Star formation in AGN host galaxies
SPICA and the high-z universe

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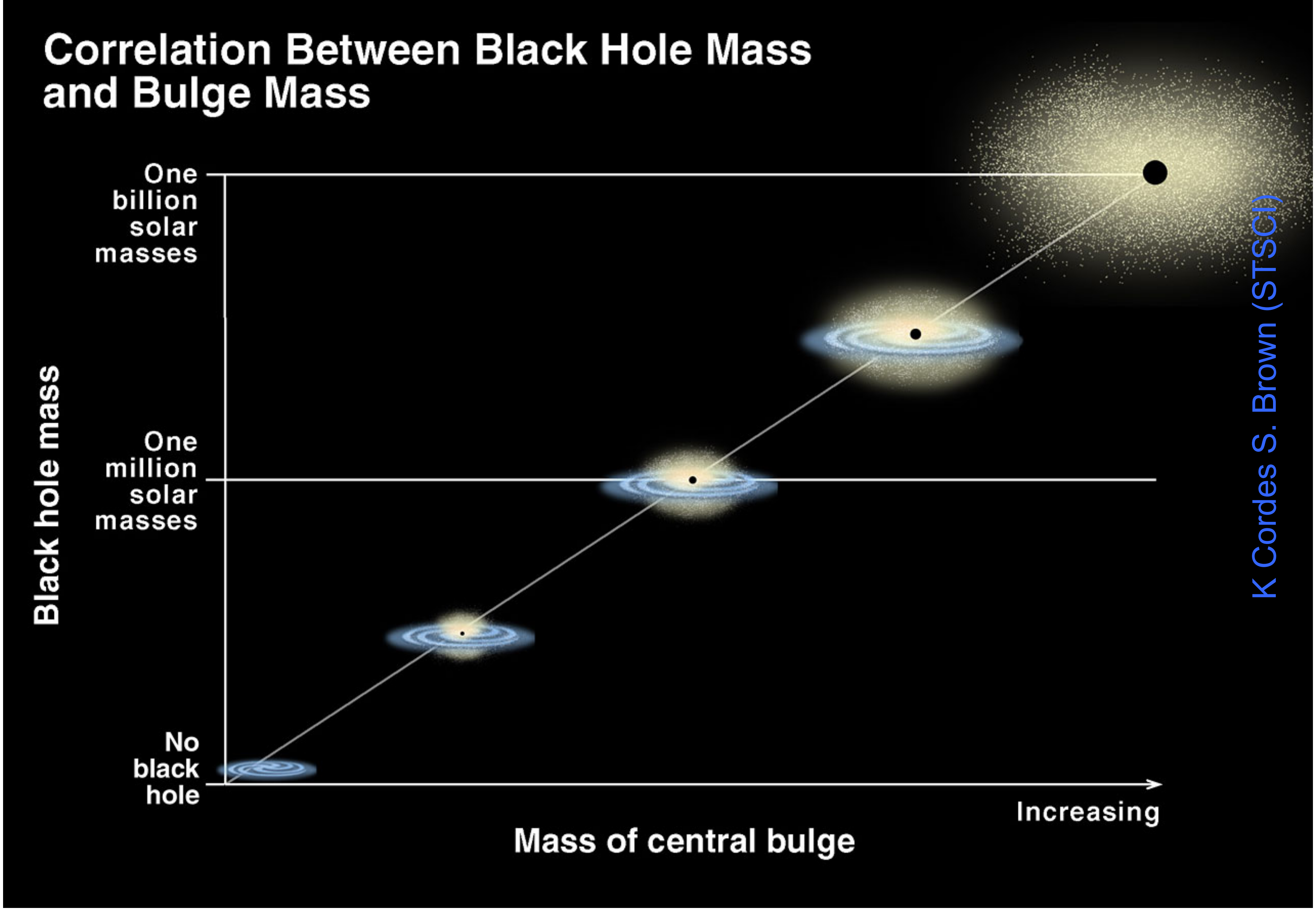
Contents

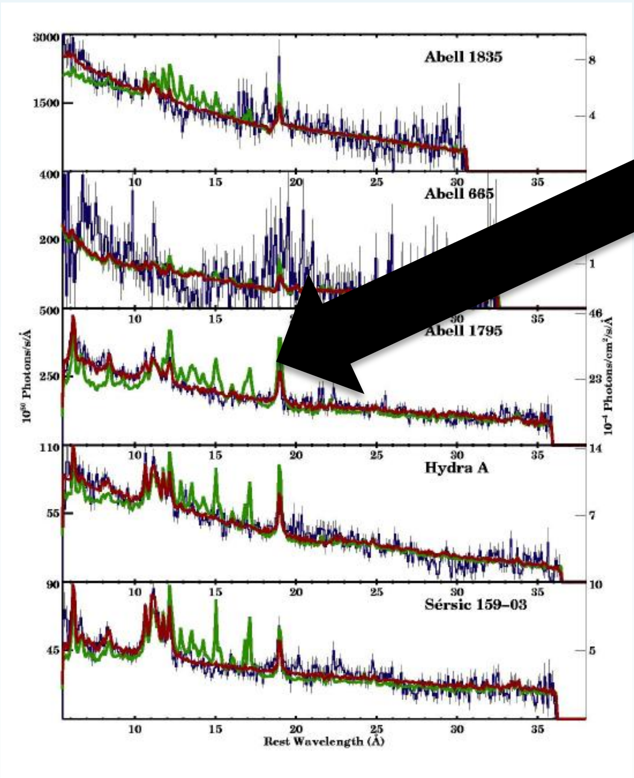
- AGN and star formation through cosmic time.. Why does it matter?
- Current picture, (and why I think it is probably wrong).
- Why turn to PAHs?
- The value of SPICA.



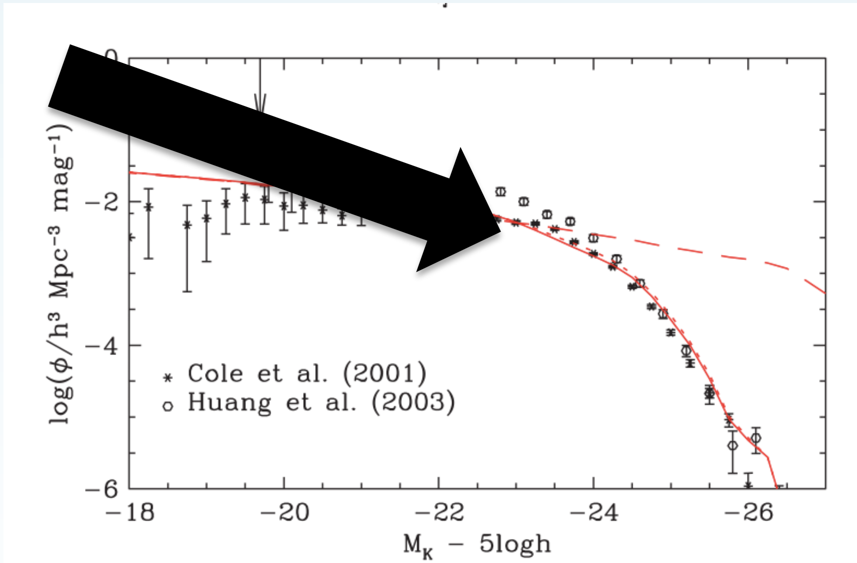
K Cordes S. Brown (STScI)

Massive black holes rule

- Nowadays we think that accreting massive black holes control the growth of all massive galaxies.



Peterson et al. 2003, ApJ, 590, 207



Bower et al. 2006, MNRAS, 370, 645

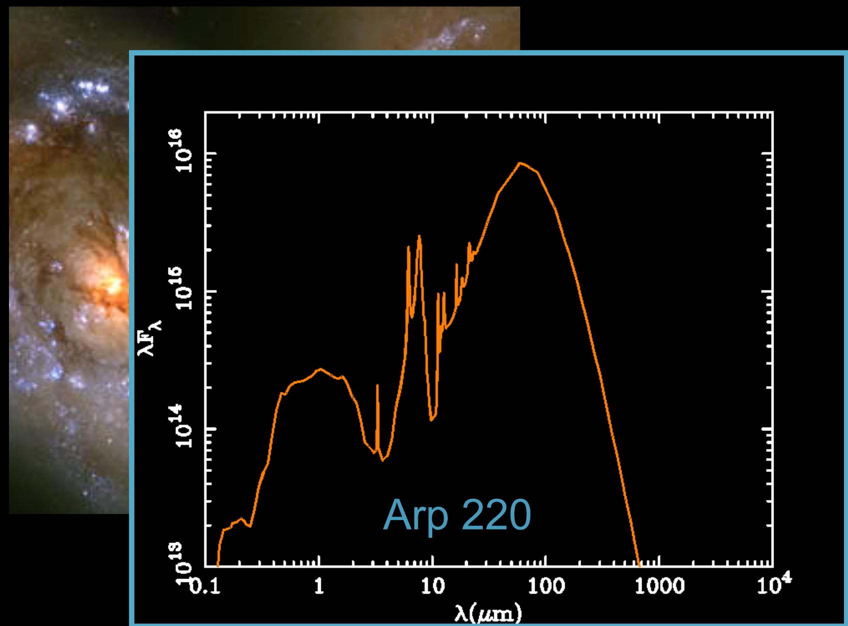
The chicken and egg question.

- Until we understand the sequence of star formation and accretion, we won't really understand black holes **or** galaxies.
- We need to measure how much accretion is happening in star forming galaxies
- And how much star formation is happening around accreting black holes.
- And we'd like to know that all the way back to the reionization era.

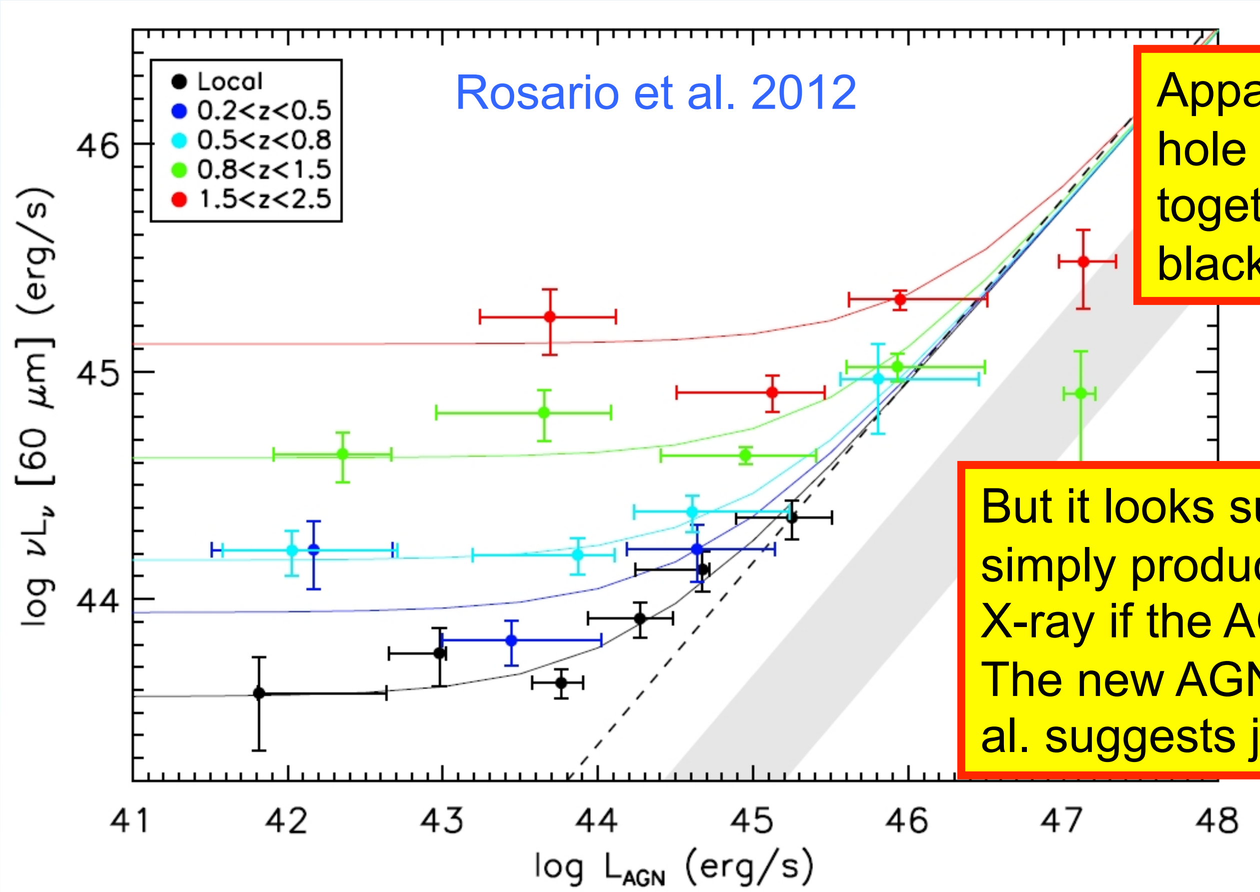
Energy release from black holes and stars

Black holes growing by accretion are best found by X-ray emission

The most rapidly star-forming galaxies are often highly obscured, emitting the bulk of their energy in the far infrared



Star formation in accreting black holes.

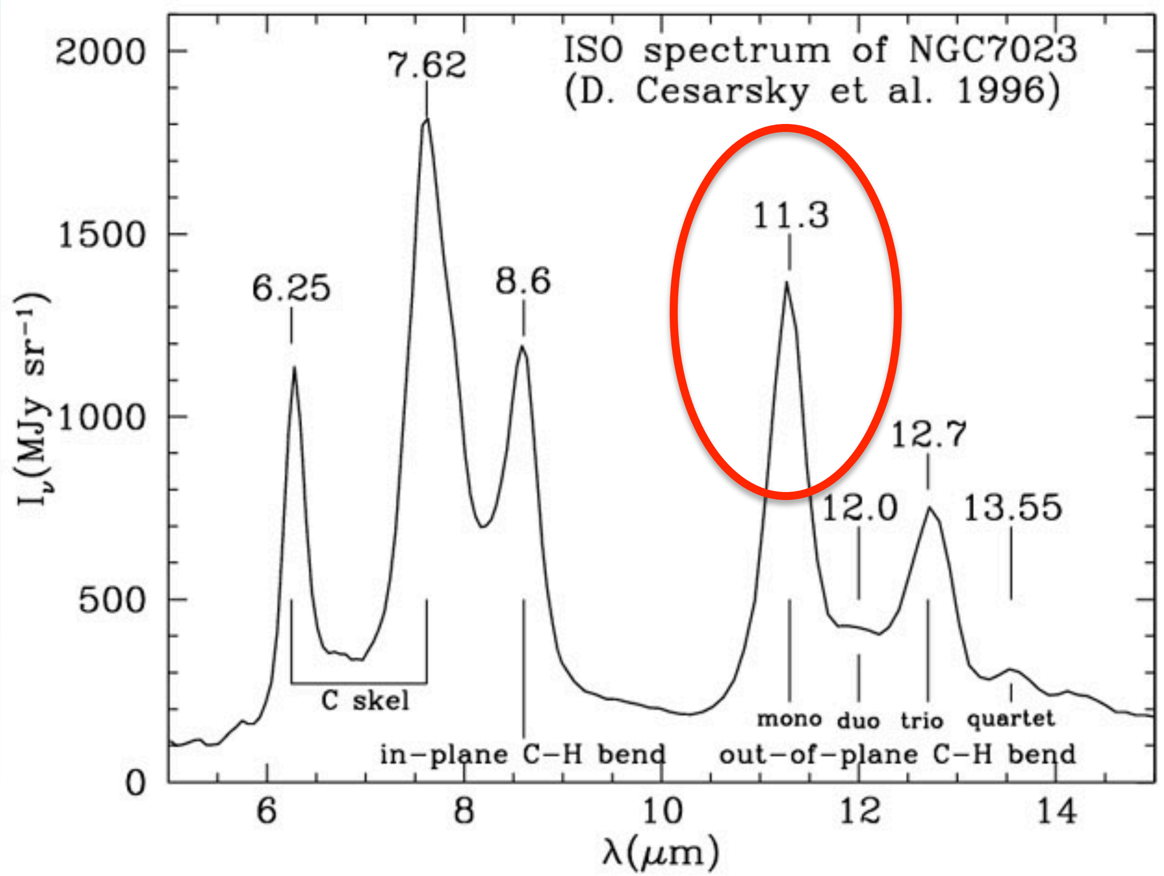


Apparently stellar and black hole components grow together on average when black holes are bright.

But it looks suspiciously like the AGN is simply producing the FIR as well as the X-ray if the AGN is bright enough. The new AGN SED from Symeonidis et al. suggests just that.

For powerful AGN, there's no safe part of the continuum to measure star formation.

- We need a measure of star formation that the AGN doesn't contribute to.
- Enter the PAHs

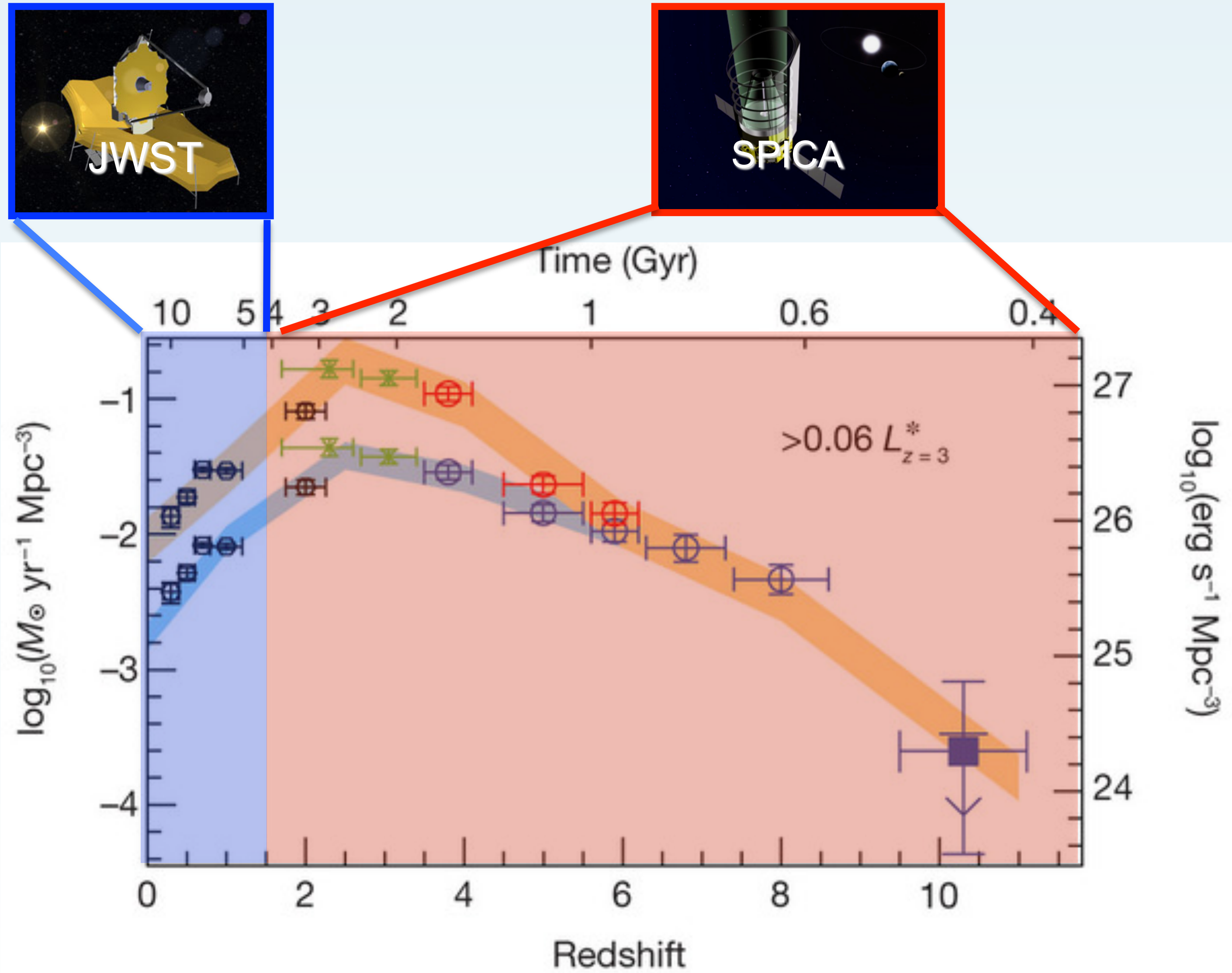


Why are PAHs useful?

- PAHs are easily destroyed by far-UV, EUV and soft X-ray photons.
    - AGN emit a lot of far UV, EUV and soft X-rays.
    - When AGN directly illuminate PAHs, they get destroyed.
    - So we don't expect PAH emission to be produced by AGN.
    - Observationally, PAH emission is not observed from AGN.
    - On large scales, PAHs **do** trace star-formation.
- In the host galaxies of AGN, some PAH molecules do seem to be destroyed (probably by soft X-rays), so the 7.7 micron feature may not trace star formation in AGN hosts.
- But the molecules that produce the 11.3 micron PAH appear to survive in star-forming regions even very close to the AGN (e.g. 10 parsecs, Alonso Herrero et al. 2014) and provide robust star formation rates (e.g. Diamond-Stanic & Rieke 2010).

- **<u>The 11.3 micron PAH provides an AGN-safe star formation measure.</u>**

Making those PAH measurements.



Bouwens et al. 2011, Nature, 469,504

SPICA/SAFARI Fact Sheet

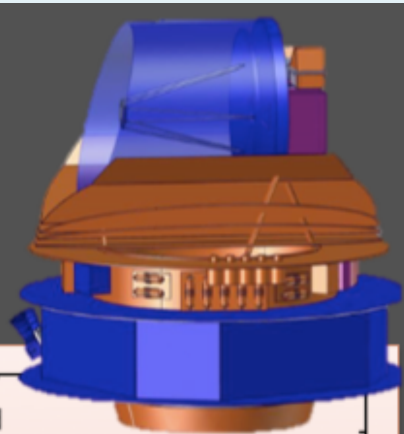
SAFARI Overview

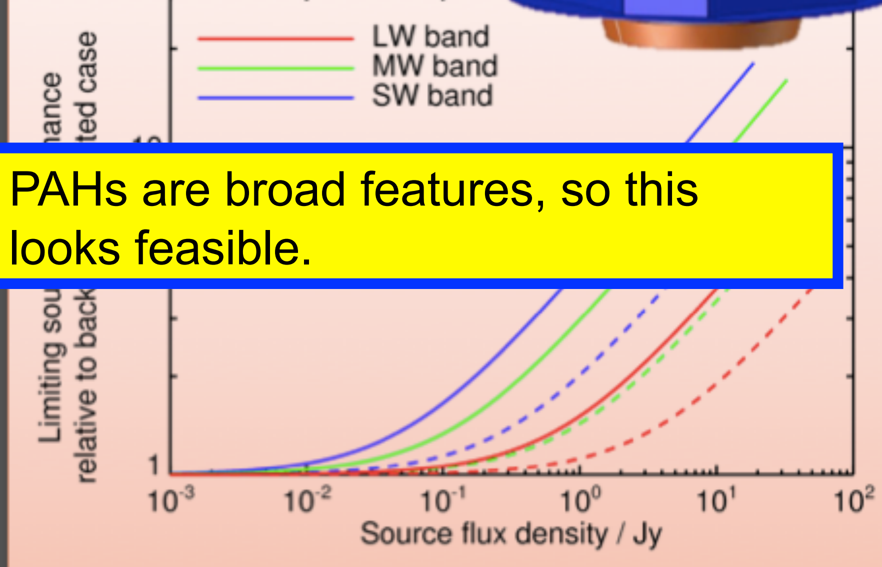
- Three band ***grating spectrometer***
- Continuous spectroscopic capability from 34-210 μm

Parameter	Waveband		
	SW	MW	LW
Band centre / μm	47	85	160
Wavelength range / μm	34-60	60-110	110-210
Band centre beam FWHM	4.7″	8.6″	16″
Point source spectroscopy (5σ-1hr)			
R~300* **Limiting flux** / $\times 10^{-20}$ Wm^{-2}	5.3	4.5	6.5
R~300* **Limiting flux density** / mJy	0.25	0.36	0.92
R~3000* **Limiting flux** / $\times 10^{-20}$ Wm^{-2}	25	24	29
R~3000* **Limiting flux density** / mJy	12	20	41
Mapping spectroscopy (5σ-1hr)**			
R~300* **Limiting flux** / $\times 10^{-20}$ Wm^{-2}	59	28	22
R~300* **Limiting flux density** / mJy	2.8	2.3	3.0
R~3000* **Limiting flux** / $\times 10^{-20}$ Wm^{-2}	340	190	120
R~3000* **Limiting flux density** / mJy	170	150	170
Photometric mapping (5σ-1hr)**			
Limiting flux density / mJy	0.15	0.12	0.16

SPICA Mission

- ESA/JAXA collaboration
- Telescope effective area 5 m^2
- Primary mirror temperature 8K
- Goal mission lifetime – 5 years





PAHs are broad features, so this looks feasible.

- Change in system performance, as a function of target flux density, relative to the background limited case.
- The decrease in sensitivity is a result of the increased photon noise from the target source
- Data given up to the instrument saturation limits for each band (22, 37 and 73 Jy for the SW, MW and LW bands respectively.

* Resolving powers are all calculated at band centre
** Mapping performance is for a reference area of 1 arcmin²

SAFARI

Conclusions

- If we're ever going to understand the formation of massive galaxies or the growth of massive black holes, we need to measure accretion in star-forming sources and star formation in accretion sources.
- For powerful AGN, measuring star formation is going to be a problem. The continuum at **all** wavelengths may be dominated by the AGN.
- PAHs, and particularly the 11.3 micron feature provide an AGN-proof measure of star formation.
- With James Webb running out of steam at 28 microns (redshift < 1.5 for the 11.3 micron feature) the most interesting period of cosmic history is only accessible with SPICA.