PACS photometry of two z > 4 QSO

Christian Leipski


1 MPIA
2 CEA Saclay
3 Argelander Institut, Universität Bonn
4 Steward Observatory, University of Arizona
5 Astronomisches Institut, Universität Bochum
6 Institut d’ Astrophysique, Liege
7 Instituut voor Sterrenkunde, Universiteit Leuven
Introduction

• Large quantities of cold and hot dust are detected in high-redshift quasars (e.g. Bertoldi+03, Beelen+06, Hines+06, Jiang+06, Wang+08)
  ➔ Substantial enrichment of the ISM during the first billion years after the Big Bang
  ➔ Large SFR in the host galaxies (up to several $10^3 M_\odot/yr$)

• Similarity of SEDs between high and low redshift AGN
  ➔ General structures characterizing local AGN already in place at $z \sim 6$

• Key Project: The Dusty Young Universe
  ➔ SEDs at $\lambda = 100 - 500 \mu m$ of the highest redshift quasars (77 sources at $z > 5 + 17$ radio-loud/mm-loud sources at $z \sim 4$)
  ➔ Dust masses and temperatures, FIR luminosities of host galaxies 1 Gyr after big bang. History and frequency of dust production.
Observations

PACS photometry of two FIR / (sub)mm bright QSOs at high-z

<table>
<thead>
<tr>
<th>SDSS J1148+5251</th>
<th>BR 1202-0725</th>
</tr>
</thead>
<tbody>
<tr>
<td>z = 6.42</td>
<td>z = 4.69</td>
</tr>
<tr>
<td>M_{dust} ≈ 4 \times 10^8 M_☉</td>
<td>M_{dust} ≈ 8 \times 10^8 M_☉</td>
</tr>
<tr>
<td>L_{FIR} ≈ 2 \times 10^{13} L_☉</td>
<td>L_{FIR} ≈ 4 \times 10^{13} L_☉</td>
</tr>
<tr>
<td>SFR ≈ 2000 M_☉ yr^{-1}</td>
<td>SFR ≈ 2500 M_☉ yr^{-1}</td>
</tr>
<tr>
<td>T_{dust} ≈ 60 K</td>
<td>T_{dust} ≈ 50 K</td>
</tr>
</tbody>
</table>

PACS
100 + 160 μm
chop-nod + scan-map
2100 + 1150 sec on-source

PACS
70 + 160 μm
chop-nod
1980 sec on-source
Results

BR 1202-0725

- $z = 4.69$
- $F_{70} = 15.0 \pm 2.0 \text{ mJy}$
- $F_{160} = 39.8 \pm 3.7 \text{ mJy}$
- chop-nod works well for brighter sources in empty fields

10.05.2010

Christian Leipski - Herschel First Results Symposium
Results

**BR 1202-0725**

- FIR dominated by dust at \( \sim 50 \) K
- SED implies wide range of dust temperatures
- Local AGN template needs excess FIR emission to match observations
  - Strong star formation
- Mismatch in MIR can be explained by the close (\( \sim 4" \)) companion

![Graph showing observed wavelength vs. flux (mJy) and vFv vs. rest wavelength (\( 10^{-13} \) erg/s/cm²)]
BR 1202-0725

- FIR dominated by dust at \( \sim 50 \) K
- SED implies wide range of dust temperatures
- Local AGN template needs excess FIR emission to match observations
  - Strong star formation
- Mismatch in MIR can be explained by the close (\( \sim 4'' \)) companion

\[ L_{\text{IR}} = 3 \times 10^{14} L_\odot \]
Results

SDSS J1148+5251

- $z = 6.42$
- $F_{100} = 4.1 \pm 1.0 \text{ mJy}$
- $F_{160} = 6.3 \pm 2.0 \text{ mJy}$
- Not detected in chop-nod at 160 $\mu$m
- (mini)scan-map preferable for faint sources
- confusing source at 160 $\mu$m at $\sim 10''$ distance
SDSS J1148+5251

- $z = 6.42$
- $F_{100} = 4.1 \pm 1.0 \text{ mJy}$
- $F_{160} = 6.3 \pm 2.0 \text{ mJy}$
- Not detected in chop-nod at 160 $\mu$m
- (mini)scan-map preferable for faint sources
- Confusing source at ~10” distance

2100 sec
1150 sec
Results

SDSS J1148+5251

- FIR dominated by dust at \( \sim 60 \) K
- SED implies wide range of dust temperatures
- Local AGN template needs excess FIR emission to match observations
  - Strong star formation
- Mismatch in NIR possibly due to larger fraction of dust at high temperatures?
Results

**SDSS J1148+5251**

- FIR dominated by dust at ~ 60 K
- SED implies wide range of dust temperatures
- Local AGN template needs excess FIR emission to match observations
  - Strong star formation
- Mismatch in NIR possibly due to larger fraction of dust at high temperatures?
Results - J1148+5251

- Companion bright in FIR / (sub)mm
- Possible contributions to $L_{\text{FIR}}$ of the QSO
- Nature of this source unclear → further studies needed
Summary & Conclusion

- Herschel allows detection of dust emission at the highest redshifts
- (mini) scan-map mode well suited for detecting faint point sources
- Excess FIR emission for the two observed high-z QSOs
  - Rapid bulge formation in the host galaxies at high redshift?
  - But: selected for being FIR/(sub)mm bright → they could be exceptions
- 'confusing' source close to the z = 6.42 QSO J1148+5251