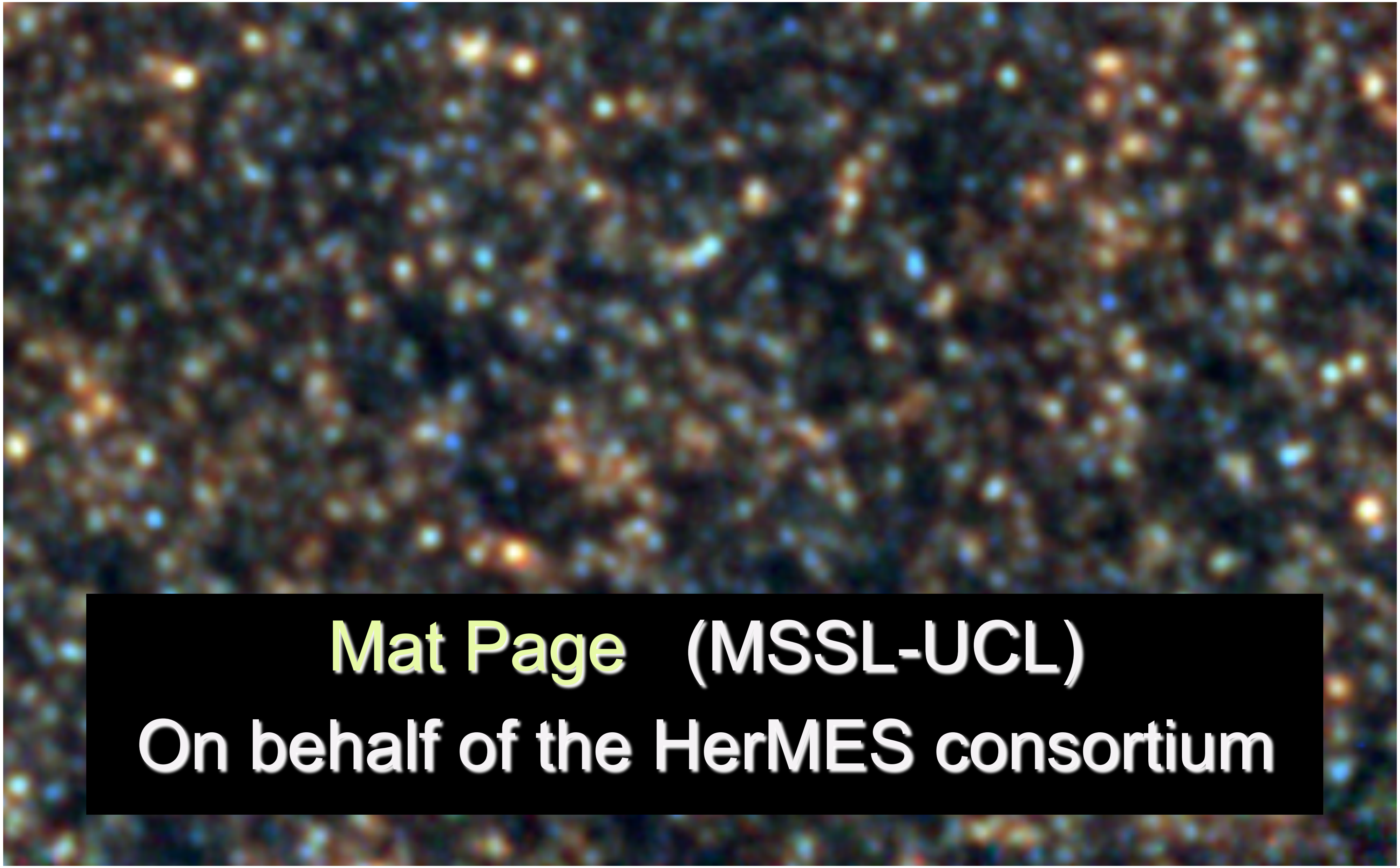
HERMES

The Herschel multi-Tiered Extragalactic Survey: Active Galactic Nuclei and the Growth of Galaxy Bulges



Mat Page (MSSL-UCL)

On behalf of the HerMES consortium

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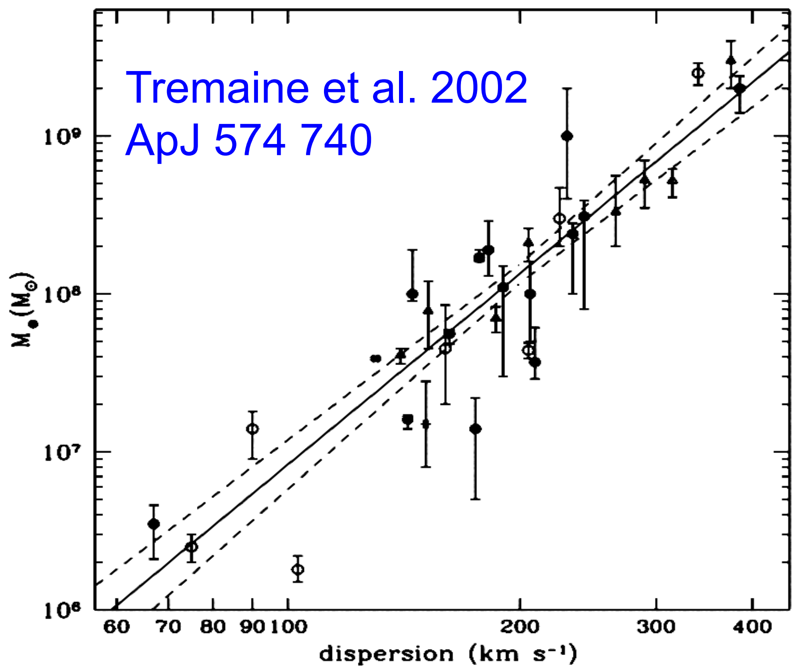
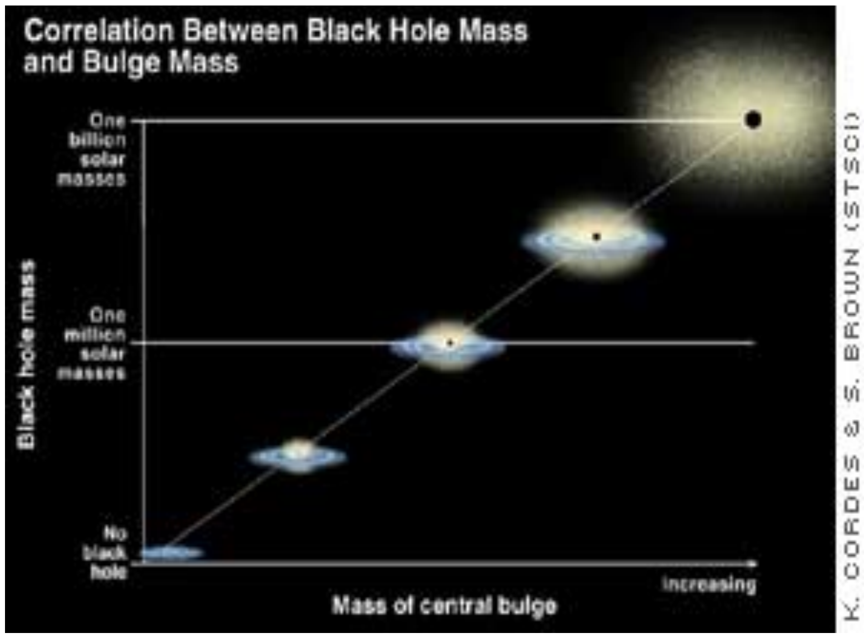
Contents:

- Background: black holes and galaxy bulges.
- HerMES
- Star formation in QSOs.
- Obscured vs unobscured AGN.
- Star formation around lower luminosity AGN.
- Conclusions

Background: the present day black hole / bulge mass relation

- We know that the masses of black holes and galaxy bulges are strongly correlated in the nearby universe.
- The stellar and black hole components must be related and interact somehow.
- Widely speculated that black hole terminates star formation in its host galaxy.*
- Growth of the black hole and formation of the stellar spheroid must be intimately related.

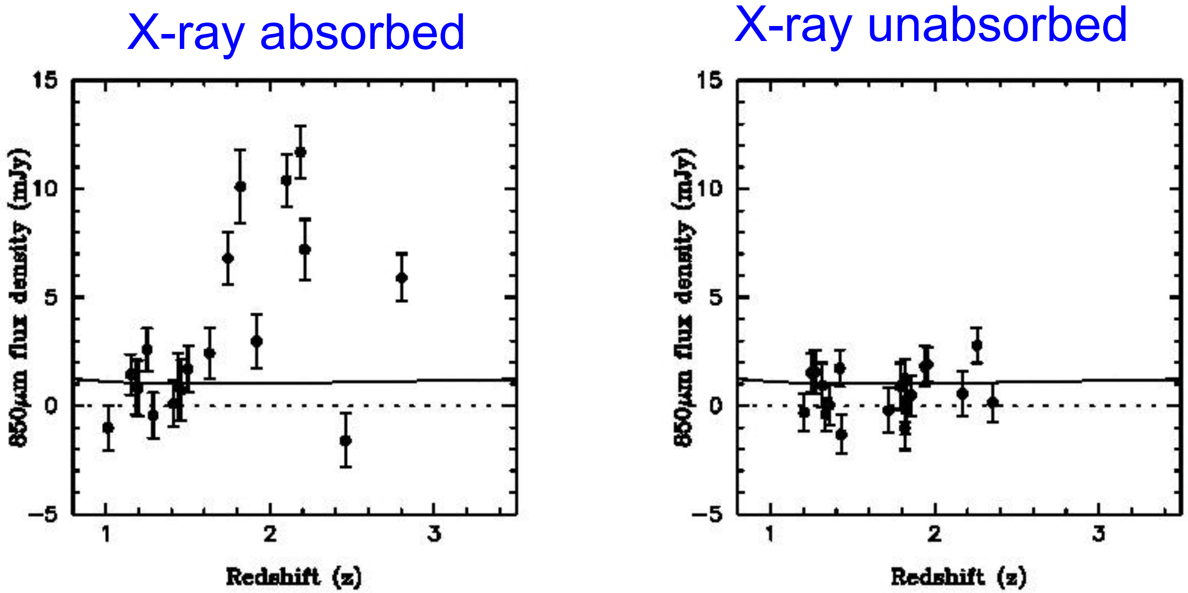




* Semi-analytical modellers can't make the galaxy population without this.

- The black hole/bulge mass relation tells us that the formation of spheroids and black holes are somehow linked.
- Peak of Universe's star formation rate was at 1< z < 3.
- Massive black holes also had their heyday at 1< z < 3.
- But how was the black hole growth and star formation related in individual galaxies?

- Until now, studies limited to:
  - small numbers
  - luminous objects
  - stacking analyses



Page et al. 2004, ApJ 611, L11
Stevens et al. 2005, MNRAS, 360, 610

- **Very ripe area for investigation with HerMES.**

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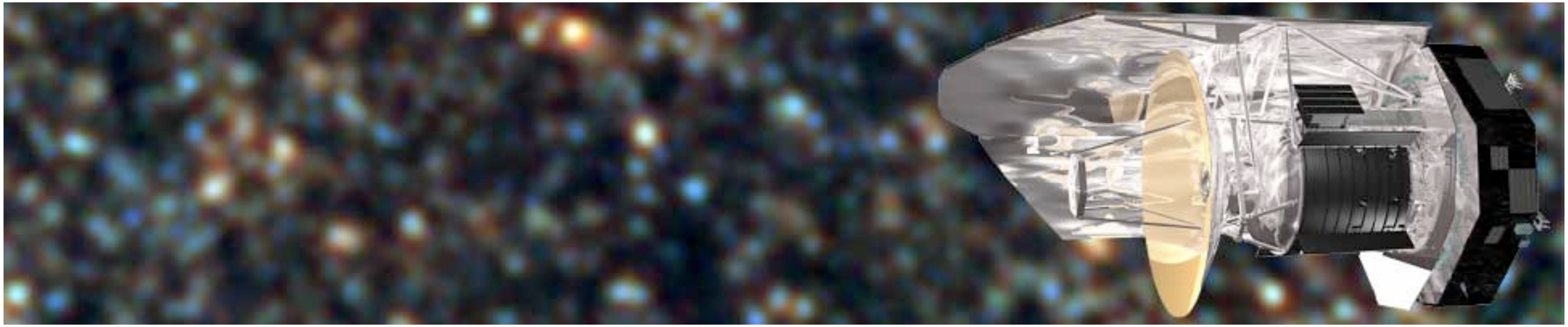
hermes.sussex.ac.uk



HERSCHEL MULTI-TIERED EXTRAGALACTIC SURVEY

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The HERMES Team

Bruno Altieri, Alex Amblard, Vinod Arumugam, Robbie Auld, Herve Aussel, Tom Babbedge, Alexandre Beelen, Matthieu Bethermin, Andrew Blain, Jamie Bock, Alessandro Boselli, Carrie Bridge, Drew Brisbin, Veronique Buat, Denis Burgarella, Nieves Castro-Rodriguez, Antonio Cava, Pierre Chanial, Ed Chapin, Scott Chapman, Michele Cirasuolo, Dave Clements, Alex Conley, Luca Conversi, Asantha Cooray, Emanuele Daddi, Gianfranco DeZotti, Darren Dowell, Naomi Dubois, Jim Dunlop, Eli Dwek, Simon Dye, Steve Eales, David Elbaz, Erica Ellingson, Tim Ellsworth-Bowers, Duncan Farrah, Patrizia Ferrero, Matt Fox, Alberto Franceschini, Ken Ganga, Walter Gear, Elodie Giovannoli, Jason Glenn, Eduardo Gonzalez-Solares, Matt Griffin, Mark Halpern, Martin Harwit, Evanthia Hatziminaoglou, Sebastien Heinis, George Helou, Jiasheng Huang, Peter Hurley, HoSeong Hwang, Edo Ibar, Olivier Ilbert, Kate Isaak, Rob Ivison, Ali Ahmed Khostovan, Martin Kunz, Guilaine Lagache, Louis Levenson, Carol Lonsdale, Nanyao Lu, Suzanne Madden, Bruno Maffei, Georgios Magdis, Gabriele Mainetti, Lucia Marchetti, Elizabeth Marsden, Gaelen Marsden, Jason Marshall, Ketron Mitchell-Wynne, Glenn Morrison, Angela Mortier, HienTrong Nguyen, Brian O'Halloran, Seb Oliver, Alain Omont, Frazer Owen, Mathew Page, Maurillo Pannella, Pasquale Panuzzo, Andreas Papageorgiou, Harsit Patel, Chris Pearson, Ismael PerezFournon, Michael Pohlen, Naseem Rangwala, Jason Rawlings, Gwen Raymond, Dimitra Rigopoulou, Laurie Riguccini, Davide Rizzo, Giulia Rodighiero, Isaac Roseboom, Michael Rowan-Robinson, Miguel SanchezPortal, Rich Savage, Bernhard Schulz, Douglas Scott, Paolo Serra, Nick Seymour, David Shupe, Anthony Smith, Jason Stevens, Veronica Strazzullo, Myrto Symeonidis, Markos Trichas, Katherine Tugwell, Mattia Vaccari, Elisabetta Valiante, Ivan Valtchanov, Joaquin Vieira, Laurent Vigroux, Lingyu Wang, Rupert Ward, Don Wiebe, Gillian Wright, Kevin Xu, Michael Zemcov

Faculty and Researchers PostDocs Students

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Clusters

Level1 0.11 □°

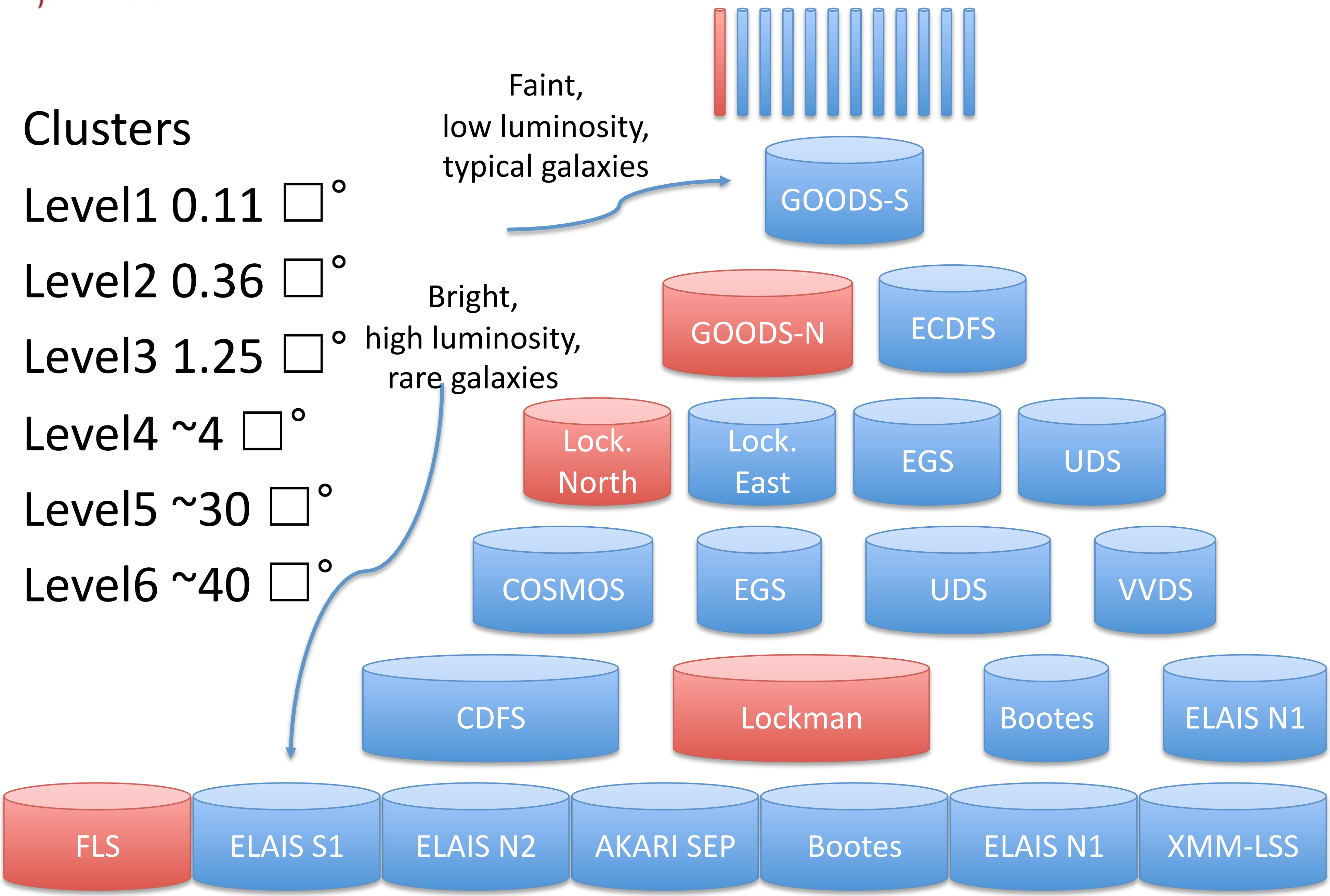
Level2 0.36 □°

Level3 1.25 □°

Level4 ~4 □°

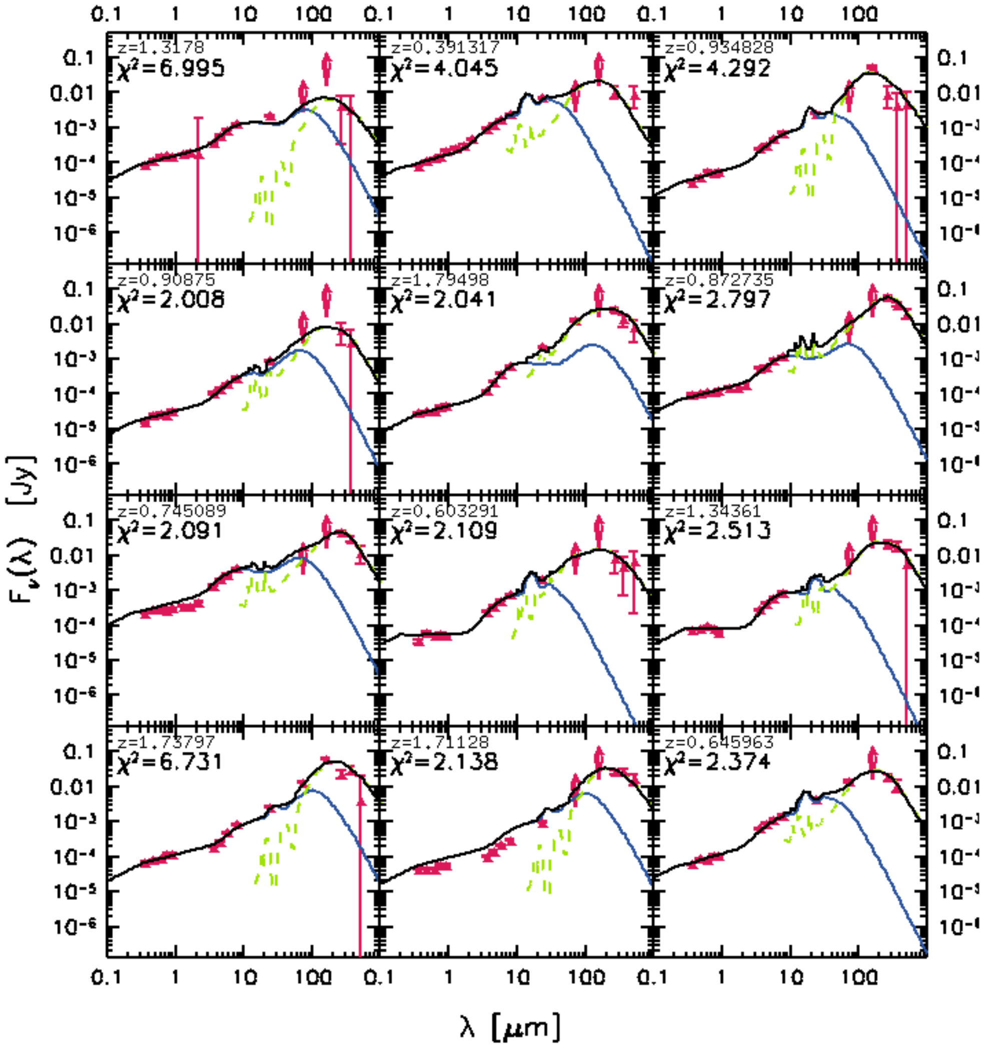
Level5 ~30 □°

Level6 ~40 □°



Star formation in QSOs

- 496 type-1 and type-2 AGN in HerMES FLS and Lockman fields
- 25% are detected at 250 microns with SPIRE.
- No strong dependence on accretion luminosity.
- SEDs are modelled with AGN torus and starburst components.
- SPIRE flux is always dominated by the starburst component.

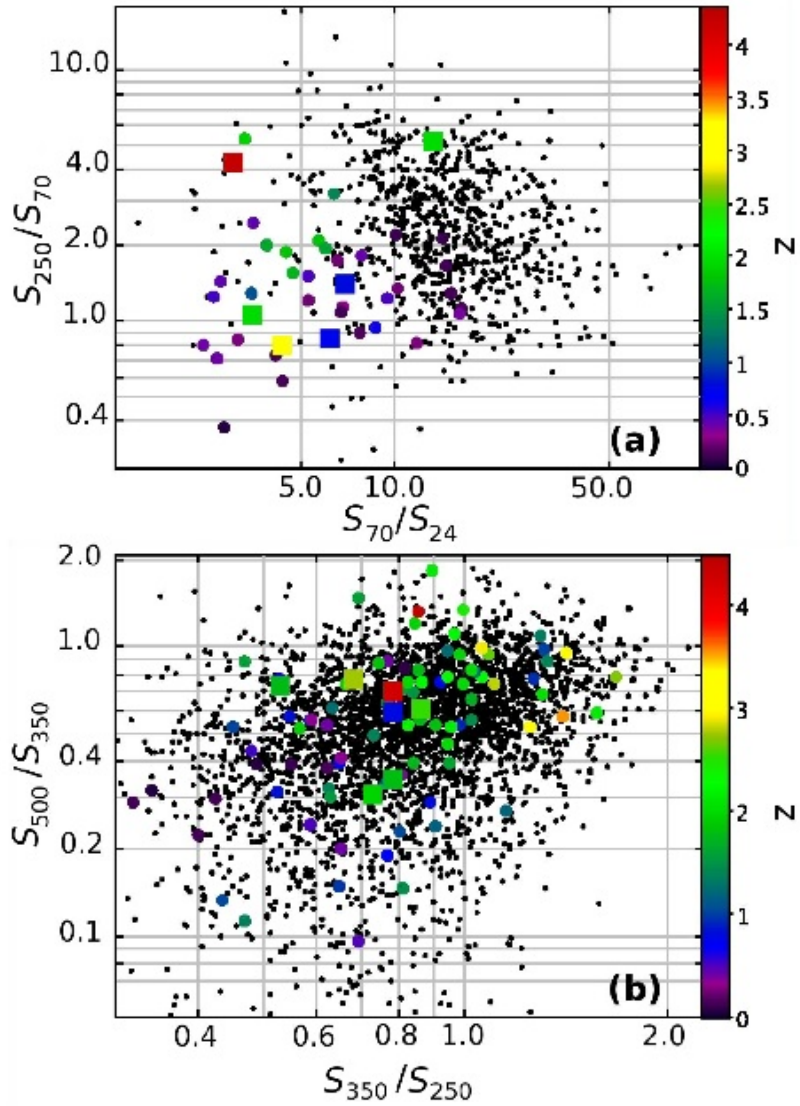


Hatziminouglou et al. 2010

HERMES

- Nicely illustrated by SPIRE and MIPS colours.
- In 250/70 vs 70/24 colours the AGN are distinct from the star forming galaxies.
- In 500/350 vs 350/250 colours, star forming galaxies and AGN are indistinguishable.

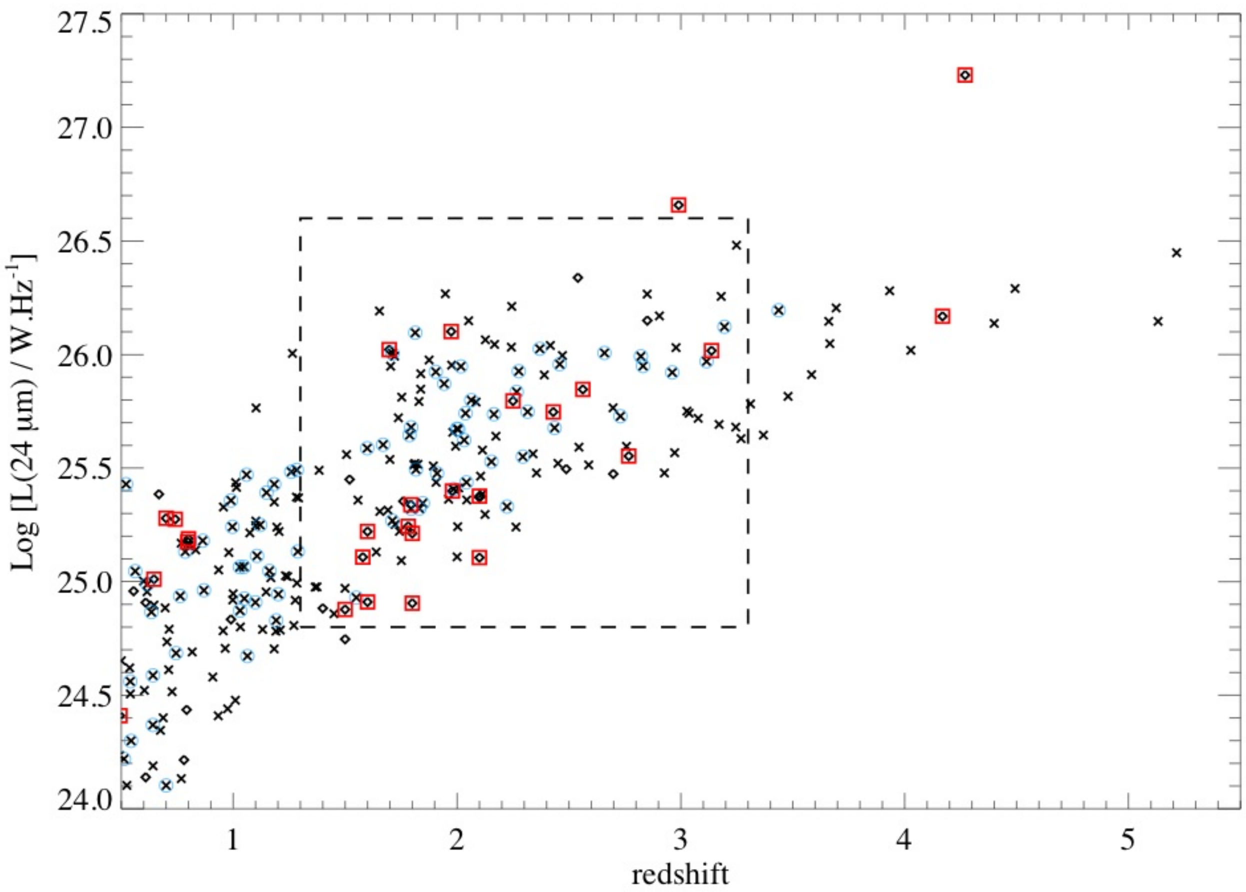
Emission in the SPIRE band is dominated by star formation even in QSOs.



Hatziminouglou et al. 2010

Obscured AGN

- Type 1/2 AGN matched at 24 microns.
- Equivalent AGN power.
- How do the far-IR luminosities compare?



Stevens et al. 2010

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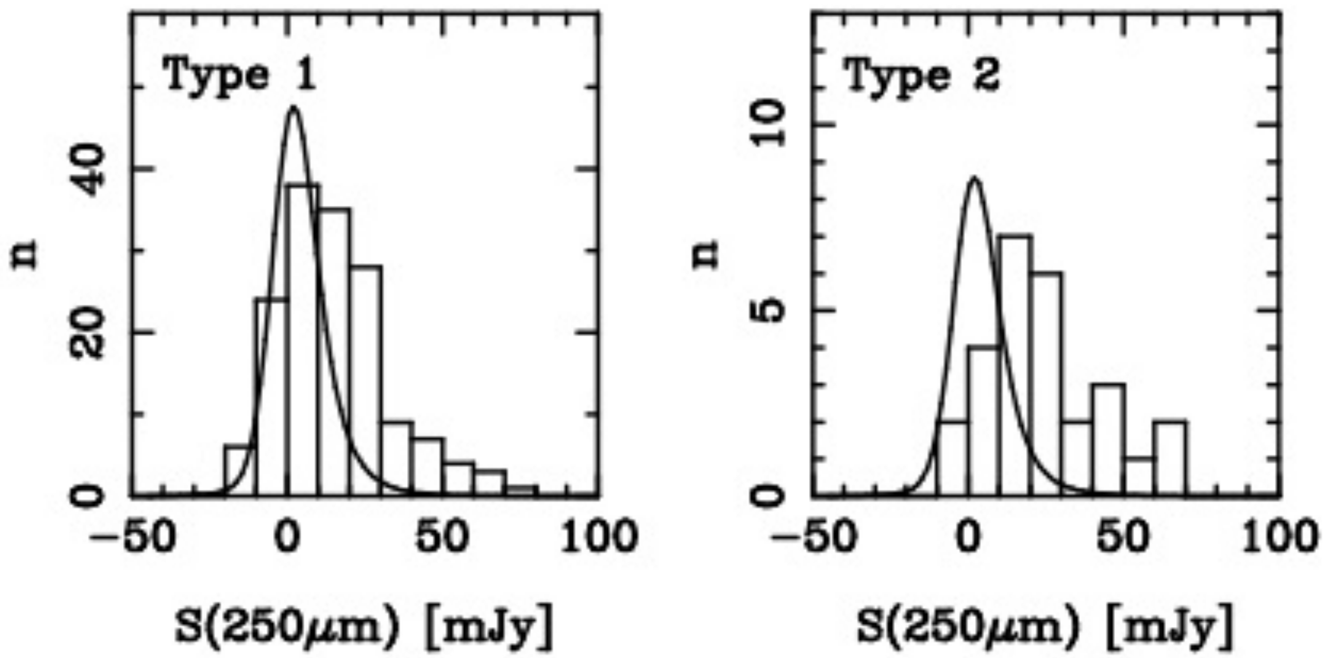
Obscured AGN



- Both type 1s and type2s are detected, with a similar range of fluxes.
- Distributions are different: type 2s skewed towards brighter fluxes.
- Star formation more vigorous in type 2s?

Stevens et al. 2010

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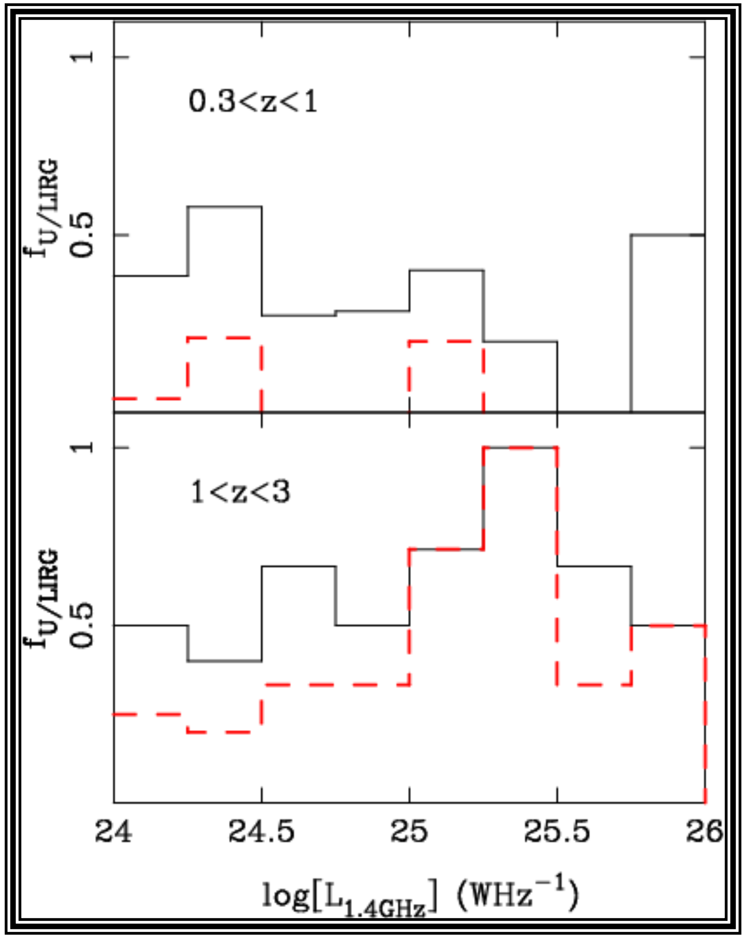
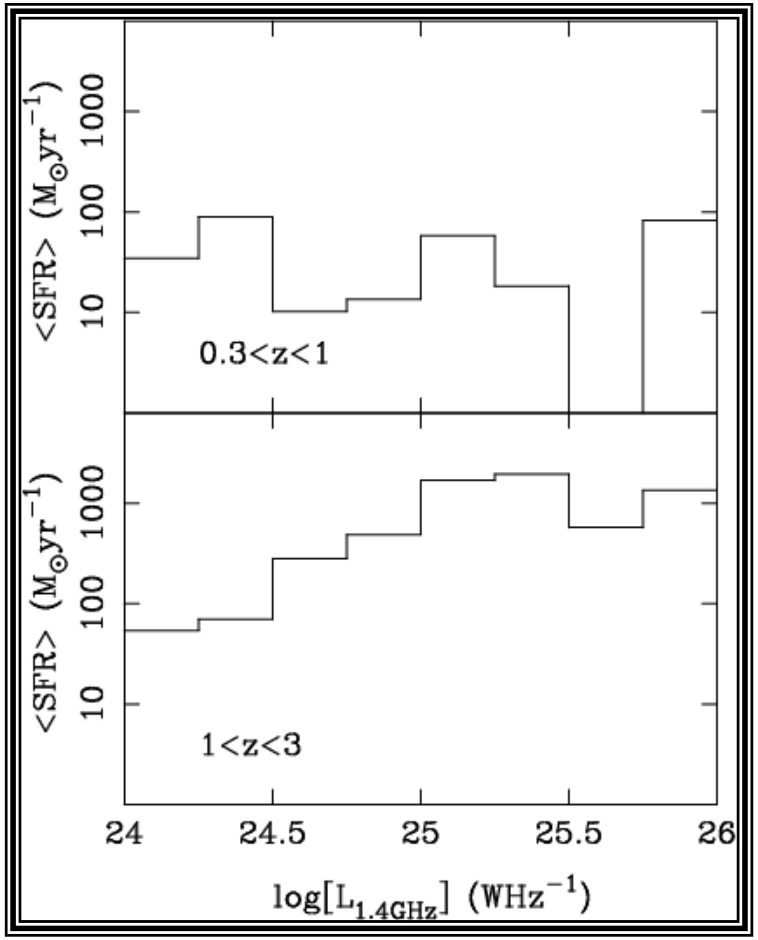
Star formation in radio loud AGN

- 1909 radio sources in the HerMES FLS field
- Select radio-loud AGN with $L_{1.4GHz} > 10^{24.25}$ WHz^{-1}
- Divide sample into
  - Low redshift (0.3<z<1.0 - 100% complete)
  - High redshift (1<z<3 - ~50% complete)
- Model and subtract AGN contribution to the IR luminosity
- Remove any radio sources with luminosities consistent with the radio/far-IR correlation for local star forming galaxies.
- Determine star formation rates of radio-loud AGN from IR luminosities

Seymour et al. 2010



Fraction of radio-selected AGN in LIRGs and ULIRGs.



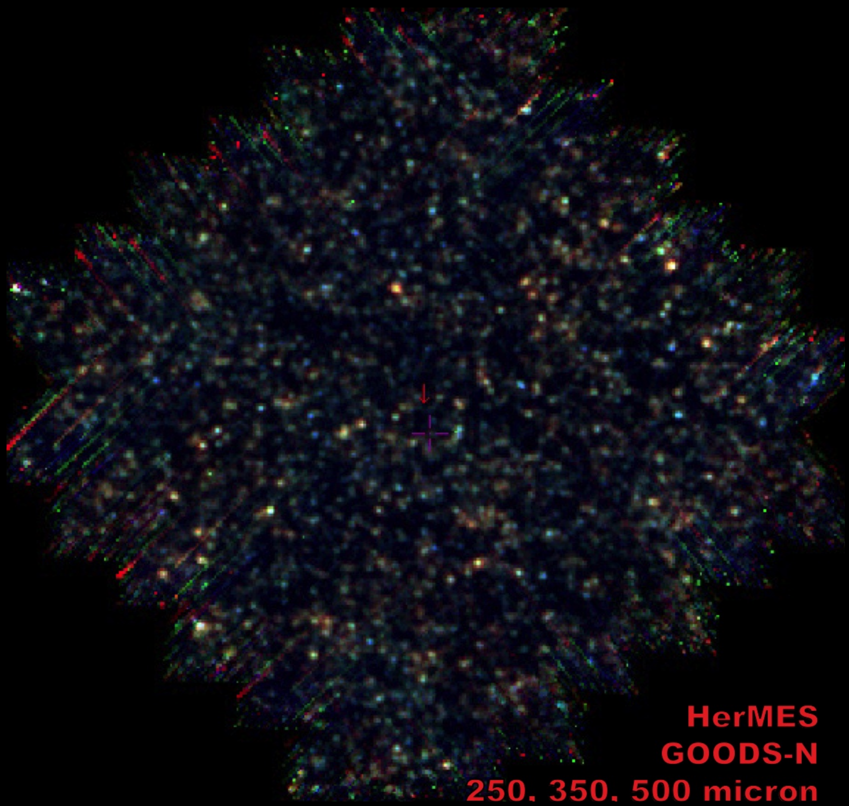
Mean star formation rates.

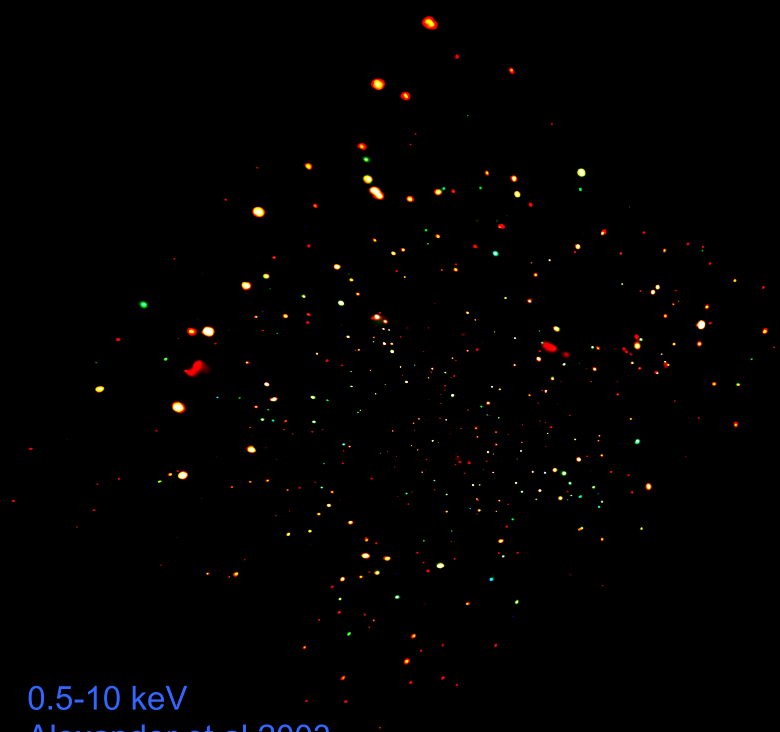
Remarkable increase in star formation rate in radio-loud AGN with lookback time

Seymour et al. 2010

HerMES GOODS North: matching the deepest X-ray survey with the deepest submm data

- With HerMES we can study the far-IR/submm emission from individual AGN at moderate luminosities at cosmological redshifts.





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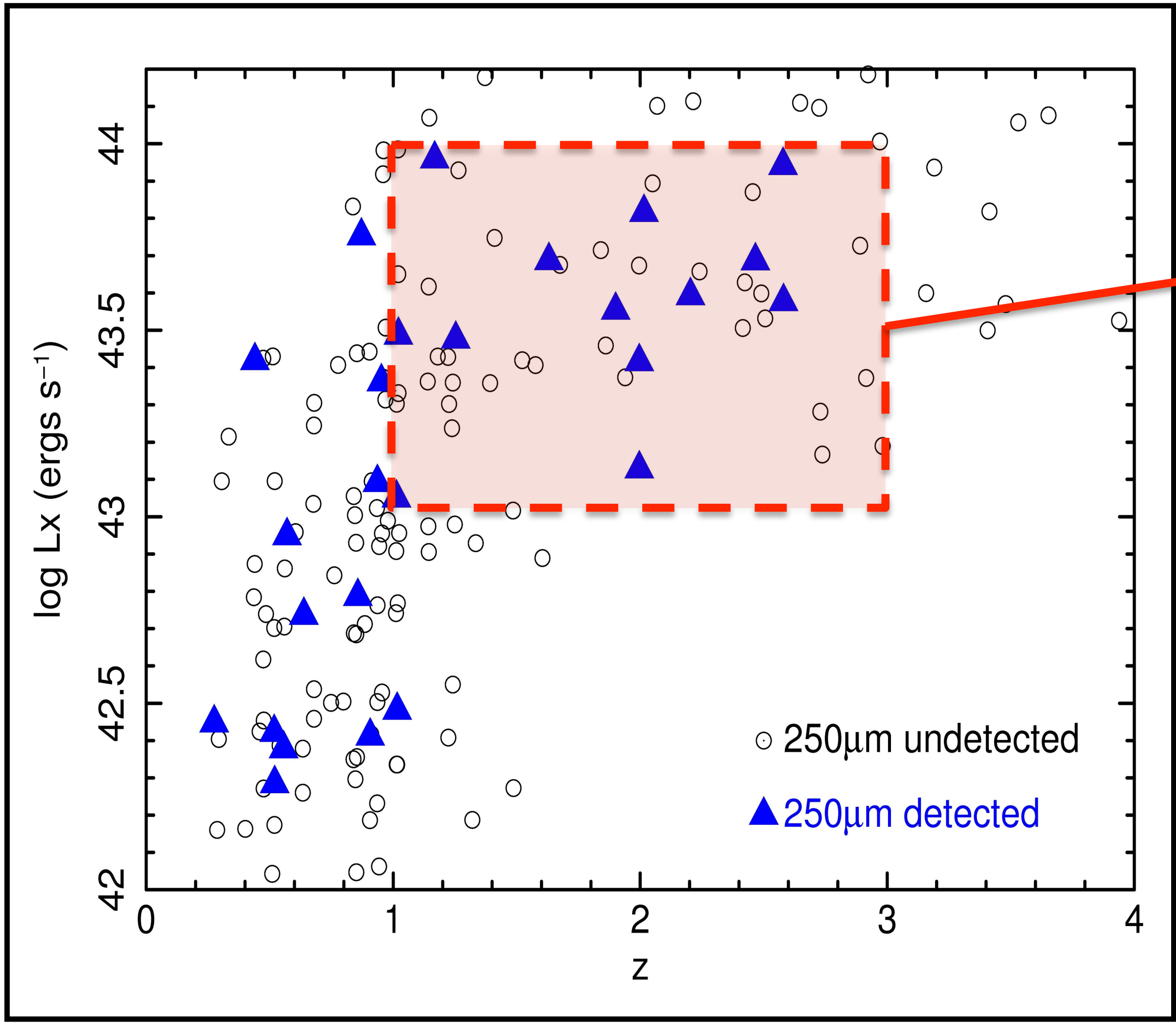
Probing star formation right down the AGN luminosity function



Significant detection fraction at z>1, even at low AGN luminosities.

Many AGN lived in ULIRGs between redshifts of 1 and 3.

Page et al. 2010

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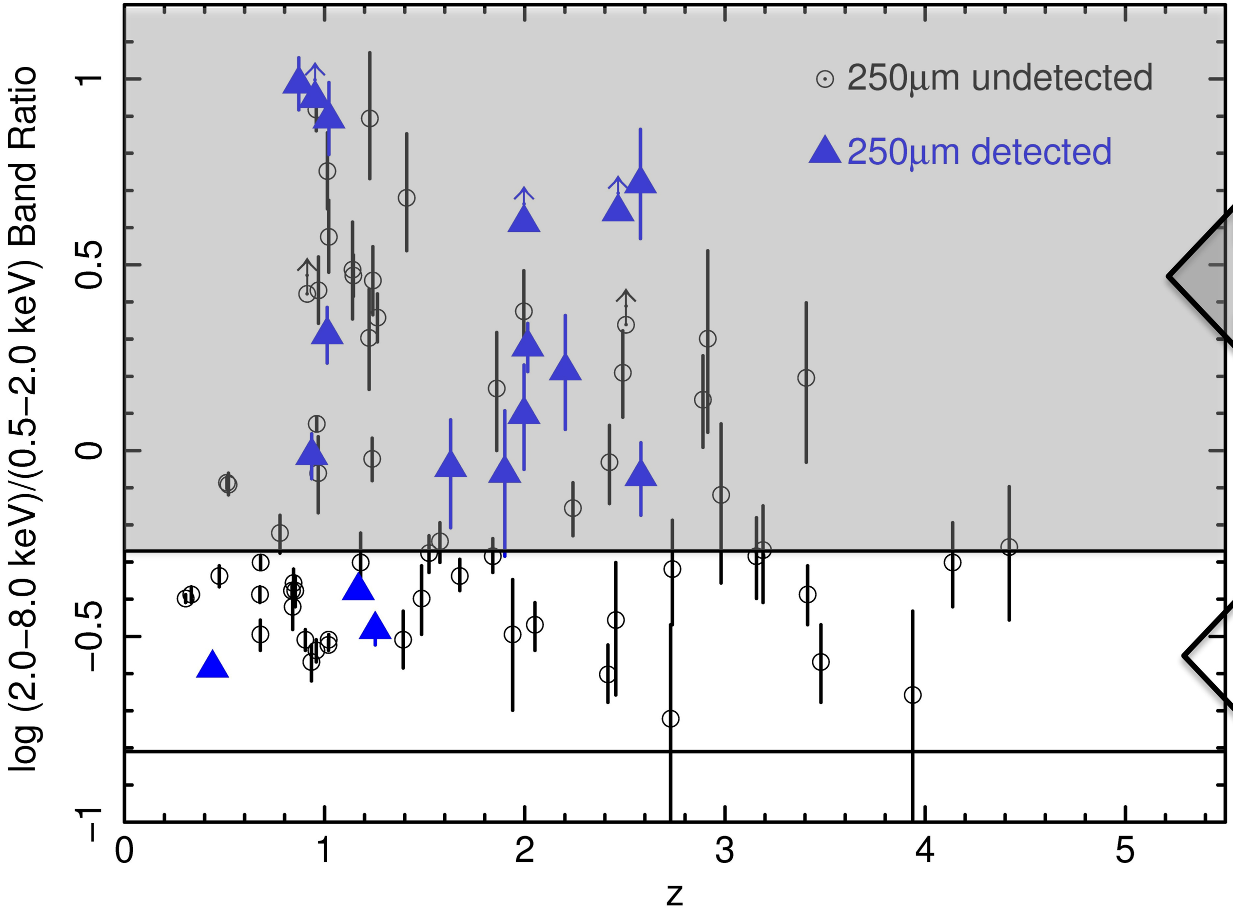
X-ray absorption



Hardness ratios indicate X-ray absorption

Normal range of unabsorbed AGN hardness ratios

Page et al. 2010

Absorption/obscuration

- Both optical obscuration (i.e. type 2 objects) and X-ray absorption appear to be associated with the bright submm population.
- Lends support to the hypothesis that AGN have an obscured growth phase while their host spheroid is forming.
- Alternatively, could imply that the host galaxy ISM contributes to the obscuration.

Conclusions

- HerMES brings a huge range of AGN into view at far-IR/submm wavelengths.
- Many AGN (>= 20% of optical/X-ray/radio AGN) are detected at 250 microns at redshifts > 1.
- The far-IR emission appears to be star-formation powered.
- AGN lived in vigorously star-forming galaxies in the past.
- Detection rate doesn't appear to depend very strong trend on the AGN luminosity.
- Optical and X-ray obscuration/absorption appears to be a common feature of star-forming AGN.

For more info:

- Hatziminouglou et al., Poster P1.47
- Page et al., Poster P2.59
- Seymour et al., Poster P2.56
- Stevens et al., Poster P2.49