

PACS photometry of two $z > 4$ QSO

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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 $10^3 M_\odot/\text{yr}$)
- 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 $\lambda = 100 - 500 \mu\text{m}$ 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

SDSS J1148+5251

- $z = 6.42$
- $M_{\text{dust}} \sim 4 \times 10^8 M_{\odot}$
- $L_{\text{FIR}} \sim 2 \times 10^{13} L_{\odot}$
- $\text{SFR} \sim 2000 M_{\odot} \text{yr}^{-1}$
- $T_{\text{dust}} \sim 60 \text{ K}$

PACS

100 + 160 μm

chop-nod + scan-map

2100 + 1150 sec on-source

BR 1202-0725

- $z = 4.69$
- $M_{\text{dust}} \sim 8 \times 10^8 M_{\odot}$
- $L_{\text{FIR}} \sim 4 \times 10^{13} L_{\odot}$
- $\text{SFR} \sim 2500 M_{\odot} \text{yr}^{-1}$
- $T_{\text{dust}} \sim 50 \text{ K}$

PACS

70 + 160 μm

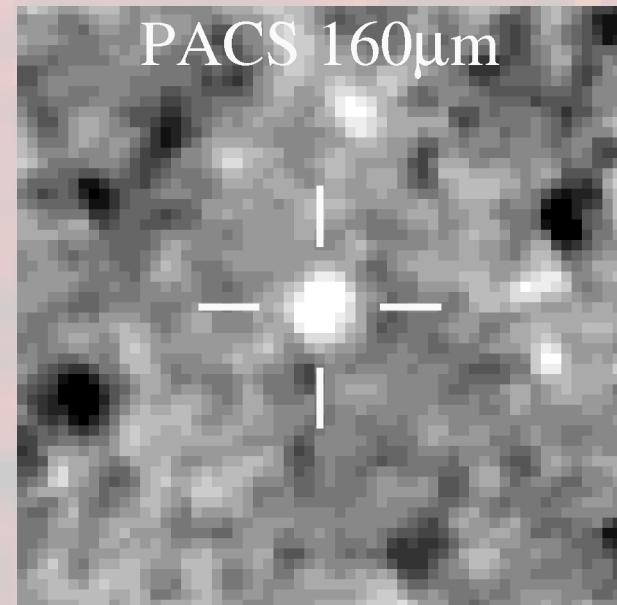
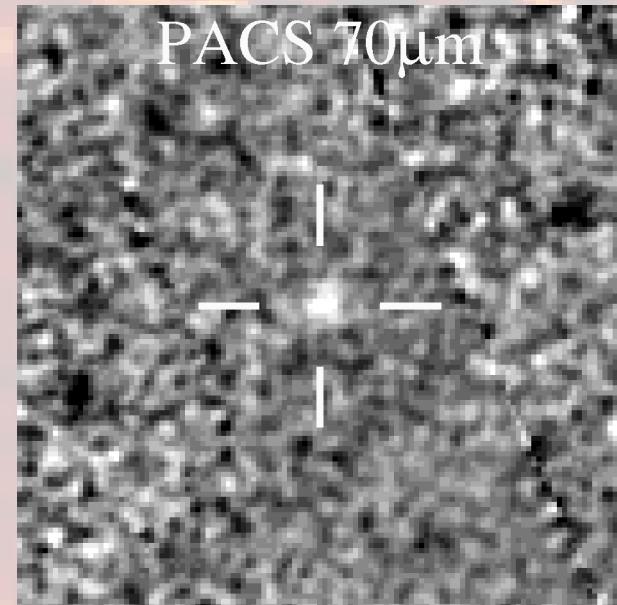
chop-nod

1980 sec on-source

Results

BR 1202-0725

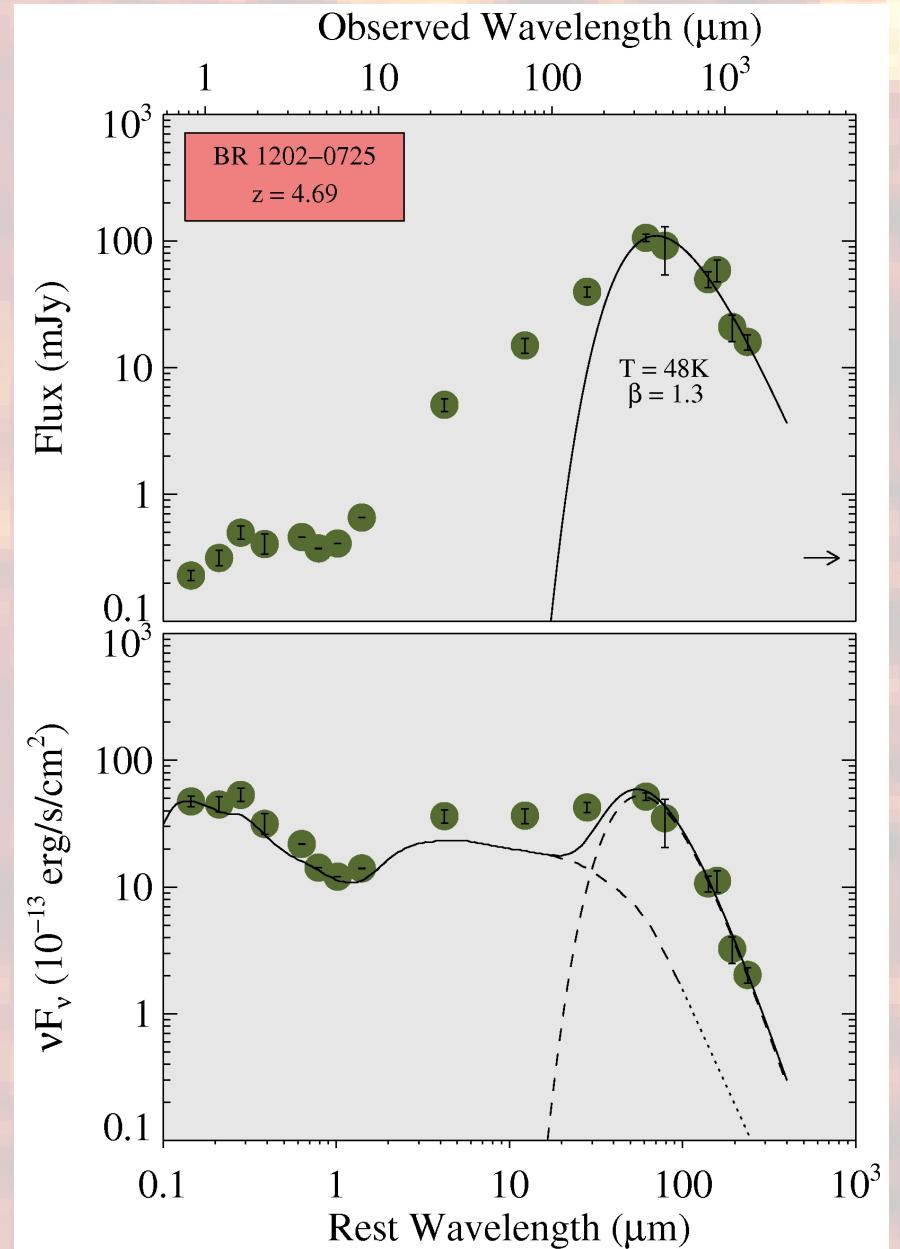
- $z = 4.69$
- $F_{70} = 15.0 \pm 2.0 \text{ mJy}$
 $F_{160} = 39.8 \pm 3.7 \text{ mJy}$
- chop-nod works well for brighter sources in empty fields



Results

BR 1202-0725

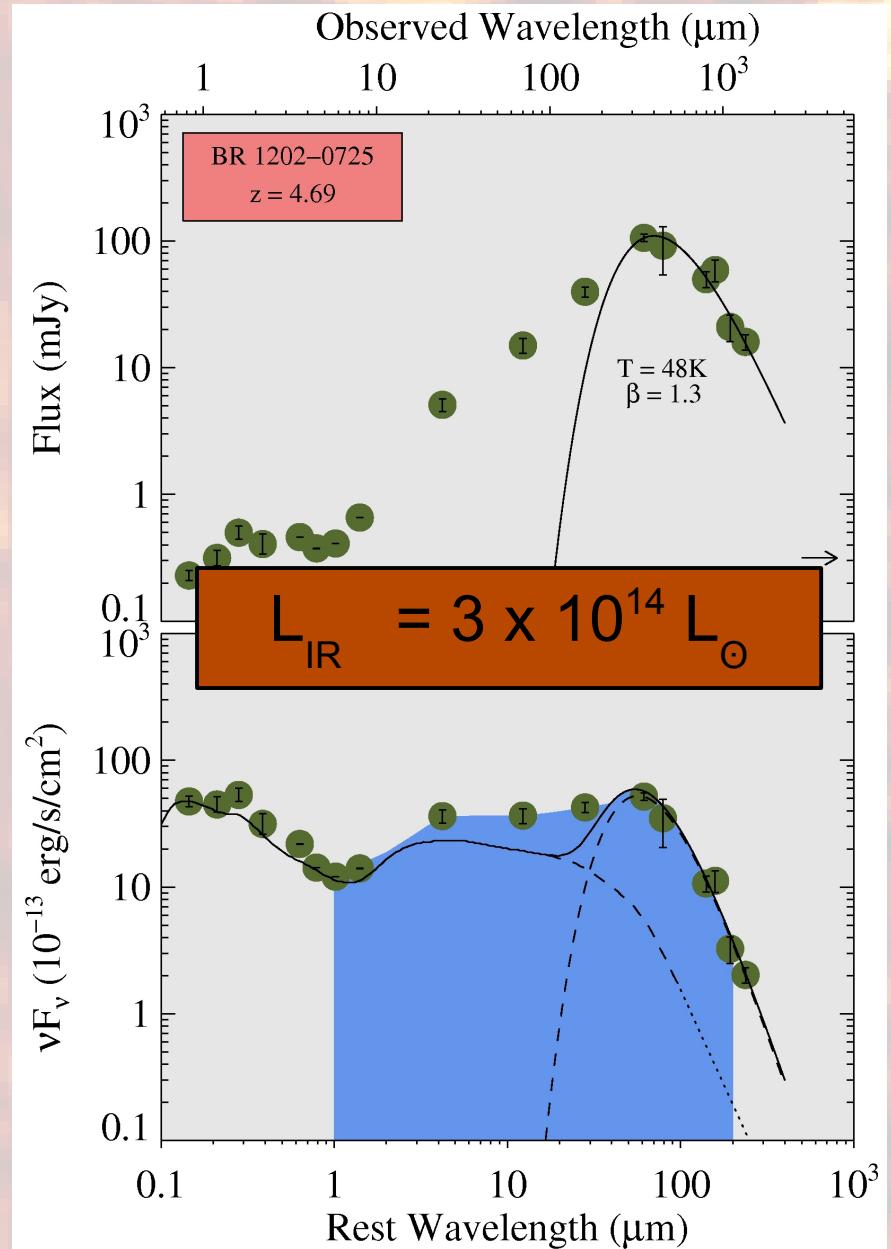
- FIR dominated by dust at ~ 50 K
- SED implies wide range of dust temperatures
- Local AGN template needs excess FIR emission to match observations
→ Strong star formation
- Mismatch in MIR can be explained by the close (~4'') companion



Results

BR 1202-0725

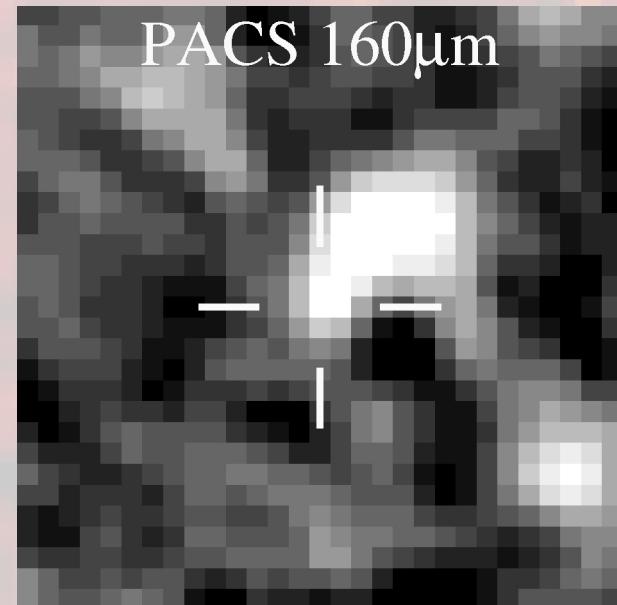
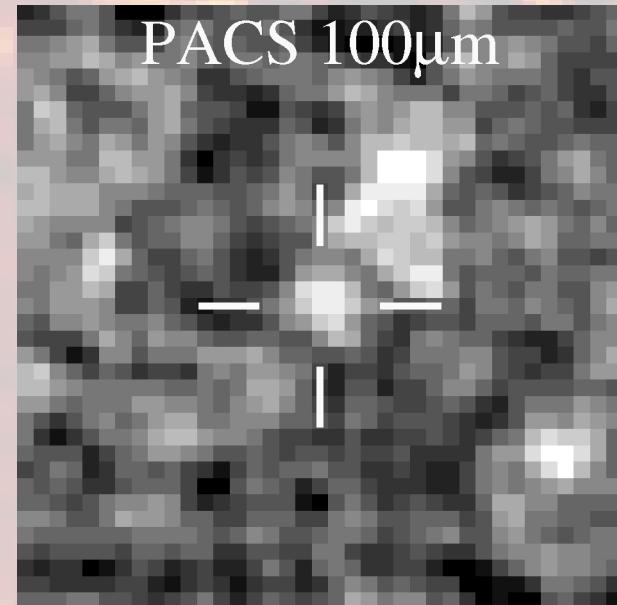
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Results

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 μm
- (mini)scan-map preferable for faint sources
- confusing source at 160 μm at $\sim 10''$ distance



Results

PACS 100 μ m – c/n

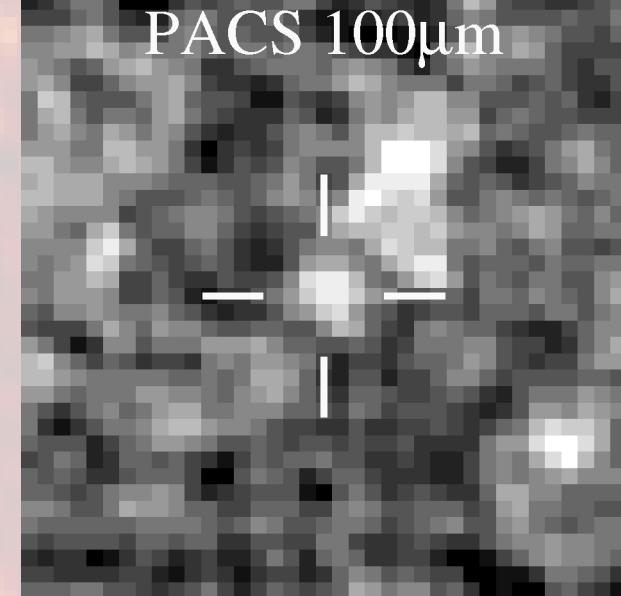
SDSS J1148-

- $z = 6.42$
- $F_{100} = 4.1 \pm 1.0$ mJy
- $F_{160} = 6.3 \pm 2.0$ mJy
- Not detected in chop-nod at 160 μ m
- (mini)scan-map p. for faint sources
- confusing source at $\sim 10''$ distance

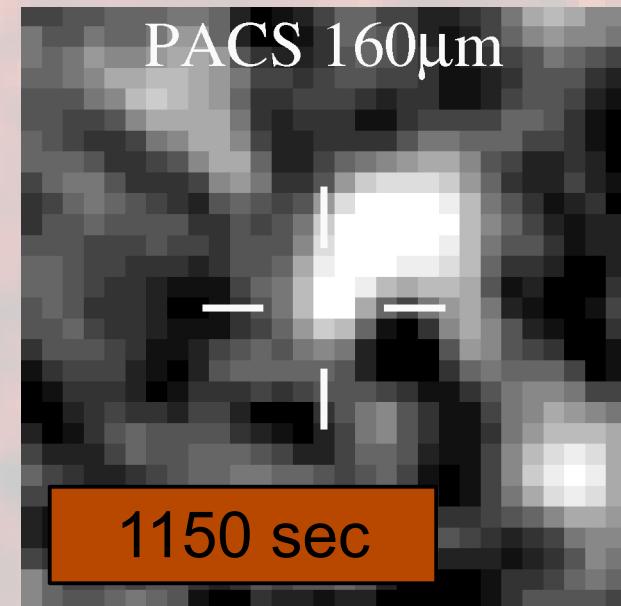
PACS 160 μ m – c/n

2100 sec

PACS 100 μ m



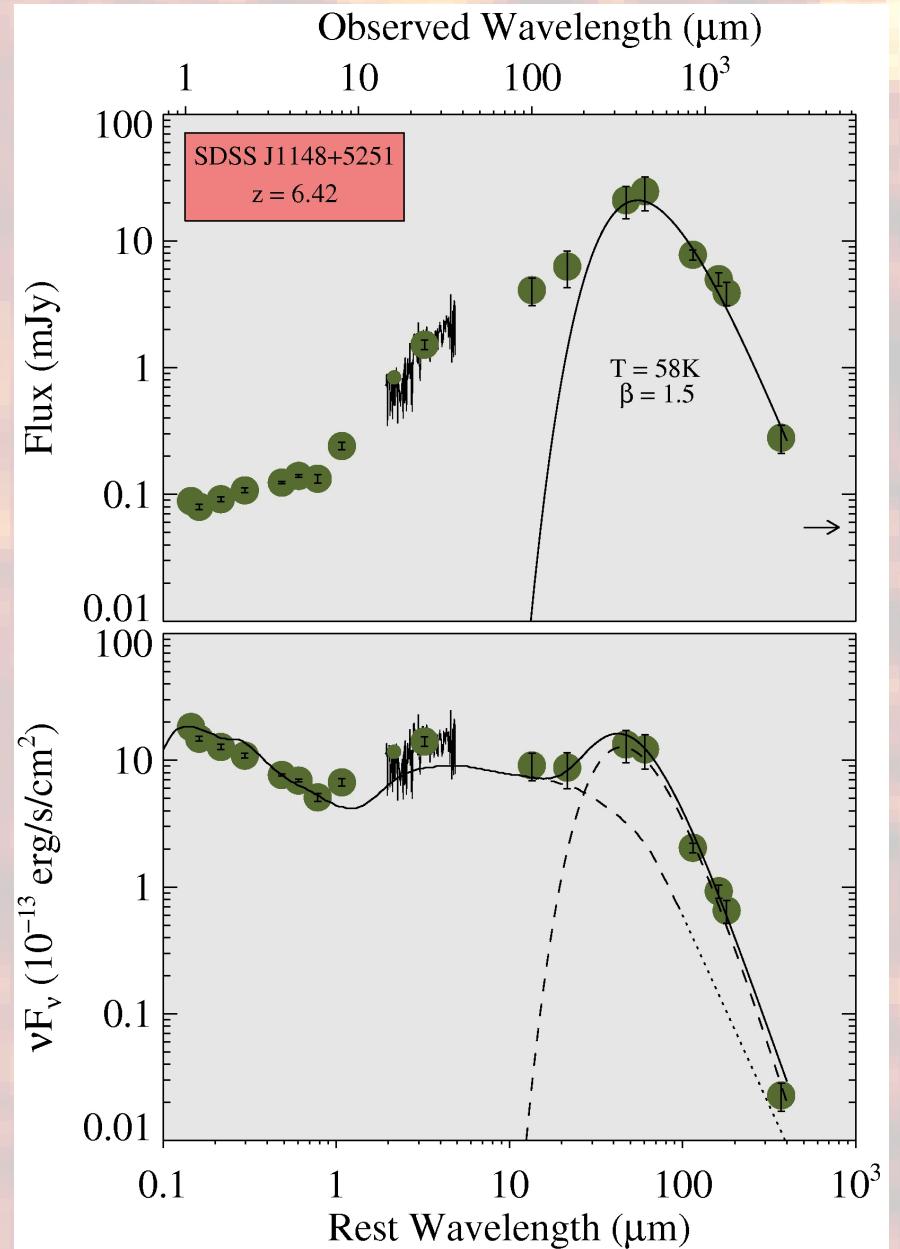
PACS 160 μ m



Results

SDSS J1148+5251

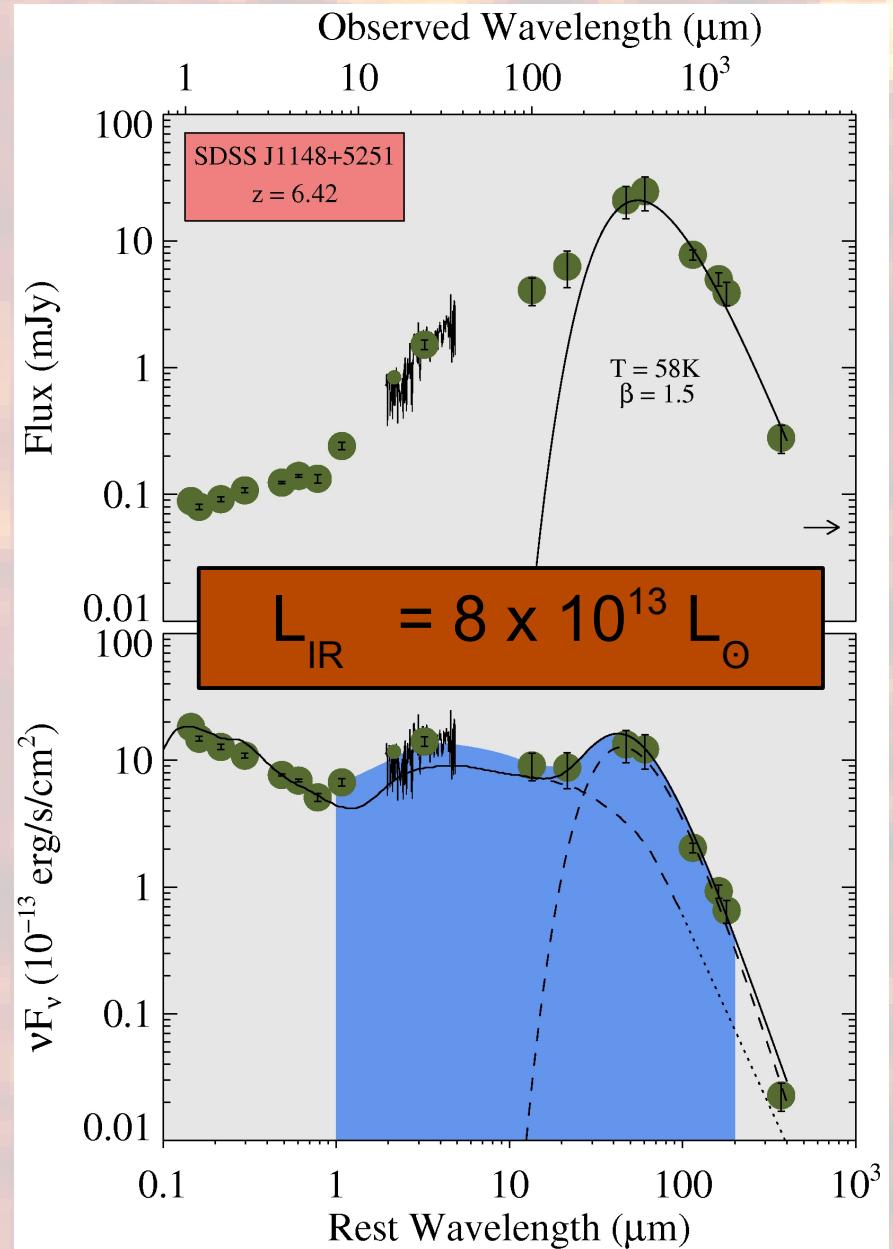
- FIR dominated by dust at ~ 60 K
- SED implies wide range of dust temperatures
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→ Strong star formation
- Mismatch in NIR possibly due to larger fraction of dust at high temperatures ?



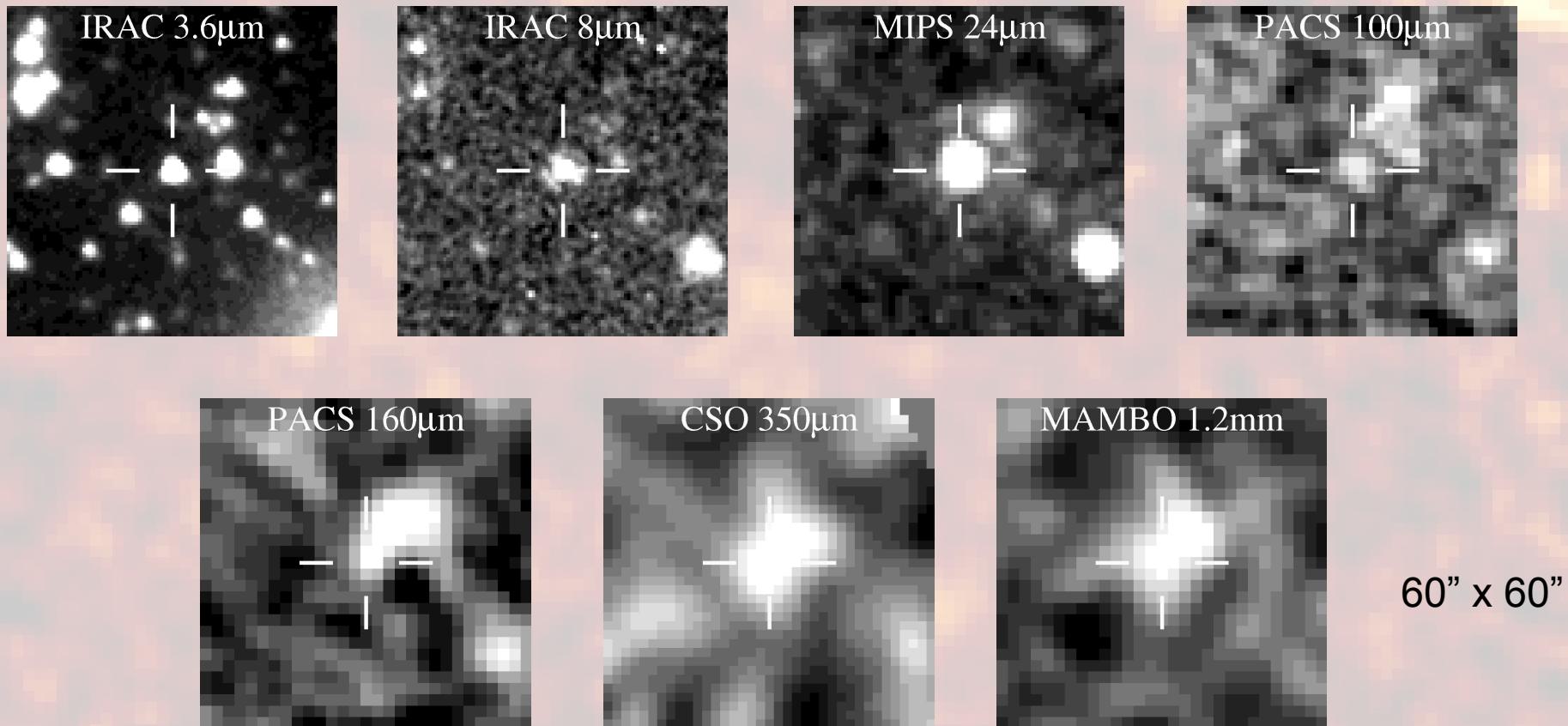
Results

SDSS J1148+5251

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Results - J1148+5251



- Companion bright in FIR / (sub)mm
- Possible contributions to L_{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

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