Finding the First Galaxies Behind the Lensing Cluster Abell 2744

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The UNCOVER Treasury Survey

Ultradeep; aided by strong gravitational lensing
PIs: Labbe & Bezanson
UNCOVER Part I: Imaging

Data Releases:
- Mosaics: Bezanson+ 2022
- Photometry: Weaver+ 2023 ApJS
- Redshifts & stellar populations: BW+ 2023d ApJS
Observations
Spectral energy distribution; SED

Models
Physical properties
- Stellar mass
- Star formation history
- Dust
- Gas
- …
State-of-the-art SED modeling

Joint probability distributions of galaxy properties (“the Bayesian revolution”)

Bayesian codes for high-dimensional SED modeling
- BEAGLE (Chevallard & Charlot 16)
- BAGPIPES (Carnall+18)
- Prospector (Johnson+21)
- ...

Photo-z codes
- LePhare (Arnouts+99; Ilbert+06)
- BPZ (Benítez+00)
- EAzY (Brammer+08)
- ...

\[
p(z)
\]
Prospector-\(\beta\): new galaxy evolution priors

\(\beta\)

\(\phi(z=1)\) [Mpc\(^{-3}\)]

Mass prior

\(P(z)\)

Number density prior

\(P_{\phi}(z=8, \log M=11.5)\)

\(P_{\phi}(z=8, \log M=9)\)

\(P_{\phi}(z=1, \log M=9)\)

\(P_{\phi}(z=1, \log M=11.5)\)

Dynamic SFHs

Intended for fitting galaxy photometry where \(z\) is unknown

Publicly available as a part of Prospector
UNCOVER Redshift & Stellar Population Catalog

≥ 60k objects; all parameters jointly inferred using Prospector-β

Contains redshifts, stellar masses, metallicities, ages, SFRs, contributions from dust, gas, and mid-IR AGN, and rest-frame colors.
Prospector-\(\beta\): applications on JWST data

Labbe+ (incl. BW) 2023 Nature

Red, candidate massive galaxies at \(z \sim 8\), dubbed “universe breakers”
- Unexpectedly massive if they are galaxies (c.f. Greene+23, Kocevski+23)
- To be followed up with JWST/NIRSpec (PIs Nelson & Labbe)
Prospector-$\beta$: applications on JWST data

van Dokkum, Brammer, BW+ 2023 Nat Ast

The highest redshift lens; enclosed is a compact, massive, quiescent galaxy
Total mass $>$ stellar mass + dark matter mass

also see Mercier+ 2023
UNCOVER Part II:
Spectroscopy
• 2 — 17hr integrations
• 7 MSA masks

Price+ (incl. BW) in prep
JWST/NIRSpec confirmation of $z > 12$ galaxies

BW+ 2023c ApJL

- ~ 300 - 400 pc in size, notably larger than the JADES $z > 10$ galaxies (Curtis-Lake+ 23; Robertson+ 23)
Systematics in SED fitting & ELT outlook

The known unknowns: burstiness of SFH, the IMF, and nebular physics

I. Photometric data are too degenerate to distinguish between the models

II. Systematics can >>
   i. formal reported uncertainties
   ii. scatter from using different SED fitting codes (Pacifici+ 2023)

BW+ 2023e sub. to ApJ