A large spectroscopic survey of the z=1-3 Universe with HST

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Surveying the $z \geq 1$ Universe

• We know vastly more than a few years ago: mass functions, cosmic star formation history, size distributions, etc out to $z=4-8$

• Keck and HST have not been superseded and have been around for nearly 20 years: what changed?
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• Keck and HST have not been superseded and have been around for nearly 20 years: what changed?
  
  - Instrumentation such as SINFONI on VLT: excellent information on relatively small, bright samples
    Forster Schreiber et al 2007-11, Kriek et al 2008-11, etc
  
  - Photometric redshifts, and stellar population fitting, have gone mainstream: 10s of 1000s of galaxies
Quality of broad-band redshifts

- Excellent for (optically) bright samples
Quality of broad-band redshifts

- Excellent for (optically) bright samples
- Not so good for K-selected, optically-faint samples

Note: Milky Way would have $K \sim 23$, $R \sim 27$ at $z=2$
Having your cake ..

• Ideally, combine efficiency and depth of imaging with accuracy of spectroscopy

• **NEWFIRM Medium Band Survey** (Whitaker et al 2011): replace J and H band with five medium-band filters

• **3D-HST** (Brammer et al, in prep): use grisms on HST to obtain R~100 spectra
NEWFIRM Medium Band Survey

Kate Whitaker+ (2010,11) Redshifts good to ~2% for ~13,000 galaxies at z>1.5
separate star-forming and quiescent galaxies
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1.5 < z < 2.0

quiescent

star-forming

age spread of quiescent galaxies

Whitaker et al 2010

Whitaker et al 2011
NEWFIRM Medium Band Survey
Whitaker et al 2011

separate star-forming and quiescent galaxies

$1.5 < z < 2.0$

quiescent

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Whitaker et al 2010

mass and number density evolution

vD et al 2010

Brammer et al 2011
Many more results!
- all data and data products publicly available -

separate star-forming and quiescent galaxies

NEWFIRM Medium Band Survey
Whitaker et al 2011

Whitaker et al 2010

Brammer et al 2011
248 orbit Treasury program
2-orbit depth WFC3 + ACS grism
redshifts to ~0.4%

Gabriel Brammer (ESO) et al, 2011
WFC3 G141 grism

Nelson+ 2011
Schmidt+ 2011
WFC3 G141 grism

• Provides spectra of all objects in the 2′x2′ WFC3 field simultaneously

• R~100, wavelength coverage 1.10 - 1.65 micron

• Redshifts, line diagnostics, and 2D spatial distribution of line emitting gas
Brammer et al, in prep
Growing compact galaxy at z=1.9!
So .. can we now do better?

- Complete, mass-limited spectroscopic samples do not exist beyond $z\sim0.8$
- From early 3D-HST data, selected $M_{\text{star}} > 10^{11} \, M_{\odot}$ galaxies with $z=1-1.5$
massive galaxies at $z=1-1.5$, from 3D-HST
massive galaxies at $z=0.1$, from SDSS
Massive galaxies at $z=1-1.5$ are bluer and have stronger $\text{H}\alpha$ emission than at $z=0$. 
Status / next steps

• About 1/3 of observations obtained; remainder to come over course of next ~12 months

• Optimizing reduction, analysis; adding ACS + WFC3
Summary

- **R~5**
  - Broad-band photometric redshifts useful for general properties of high redshift galaxies (e.g., mean color)

- **R~10**
  - Medium-band filters provide redshifts to ~2%, accurate colors, masses, crude environmental information

- **R~100**
  - 3D-HST: redshifts to ~0.4%, line diagnostics, spatially-resolved information for 1000s of galaxies in CANDELS
Meet the students + postdocs!

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