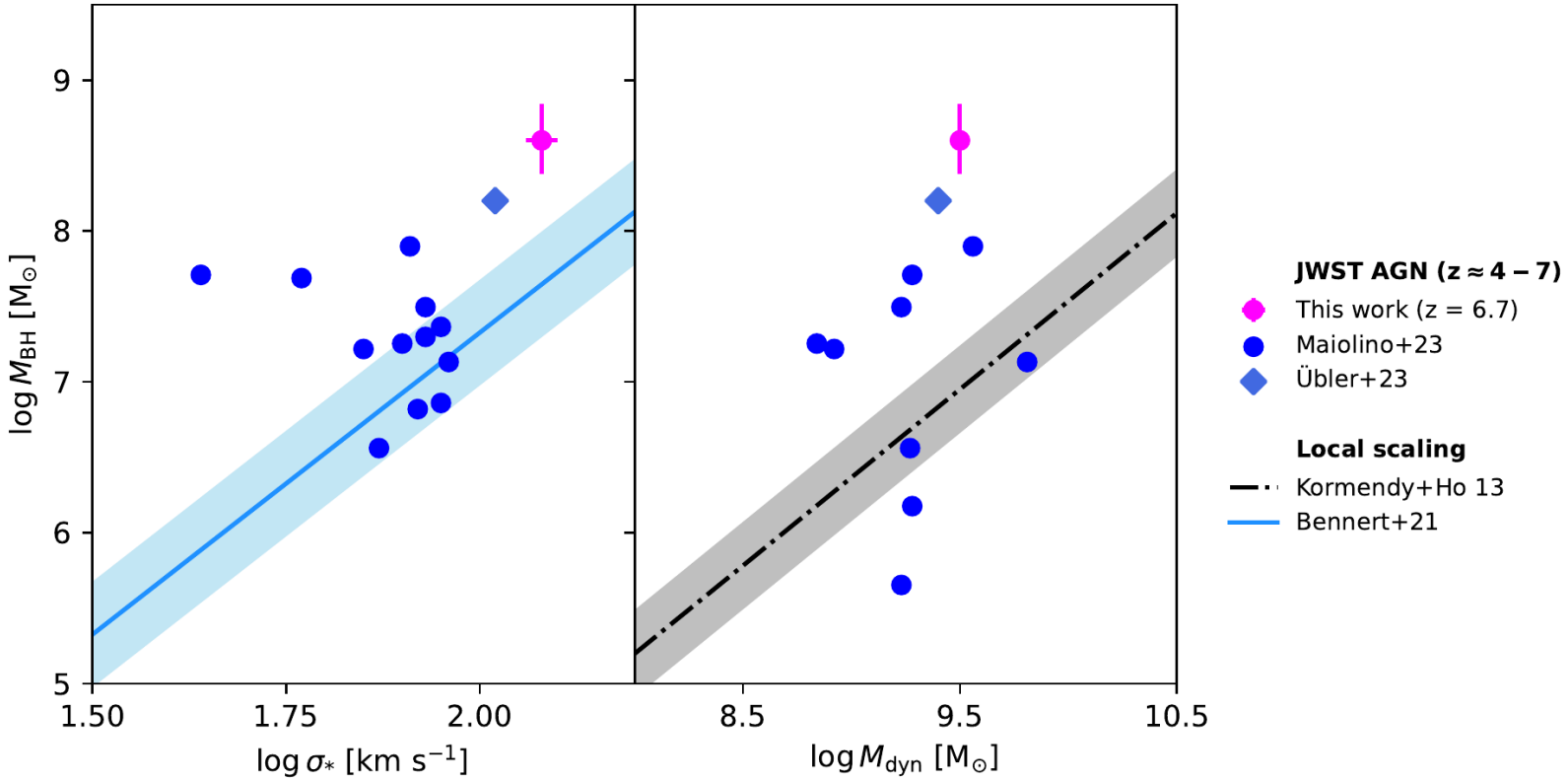


Scholtz+23

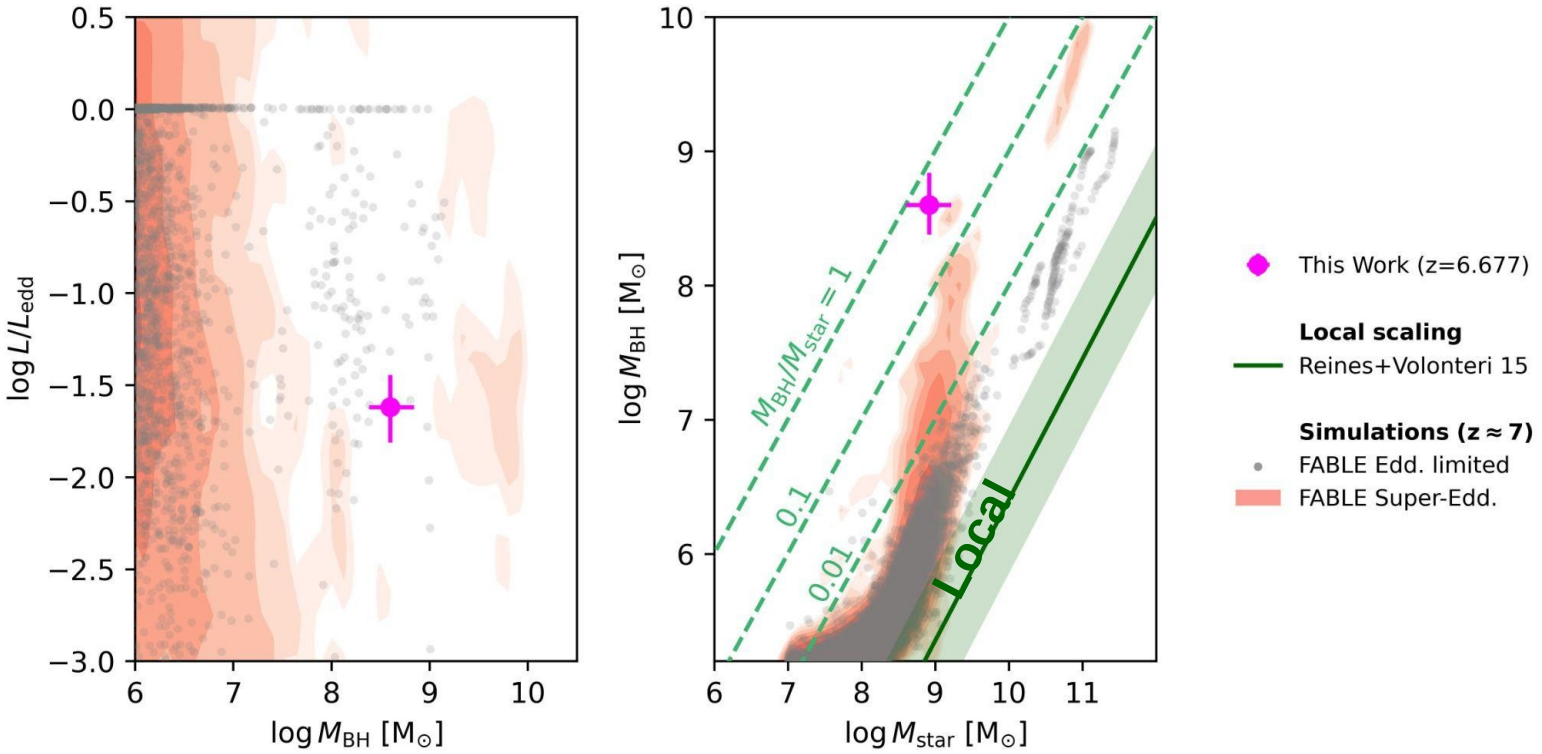


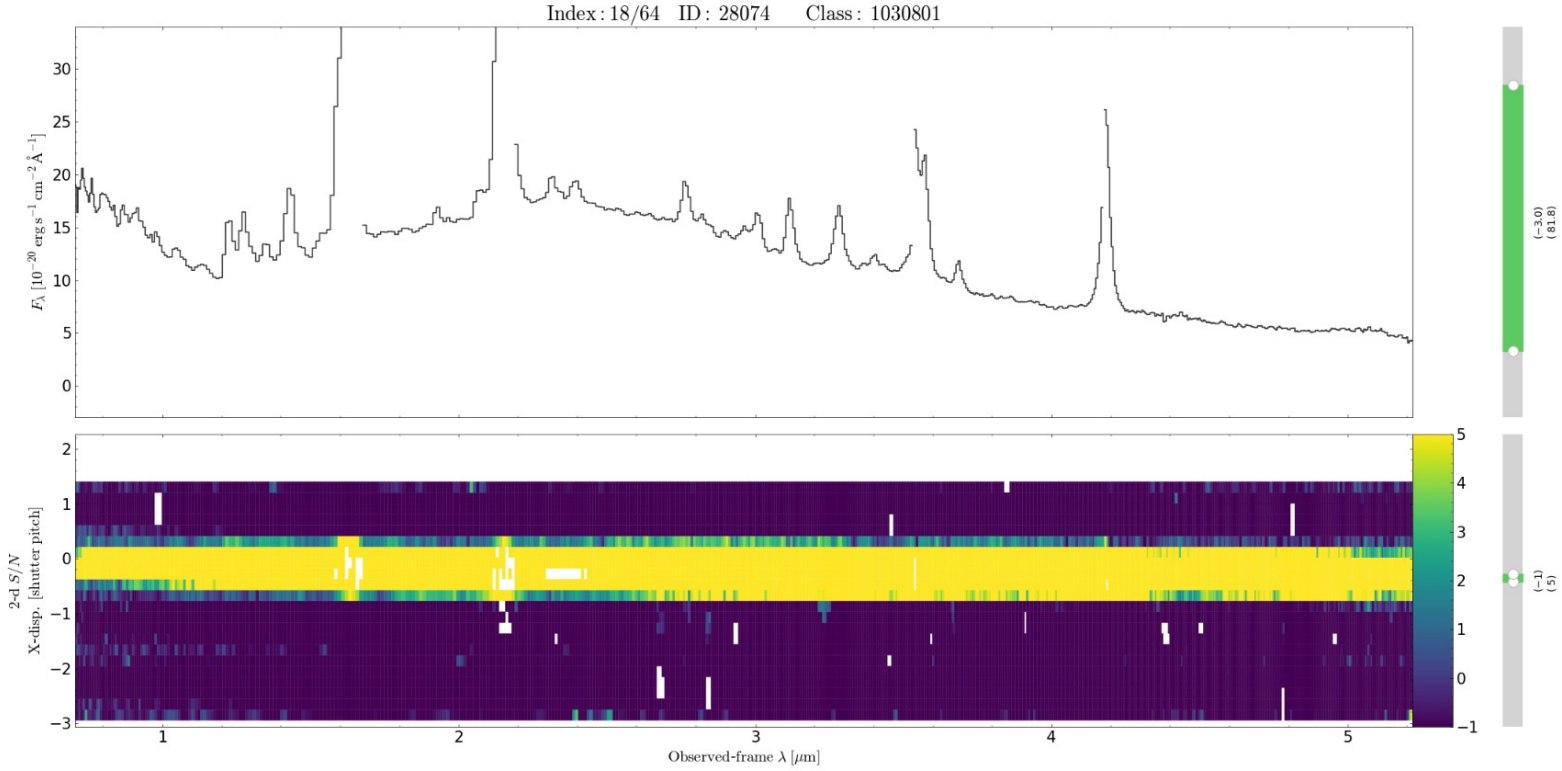
GN 1146115 lies in the SF region of the BPT, but passes some cuts in Mazzolari+24

BH mass - sigma and dynamical mass relations



Comparison with FABLE simulations




Index : 18/64 ID : 28074 Class : 1030801
F_λ [10^{-20} erg s^{-1} cm^{-2} Å^{-1}]
2-d S/N
X-disp. [shutter pitch]
Observed-frame λ [μm]
(−3.0)
(81.8)
(−1)
(5)