Bright End of the UV Luminosity Functions at $z=4-7$ Derived with the 200 deg$^2$ Data of the Subaru HSC Survey

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Introduction

(Bowler et al. 2015)

- Bright end of the UV luminosity function at high redshift
  - power law or exponential?
  - inefficient quenching at high redshift?
Data

- Subaru Strategic Program with Hyper Suprime-Cam (HSC SSP)

![Subaru Telescope](http://subarutelescope.org/Topics/2013/07/30/fig4j.jpg)

![Hyper Suprime-Cam (HSC)](http://subarutelescope.org/Observing/Instruments/HSC/sensitivity.html)

- 300 night Subaru HSC time in 5 years.
- will cover 1400 deg² with broadband filters grizy.
HSC SSP Early Survey Products

- Effective area for our study
  - Ultradeep (UD) $\sim 2.4\,\text{deg}^2$ (COSMOS+SXDS)
  - Deep (D) $\sim 13\,\text{deg}^2$.
  - Wide (W) $\sim 60\,\text{deg}^2$.

Example:

$W\_GAMA09H$

- Limiting magnitude (5-sigma ABmag)
  - UD: $g\sim27$, $r\sim27$, $i\sim26.5$, $z\sim26$, $y\sim25$
  - D: $g\sim26.5$, $r\sim26$, $i\sim26$, $z\sim25$, $y\sim24.5$
  - W: $g\sim26$, $r\sim26$, $i\sim26$, $z\sim25$, $y\sim24$

→ select high-z galaxy candidates by using the Lyman break technique.
## Dropout Sample

### # of g-drops, r-drops, i-drops, z-drops

<table>
<thead>
<tr>
<th>Field</th>
<th>z=4</th>
<th>z=5</th>
<th>z=6</th>
<th>z=7</th>
</tr>
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<tbody>
<tr>
<td>D_COSMOS</td>
<td>43693</td>
<td>5997</td>
<td>67</td>
<td>4</td>
</tr>
<tr>
<td>D_DEEP2_3</td>
<td>31523</td>
<td>1306</td>
<td>48</td>
<td>5</td>
</tr>
<tr>
<td>D_ELAIS_N1</td>
<td>5405</td>
<td>188</td>
<td>4</td>
<td>1</td>
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<tr>
<td>D_XMM_LSS</td>
<td>3316</td>
<td>335</td>
<td>3</td>
<td>0</td>
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<tr>
<td>UD_COSMOS</td>
<td>10644</td>
<td>1990</td>
<td>50</td>
<td>12</td>
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<tr>
<td>UD_SXDS</td>
<td>9916</td>
<td>1209</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>W_GAMA09H</td>
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<td>4478</td>
<td>71</td>
<td>0</td>
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<td>W_GAMA15H</td>
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<td>4882</td>
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<td>0</td>
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<tr>
<td>W_HECTOMAP</td>
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<td>745</td>
<td>11</td>
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<tr>
<td>W_VVDS</td>
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<td>1009</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>W_WIDE12H</td>
<td>66697</td>
<td>3837</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>W_XMM</td>
<td>85085</td>
<td>4648</td>
<td>56</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>408487</strong></td>
<td><strong>30624</strong></td>
<td><strong>443</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

# in total

\[ \approx 400,000 \]
Dropout Sample

This Study
Bouwens+15
van der Burg+10 (z=4,5)
Bowler+15,16 (z=6,7)

- z=4 and 5: larger than previous work
- z=6 and 7: comparable with previous ground-based survey

- dropout galaxy studies
  - clustering analysis: Y. Harikane et al. → Yuichi’s talk
  - protocluster study: J. Toshikawa et al. → Jun’s poster
  - UV luminosity function: Y. Ono et al. → This talk
  - and others …
Comparison with Spectroscopic Results

- In the W layer, several candidates have been confirmed by Matsuoka+2016.
- In the UD layer (COSMOS+SXDS), many (>100) g-dropouts and r-dropouts have been spectroscopically identified by previous work.
- Contamination fractions = 10-20% based on previous spectroscopy results.
Selection Completeness

- mock catalog of galaxies
  + size distribution (Shibuya+15)
  + Sersic index n = 1.5
  + random ellipticity & position angle
  + Bruzual & Charlot (2003) SED
    - beta vs. redshift (Bouwens+14)
    - beta vs. Muv

- Monte Carlo simulations with SynPipe
  (S. Huang+ in prep.)
UV Luminosity Function at z=4

- broadly consistent with previous results at $M_{UV} > -23$ mag
- appear to have a hump at the bright end
UV Luminosity Functions at $z=5-6$

- broadly consistent with previous results at $M_{UV} > -23$ mag
- appear to have a hump at the bright end
the bright end hump can be partly due to quasar contamination.

Spectroscopy results of Matsuoka et al. (2016) suggest that our bright end LF is affected by quasar contamination.
UV Luminosity Functions at $z=4-7$

$z=4$  $z=5$

$z=6$  $z=7$
UV Luminosity Function at $z=4$

This Study

- Based on the chi2 fitting results, double power law function gives a better fit, although the observed LF seems consistent with the Schechter function within 1-sigma
UV Luminosity Functions at $z=4-7$

$z=4$  $z=5$

$z=6$  $z=7$
UV Luminosity Functions at $z=4-7$

Little Evolution?

- Bouwens+15

This Study
- $z=4$
- $z=5$
- $z=6$
- $z=7$

Evolution (Bowler+15)

- At $M_{UV} \sim -21$ mag, the LF decrease with increasing redshift.
- At $M_{UV} \sim -23$ mag, the LF appear to show little evolution, although the errors are large.
Little Evolution at the Very Bright End?

\[ \phi(M_{UV}) = \frac{\phi^{\text{star}}}{10^{0.4(\beta+1)(M_{UV}+23)}} \]

- fit single power law functions to the observed z=4-7 LFs in \(-24 < M_{UV} < -22\) mag.
- normalization \(\phi^{\text{star}}_{-23}\) seems to show no evolution
  → quenching feedback at the very bright end is less efficient at higher z?
Summary

- We construct a large sample of bright high-z galaxy candidates based on the HSC SSP data.

- The UV LFs of our dropouts show humps at the very bright end, which are partly caused by the contributions of quasars.

- After subtracting the quasar UV LFs, we fit Schechter functions and double power law functions with the observed results and find that double power laws are favored.

- We confirm that at $M_{UV} \sim -21$ mag, the UV LFs decrease with increasing redshift. We find that, at $M_{UV} \sim -23$ mag, the UV LFs seem to show little evolution.