Herschel-ATLAS: Studying the link between star formation and black hole accretion

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on behalf of the Herschel-ATLAS consortium

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Outline

- The Herschel-ATLAS Survey
- A quasar sample – SDSS and 2SLAQ
- Fitting FIR luminosities
- Using "non-detections" without stacking
- Dealing with confusion
- Results
- Implications?

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Motivation

- Use H-ATLAS to constrain far-infrared (star-formation) luminosities of bright, optically-selected quasars, as a function of optical (quasar) luminosity
- Previous work by Sergeant & Hatziminaoglou (2009) used large sample of quasars with heterogeneous IR data (SWIRE, MAMBO, SCUBA, IRAS, ISO)
  - Found SFR ~ $L_{QSO}^{0.44\pm0.07}$
  - assumption that SED model can correct mid-IR to total L_{IR}
- Present work aims to determine constraint on this relationship using FIR H-ATLAS data alone

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Herschel ATLAS

- (Herschel Astrophysical Terahertz Large Area Survey**)**
- **Eventually** 550 sq deg
  - NGP, SGP, equatorial (GAMA) fields
  - **This work uses only ~15 sq deg of Science Demonstration Phase data**
- PACS 100/160um, SPIRE 250/350/500 um
  - BUT only SPIRE used here to avoid contamination by warm dust heated directly by quasar

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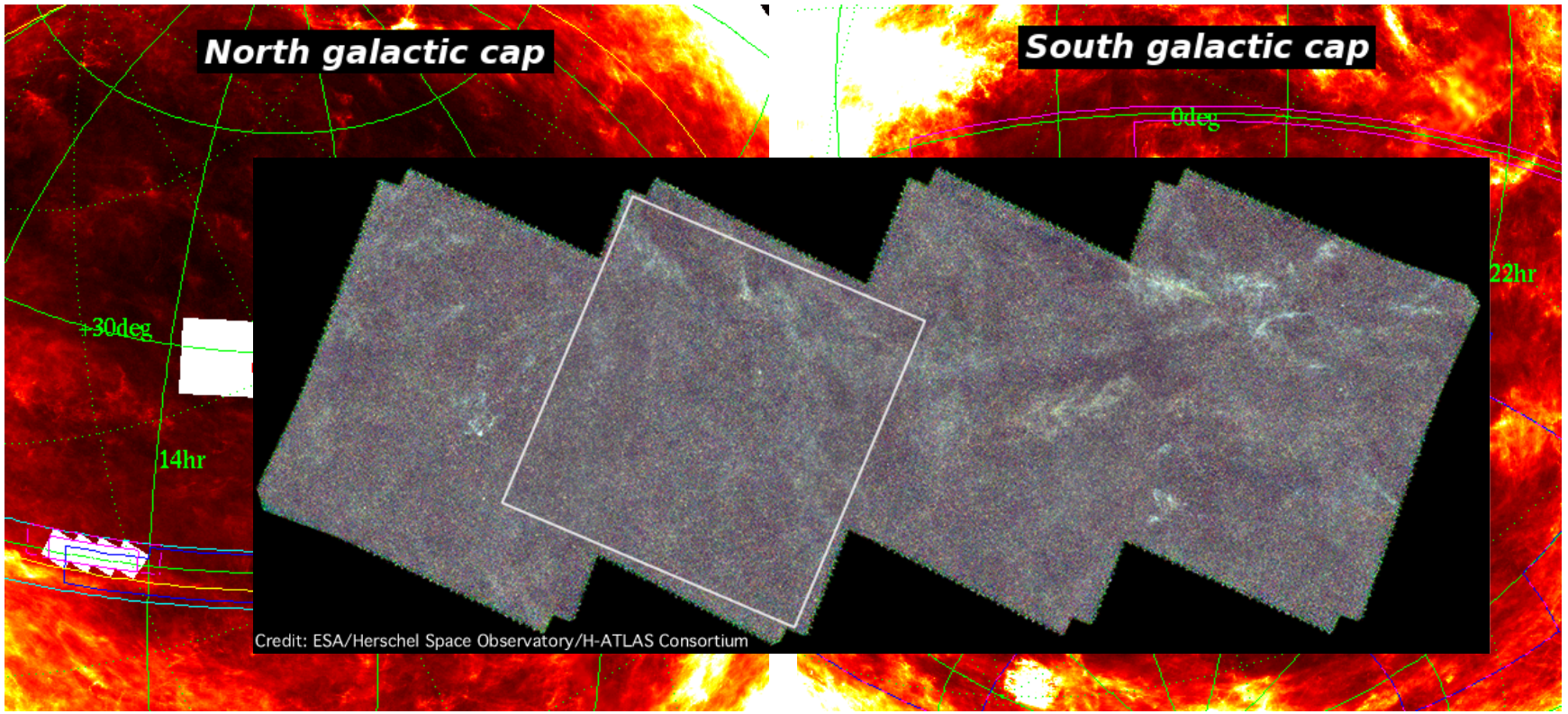
Herschel ATLAS



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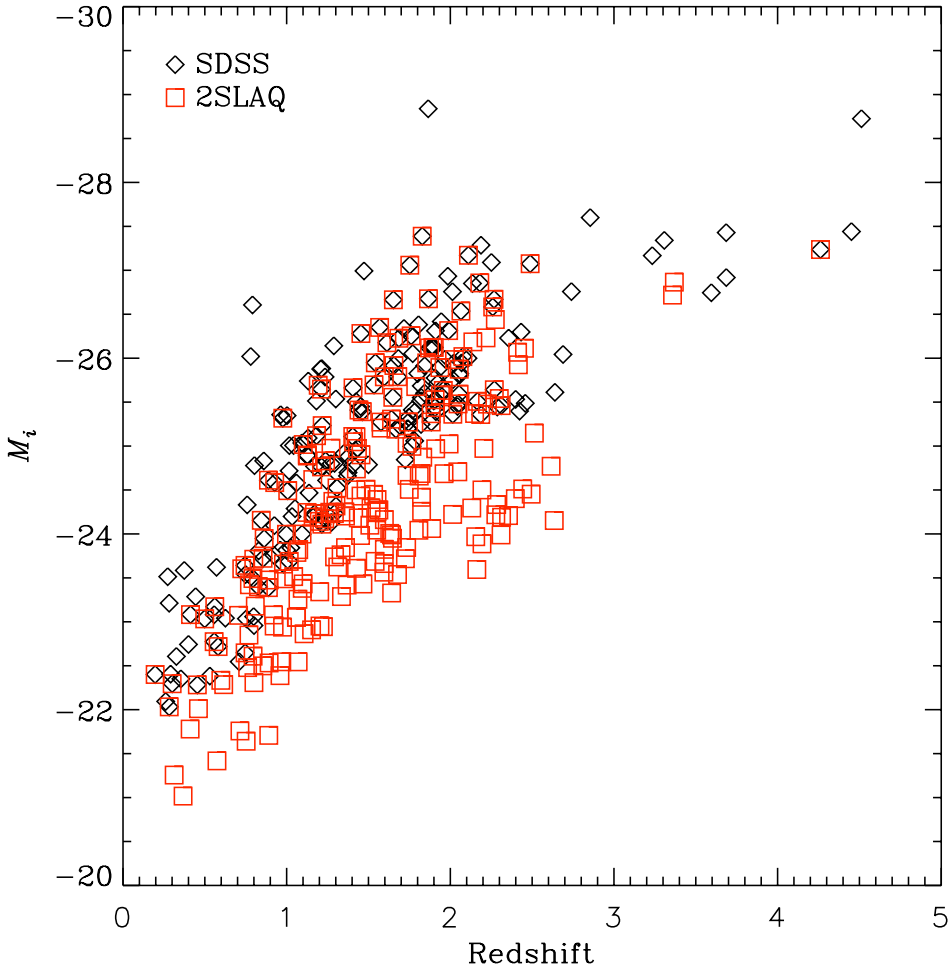
Quasar sample



- 372 objects from SDSS and 2SLAQ quasar samples
- luminous quasars
  10^{45} erg/s < L_{bol} < 10^{48} erg/s
- 2SLAQ very useful in providing fainter luminosity objects

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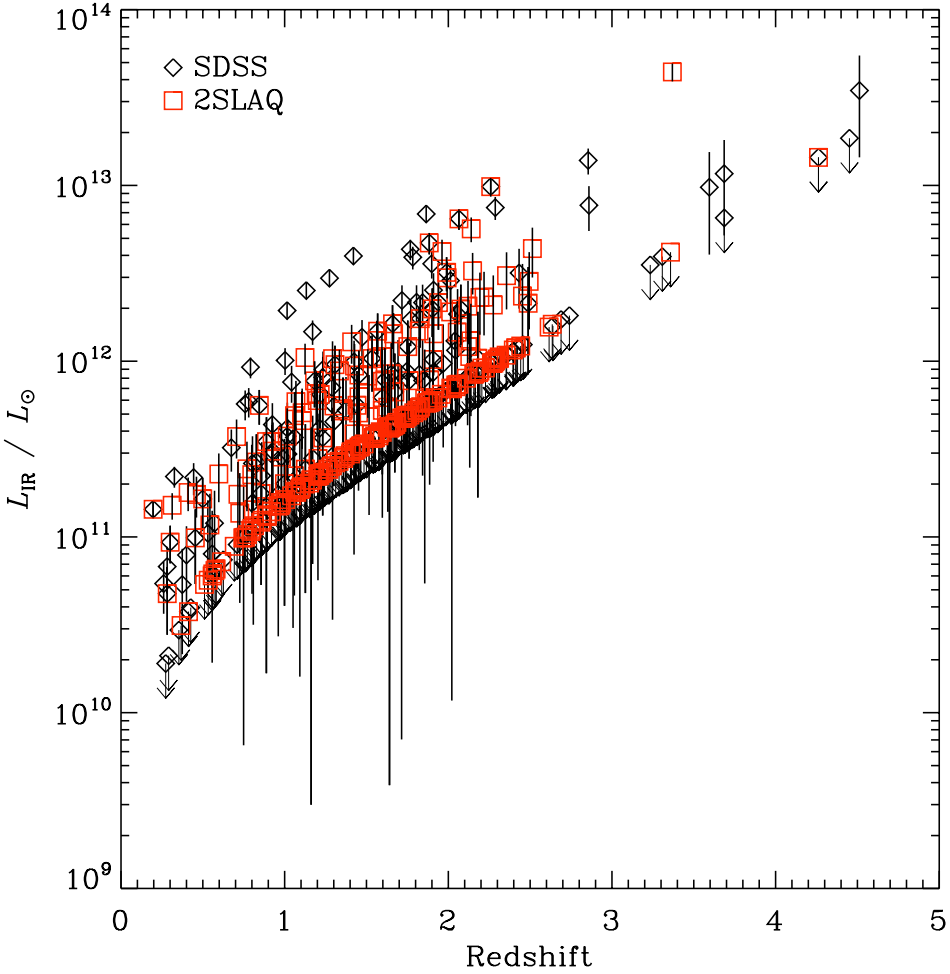
First: Fit FIR luminosity



- Assume grey dust: beta=1.5, T=35K
- Fit to 3 SPIRE fluxes
- Allow negative luminosities (as most objects are in the noise)
  - (limits plotted here because of log scale...)

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Next: Fit power law

- Assume $L_{IR} \propto L_{QSO}^{\theta} (1+z)^{\zeta}$
  - single power law describing all objects...

- Maximum likelihood fit for θ, ζ, $\Delta\theta$, $\Delta\zeta$, and normalisation

- Fit directly to **all** datapoints, including non-detections, to extract maximum information, but need to correct for asymmetric confusion noise...

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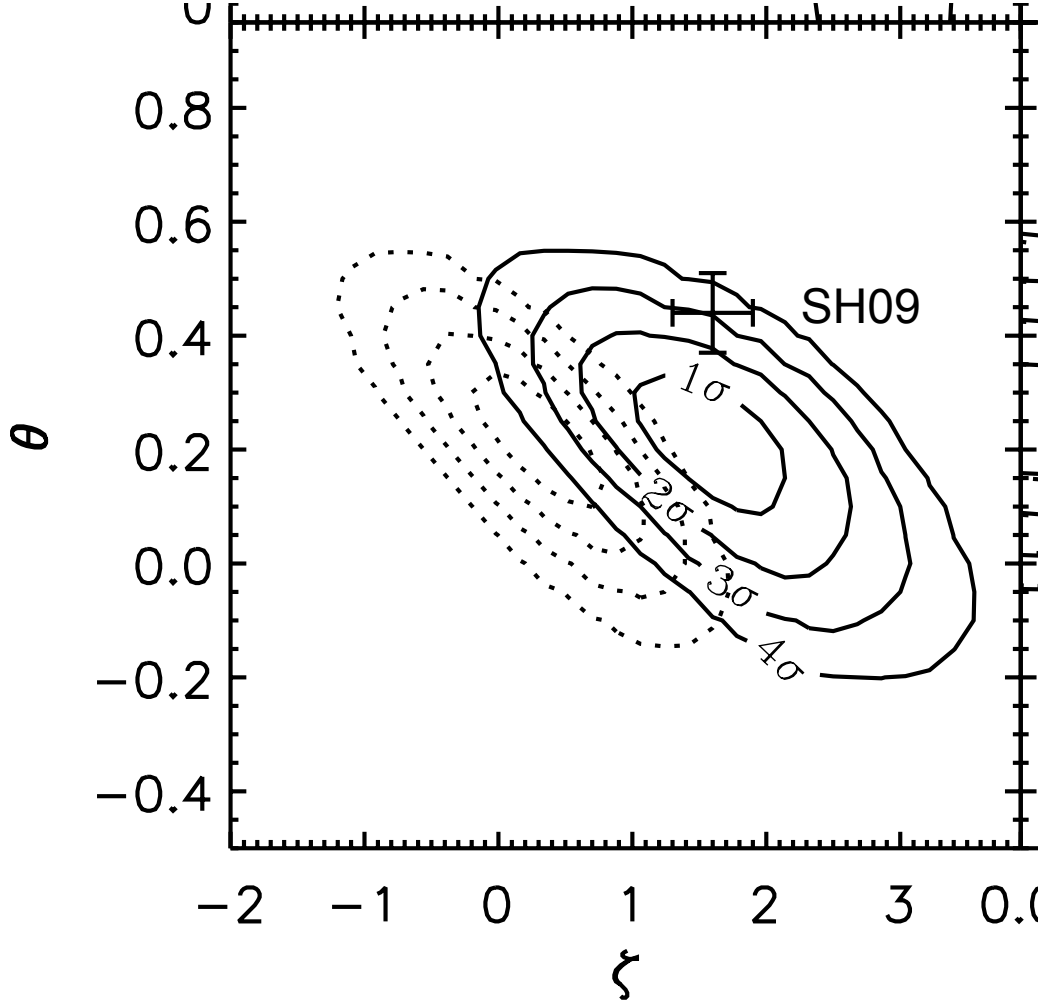
Confusion

- Implicit assumption of fitting is that noise is **symmetric** for each object
  - not true for a confusion background
- Deal with this by subtracting random pixel to symmetrise noise
- Downside is increased noise level
  - multiple random background realisations, and stacking of likelihoods

Results



solid = 30 K
dotted = 45 K

Correlation of L_{IR} with z is sensitive to assumed T

Slope on L_{IR} vs L_{QSO}:

$\theta = 0.22 \pm 0.08$

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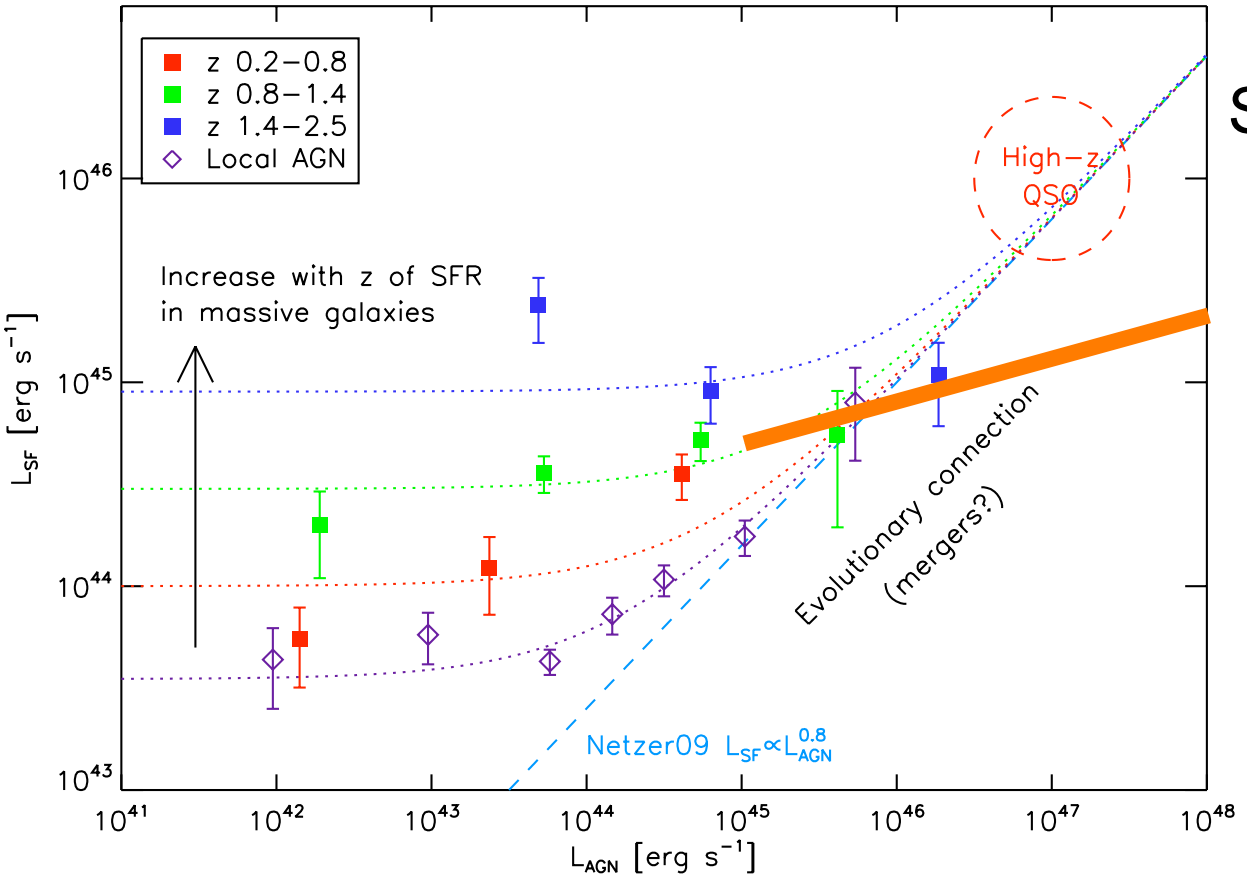
Results



Shao et al 2010

Our result (at z~1.5)

Note: Normalisation depends a little on assumed dust temperature...

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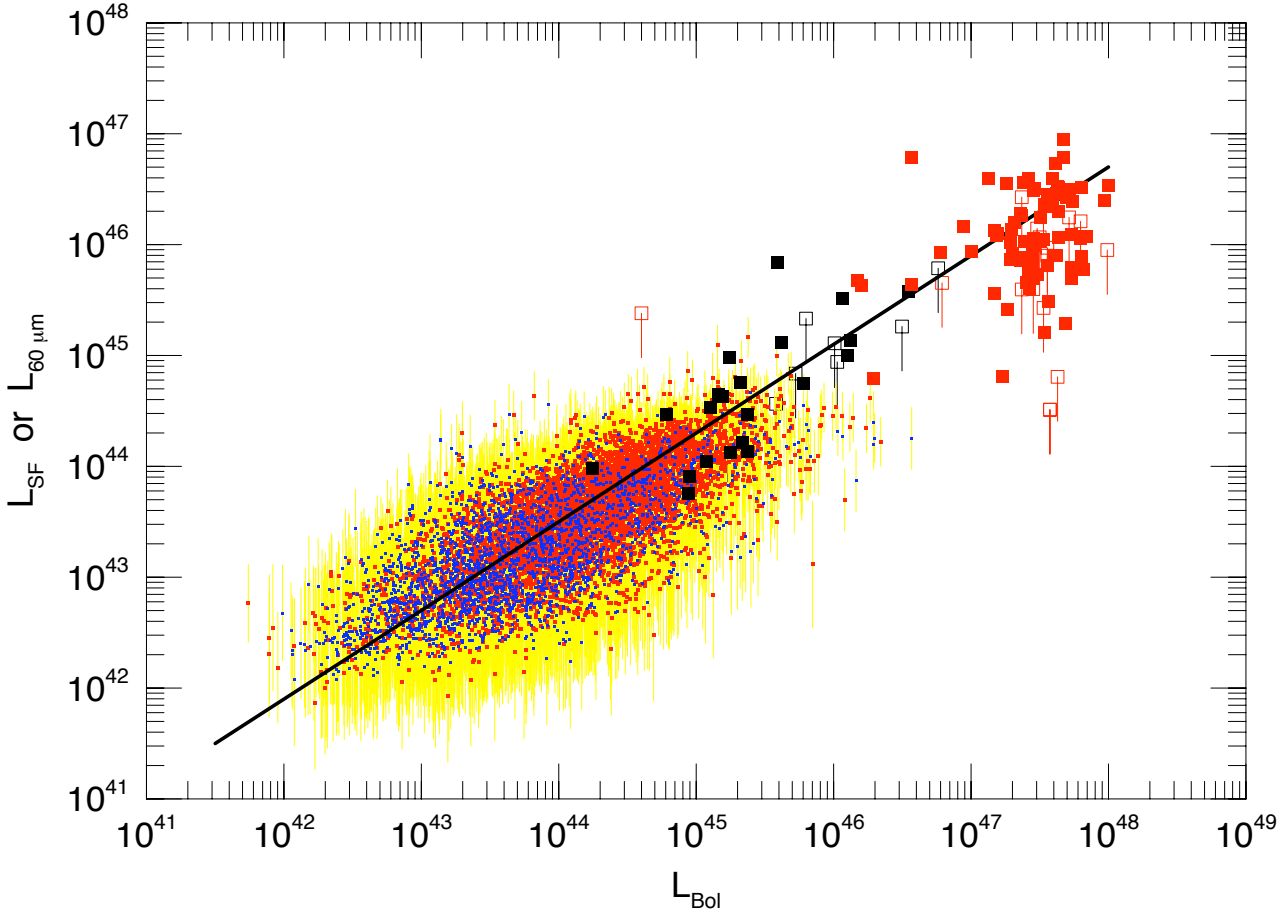
Results



Netzer 2009 slope:

- never claimed to be a fit to data (ignores upper limits)

- red points (Lutz+ 2008) preselected to have sub-mm detections

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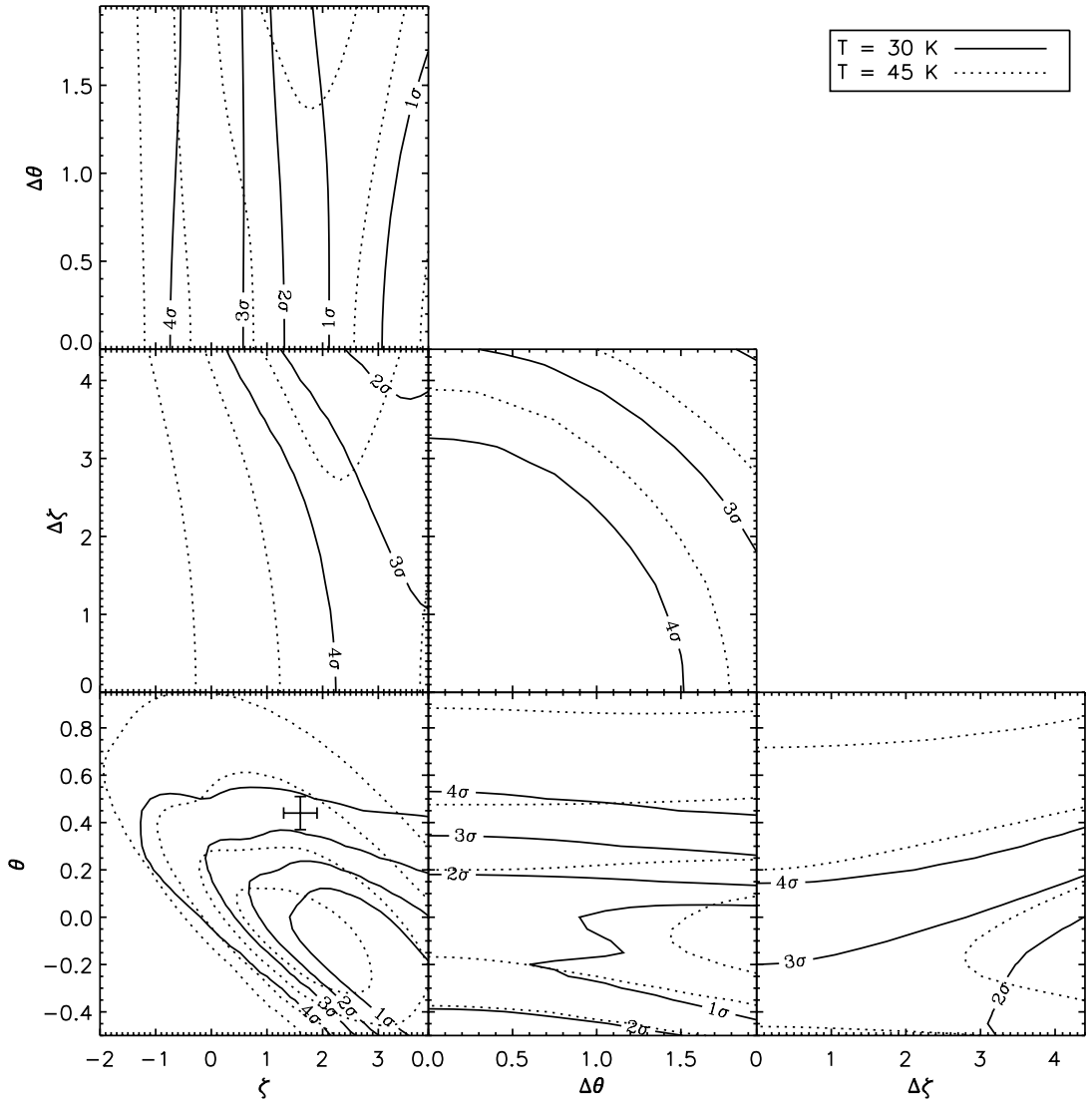
Results



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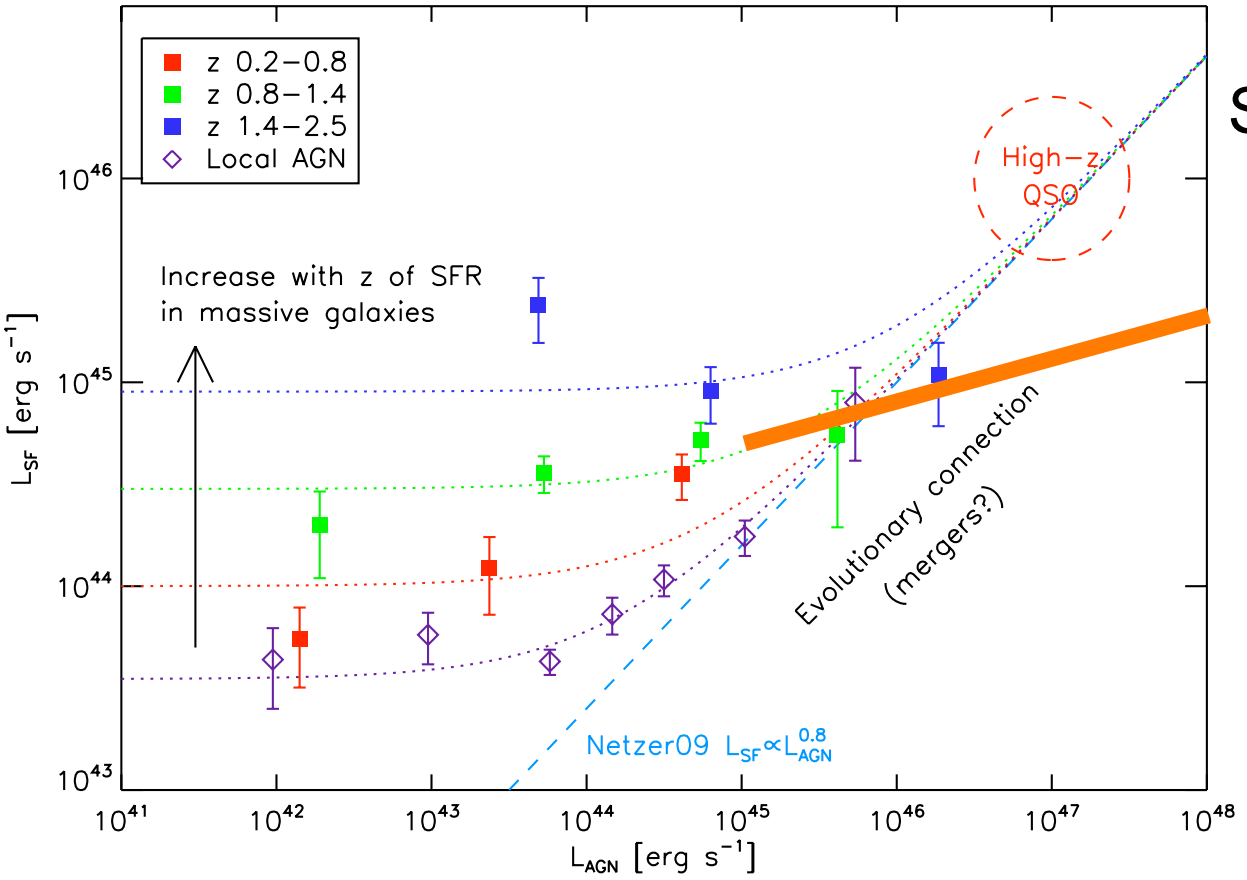
Results



Shao et al 2010

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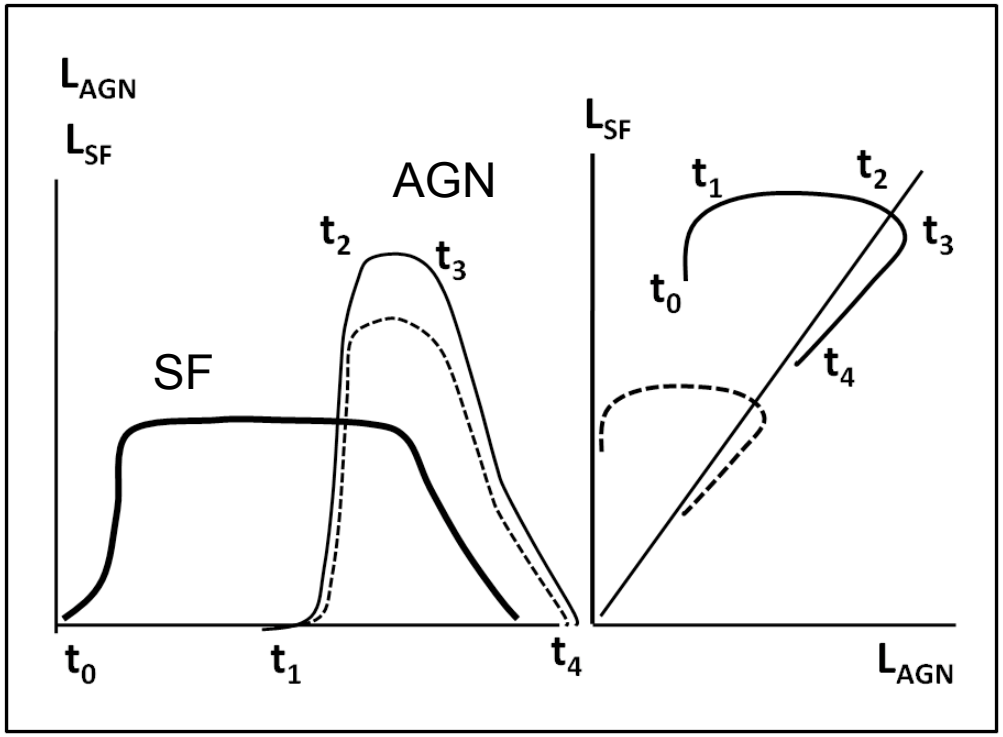
Interpretation

- Evidence for a connection between L_{IR} and L_{QSO} (e.g. due to mergers)

- BUT not simple linear relationship

Interpretation

- Netzer 2009:



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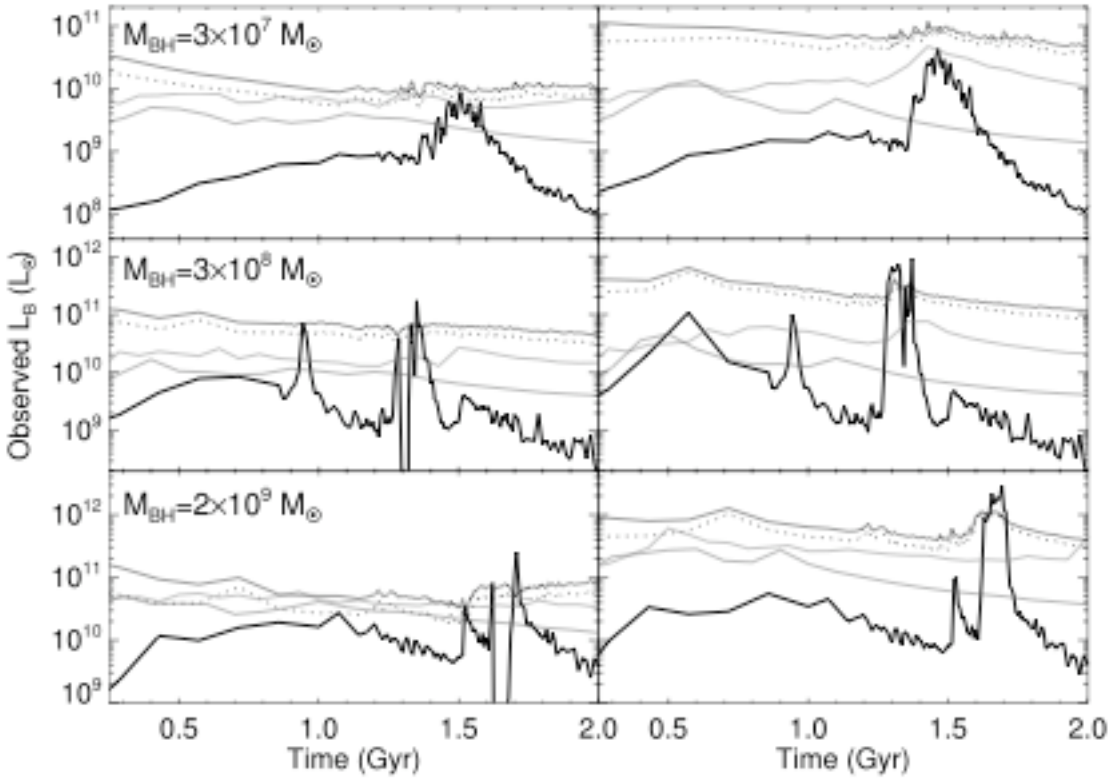
Interpretation

- Hopkins et al (2006) models (SF and QSO triggered by merger):
  - L_{SF} depends on gas fraction
  - L_{QSO} insensitive to gas fraction



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Summary

- Herschel-ATLAS SDP field is ~15 sq deg
- We use data from SPIRE 250/350/500 micron bands to fit L_{IR}
- We use optical (rest-frame *i*-band) to determine L_{QSO}

- Constrain power law slope of L_{IR} vs L_{QSO} as 0.22 ± 0.08 for luminous quasars (assuming all quasars are the same!)

  (for more details see Bonfield et al 2011, MNRAS 416, 13)

- Consistent with models where mergers trigger QSOs, with either:
  - different timescales for QSO and SF
  - variation of SF luminosity with gas content
- Full H-ATLAS survey will allow splitting of sample by L_{QSO}, z,
  - perhaps also fitting for variations in dust temperature?

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