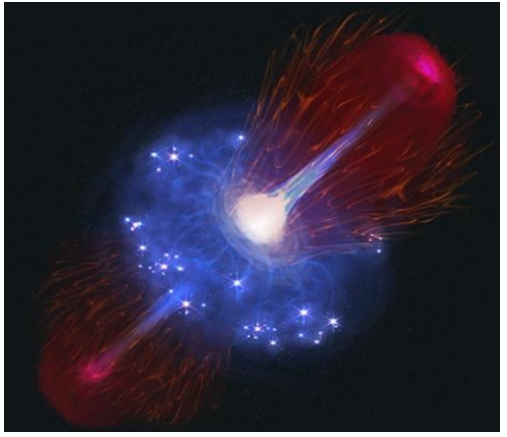
JADES census of Type 1 AGN and their hosts

Tracing black hole growth across cosmic time



Ignas Juodžbalis

William Baker, Roberto Maiolino, Xihan Ji, Jan Scholtz and Francesco D’Eugenio

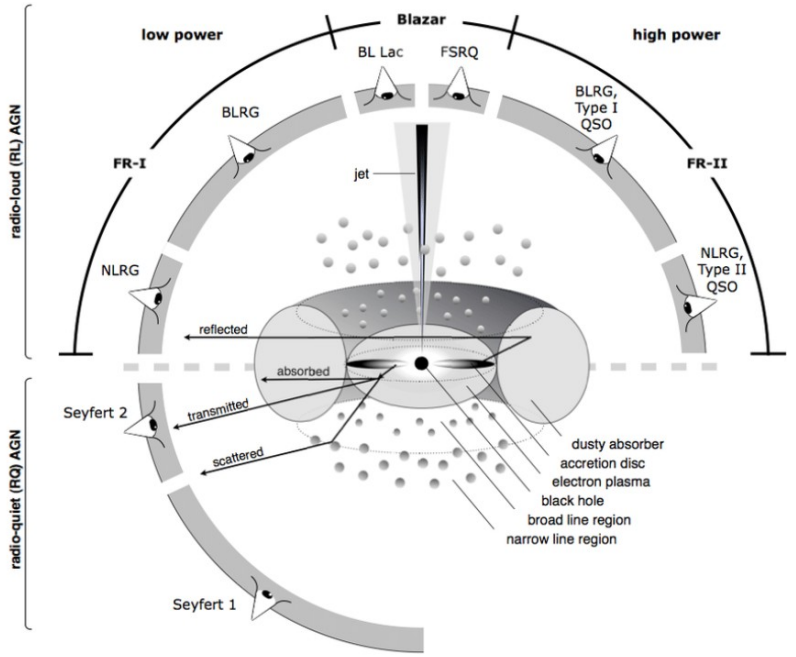
JADES JWST ADVANCED DEEP EXTRAGALACTIC SURVEY

KICC Kavli Institute for Cosmology Cambridge

UNIVERSITY OF CAMBRIDGE

Anatomy of an AGN

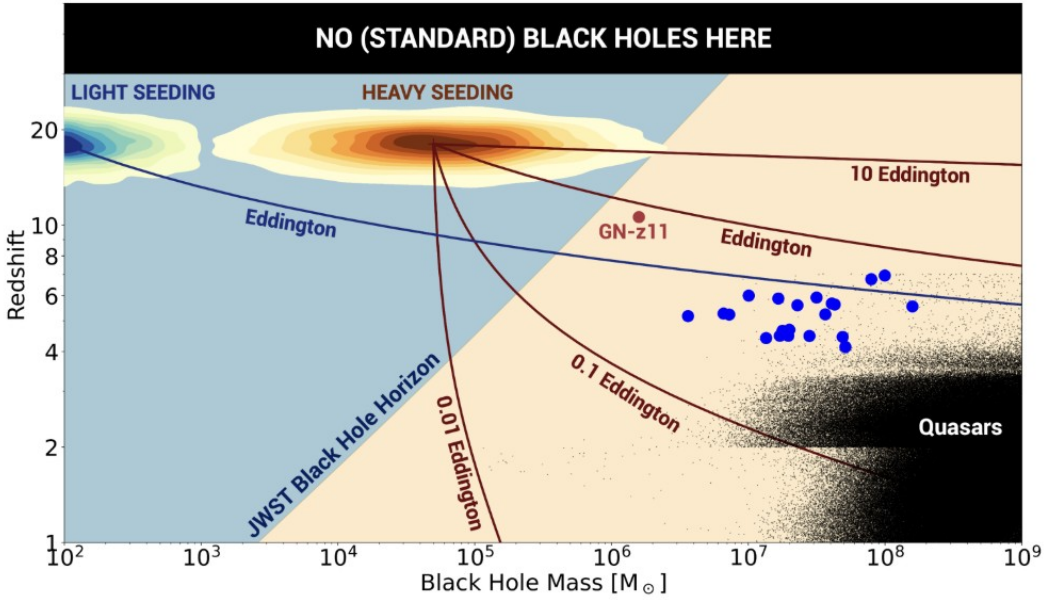
- Main engine – accretion disk around a black hole (BH) heated by viscous friction.
- Depending on the viewing angle can be classified as Type 1 or Type 2
- Here, we will focus on Type 1



The unified AGN model, Beckmann & Shrader (2012)

Why do we care?

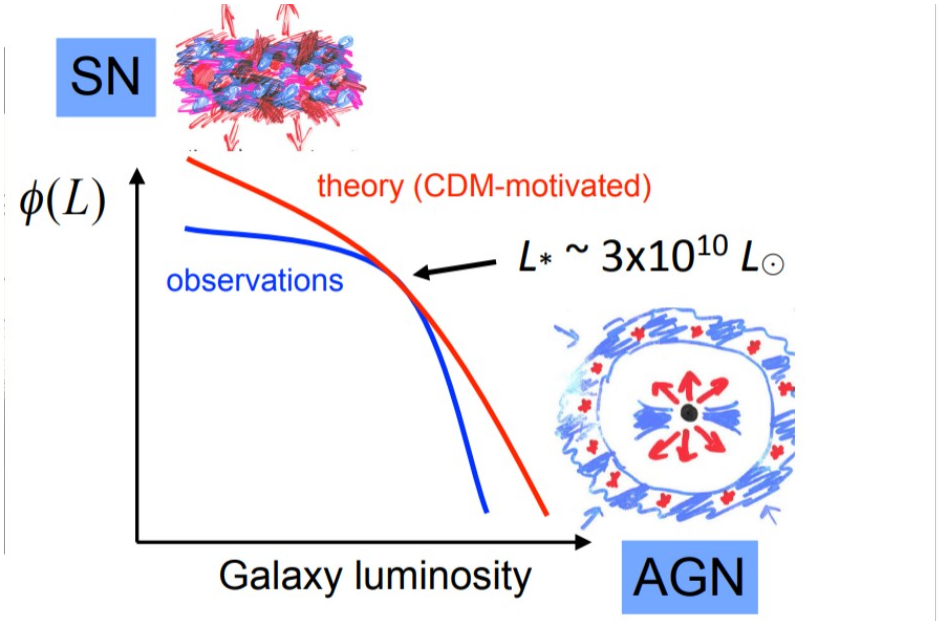
- Emergence of massive BHs is still an open question.



Black hole seeding models, Paccuci et al. (2023)

Why do we care?

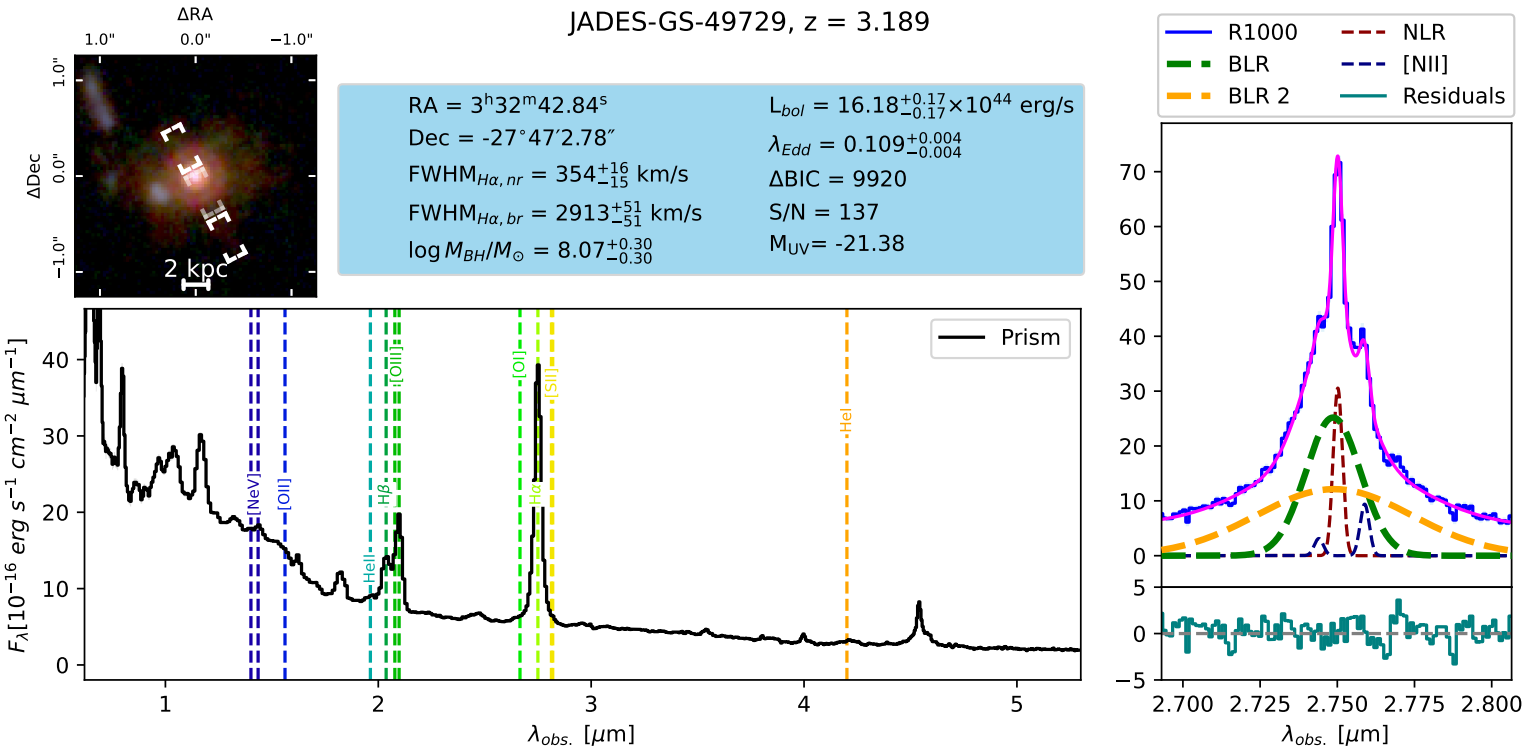
- AGN feedback frequently invoked to explain discrepancies between theory and observation



Effects of feedback on galaxy luminosity function, Silk & Mamon (2012)

Identifying Type 1 AGN

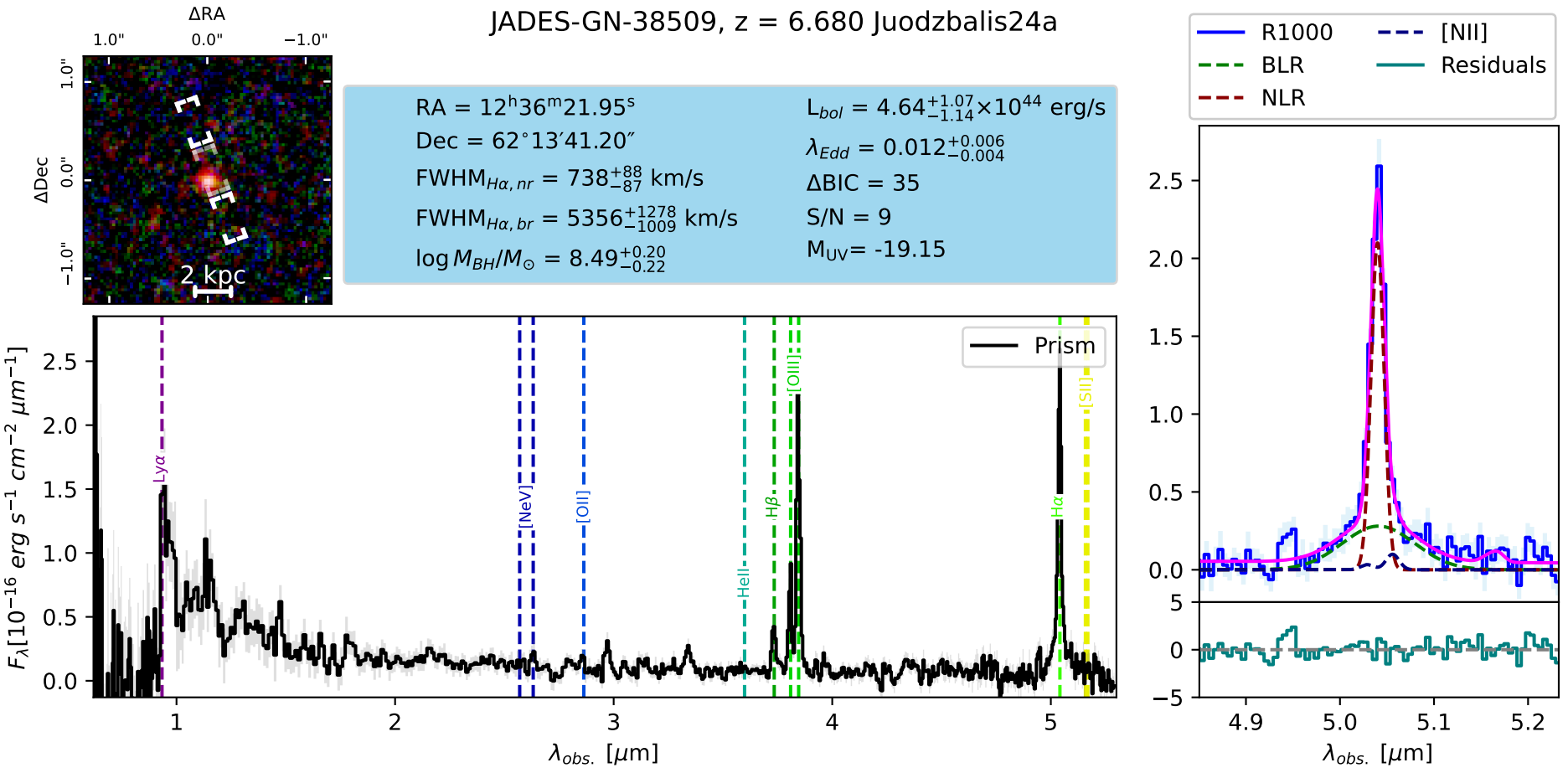
- Broad permitted and relatively narrow forbidden lines are the key characteristic.



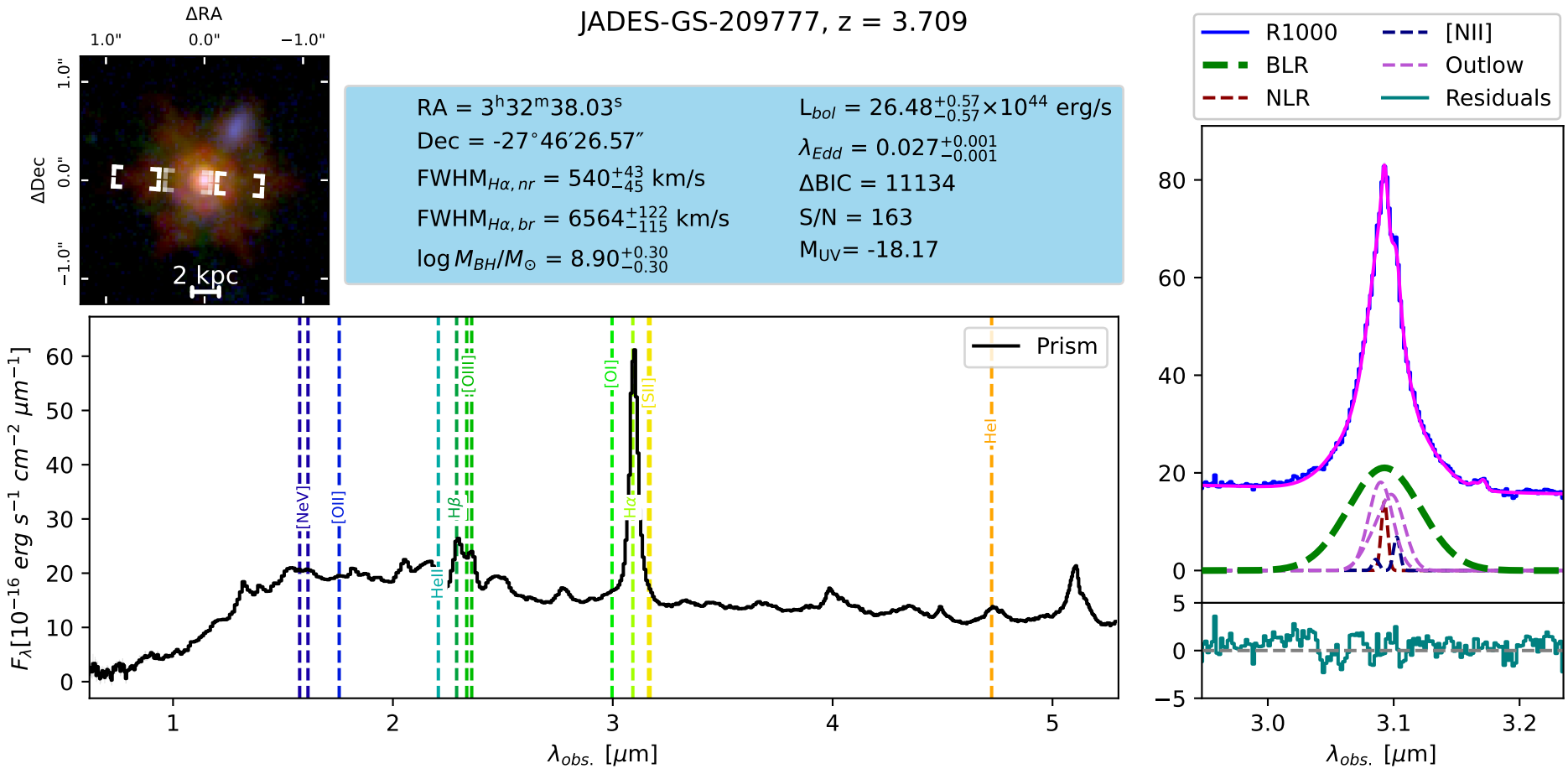
JADES data in brief

- The spectroscopic 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.
- These methods were extended across the remainder of the survey to obtain a catalog of 34 unique sources.
- As the main line fitted for broad components is Hα, the redshifts are limited to $z = 7$.

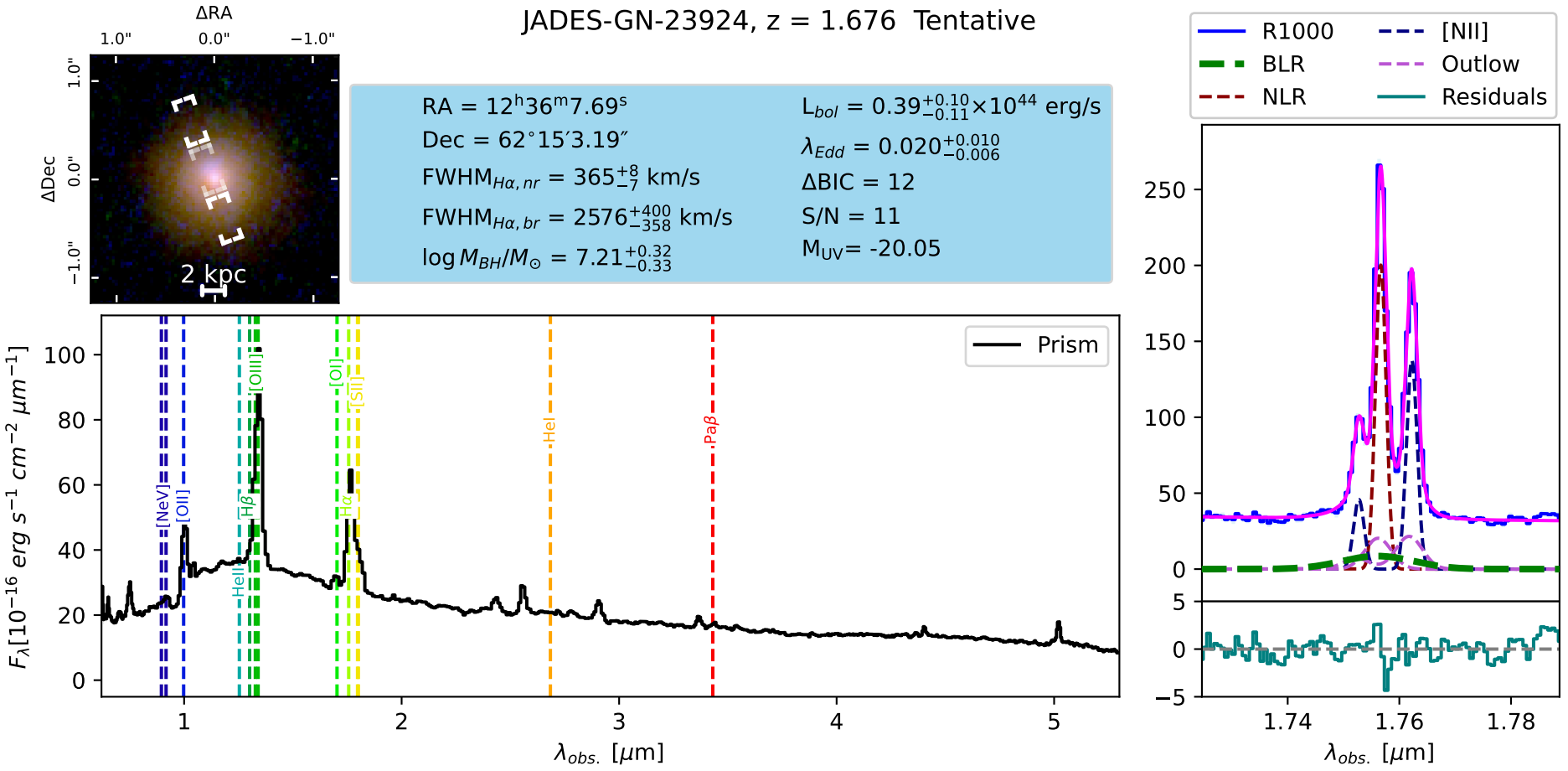
Snapshots from the sample I – end of reionization



Snapshots from the sample II – Cosmic Morning

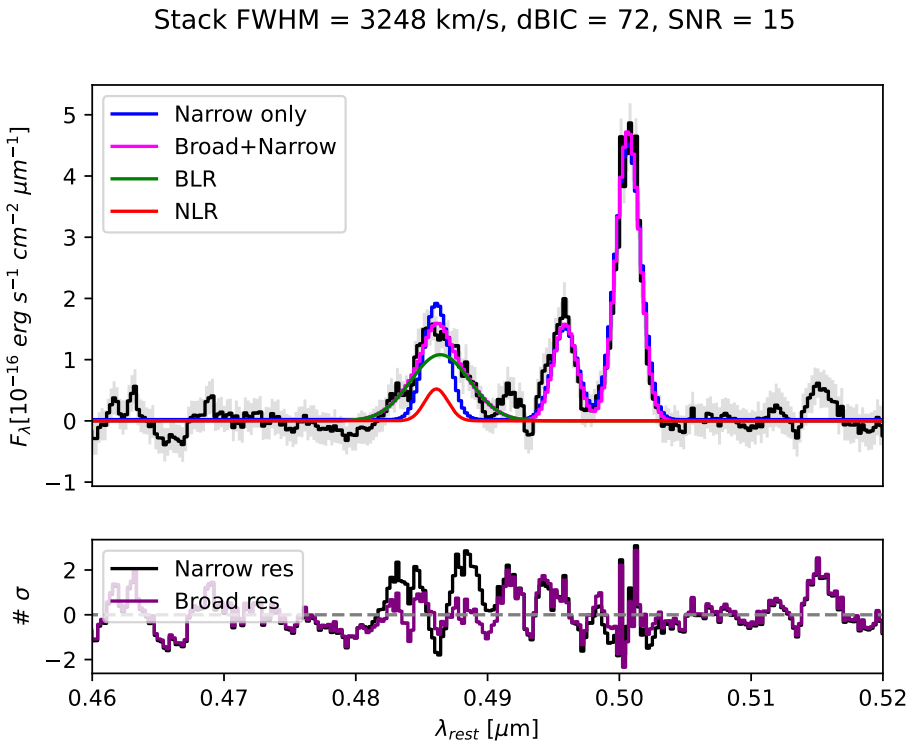


Snapshots from the sample III – Cosmic Noon

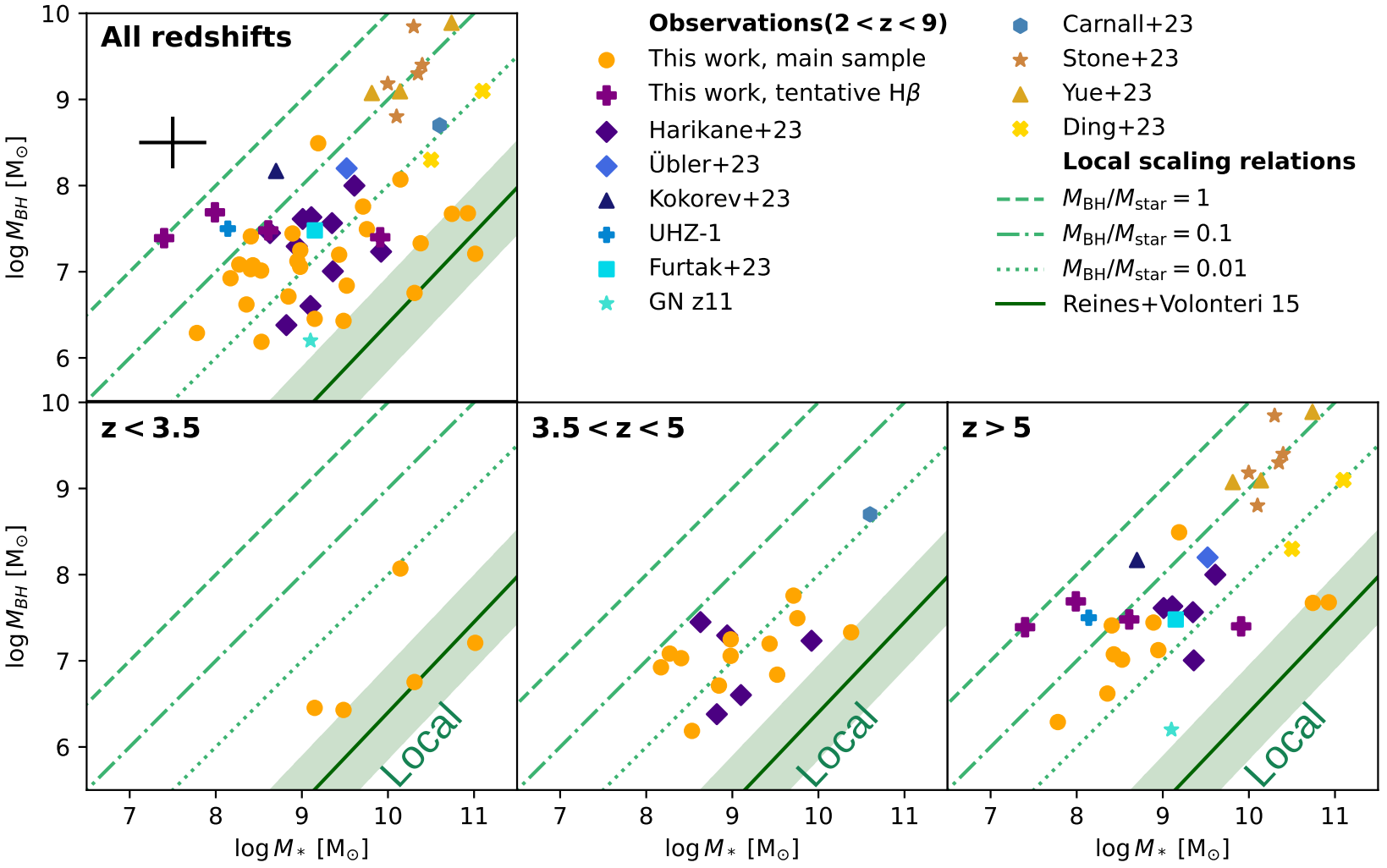


Exploring the Hβ line pushes the boundary to z = 9

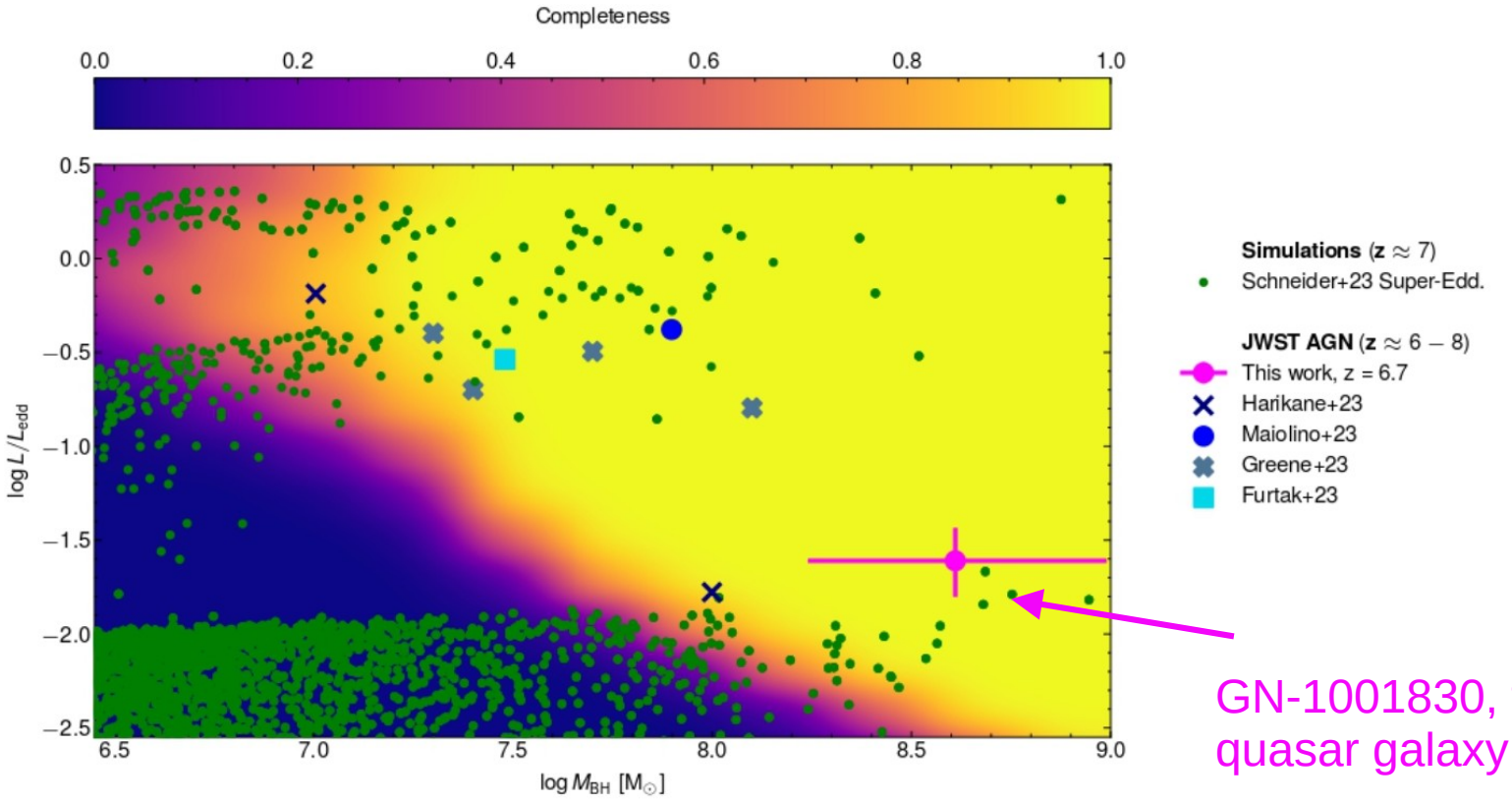
- No individually significant detections, however, stacking 4 visually identified objects results in a detection
- Consistent with low luminosity, $10^7\,M_\odot$ BHs



Mass scaling relations

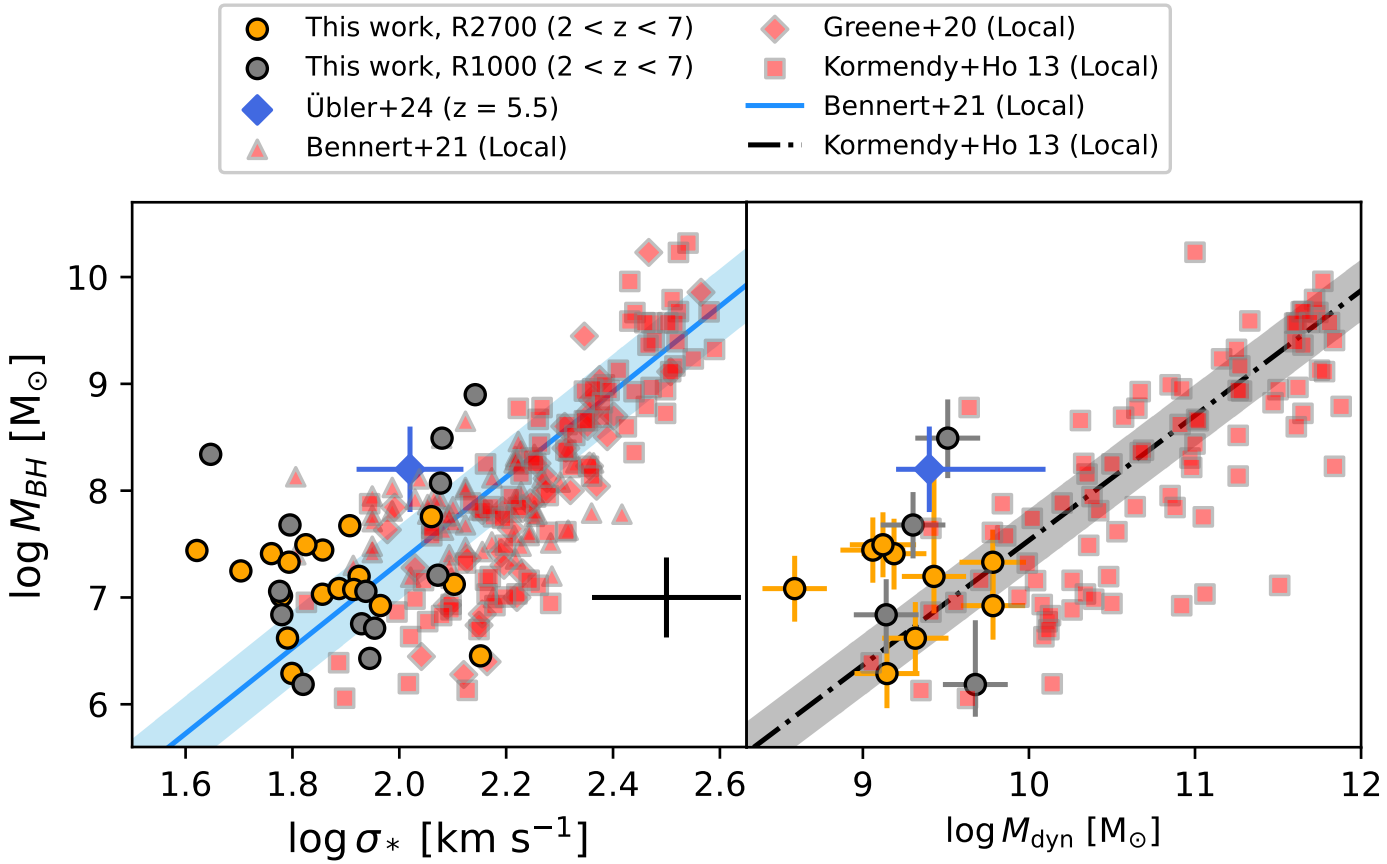


The observed deviation can not be attributed solely to low completeness



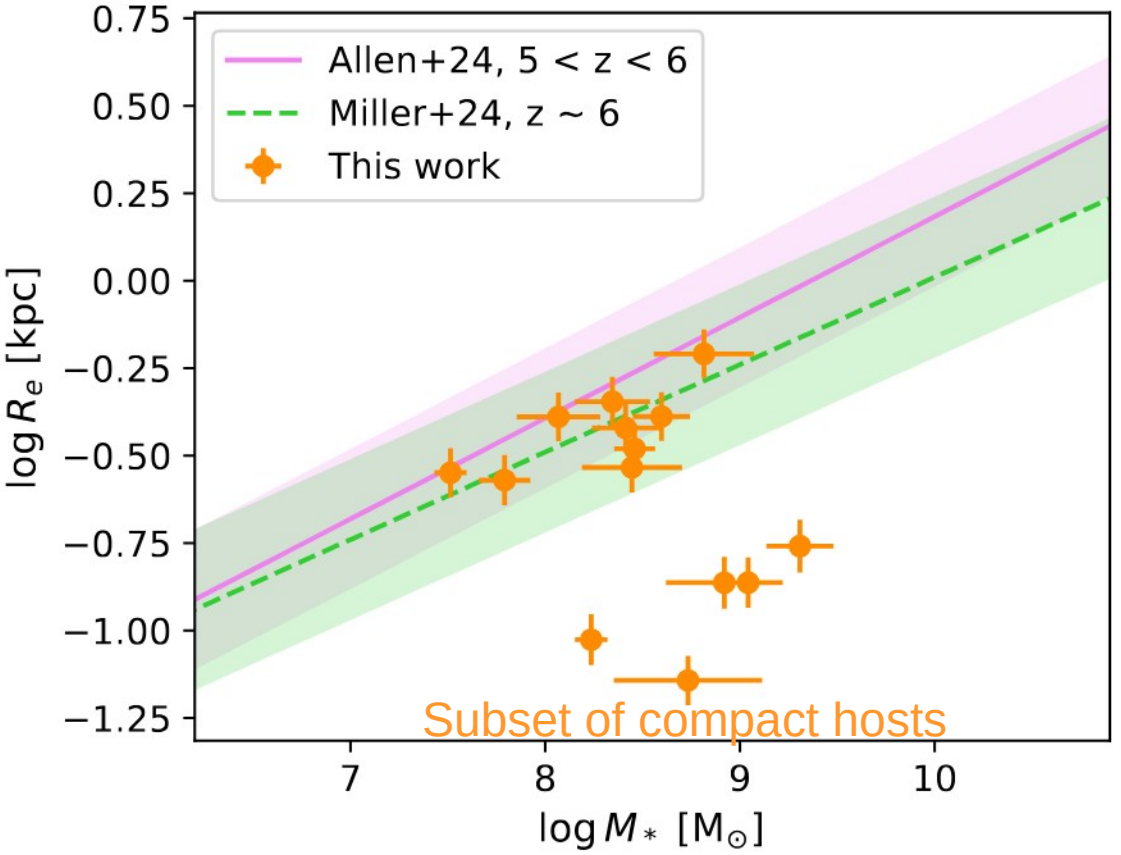
GN-1001830, the post-quasar galaxy

In particular when dynamical mass scaling is taken into account

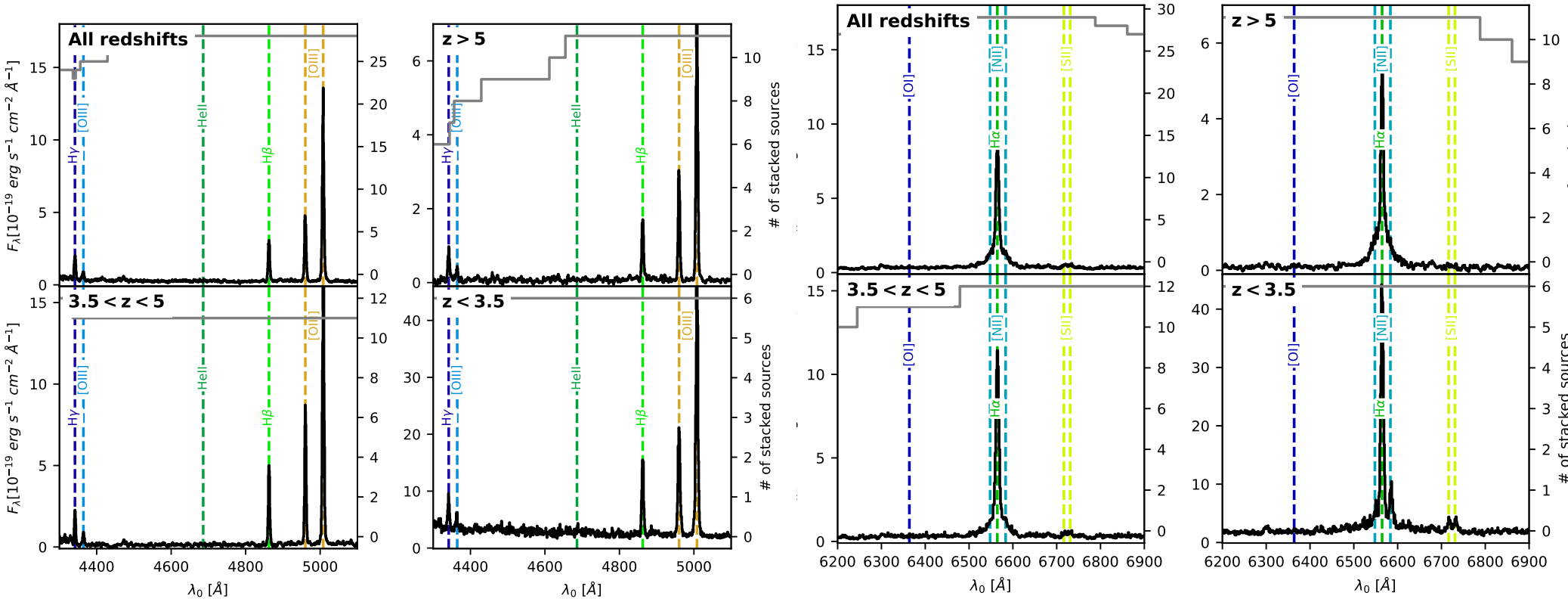


Preliminary morphologies of Type 1 AGN hosts

- Host morphologies obtained with ForcePho.
- Only available for a subset as the code fails for bright point sources.

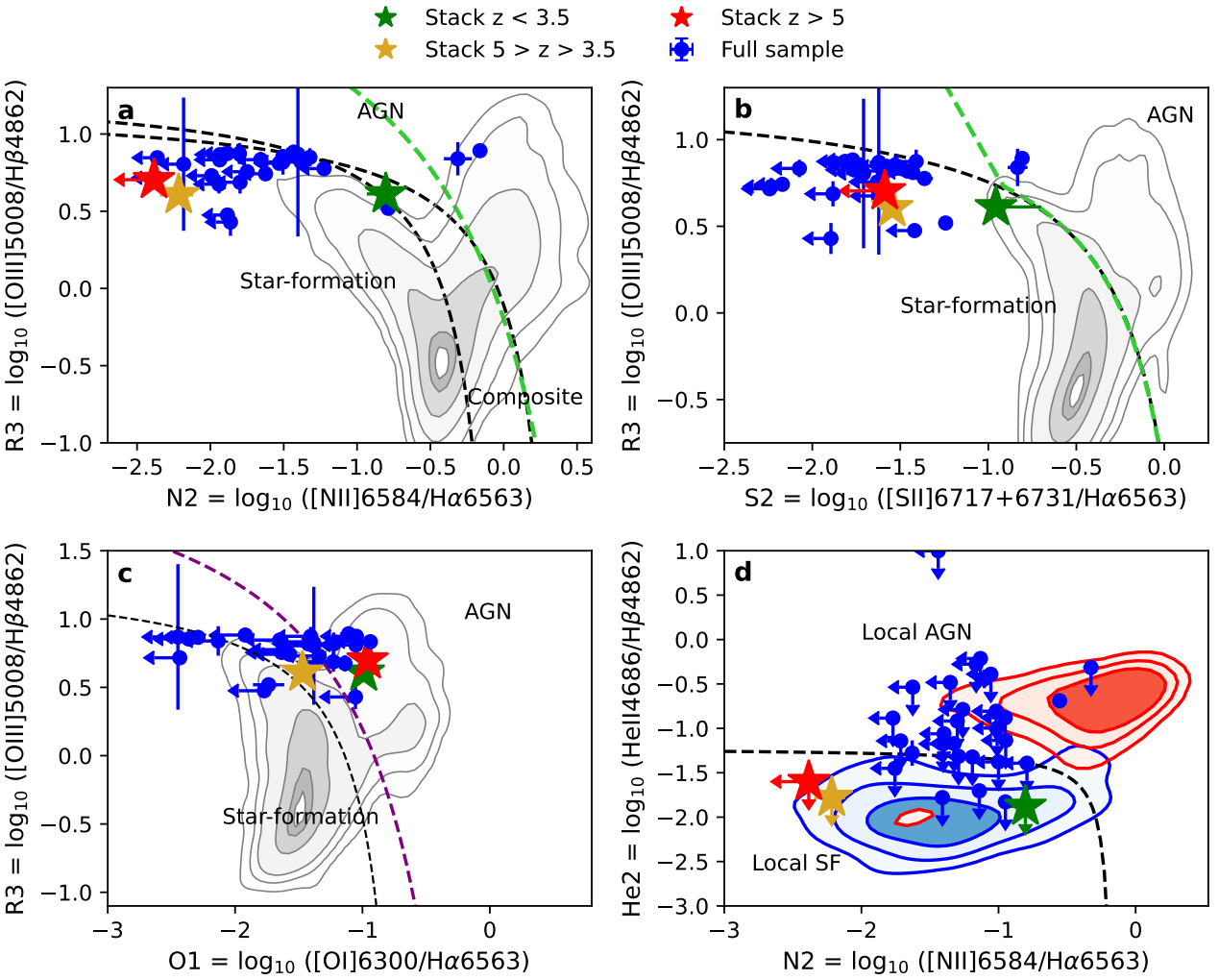


Spectral stacking and the hunt for Type 2



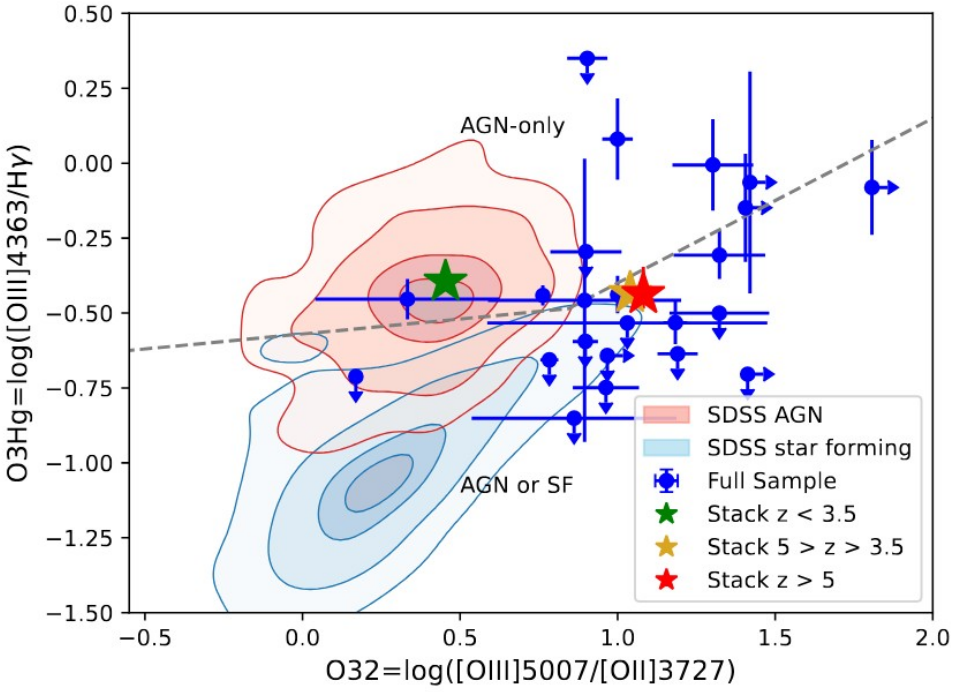
Stacking performed using inverse rms weighting

BPT and VO87 struggle at high redshifts



[OIII] auroral line diagnostics do better

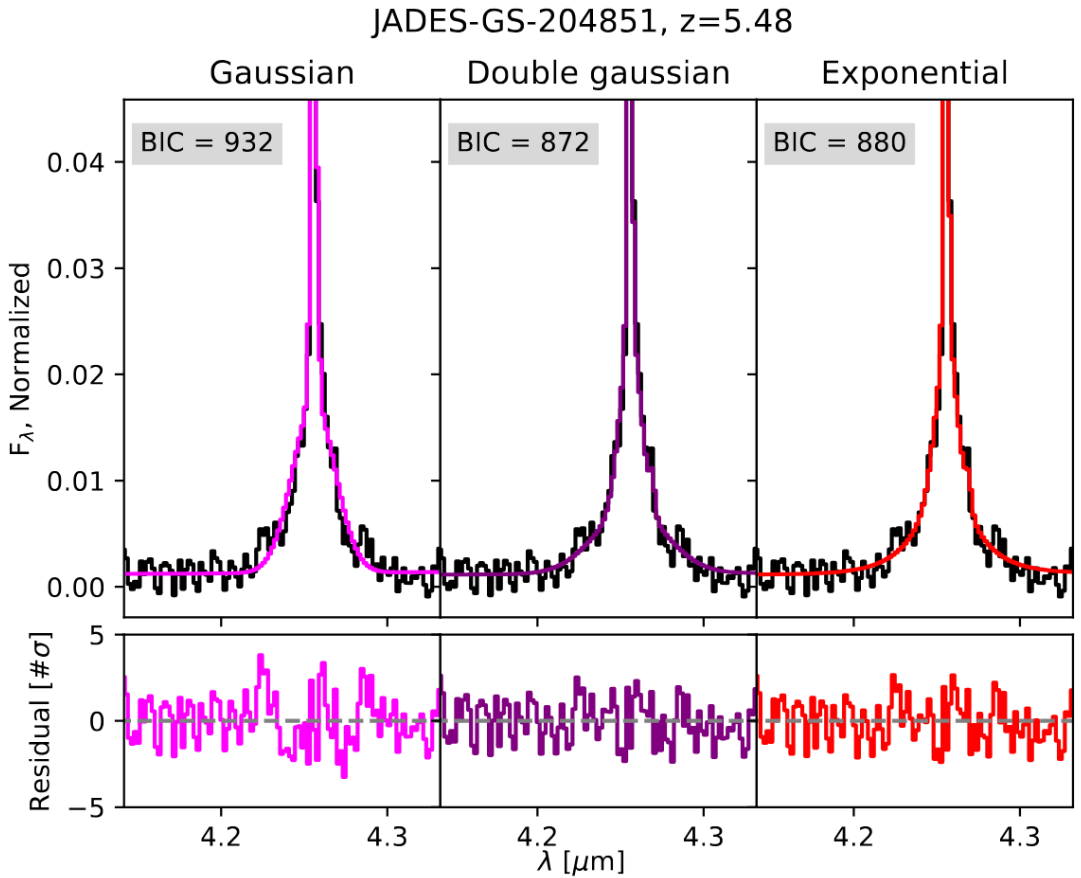
- Seemingly at odds with star formation dominated NLR.
- Potential hints of a bimodal structure with [OIII]λ4363 contributed by denser regions.



Auroral diagnostics by Mazzolari+24

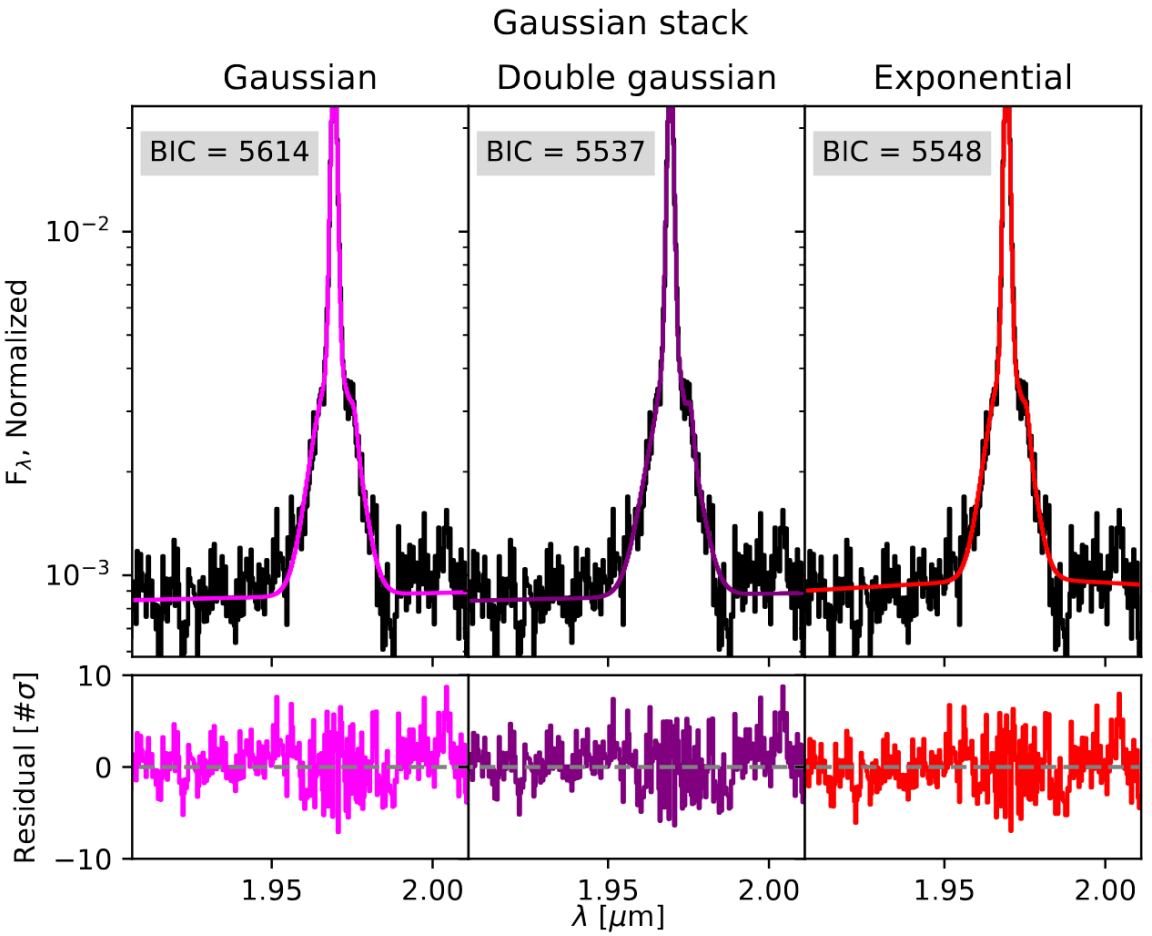
Shapes of the broad emission lines

- Some AGN in our sample exhibit non-Gaussian wings in the BLR



Exponential model from Rusakov+25

Stacking apparently Gaussian AGN also reveals non-Gaussianity



Summary

- Early AGN feedback operates through preventative rather than ejective modes.
- Compaction of early galaxies may be a driver of BH accretion in addition to bursty star formation.
- There exists a significant population of Type 1 AGN that would be undetectable as Type 2s.
- Lack of HeII lines suggests inefficient escape of high energy photons.
- Broad line regions are likely non-Gaussian in nature.