Forecasting the yield of strongly-lensed AGNs in Roman: from quasars to LRDs

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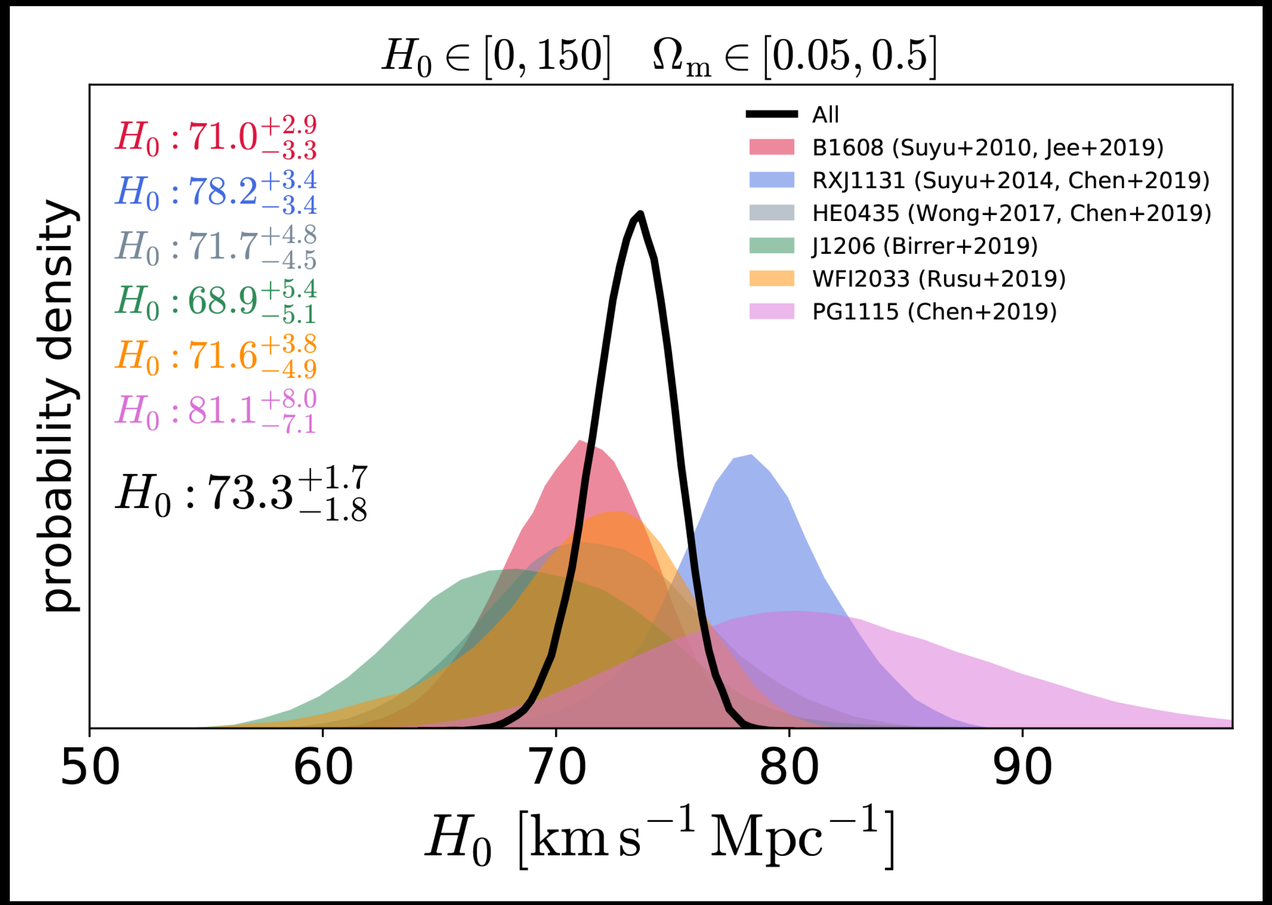
Lensed Quasars are Useful…

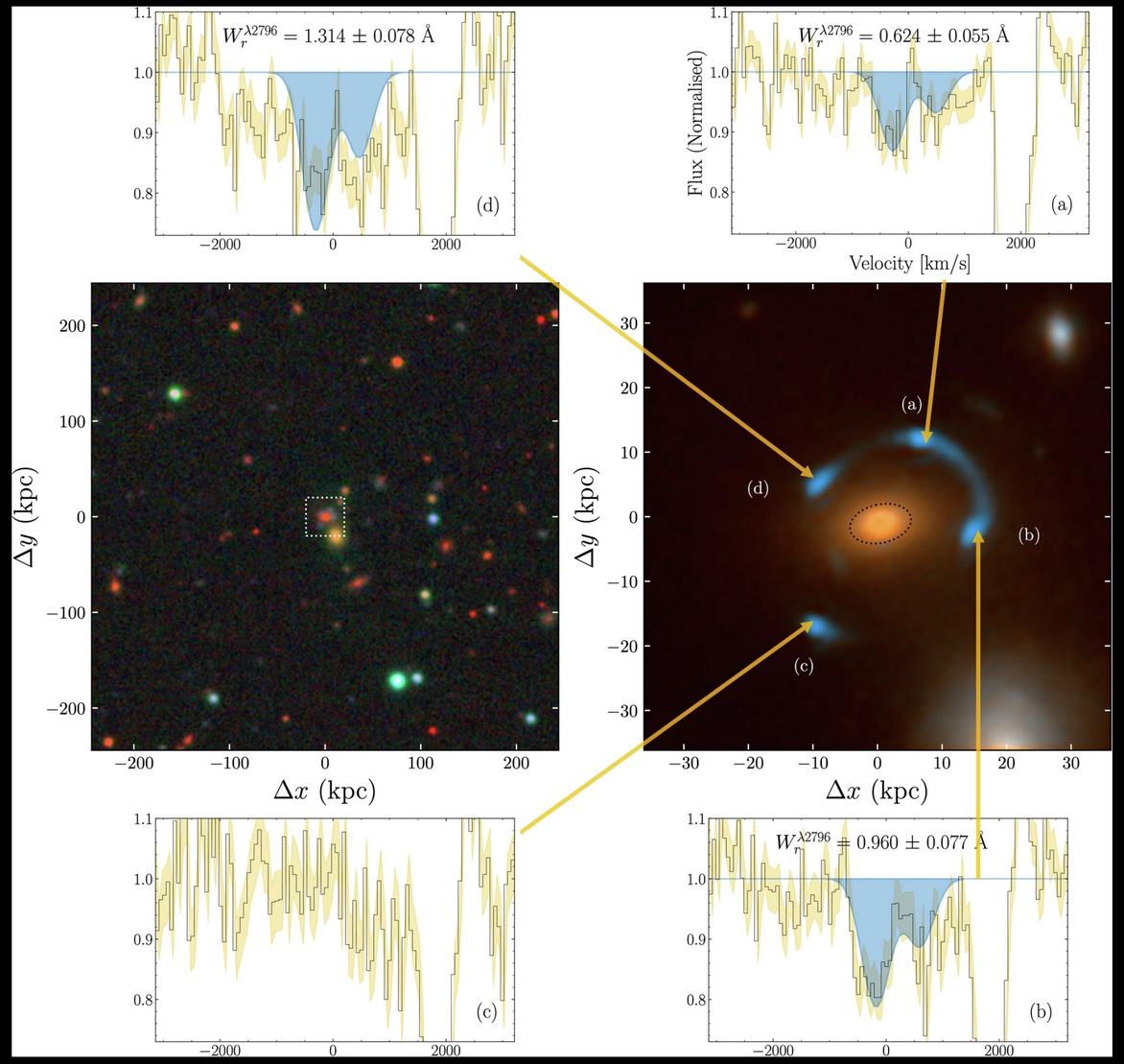
- Time-delay cosmology:
  - Using the time delay between quasar light curves to constrain H_0



Wong+19

Lensed Quasars are Useful…

- Foreground lensing galaxy:
  - Mass profile, CGM absorption, dark matter, etc.

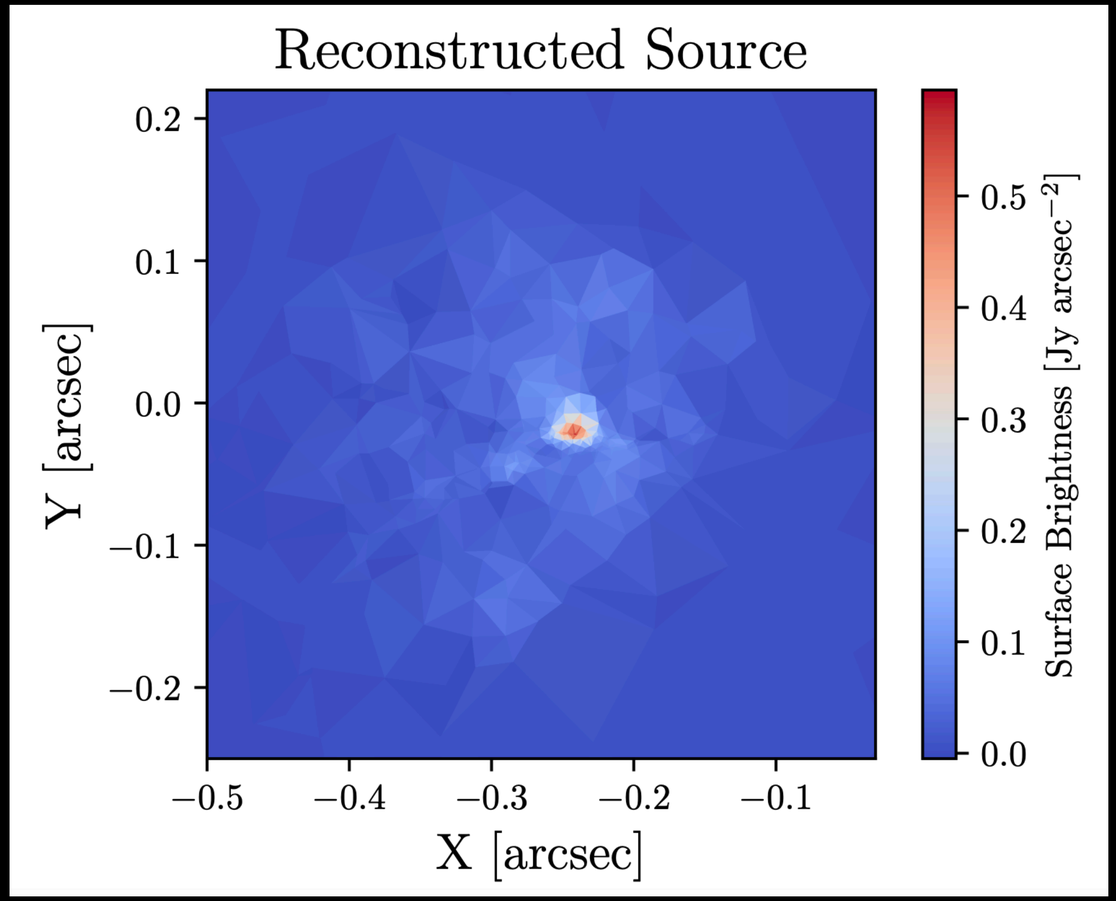


Barone+24

(The figure shows a lensed SF galaxy, though)

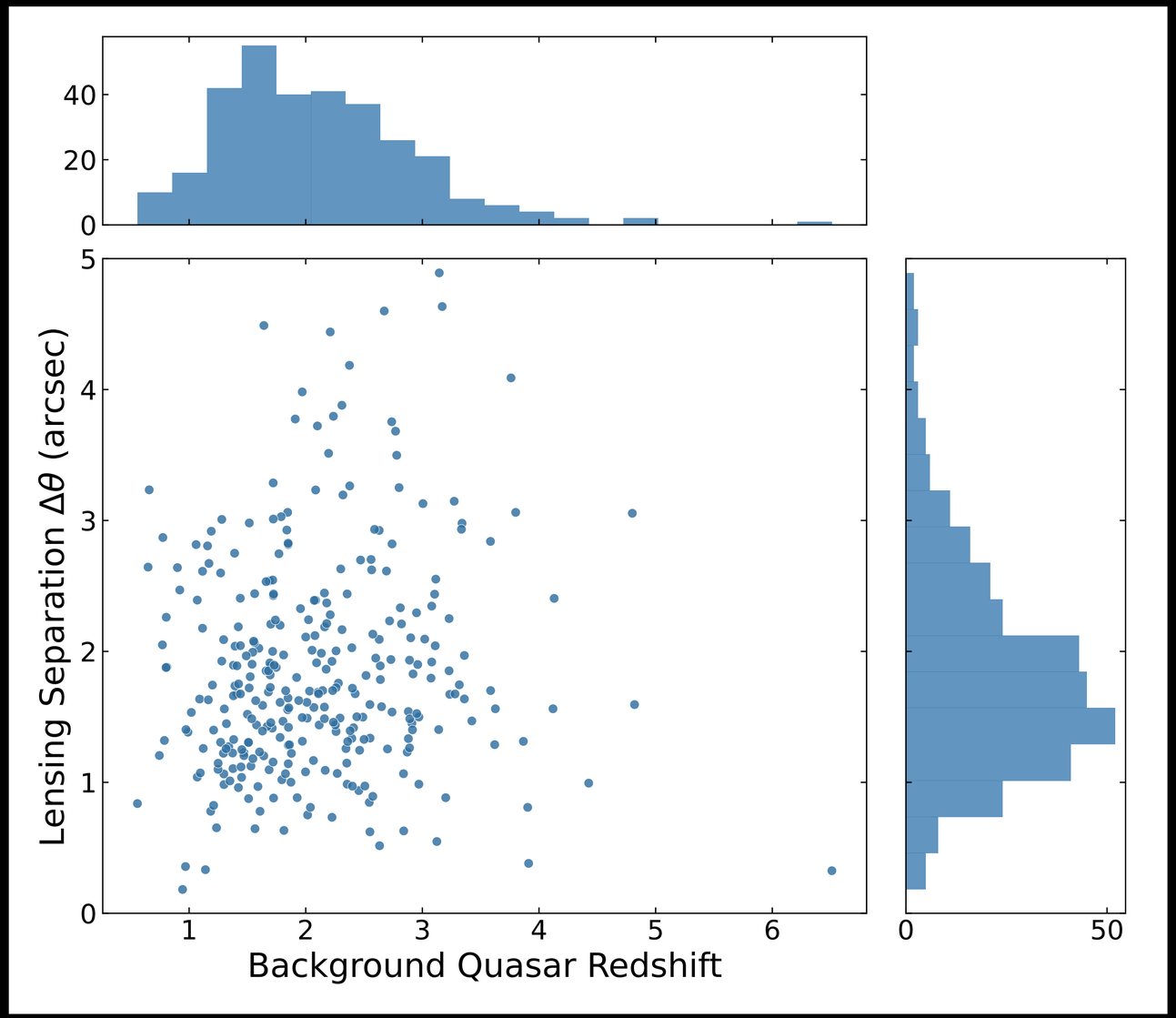
Lensed Quasars are Useful…

- SMBH & Host galaxy:
  - Getting faint signal and high spatial resolution aided by lensing magnification



Yue+26

The Current Status of Lensed Quasar Surveys



- 347 lensed quasars discovered (as of late 2025; Ducourant+26)
- Highly-complete for $z < 1,\ \Delta\theta > 1''$, Gaia-detected systems (Lemon+23)

- **However, two critical populations are missed:**
  - **Small-separation lensed quasars**
  - **High-redshift lensed quasars**

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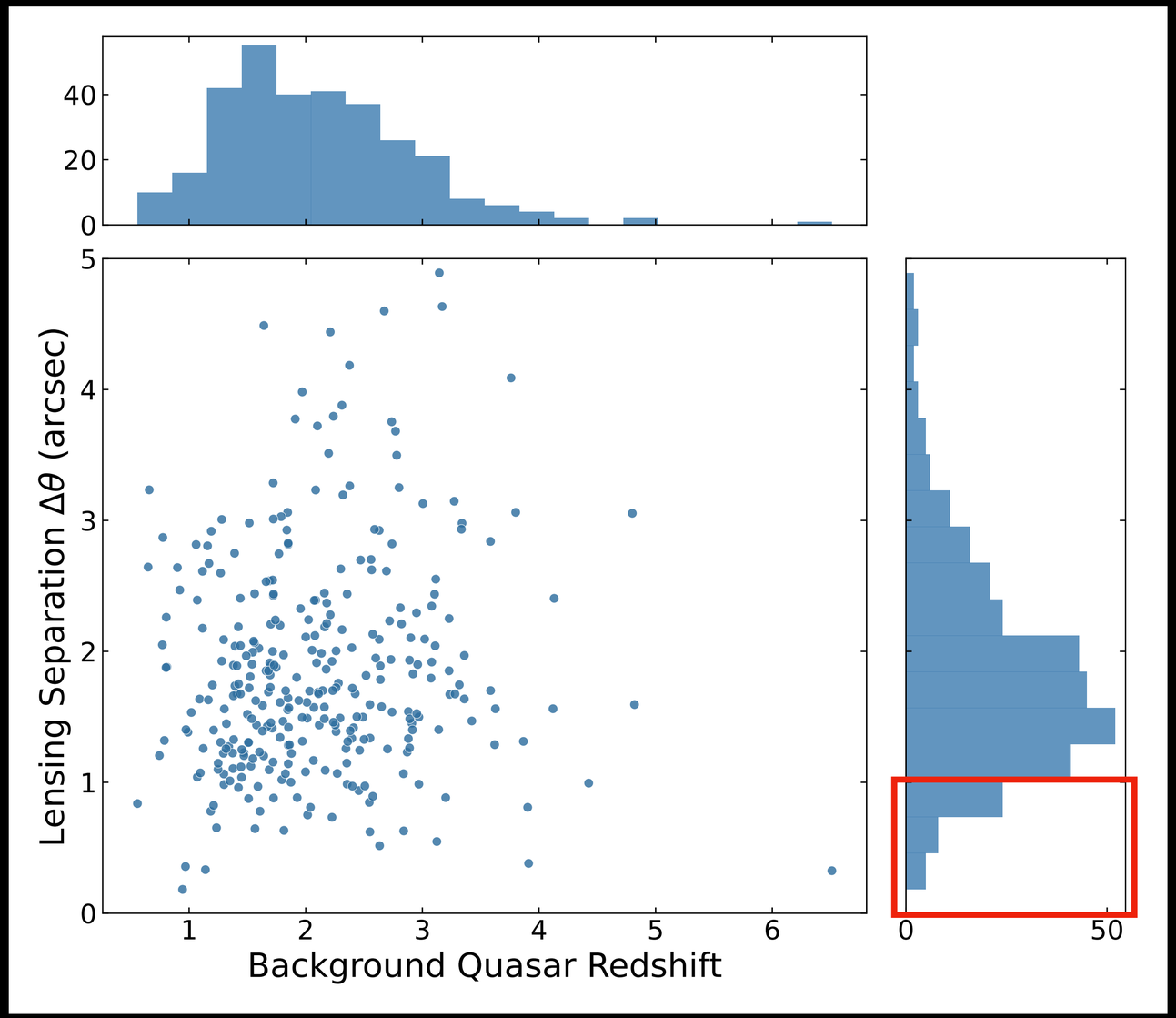

- Small-separation (compact) lensed quasars:
  - Prediction: $\sim 60\,\%$ lensed quasars should have $\Delta\theta < 1''$ (e.g., Yue+22a)
  - Observation: only $\sim 10\,\%$ have $\Delta\theta < 1''$

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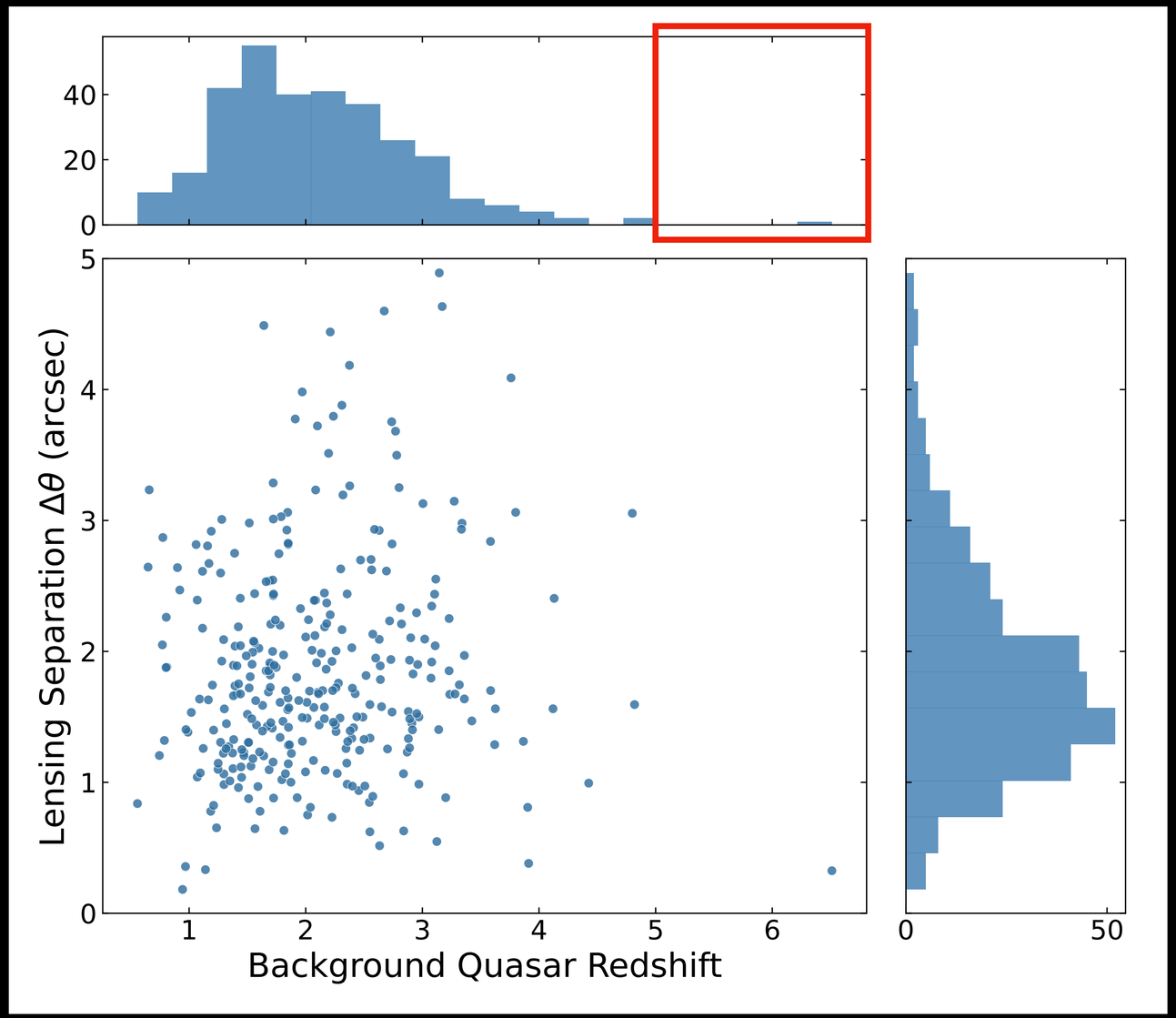

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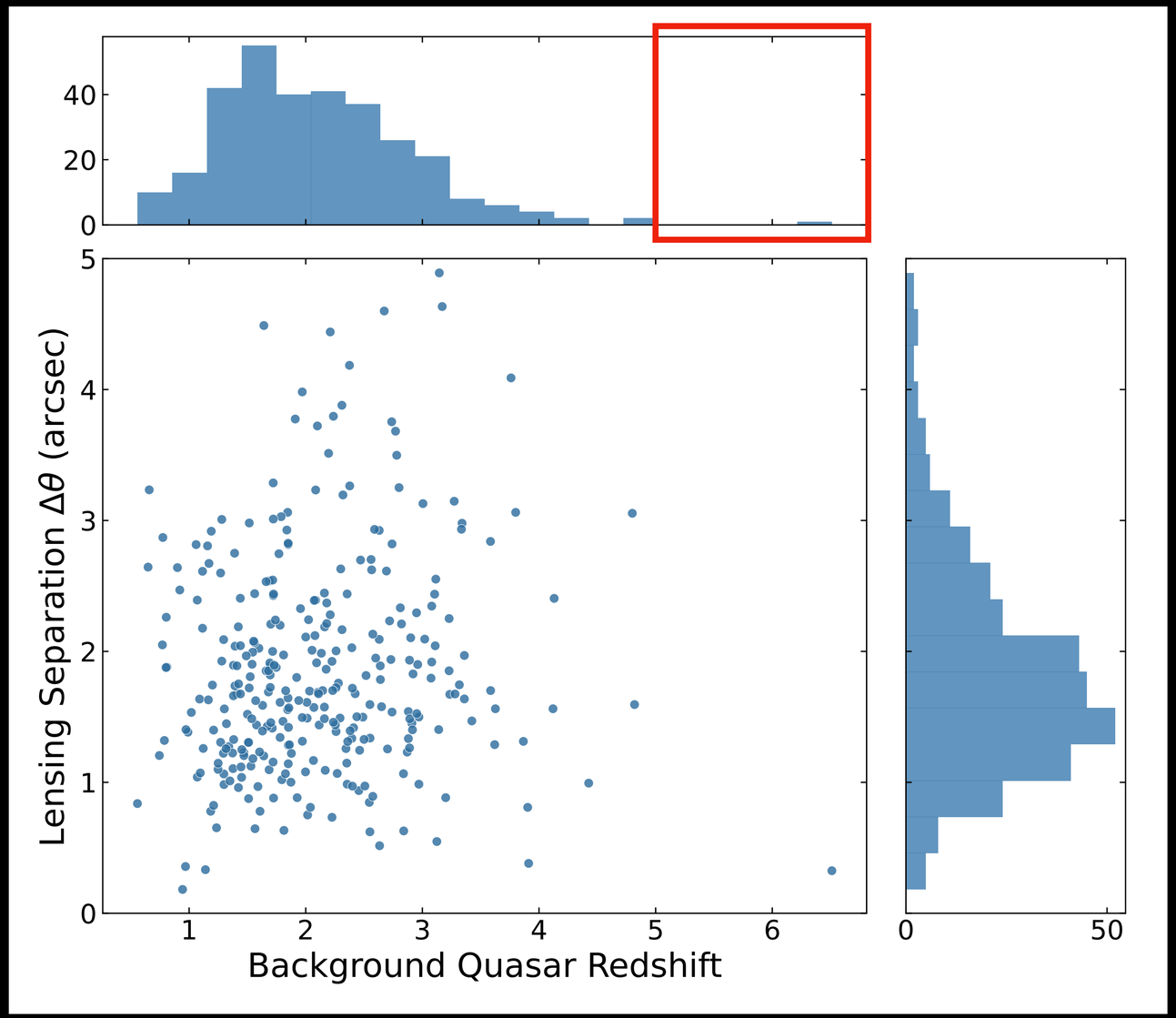

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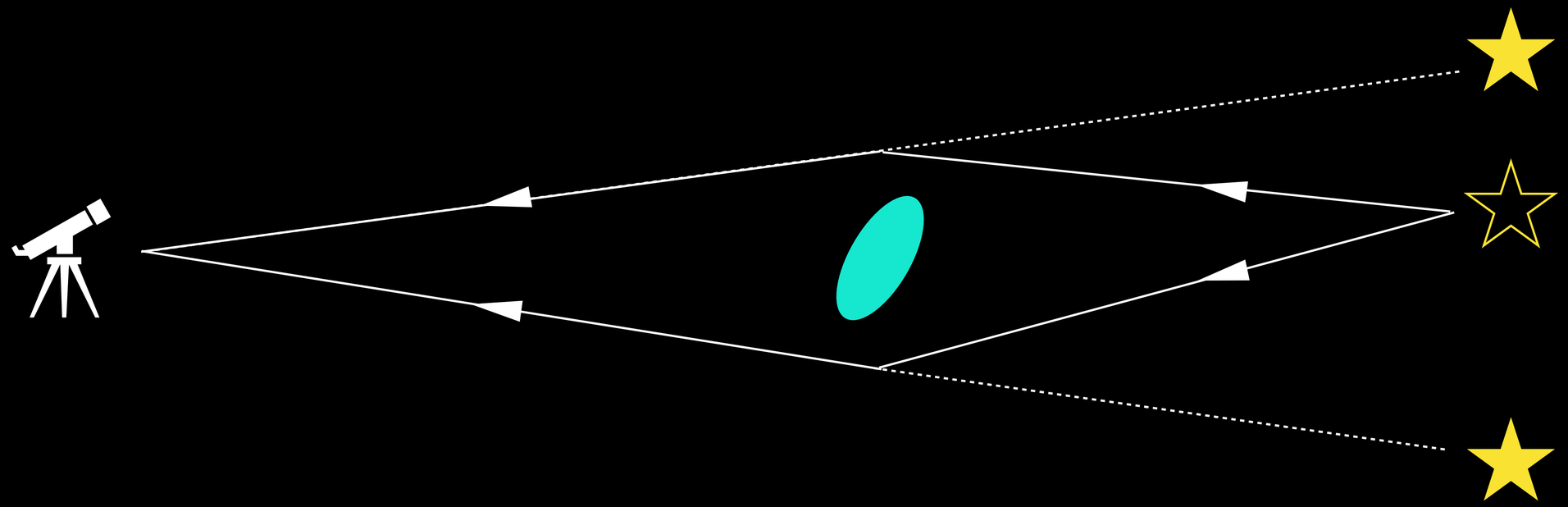
Question: Why we care?

Why we care about the missing populations?

Because they enable unique experiments that are otherwise unaccessible.



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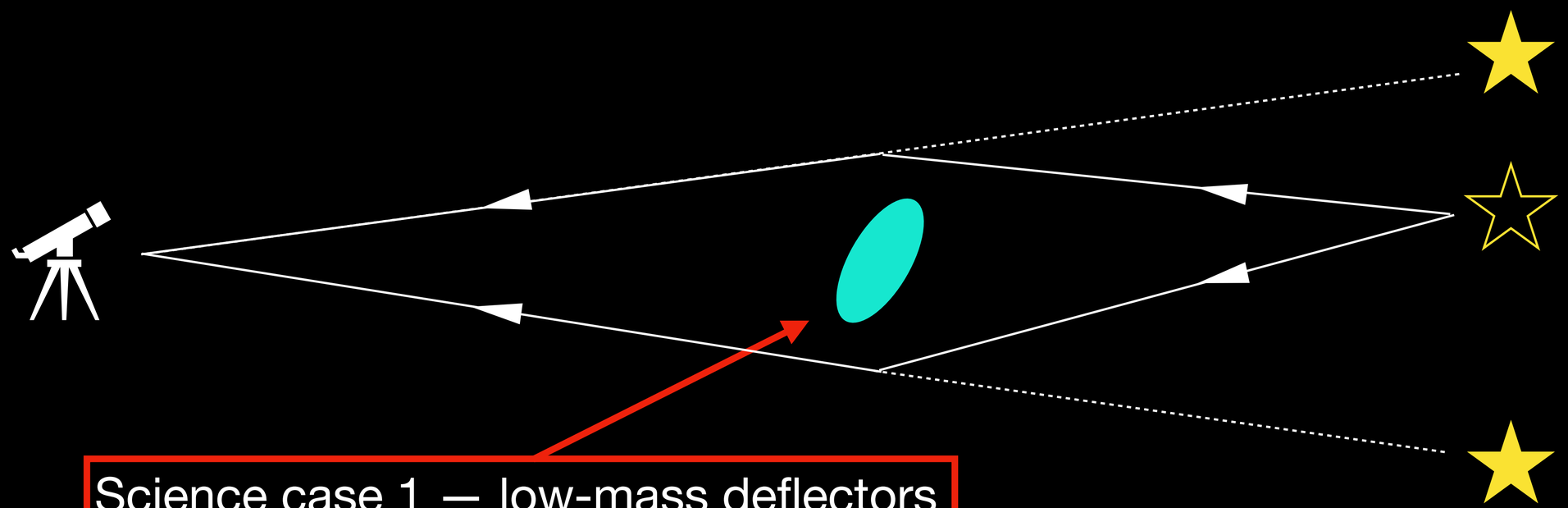

Science case 1 — low-mass deflectors (for small-separation lensed quasars):

- Light-to-mass ratio
- Gravitational potential
- CGM kinematics and enrichment

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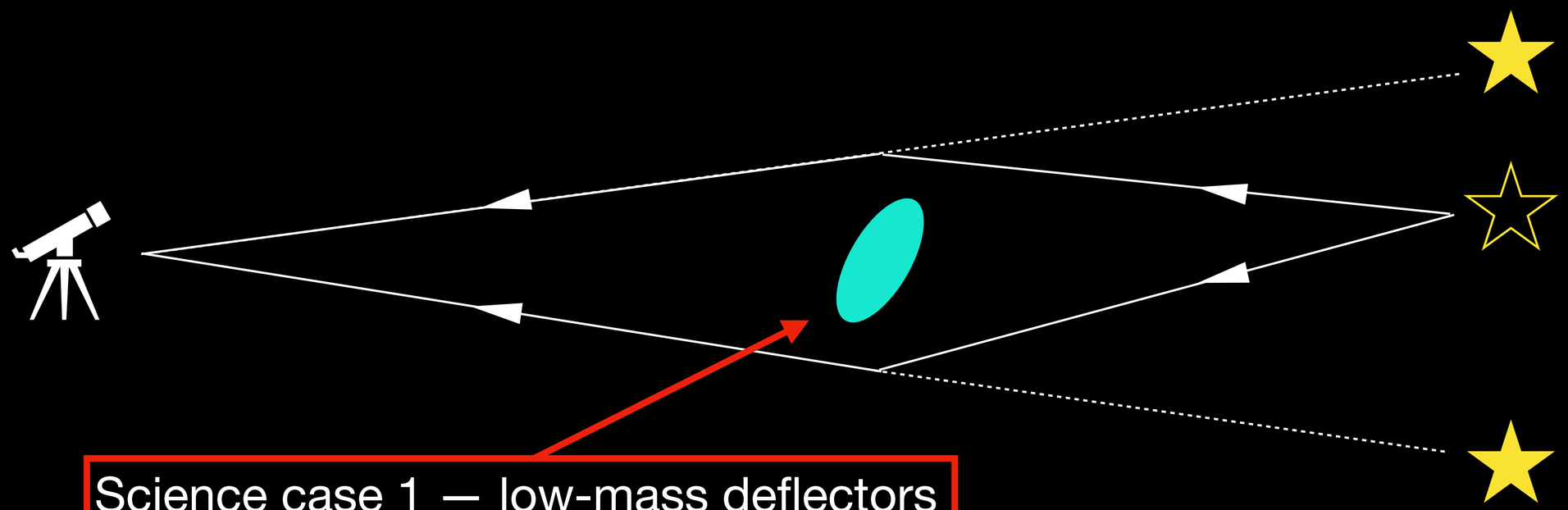

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How baryons cycle around low-mass galaxies?

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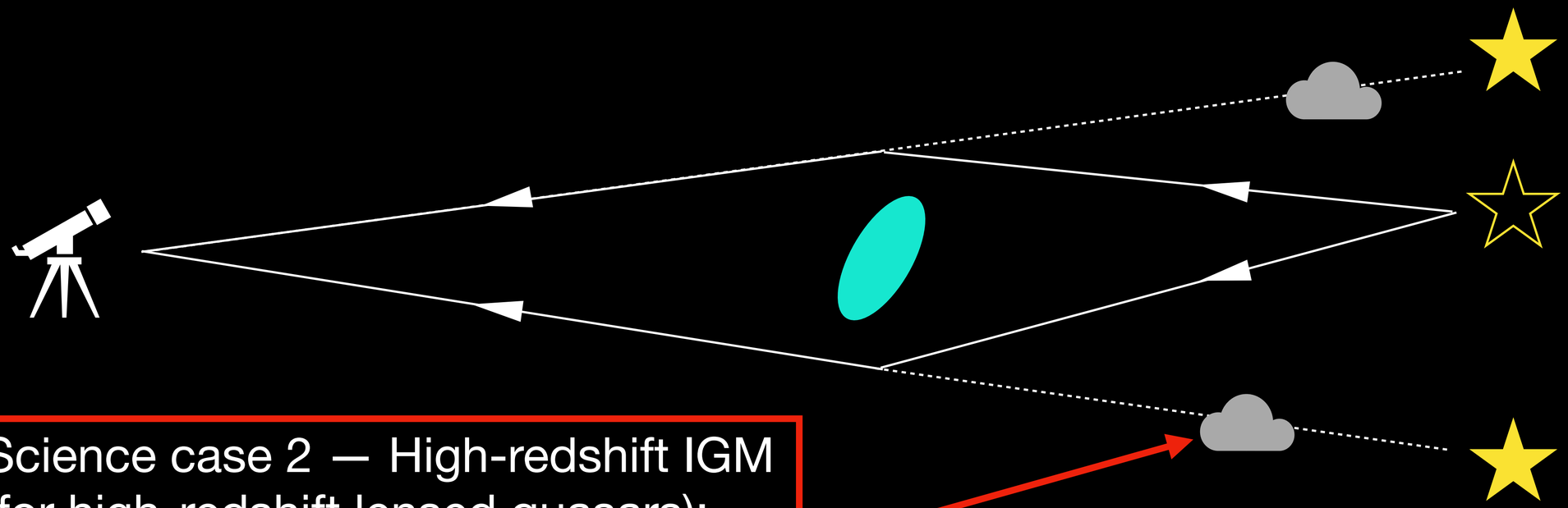

Science case 2 — High-redshift IGM (for high-redshift lensed quasars):

- Kpc-scale IGM variation
- Reionization inhomogeneity at smallest scales

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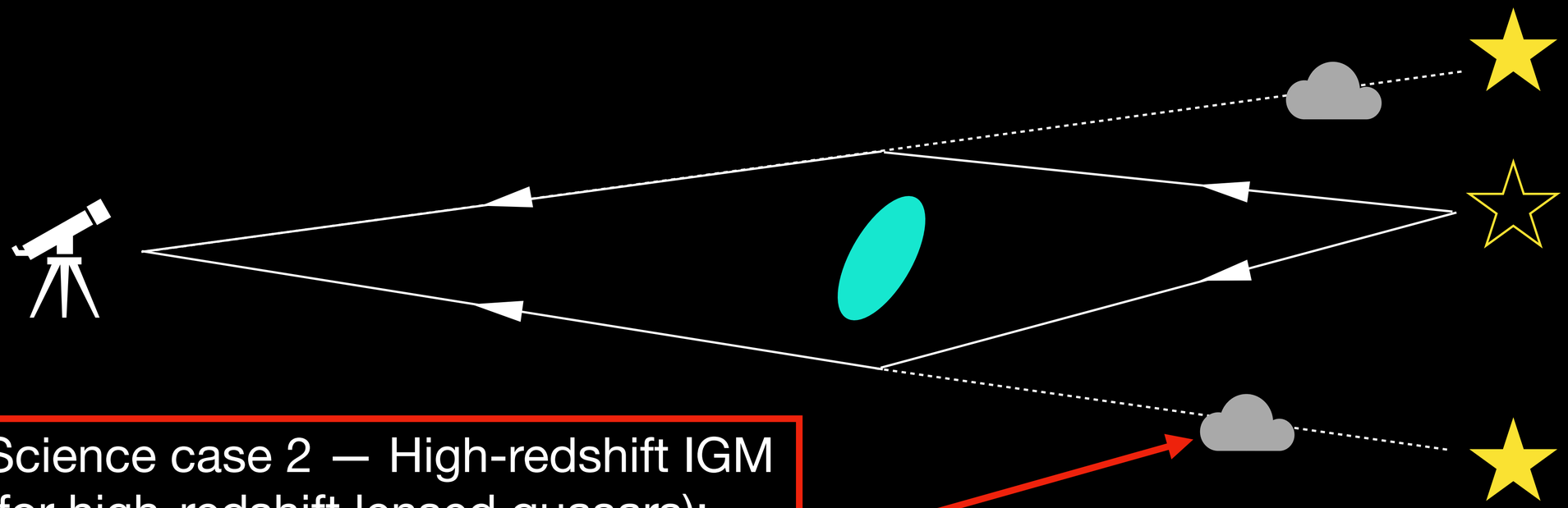

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How did reionization happen at the smallest scales?

The Unique Power of Roman

- Roman has
  - Sharp PSF -> Probe small separation (compact) lensed quasars
  - Deep near-IR imaging -> Probe High-redshift (z>5) lensed quasars
  - Large survey area -> Build a decent sample of these rare objects
  - Grism capacity -> Built-in spectroscopic confirmation and redshift

Roman is THE best facility for a high-completeness lensed quasar survey!

Forecasting the Yield of HLWAS

*based on the mock catalog in Yue+22

	Deep	Medium	Wide
Year 1-2	~2	~65	-
Total	~2	~320	~450
Sep<0.5”	-	~40	~52
z>5	-	~15	~20

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Cycle 1 Project #19009:

A Complete Census for Gravitationally Lensed Quasars with Roman

Strongly-Lensed “Little Red Dots”

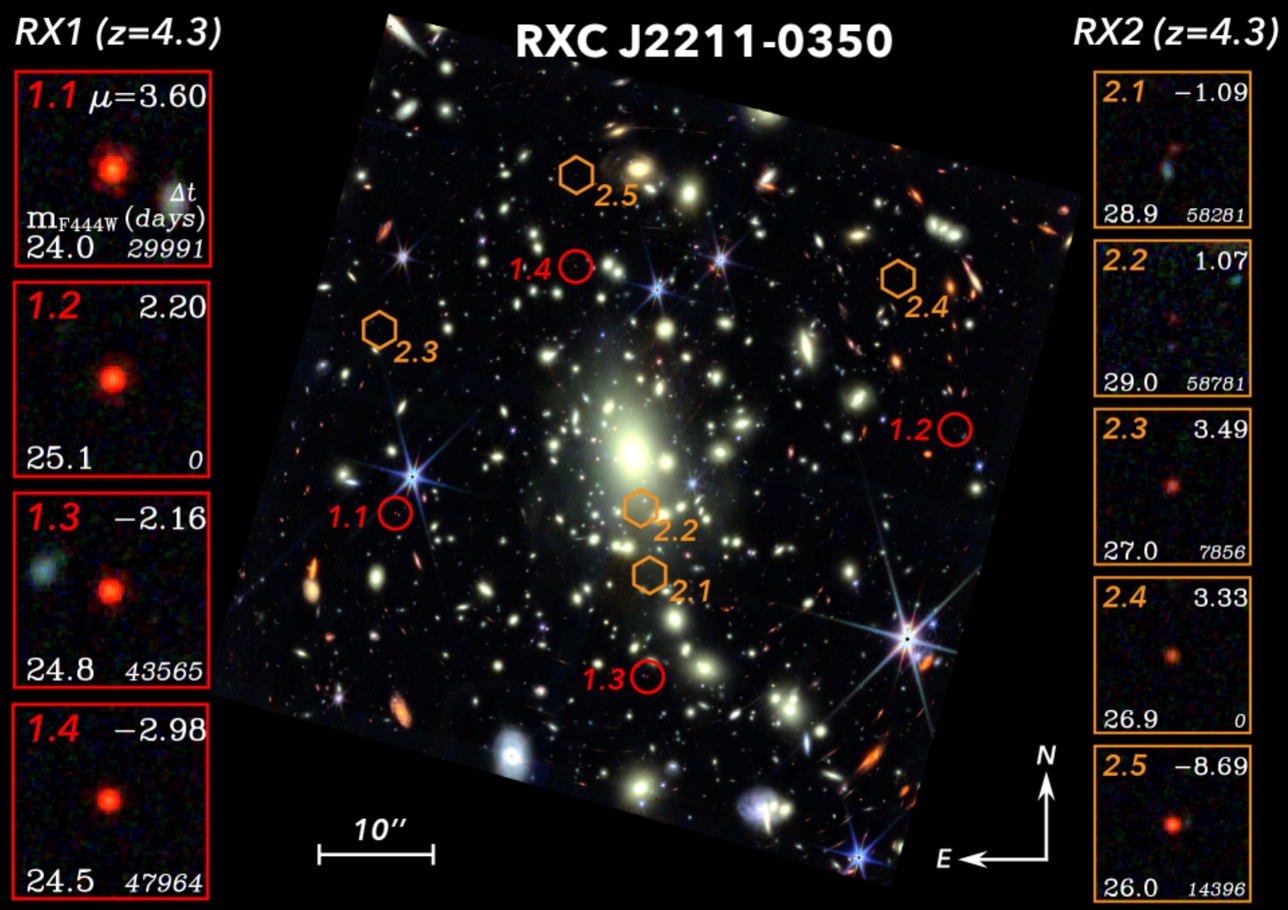


Image credit:
Zhang et al. 2026

JWST have already found many LRDs in lensing cluster fields

JWST is *not* optimal for finding lensed LRDs

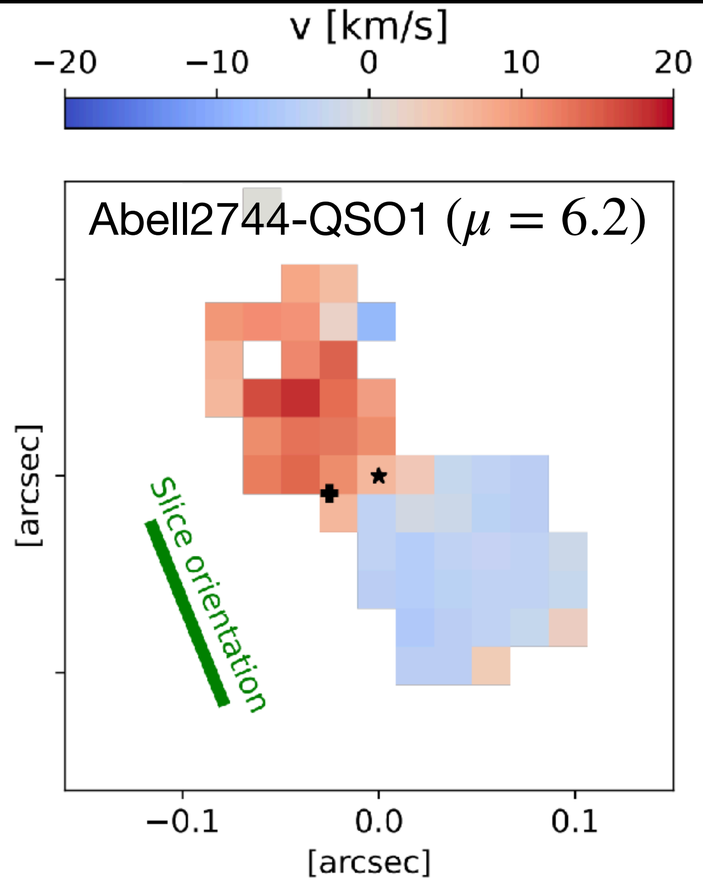
- Small survey volume -> only find a few lensed LRDs in cluster fields
- Insufficient to build a statistical sample

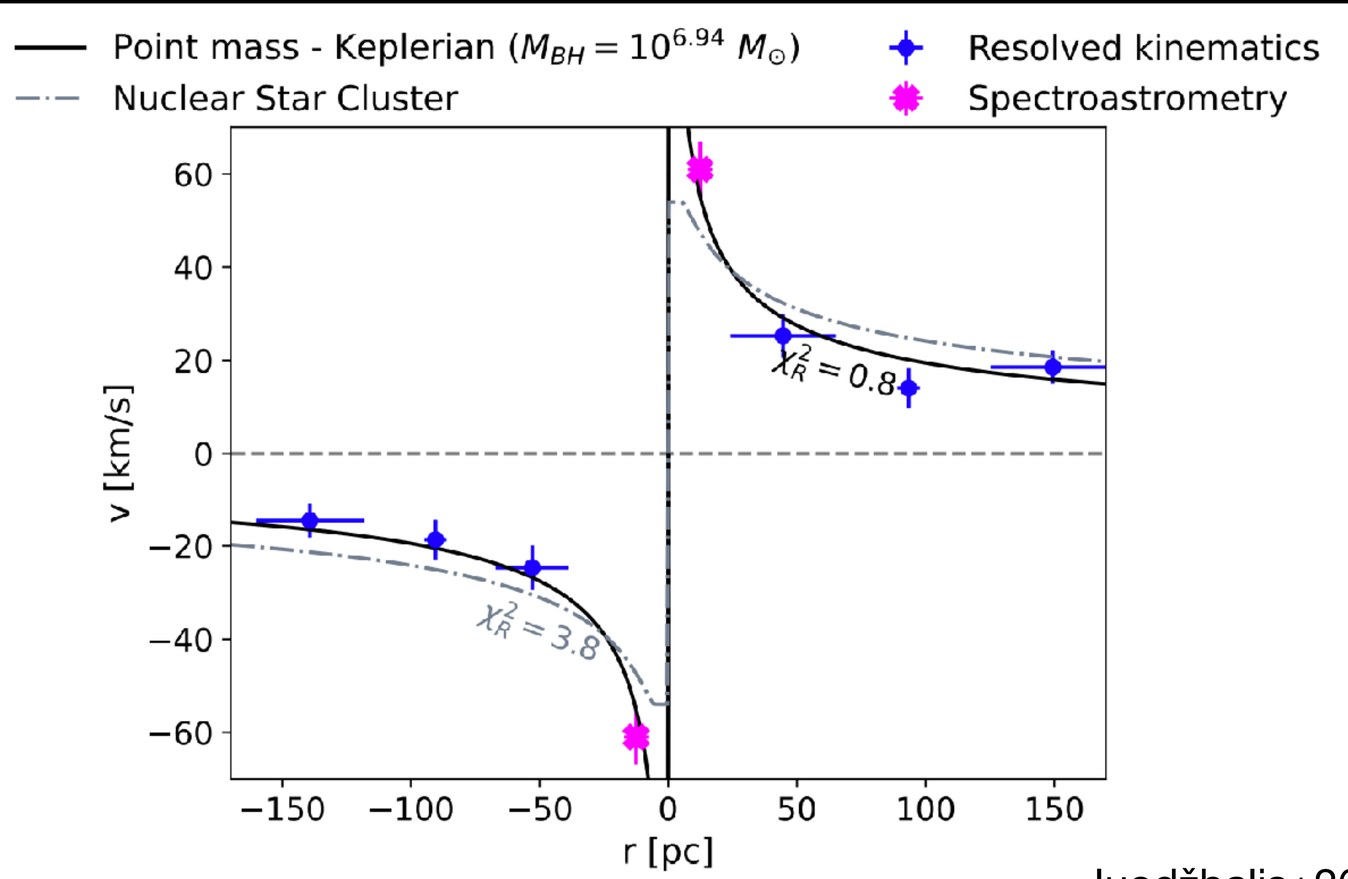
Roman is *the best* facility to find more lensed LRDs

- Large survey volume -> more lensed LRDs
  - Especially galaxy-lensed ones, which are ~20x more abundant than cluster-lensed ones!
- Near-IR coverage -> well suited for LRDs which shines in near-IR

What can we do with lensed LRDs?

Lensing magnification enables, e.g., direct BH mass measurement





Juodžbalis+26

Summary

- Roman is the best facility for a high-completeness lensed quasar search
  - Sharp PSF recovers compact lensed quasars
  - Near-IR coverage probes high-redshift lensed quasars

- The previously under-explored populations enable crucial experiments
  - Compact lensed quasars -> baryonic cycle in low-mass galaxies
  - High-z lensed quasars -> Small-scale structure of IGM and reionization

- Roman is also well-suited for finding lensed LRDs

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