The University of Texas at Austin
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The Emerging Black Hole Mass Function in the High-Redshift Universe

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Shifting Landscapes in Astrophysics:
New Frontiers to Explore with Roman

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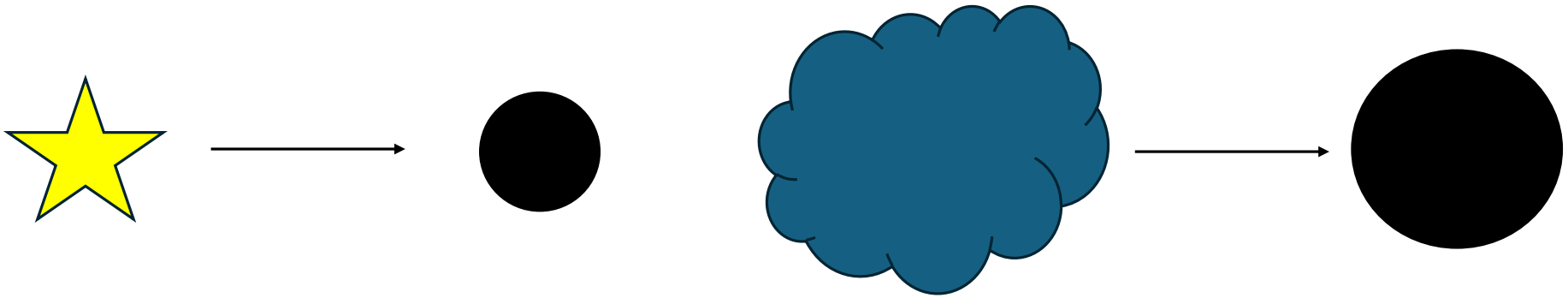
Introduction

- Too massive AGN/SMBHs in the early Universe
- Current mass measurement indicate deviations from local relations
- New class of objects named ‘Little Red Dots’, suggested to be AGN

SMBH seeding models

- Current theoretical models can reproduce observations
- Unclear what the Universe really does

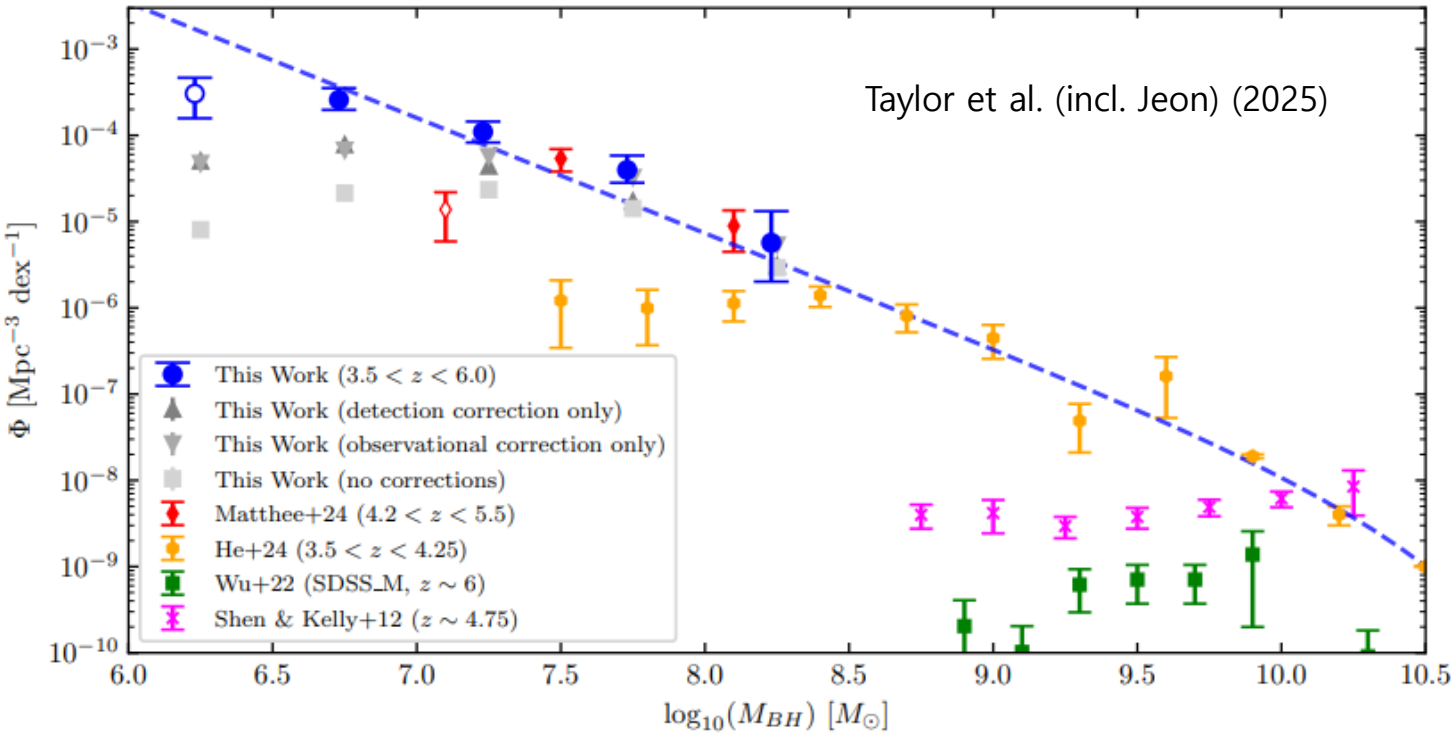
- **Light Seeds** from Pop III remnants
- **Heavy Seeds** from Direct Collapse



- 40-260 $M_{\odot}$
- ~10^4-10^5 $M_{\odot}$

Discerning SMBH Origins

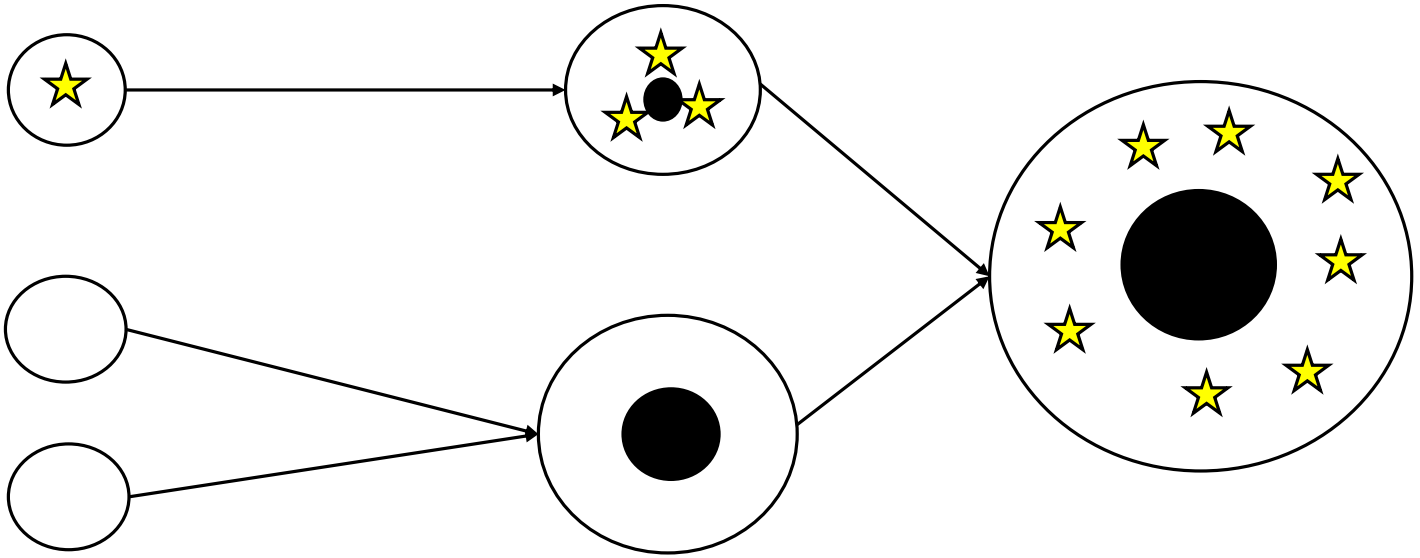
- Could the overall SMBH population determine SMBH evolution pathways?
- Roman will observe such SMBH populations at high-redshift



High-z SMBH Populations

- Semi-Analytic Model attuned to high redshift

  A-SLOTH (Ancient Stars and Local Observables by Tracing haloes, Hartwig et al. 2022; Liu et al. 2024)

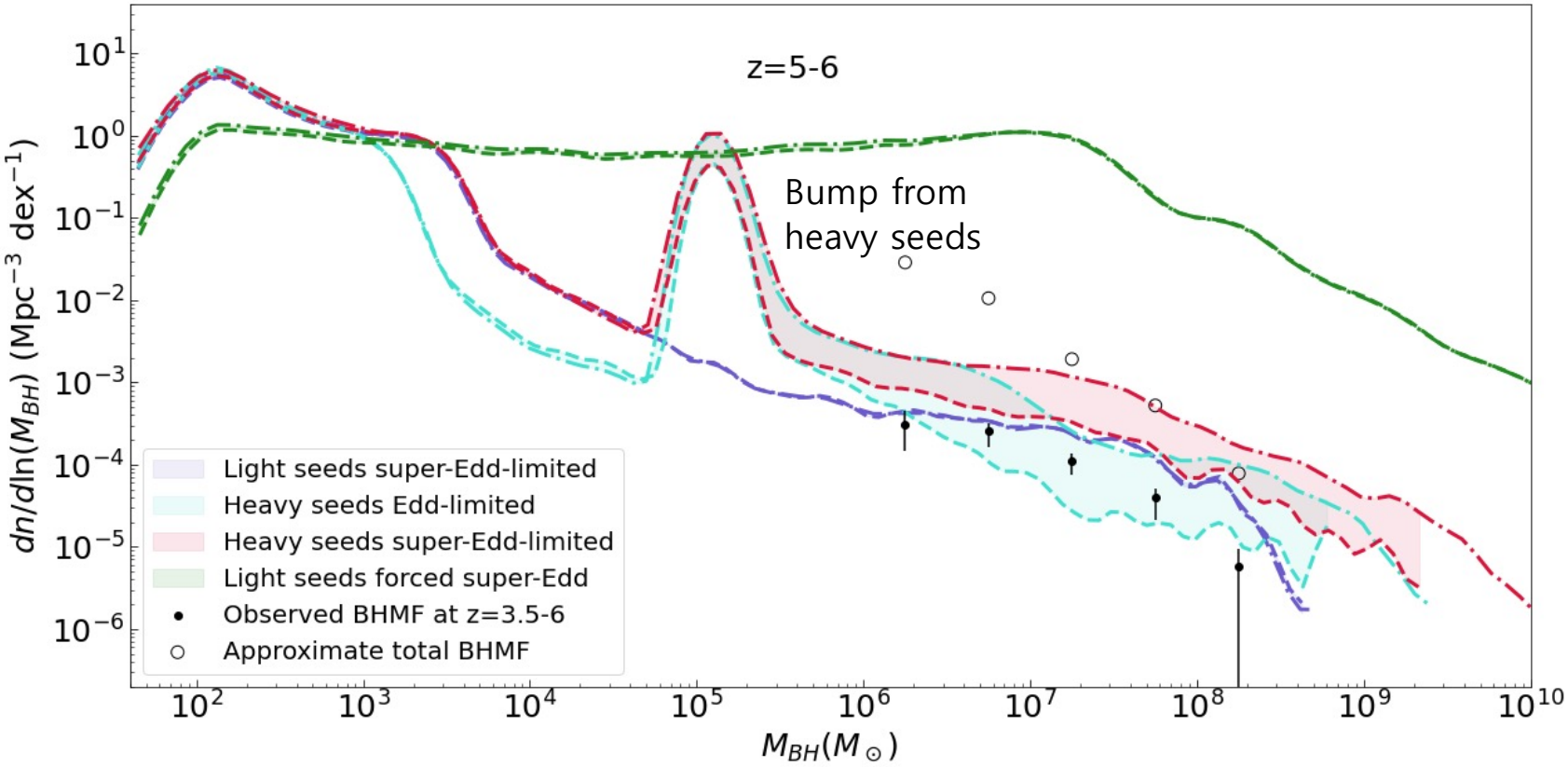


Extended Press-Schechter (EPS) halo merger tree.
Added models for SMBH seeding, accretion, mergers, and feedback

Jeon et al. (2025b), ApJ, 988, 110

Mass Function Predictions

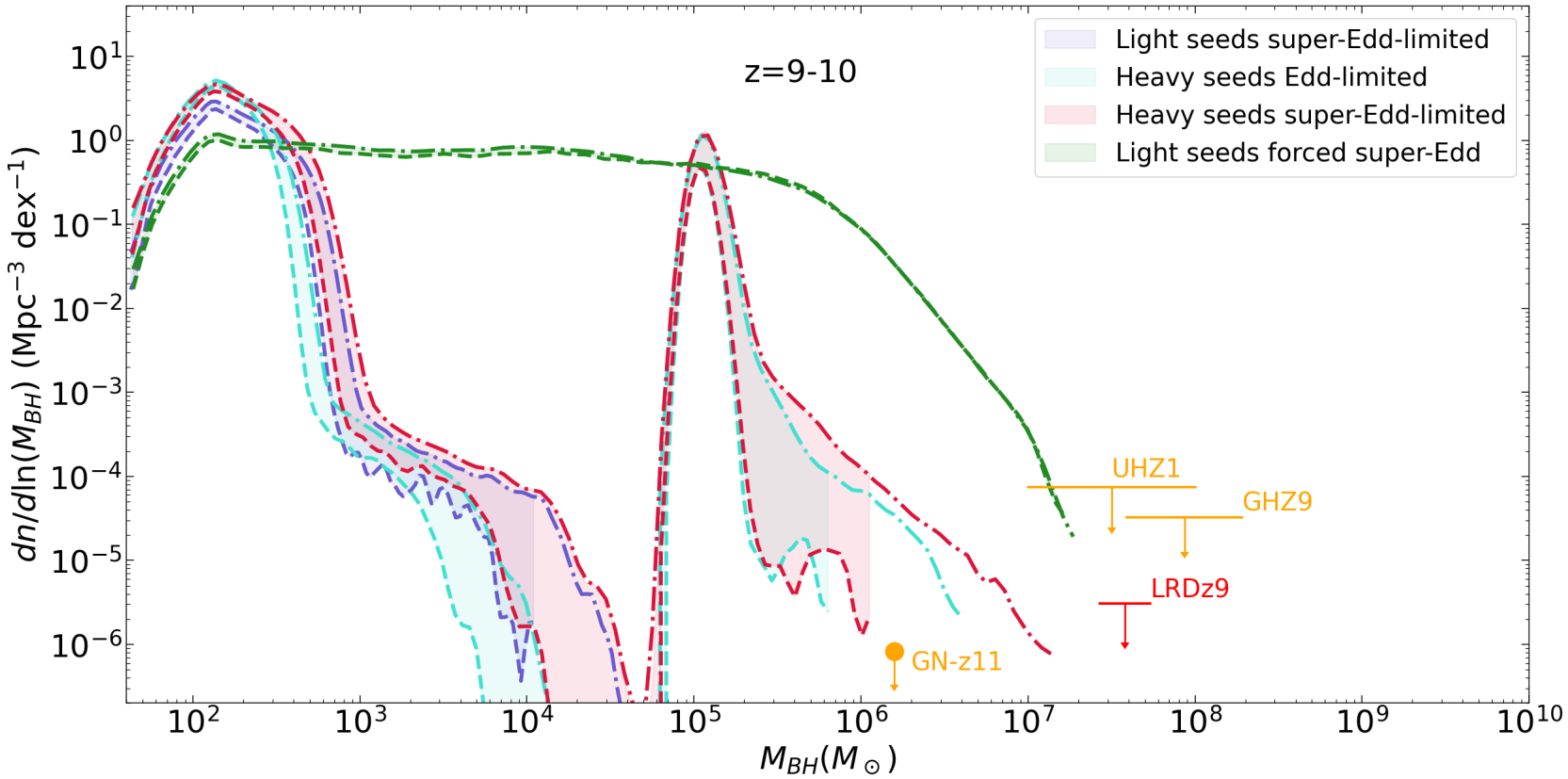
- Different scenarios can reproduce current observations



Jeon et al. (2025b), ApJ, 988, 110

Mass Function Predictions

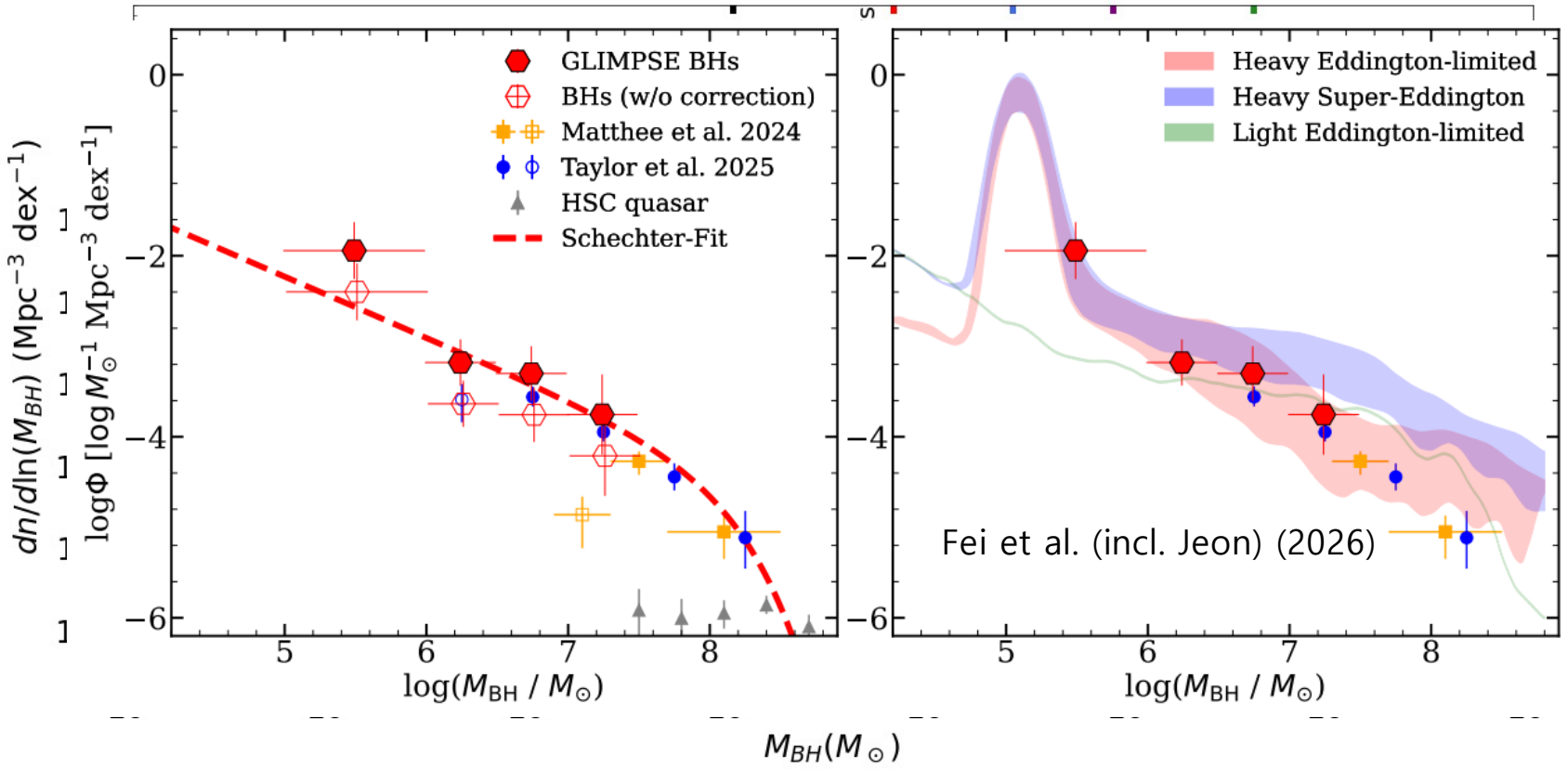
- At earlier redshifts, observable SMBHs come from heavy seeds or super-Eddington accretion



Jeon et al. (2025b), ApJ, 988, 110

Mass Function Predictions

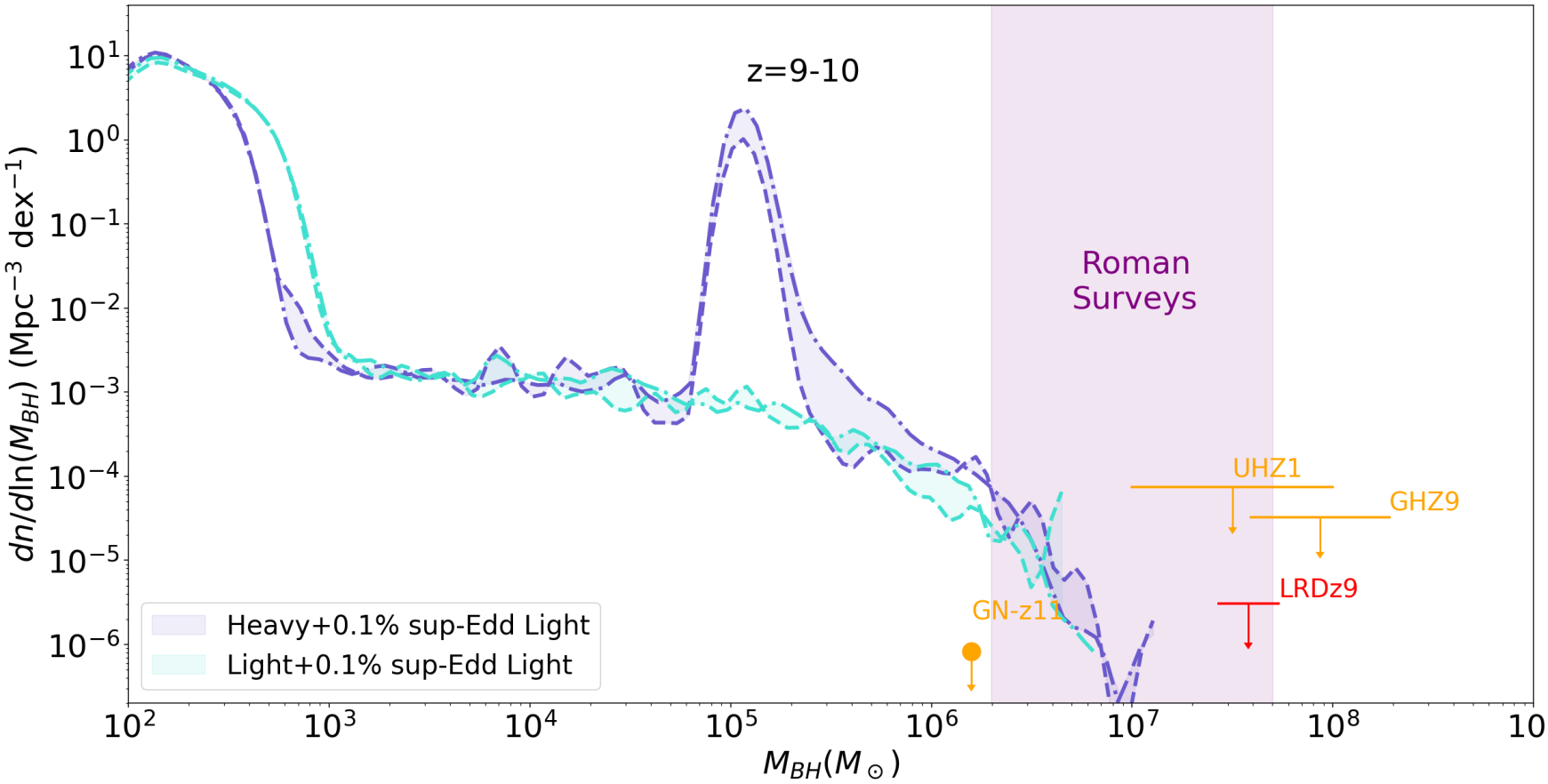
- One key difference with heavy seeds is the mass function bump, which could be explored with gravitational lensing



Jeon et al. (2025b), ApJ, 988, 110

Can the seeding channels be distinguished?

- With Roman, constrain the fraction of efficiently accreting SMBHs



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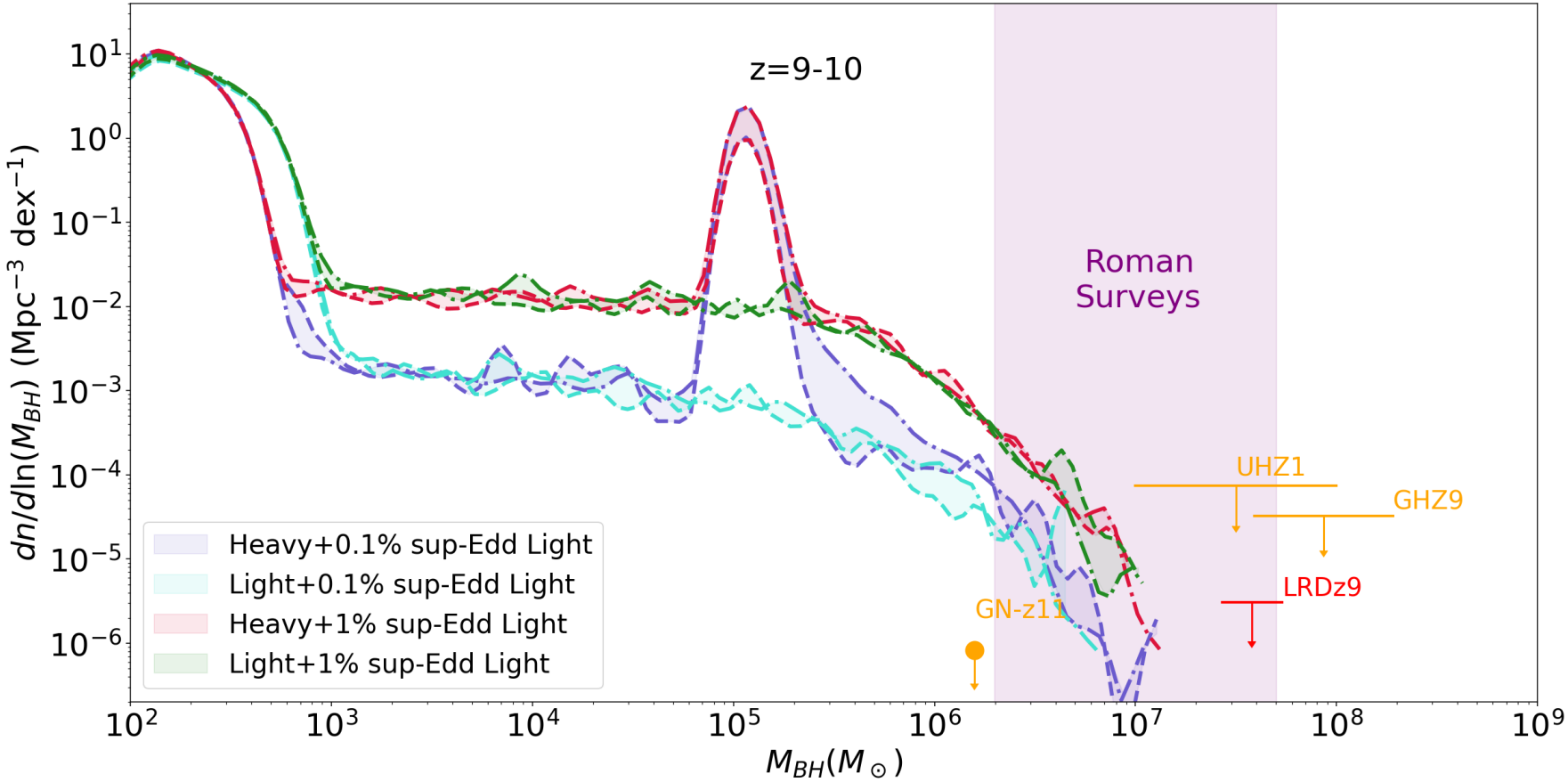

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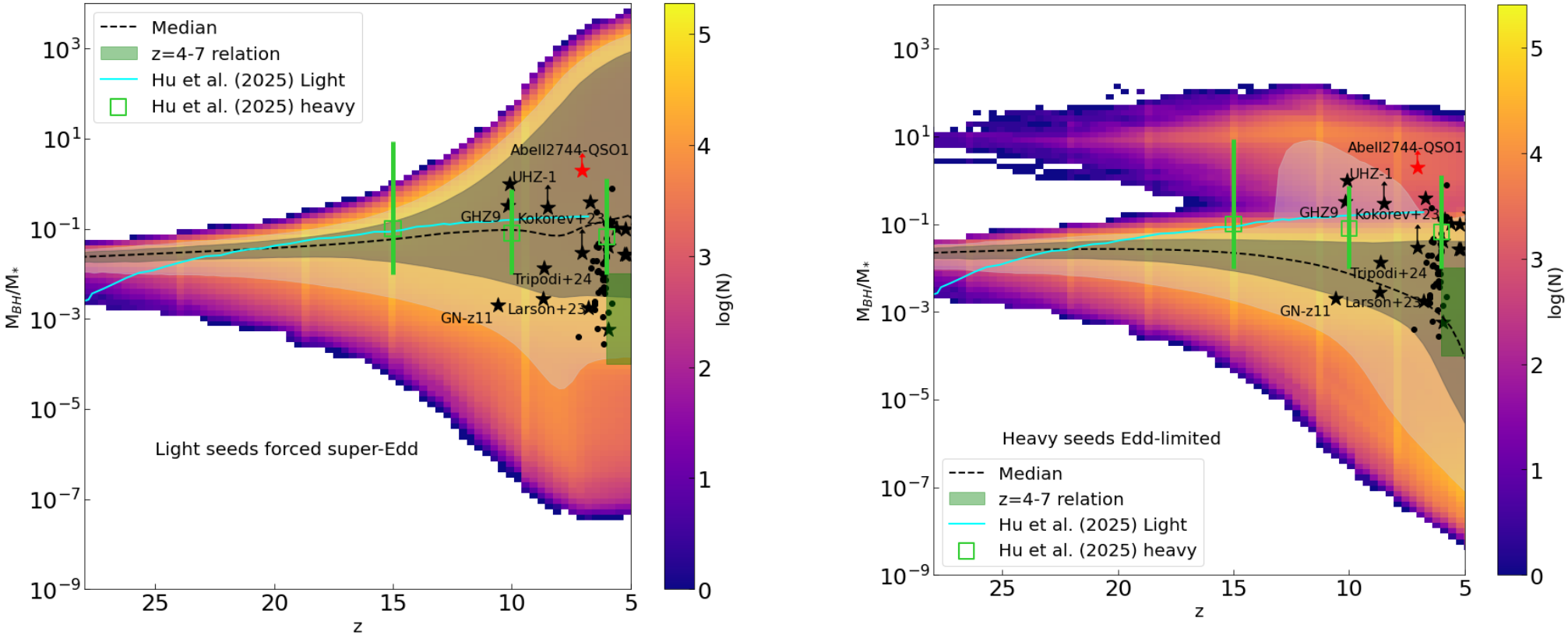
SMBH-Stellar Mass Relations

- Roman could probe population-level statistics, distinguishing theoretical models



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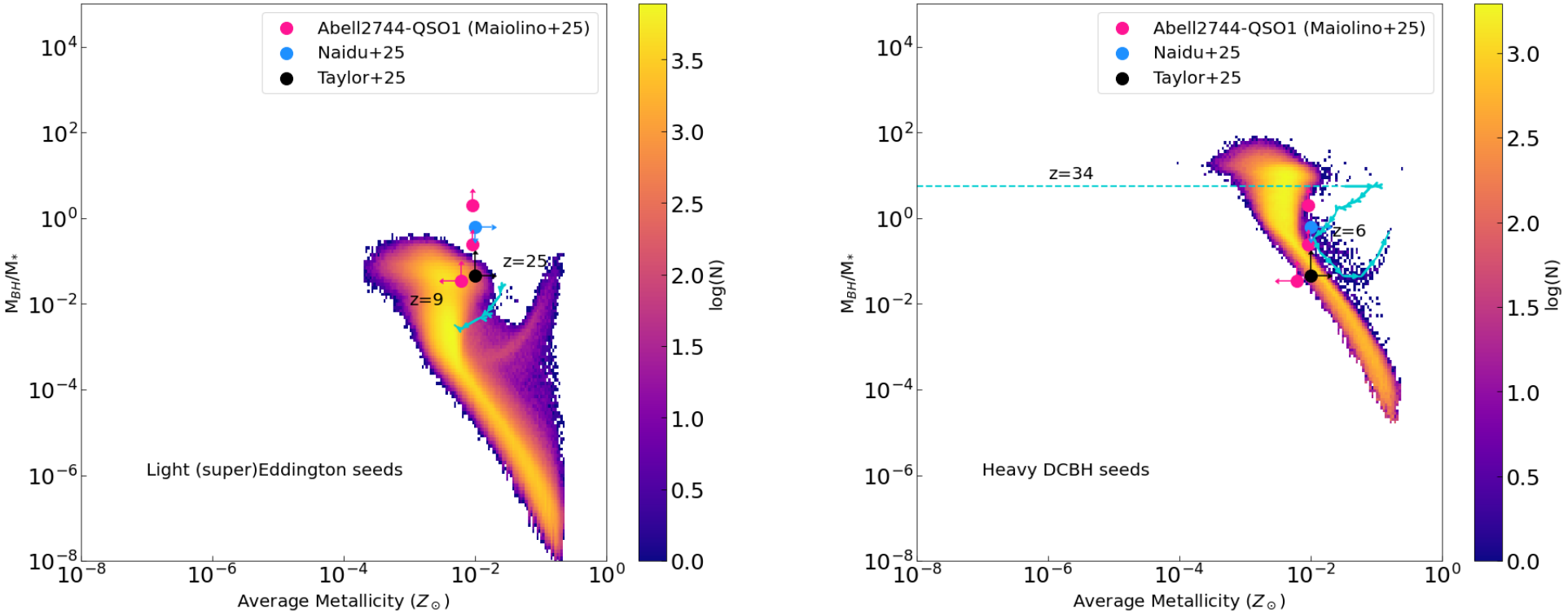
SMBH Host Metallicities

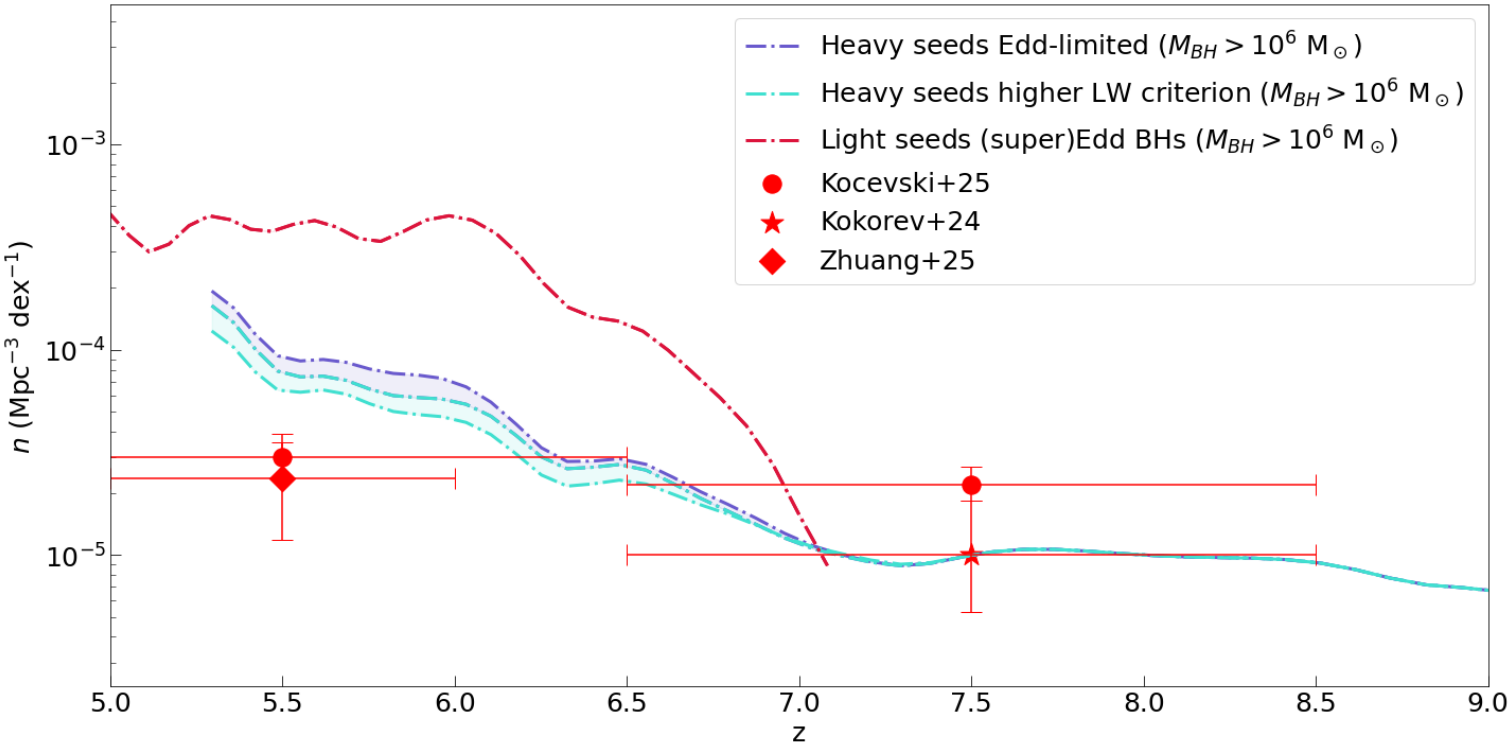
- Roman could probe population-level statistics, distinguishing theoretical models



Jeon et al. (2026a) ApJ, 998, 148

Little Red Dots

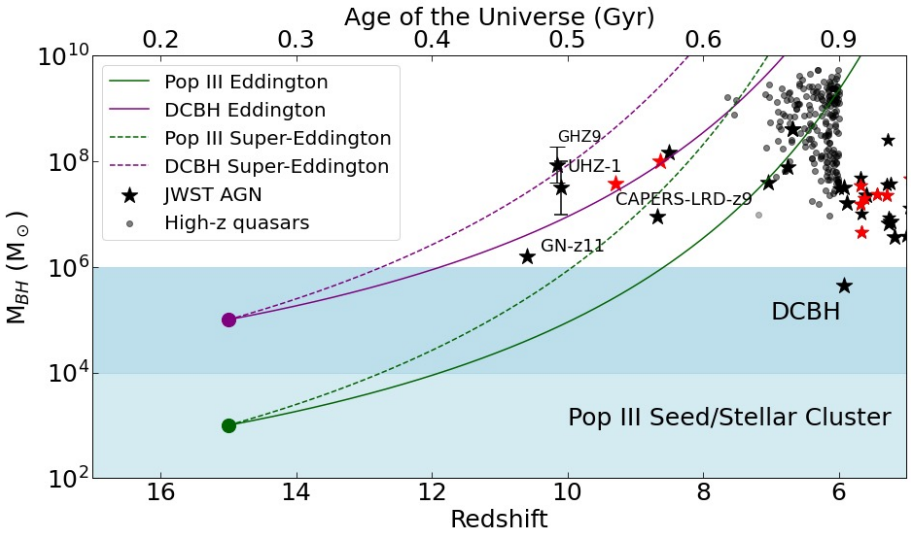
- Constraints on SMBH origins could give clues to nature of LRDs

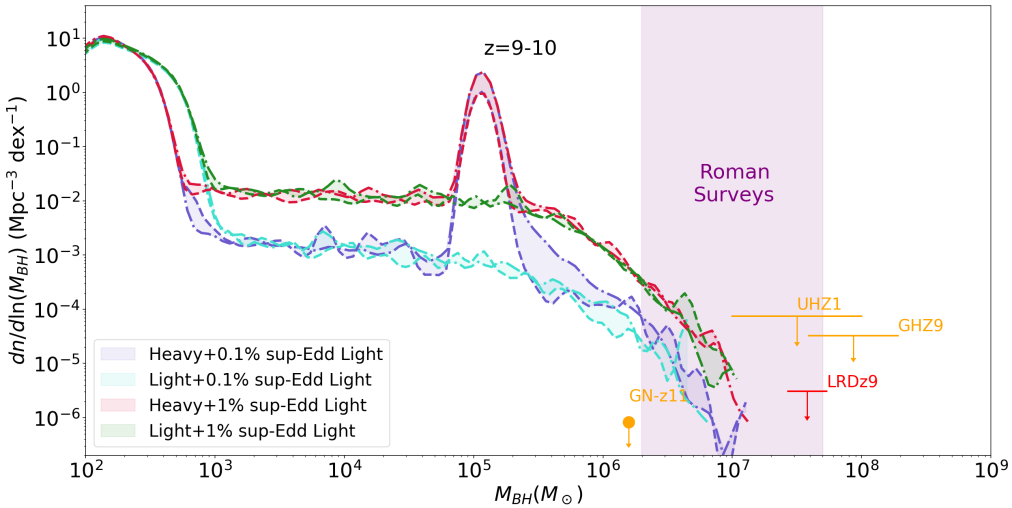


Jeon et al. (2026a) ApJ, 998, 148

Conclusions

- Multiple pathways, heavy seeds or efficient super-Eddington accretion, can produce the observed population of SMBHs
- To distinguish the scenarios, Roman surveys can constrain the fraction of highly accreting objects to constrain SMBH evolution pathways





Jeon et al. (2025a), ApJ, 979, 127

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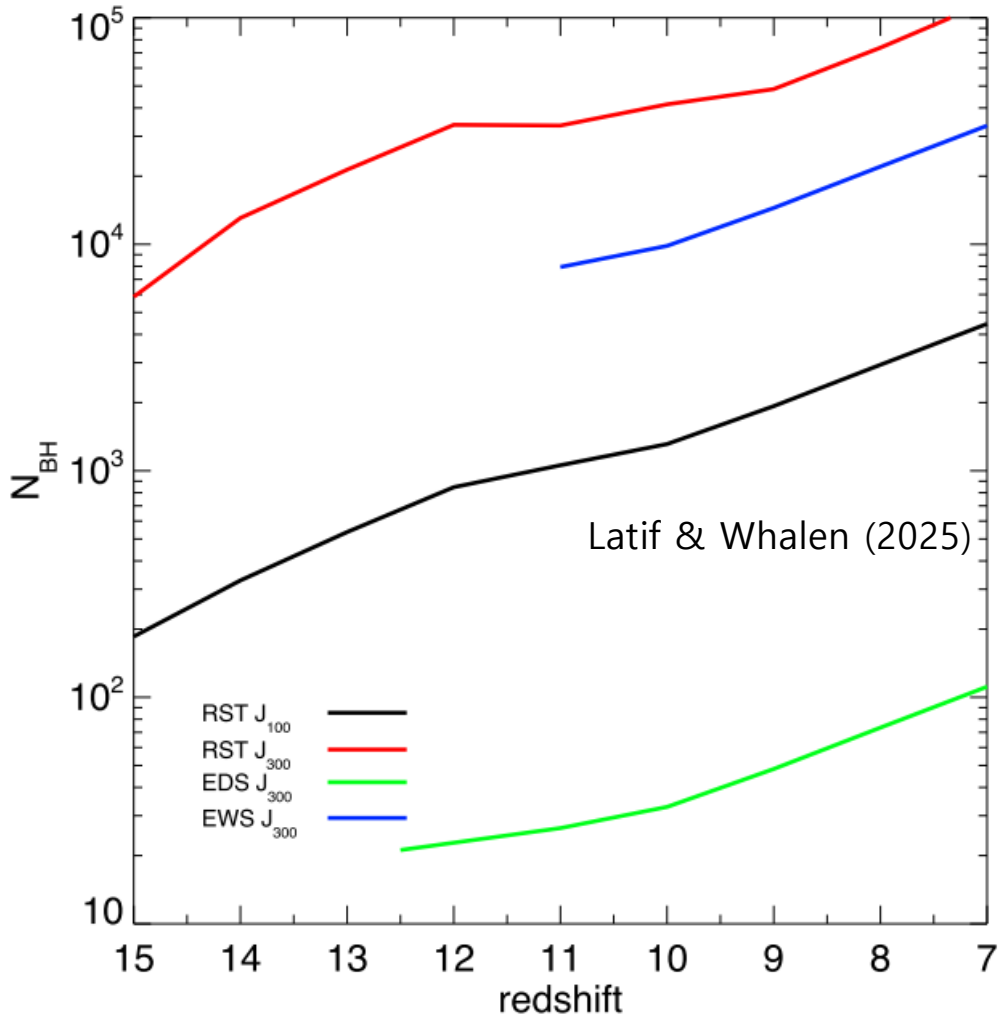
Jeon et al. (2025b), ApJ, 988, 110


10^5
10^4
10^3
10^2
10
N_{BH}
15
14
13
12
11
10
9
8
7
redshift
RST J_{100}
RST J_{300}
EDS J_{300}
EWS J_{300}
Latif & Whalen (2025)