Going Wide and Deep with Roman

The z~6-8 UV Luminosity Function

Micaela Bagley, UT Austin

Roman Science Team Community Briefing, Nov 15-19, 2021

Cosmic Dawn SIT: **James E. Rhoads (PI)**, **Sangeeta Malhotra**, Jean-Gabriel Cuby, Pratika Dayal, Xiaohui Fan, **Steven Finkelstein**, Yuichi Harikane, Anne Hutter, Rolf Jansen, Hannes Jensen, Ali Ahmad Khostovan, Garrelt Mellema, Masami Ouchi, Casey Papovich, Lucia Perez, **Rachel Somerville**, Vithal Tilvi, Rogier Windhorst, Isak Wold, **L. Y. Aaron Yung**, Erik Zackrisson

Roman Deep Field Surveys

Goals

- **Accuracy of the faint-end slope of the UV luminosity function**
- **Accuracy of the integrated luminosity density**

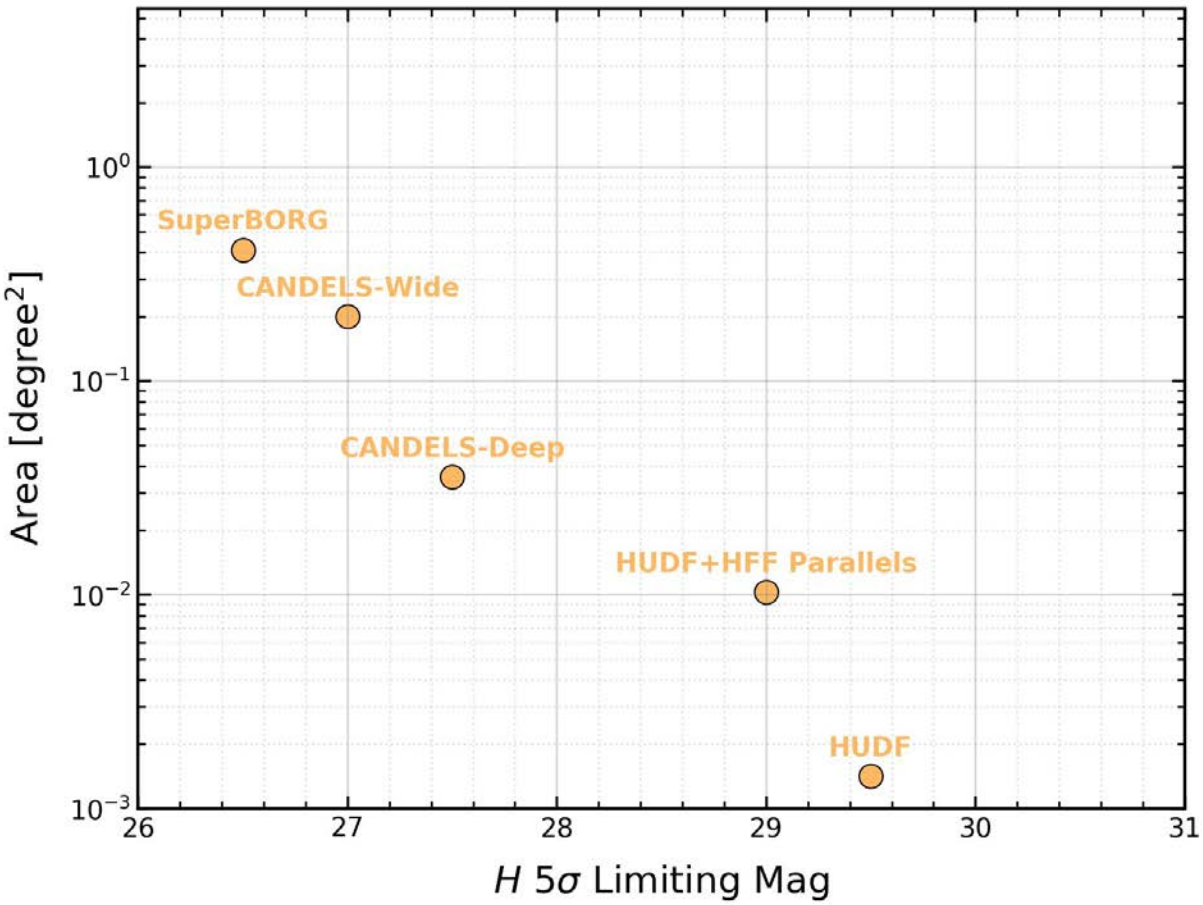
  ⟶ galactic contribution to reionization

  ⟶ constraints on the cosmic star formation rate density

- **Abundance of very bright galaxies**

  ⟶ constraints on feedback processes; star formation efficiencies, etc.

HST Surveys



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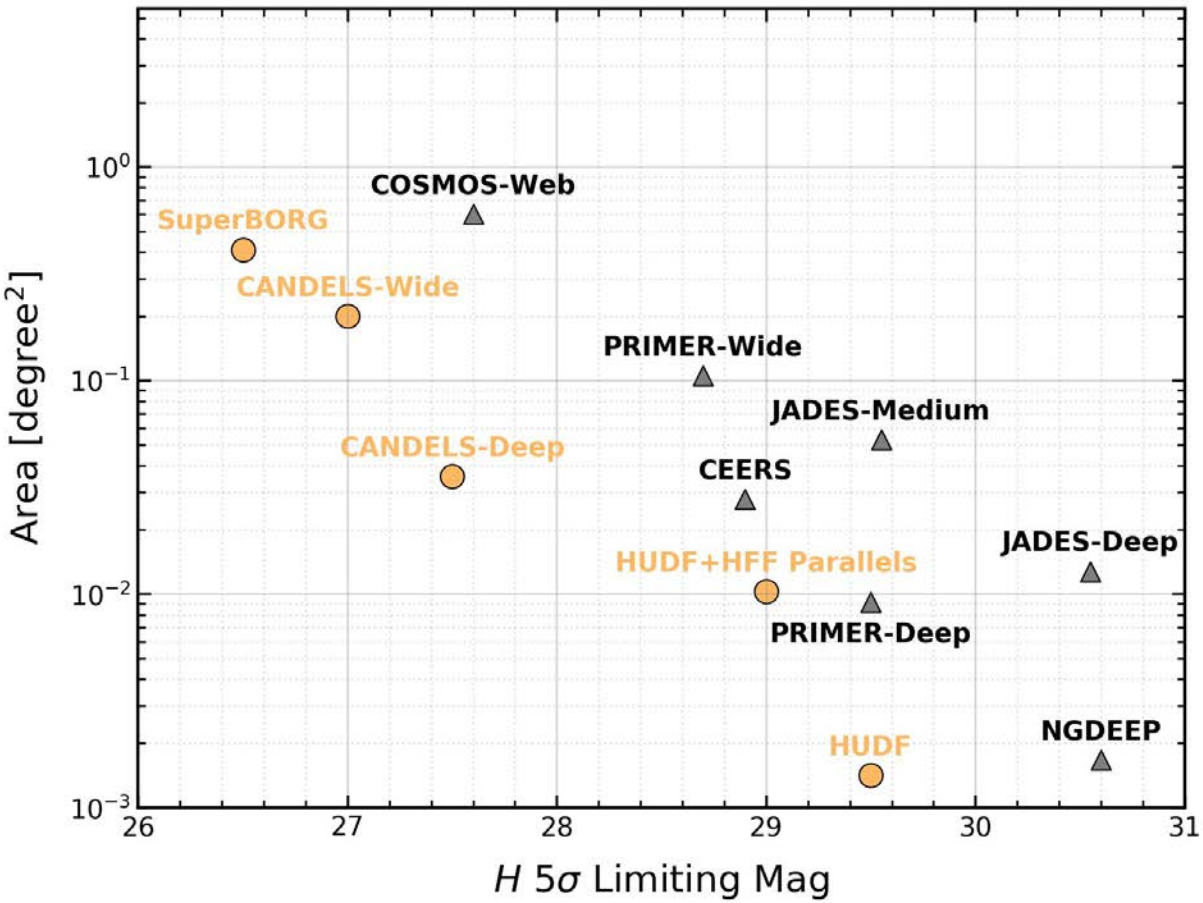
HST Surveys

JWST Surveys



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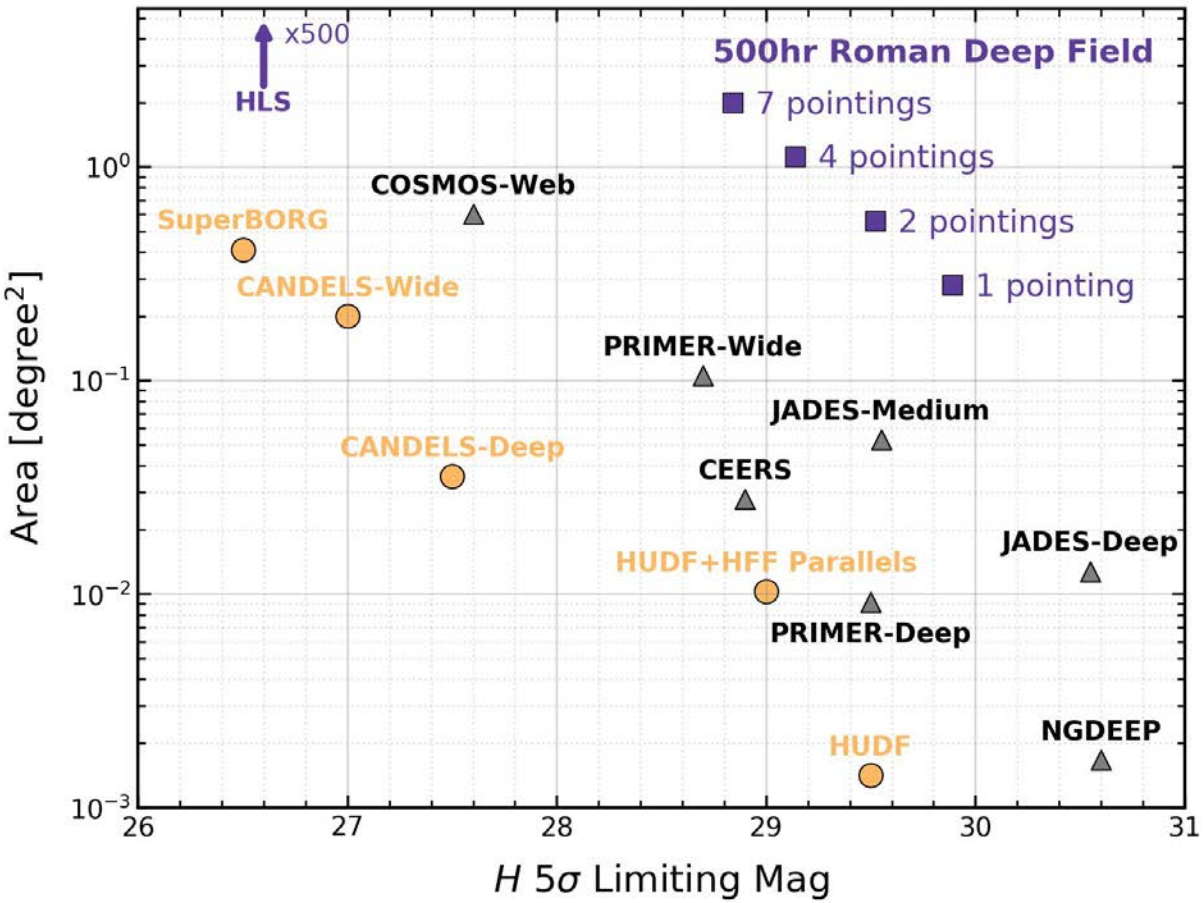
HST Surveys

JWST Surveys

Roman Surveys

We consider a 500hr Roman Deep field survey



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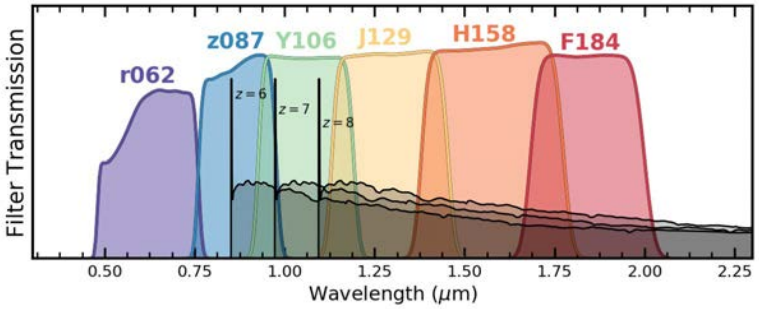
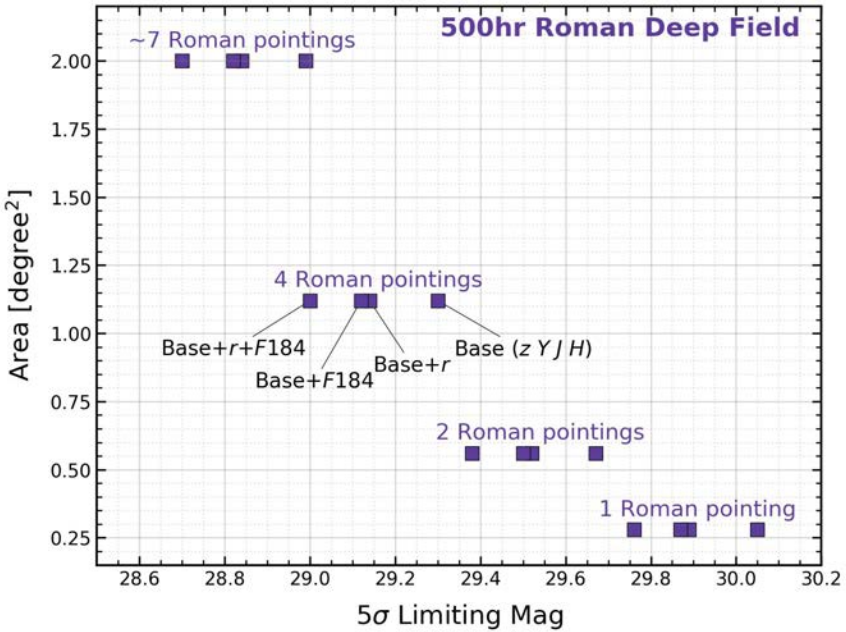
Roman Deep Field Surveys

We consider 16 possible Roman Deep Field Surveys

- Four areas:
  - 1 Roman pointing, ~0.28 deg^2
  - 2 Roman pointings, ~0.56 deg^2
  - 4 Roman pointings, ~1.12 deg^2
  - 7 Roman pointings, ~2 deg^2
- Four filter sets:
  - 'Base survey' – *z*,*Y*,*J*,*H* (F087, F106, F129, F158)
  - Base+r
  - Base+F184
  - Base+r+F184
- For a total exposure time of ~500 hours





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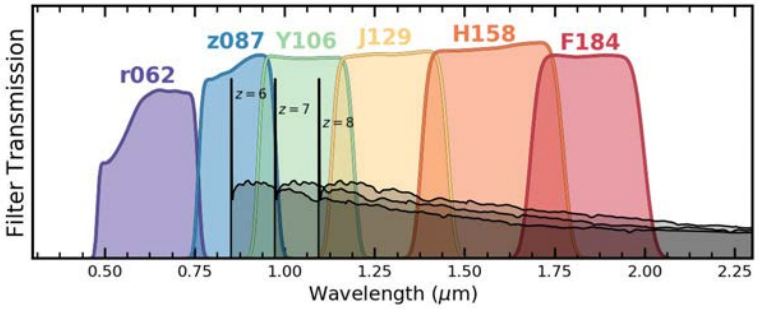

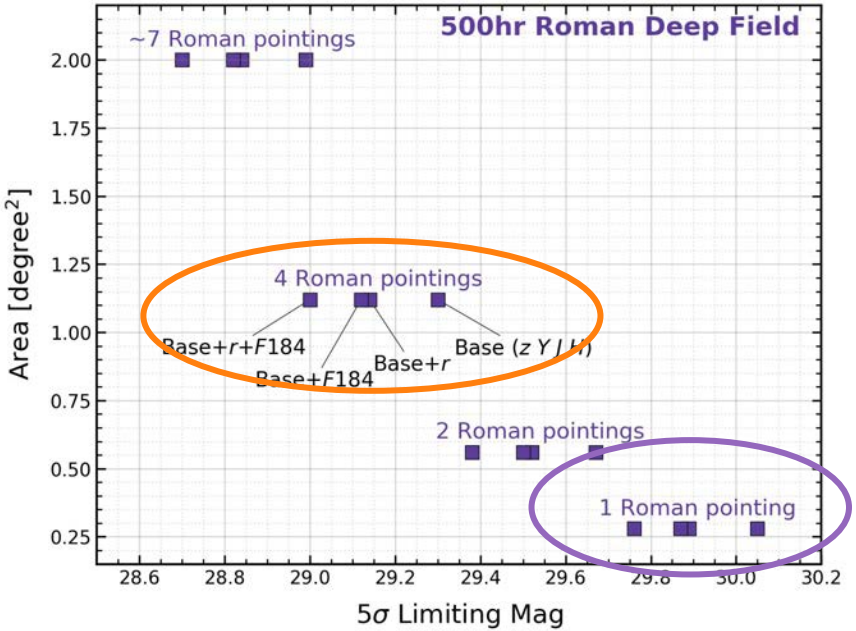

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Semi-analytic model (SAM) for galaxy formation

Mock observed "lightcone"

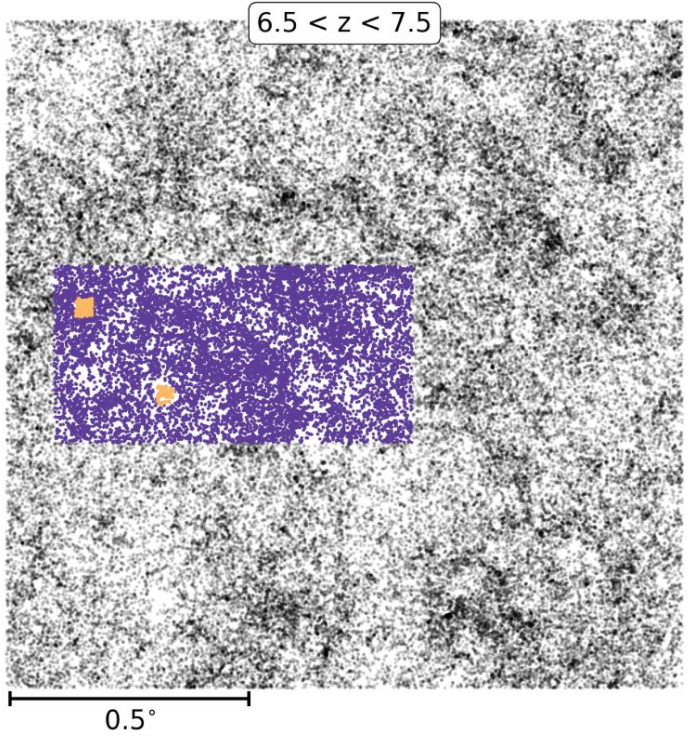
- DM halos sourced from the Multi-Dark suite (SMDPL; Klypin et al. 2016)
  400 Mpc/h on a side, resolving ~10^{10} $M_\odot$ halos
- Construction of a **2 sq deg lightcone up to *z*~10** (Yang et al. 2021, Somerville et al. 2021, **Yung et al. *in prep***)
  using UniverseMachine (Behroozi et al. 2019)
- DM halo merger histories constructed using extended Press-Schechter (Somerville & Primack 1999)

Santa Cruz SAM

Somerville et al. 2008, 2012, 2015; Popping et al. 2014

- Standard recipes for physical processes that shape galaxy evolution
- Predicted physical properties are forward modeled and reflected in synthetic SEDs and mock photometry
- Model performance at high redshift has been extensively tested (Yung et al. 2019a, 2019b, 2020a, 2020b)

Cosmic Variance — Roman vs. HST



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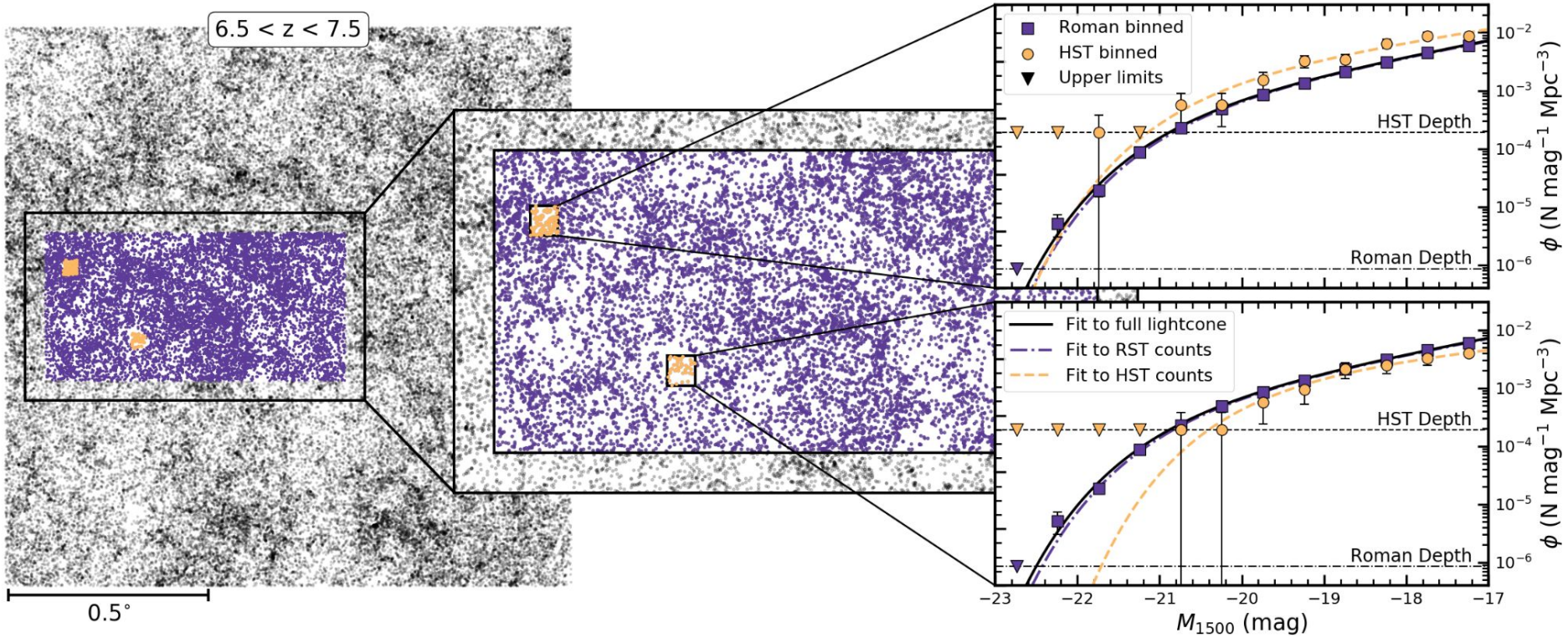

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Measuring the ‘observed’ LF

Apply photometric scatter

- 1 Roman pointing, Base+r
  F062, F087 5σ = **30.39**, F106, F129, F158 5σ = **29.89**
- 4 Roman pointings, Base+r
  F062, F087 5σ = **29.64**, F106, F129, F158 5σ = **29.14**

Calculate effective volume via catalog-level completeness

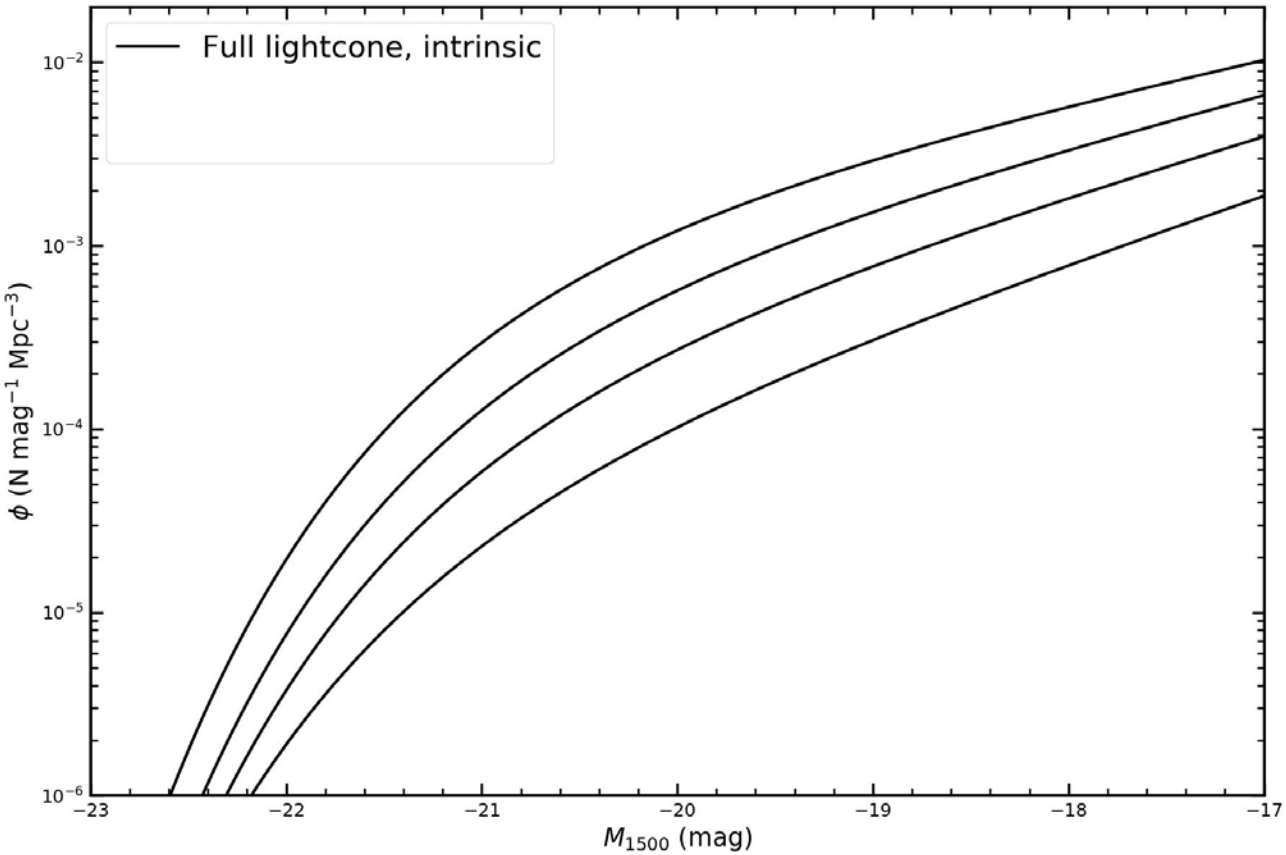
Calculate low-z contamination from SAM sources (accurate number densities)

Extract non-overlapping fields from mock lightcone

- 4 RST WFI fields, 0.75° × 0.375° (0.28 sq. deg.)

Fit a Schechter function via parametric maximum-likelihood analysis

Schechter function fits — z ~ 6-9



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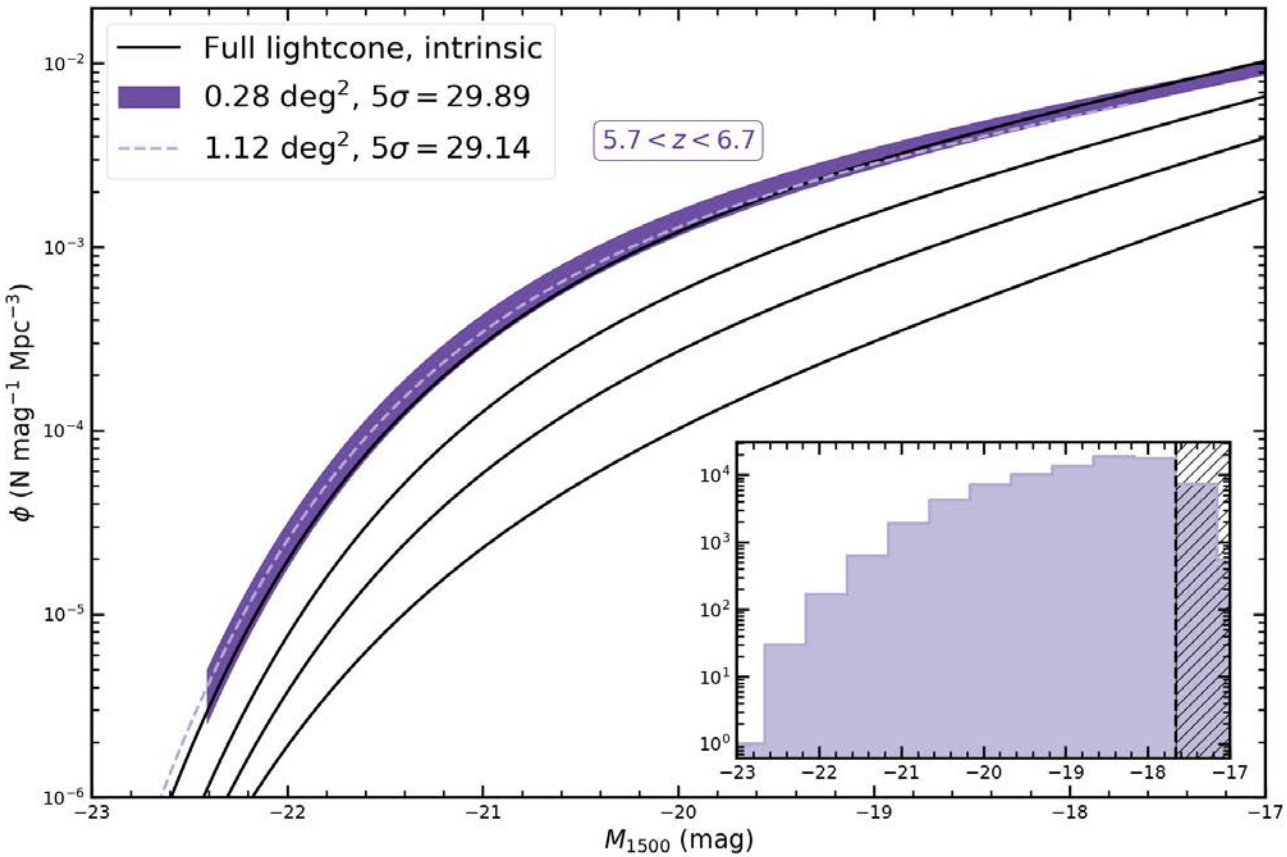

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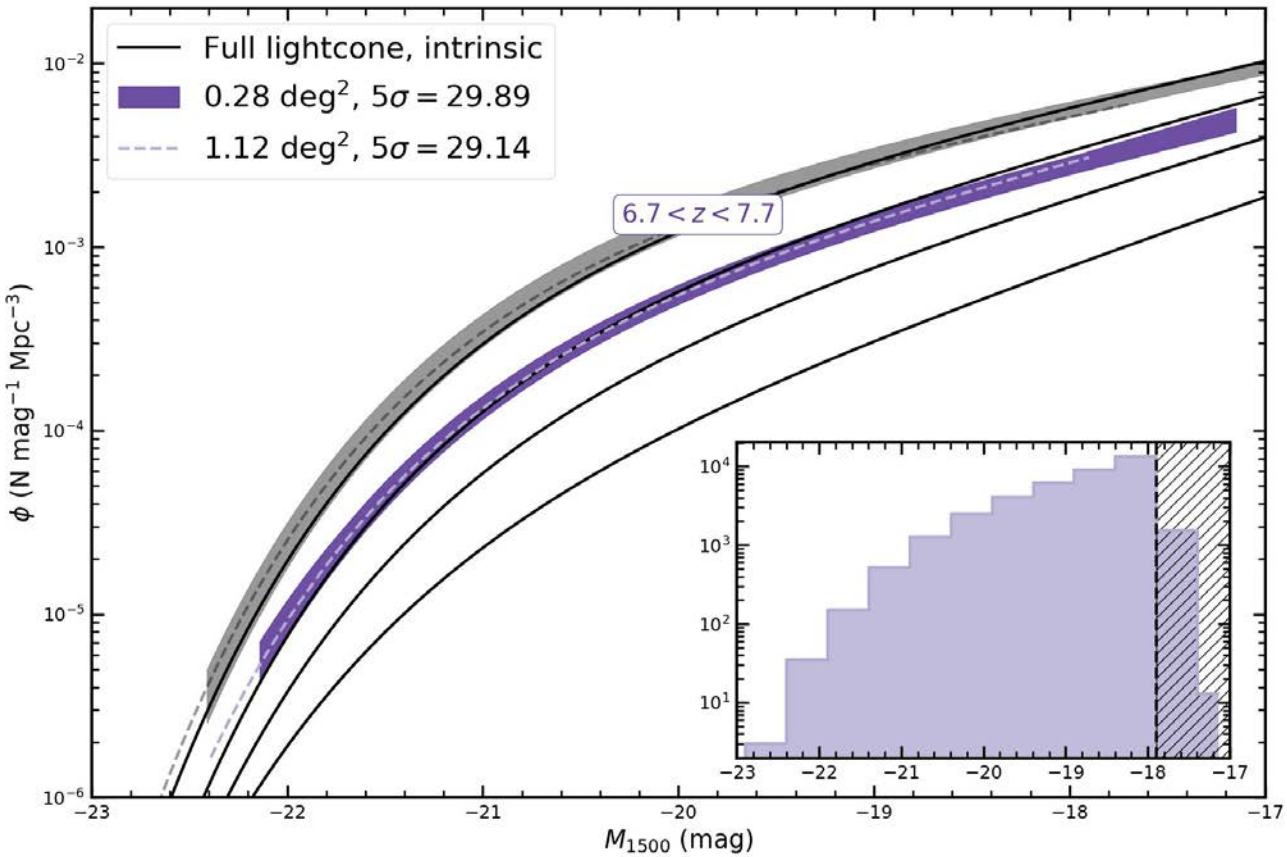

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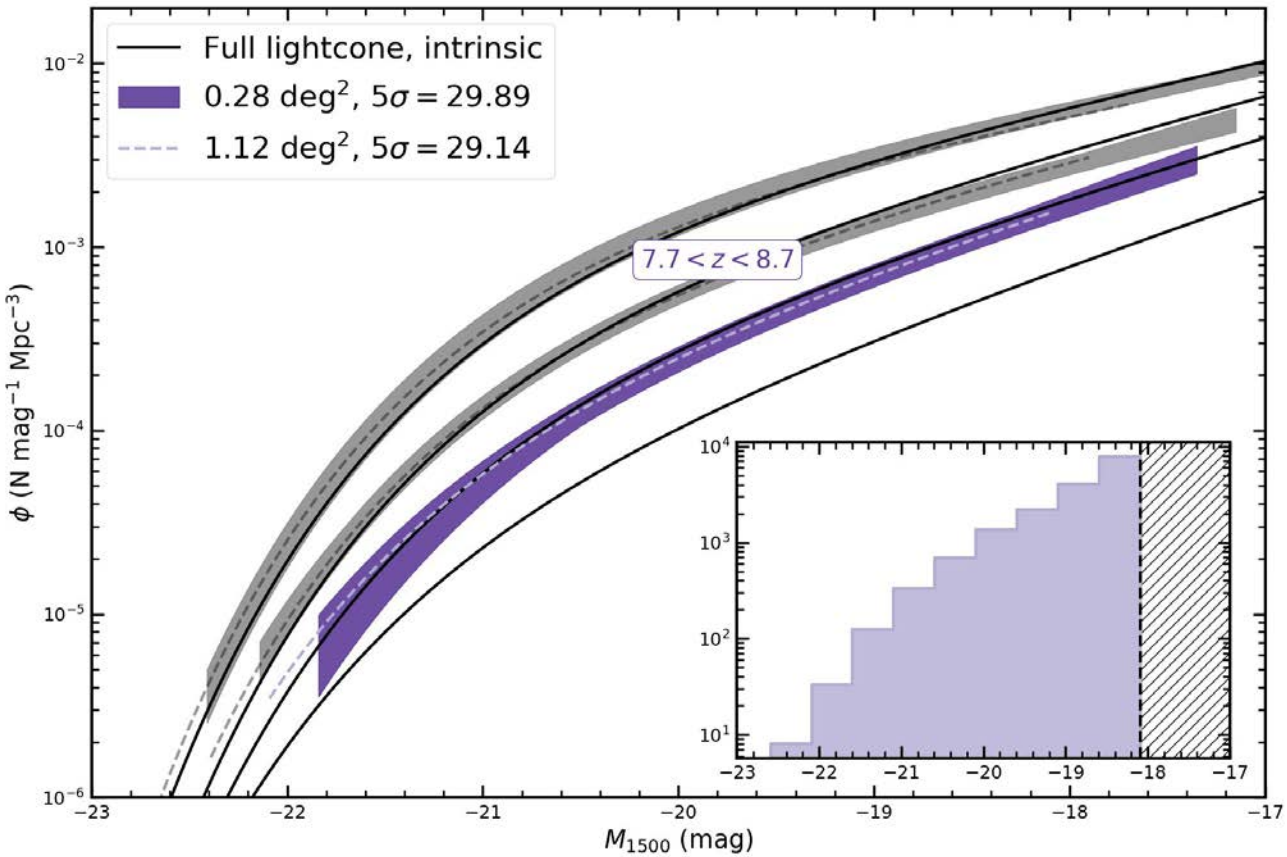

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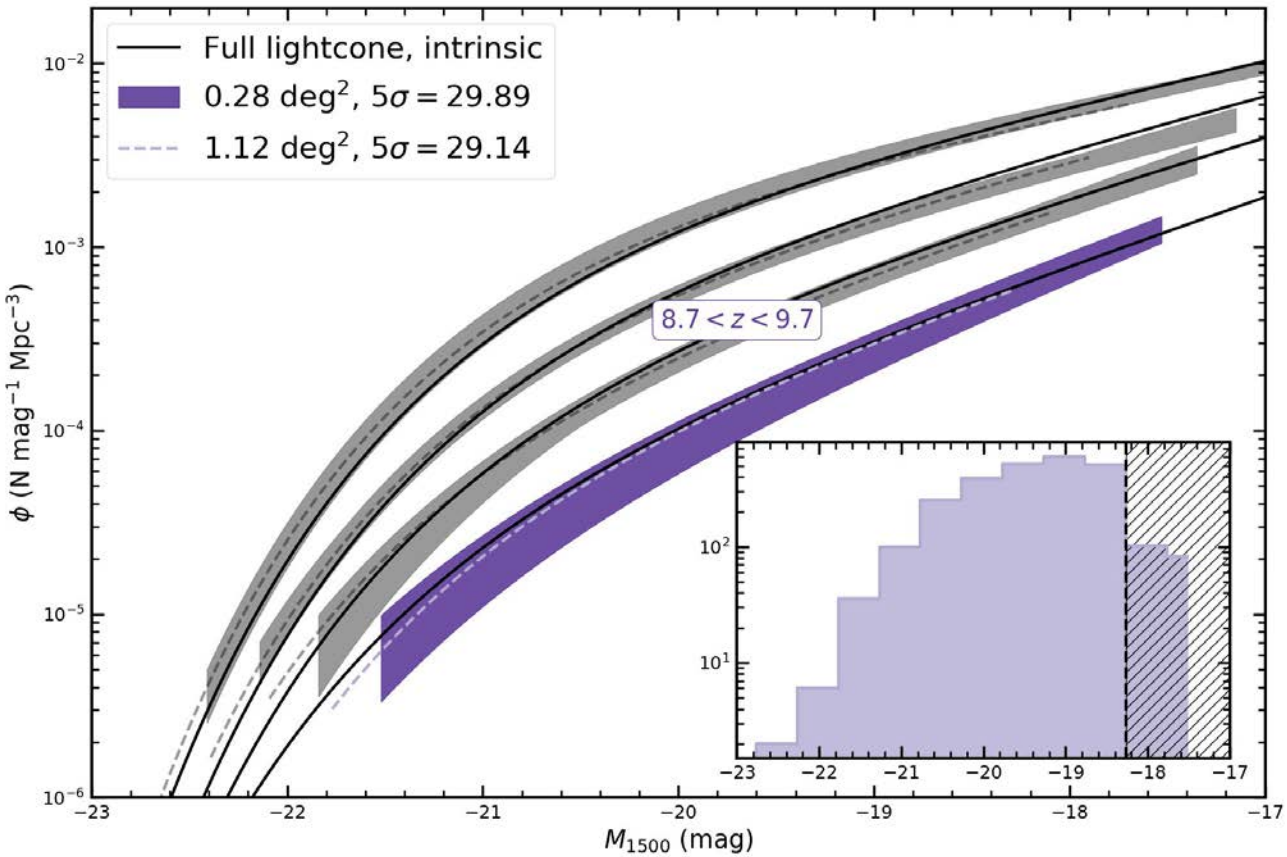

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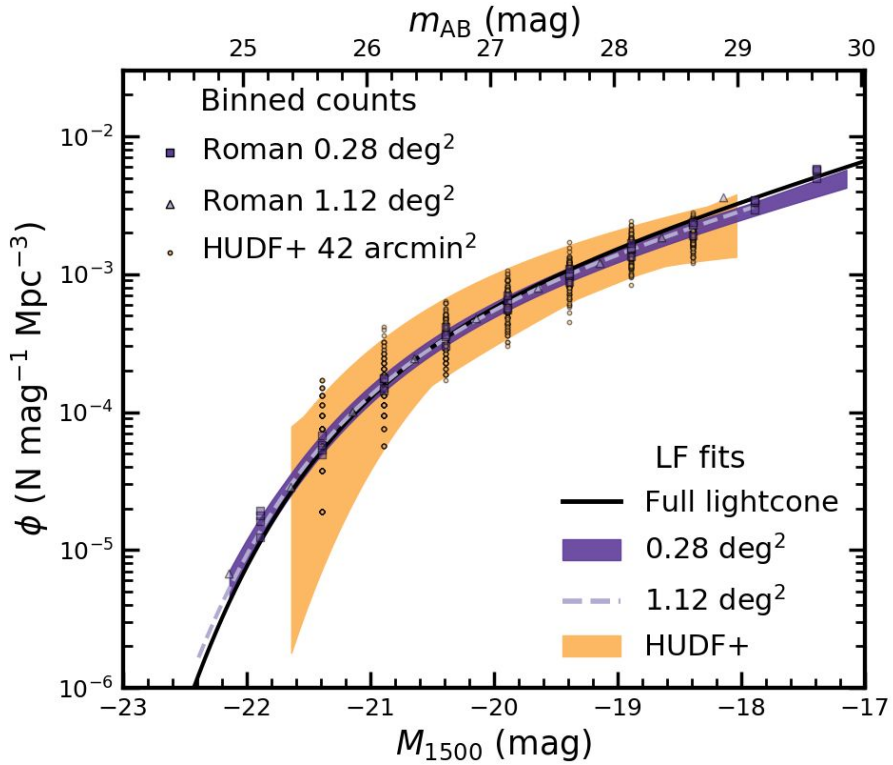
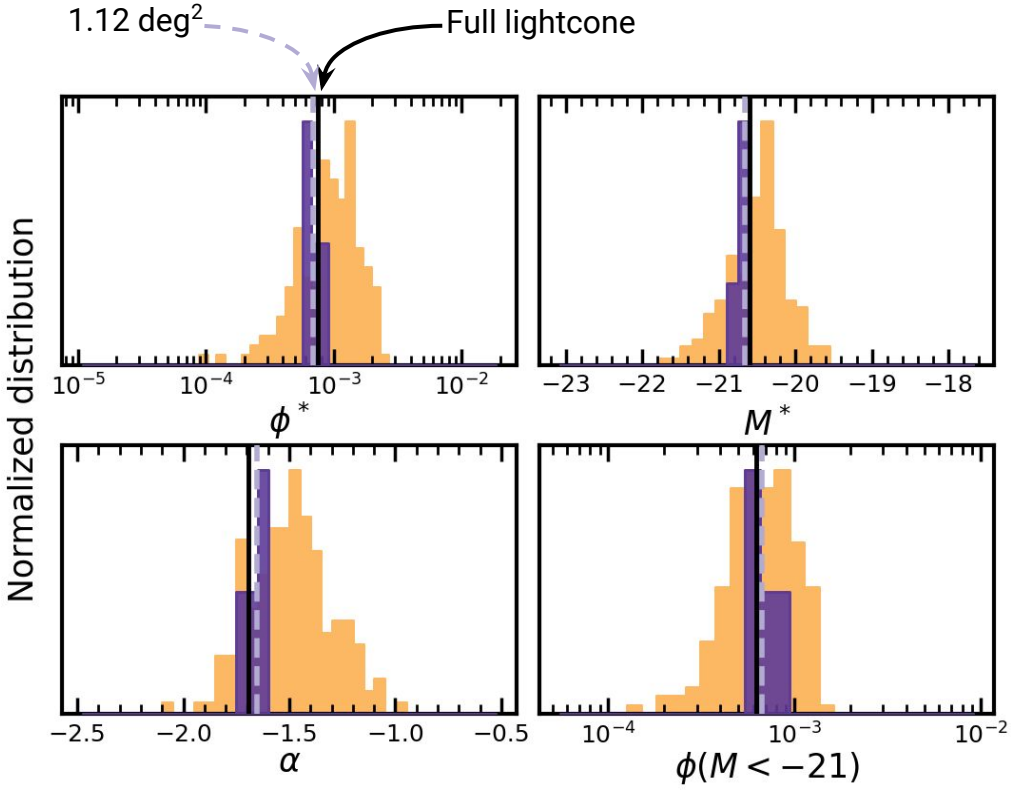
Schechter fit parameters — 6.7 < z < 7.7





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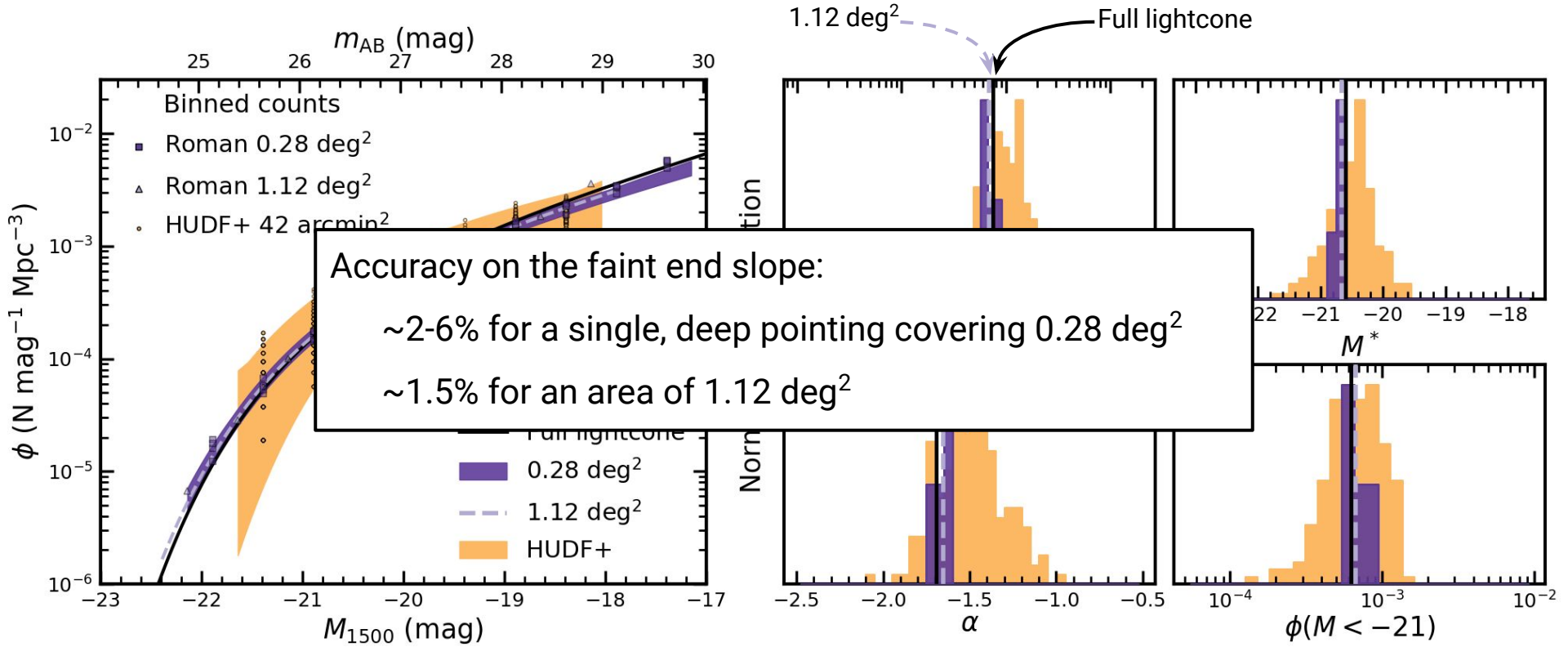

Accuracy on the faint end slope:

~2-6% for a single, deep pointing covering 0.28 deg^2

~1.5% for an area of 1.12 deg^2

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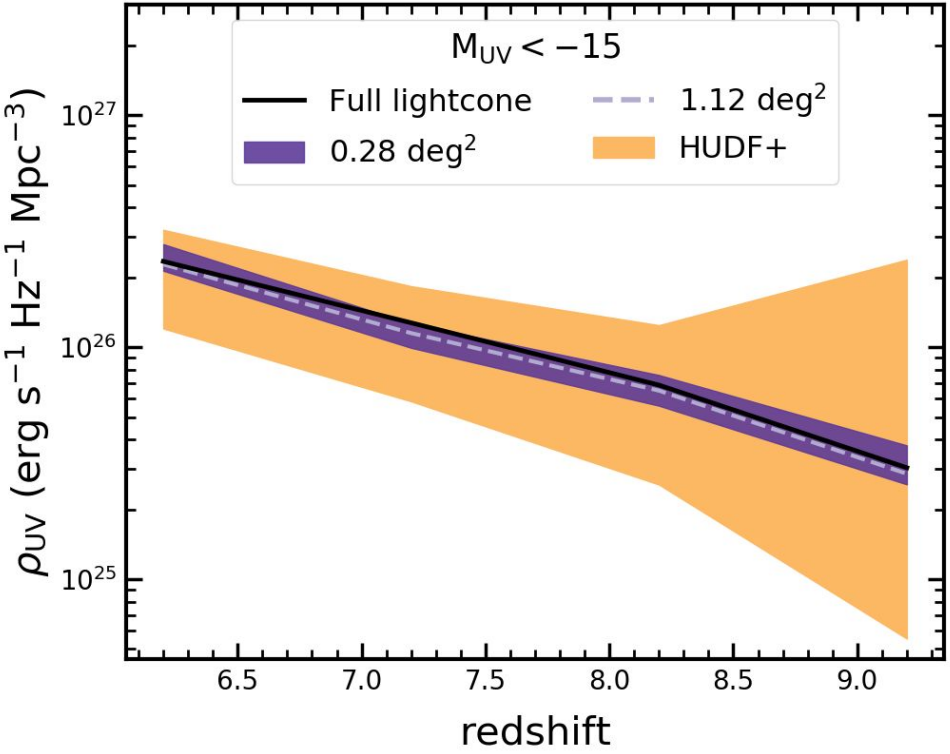
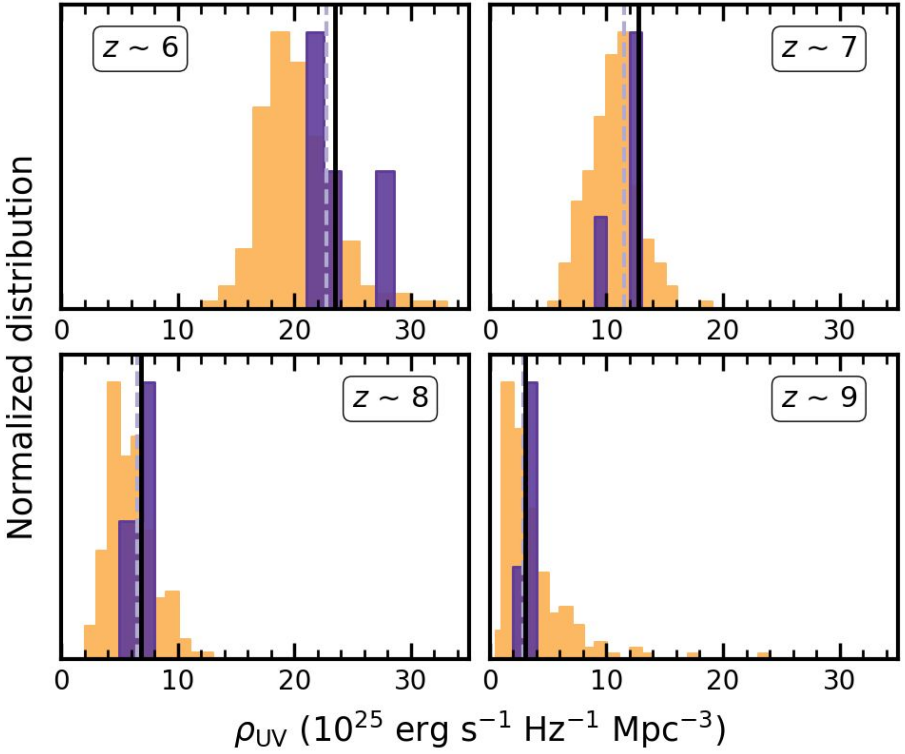
UV Luminosity density — z ~ 6-9





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Number counts per survey

z	N in full lightcone ($M_{1500} \leq -17$)	N in ~42 arcmin^2, HUDF + 8 Parallel fields (5σ m ≤ 29.5, 29.0)	N in 0.28 deg^2, 1 Roman pointing (5σ m ≤ 29.89)	N in 1.12 deg^2, 4 Roman pointings (5σ m ≤ 29.14)
6	268,704	688 ± 92	29,798 ± 3152	26,081
7	136,992	298 ± 49	15,723 ± 1018	12,469
8	62,924	108 ± 22	5297 ± 559	3694
9	20,962	27 ± 8	1094 ± 234	795

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Conclusions

- 16 Roman Deep Field survey designs, 0.28 - 2 deg^2
- Photometric scatter for a 500hr survey
- Full sample selection, completeness and contamination for z ~ 6-9
- UV luminosity function, accuracy on the faint end slope ~1-6% (see Drakos et al. 2021)
- UV luminosity density

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Thank you!

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