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On behalf of the HerMES consortium
Contents:

• Background: black holes and galaxy bulges.
• HerMES
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• Star formation around lower luminosity AGN.
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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

• Very ripe area for investigation with HerMES.

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HERMES

HERSCHEL MULTI-TIERED EXTRAGALACTIC SURVEY
The HERMES Team


Faculty and Researchers PostDocs Students
Clusters
Level1 0.11 \degree
Level2 0.36 \degree
Level3 1.25 \degree
Level4 \sim 4 \degree
Level5 \sim 30 \degree
Level6 \sim 40 \degree

Faint, low luminosity, typical galaxies
Bright, high luminosity, rare galaxies

GOODS-S
ECDFS
GOODS-N
EGS
UDS
Lock. North
Lock. East
COSMOS
VVDS
CDFS
Lockman
Bootes
ELAIS N1
XMM-LSS

FLS
ELAIS S1
ELAIS N2
AKARI SEP
Bootes
ELAIS N1
XMM-LSS
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.

Hatziminooglu et al. 2010
• 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
• Type 1/2 AGN matched at 24 microns.
• Equivalent AGN power.
• How do the far-IR luminosities compare?

Stevens et al. 2010
• Both type 1s and type 2s 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
Star formation in radio loud AGN

- 1909 radio sources in the HerMES FLS field
- Select radio-loud AGN with $L_{1.4\text{GHz}} > 10^{24.25}$ 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.

**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.
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
X-ray absorption

Normal range of unabsorbed AGN hardness ratios

Hardness ratios indicate X-ray absorption

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:

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