Studying Infrared Properties of LBGs with Subaru: from HSC to ULTIMATE

Jiasheng Huang
National Astronomical Observatories of China
CAS South American Center for Astronomy
Harvard–Smithsonian Center for Astrophysics
+CLAUDS team (M. Sawicki, S. Arnouts at al.)
what can we learn from CANDELS to understand a larger sample from CLAUDS?
CLAUDS

CFHT Large-Area U-band Deep Survey

250hr of Deep U band imaging in the Hyper Suprime Cam Deep Layer

S. Arnouts on behalf of the CLAUDS team

based on PI programs

<table>
<thead>
<tr>
<th>co-PIs</th>
<th>China</th>
<th>Jiasheng HUANG (Sebastien FOUCAUD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Marcin SAWICKI</td>
<td></td>
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<tr>
<td>France</td>
<td>Stéphane ARNOUTS</td>
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<tr>
<th>co-Is</th>
<th>China</th>
<th>Jing Y., Yang X., Li C.</th>
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<tr>
<td>Japan</td>
<td>Yamada T., Bundy K., Iwata I., Matsuda Y., Nagao T., Ouchi M., Shimasaku K., Silverman J., Tanaka M.</td>
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<tr>
<td>Canada</td>
<td>Balogh M., Chapman S., Gwyn S., Willott C., Yee H.</td>
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<tr>
<td>France</td>
<td>Ilbert O., Le Fèvre O., de La Torre S., Tresse L., Moutard T., Coupon J.</td>
<td></td>
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</tbody>
</table>
HSC Deep Fields

- Located in Extragalactic regions with multi-wavelength & spec-z informations

* HSC pointings
* MegaCam pointings
* u archives
  u CLAUDS

CFHT observations

- $T_{\text{exp}} \sim 16\text{hr}$ with u-old
- $T_{\text{exp}} \sim 15\text{hr}$ with u-new

Total: $\sim 300\text{hr}$ program
- Dark Time + IQ < 1"
- 4 sem. (14B - 16A)
- based on PI prog (C/F/S)
CFHT Large Area U-band Deep Survey

Extending Deep depth to $u^*_{AB}=27$ over $27\,\text{deg}^2$: 60 nights required!
Canada (Marcin Sawicki), France (Stephane Arnouts) and China (Seb Foucaud)

- $\sim 80\,\text{h} (15\,\text{n}) / \text{semester for 4 semesters}$ (tentative $30\,\text{h}/30\,\text{h}/20\,\text{h}$)
- regular proposal joint for the 3 agencies
- China: Telescope Access Program
- Involving 5 Canadian, 3 French and 3 Chinese (in addition to PIs) + students & postdocs: External collaborators
- Strong science cases (U-band driven): SFR in $z \sim 1$ clusters, LAEs (NB387), lensed/bright $z \sim 3$ LBGs, …
CLAUDE S enables new HSC science

The samples assembled with HSC Deep will be unique

### Table 3: Expected number of objects

<table>
<thead>
<tr>
<th>( &lt;z&gt; )</th>
<th>sample</th>
<th>( \text{Vol}(\text{Gpc}^3) )</th>
<th>( M_*(M_\odot) )</th>
<th>N of galaxies</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>photo-z</td>
<td>0.001</td>
<td>( 10^{8.7} )</td>
<td>7.2k</td>
</tr>
<tr>
<td>0.3</td>
<td>photo-z</td>
<td>0.008</td>
<td>( 10^{9.3} )</td>
<td>38.3k</td>
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<tr>
<td>0.5</td>
<td>photo-z</td>
<td>0.019</td>
<td>( 10^{9.8} )</td>
<td>71.8k</td>
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<tr>
<td>0.7</td>
<td>photo-z</td>
<td>0.029</td>
<td>( 10^{10.1} )</td>
<td>94.4k</td>
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<tr>
<td>0.9</td>
<td>photo-z</td>
<td>0.040</td>
<td>( 10^{10.2} )</td>
<td>137.3k</td>
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<tr>
<td>2.3</td>
<td>BM/BX</td>
<td>0.341</td>
<td>–</td>
<td>2.5M</td>
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<tr>
<td>3.0</td>
<td>U-dropout</td>
<td>0.340</td>
<td>–</td>
<td>0.9M</td>
</tr>
<tr>
<td>3.0</td>
<td>QSOs</td>
<td>0.340</td>
<td>–</td>
<td>1000</td>
</tr>
<tr>
<td>2.2</td>
<td>LAE / LAB</td>
<td>0.017</td>
<td>–</td>
<td>9k / 700</td>
</tr>
</tbody>
</table>

Lensing shape measurement is limited by low shear S/N for sources at \( z > 1 \)

⇒ CLAUDE S+H SC-Deep perfect for lensing magnification bias studies with LBG sample
LBGs in XMM–LSS (CLAUDS+HSC): A Large LBG sample at $z \sim 3$

- 22400 LBGs with $R < 25.5$
- 43200 LBGs with $R < 26.0$
- 14400 LBGs detected at 3.6 micron ——— (SERV)
- 1015 LBGs detected at 8.0 micron ——— (SERV)
- 509 LBGs detected at 24 micron ——— (SWIRE)
- 418 LBGs detected at 250 micron ——— (HerMES)
The “Red LBGs” puzzle in CLAUDS? Or photz Issue?

![Graph showing the relationship between r-[3.6] and [3.6] (mag) with mag values marked at 25.5, 24.5, and 23.5.]
IR properties of luminous LBGs in XMM–LSS

Photometry Sample

REDSHIFT SAMPLE

- Herschel Sources
- MIPS sources

K−[4.5]

J−K
Issues with LBGs or galaxies at z ~ 3

- Does photz really work for galaxies at z >= 3?
- Does (N+M)IR emission really come from LBGs?
- How bad is the confusion? Or what is fraction of close pair in LBG samples.
- LBG masses, morphologies, color bimodalities.
LBGs in GOODSN
Steidel et al. 2003

- 144 LBGs in GOODSN
- ~70 have Spec z, most around z=3
CANDELS Photz for LBGs in Steidel et al. 2003
LBGs resolved by the HST image in GOODSN

- 22 LBGs in GOODSN have neighboring objects within 1.2” distance.
The IR Color–Magnitude relation

![Graph showing the IR Color–Magnitude relation with various sources and markers representing different types of sources.]
Hidden Stellar Mass for red LBGs
Color–Color diagrams for LBGs in GOODSN

All LBGs

K-[4.5] vs J-K

LBGs with Spec z

K-[4.5] vs J-K

AGN/QSO

Herschel/MIPS Sources
“Red Galaxies” in UV selected LBGs?

X-ray Source

QSO?
Stellar Mass segregation in the C–C diagram
Sersic Index
Summary

• Lyman Break selection is probably better than photz

• There may be large stellar mass hidden behind dust in LBG.

• There are a few passive galaxies in the LBG sample

• We will detect a sample of ULIRG/HyperLIRG at z=3 with Lyman Break technique.