HUBBLE FRONTIER FIELDS:
THE BLANK-FIELD LUMINOSITY FUNCTION:
CONSTRAINTS ON THE FAINT-END SLOPE WITH
CANDELS+HUDF+HFF PARALLELS

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WIDE-AREA DATA IS A NECESSARY COMPLEMENT

CANDELS

z ~ 6

z ~ 7

z ~ 8

HUDF09/12+

HFFP

SF+2014

GOODS–S Deep
GOODS–S Wide
GOODS–S ERS
GOODS–N Deep
GOODS–N Wide
HUDF Main
HUDF PAR1
HUDF PAR2
MACS0416 PAR
A2744 PAR
DELS is the largest guson; Grogin et al. (2011); Koekemoer et al. (2011). CANtragalactic Legacy Survey (CANDELS; PIs Faber and Fercomes from the Cosmic Assembly Near-infrared Deep Ex HUDF09-01 and HUDF09-02 fields (Bouwens et al. 2011b). survey (PI Stiavelli; Oesch et al. 2007), referred to as the sized flanking fields, first observed with ACS in the UDF05 survey also obtained deep WFC3 imaging over two similarly-

- The deepest imaging comes from two surveys of the Hub-Goods-N field, and the southern
- GoodS-S Wide
- GoodS-N Deep
- HUDF Main
- HUDF PAR1
- HUDF PAR2
- MACS0416 PAR
- Abell 2744 PAR

<table>
<thead>
<tr>
<th>Field</th>
<th>Area (arcmin²)</th>
<th>$B_{435}$ (mag)</th>
<th>$V_{606}$ (mag)</th>
<th>$i_{775}$ (mag)</th>
<th>$I_{814}$ (mag)</th>
<th>$z_{850}$ (mag)</th>
<th>$Y_{098/105}$ (mag)</th>
<th>$J_{125}$ (mag)</th>
<th>$JH_{140}$ (mag)</th>
<th>$H_{160}$ (mag)</th>
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<td>28.6</td>
<td>27.9</td>
<td>28.1</td>
<td>27.8</td>
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<td>28.8</td>
<td>28.8</td>
<td>28.9</td>
</tr>
</tbody>
</table>

**Table 1**: Summary of imaging data for various fields.

- **CANDELS**: The Rest-Frame UV Luminosity Function at $z \sim 6$.
- **HUDF09/12+ HFFP**: Detailed data covering UV magnitudes.
- **SF+2014**: Annotation indicating the era or study. 
SAMPLE SELECTION

- $>3.5\sigma$ in $J_{125}$ and $H_{160}$, or $>5\sigma$ detection in $H_{160}$ (for $z=9,10$).

- Satisfy thresholds on $P(z)$ quality.

Following SF+2010, 2012ab, 2013, 2014
SAMPLE SELECTION

- Satisfy thresholds on $P(z)$ quality.

This object goes into the $z=7$ sample.

Following SF+2010, 2012ab, 2013, 2014
<table>
<thead>
<tr>
<th>z</th>
<th>Field</th>
<th>Image</th>
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<tr>
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<td><img src="image2.png" alt="Image" /></td>
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<td>8</td>
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**HFF PARALLEL FIELDS**
THE LUMINOSITY FUNCTION

• The distribution of galaxy luminosities is one of the most fundamental measures of galaxy evolution.

• In the distant universe, we see only the rest-frame UV light, so much work has been done to parametrize the UV luminosity function. It has a characteristic shape.
The faint-end slope evolves significantly (4σ).

\[ \alpha = -1.56 \pm 0.05 \]

\[ \alpha = -2.03 \pm 0.20 \]

\[ \alpha = -2.36 \pm 0.47 \]

\[ \alpha = -0.79 - 0.19z \pm 0.21 \pm 0.04 \]
EVOLUTION OF THE COSMIC SFR DENSITY

-log Cosmic SFRD (M_☉ yr\(^{-1}\) Mpc\(^{-3}\))

Time Since Big Bang (Gyr)

Redshift

Dust Corrected
Uncorrected

This Study
Reddy+09
Arnouts+05
Oesch+13
Bouwens+14

M_{UV} < -17

SF+2014
68% confidence statements:

Volume ionized fraction > 90% at z=6
Volume ionized fraction > 20% at z=8
Midpoint of reionization ($x_{\text{HII}}=0.5$) = 6.7 - 9.4
UTILITY OF HFF PARALLEL FIELDS

Improvement in fractional error on $\alpha$:
- $z = 6$: 5.2%
- $z = 7$: 10.2%
- $z = 8$: 20.7%
CONCLUSIONS

• Combining wide-area shallower data with deep programs is the best way to constrain the full shape of the luminosity function.

• The faint-end slope steepens with increasing redshift, from -1.5 at z=4, to -2 at z=7 (and possibly beyond at z=8).

• This provides a scenario for reionization which begins at z~10, completes at z~6, and has a midpoint at 6.7 < z < 9.4.

  • Uncertainties are still high.

• The HFF parallel fields significantly add to constraints on alpha, and the full set of six fields will be valuable.