A deep Infrared View on the Nuclear Emission of Local (z <0.1) QSOs

←CanariCam

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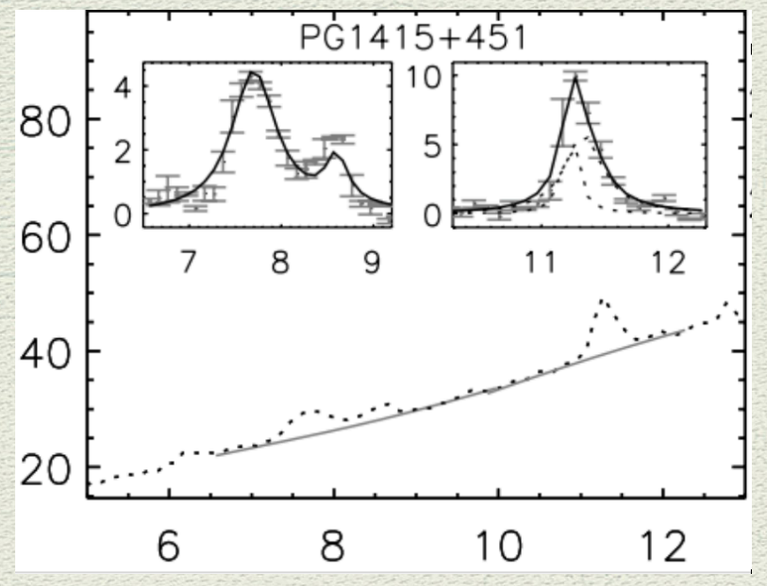
Mapping Central regions of Active Galactic Nuclei, 19-24 September, 2019, Guillin, China

A depth view in the MIR emission of QSOs

- 1. Is there a grand-design circum-nuclear ring like those present in Seyfert galaxies at easily detectable scales (~1″ or ~1 kpc)?

- 2. For those QSOs with clear PAHs detections in the Spitzer spectrum, are these originating in the inner few hundred parsec or on kpc scales? **Martinez-Paredes et al. (2019)**



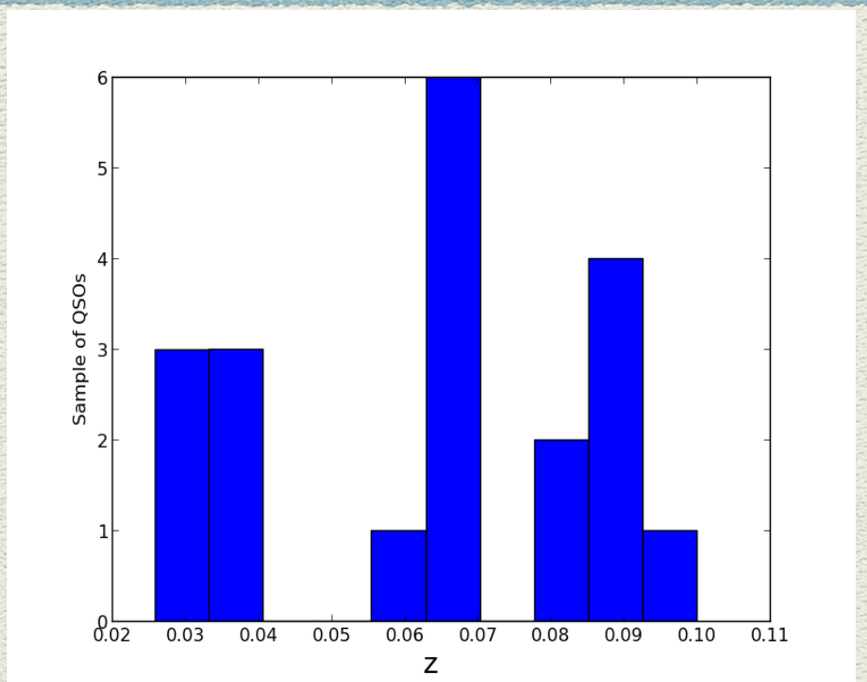
- 3. What are the physical and geometrical properties of the putative dusty torus of QSOs?

Martinez-Paredes et al. (2017)

The sample: 20 QSOs

- The AGN catalogue of Veron-Cetty M. P., Veron P. (2010)

- Redshift z < 0.1 (<~ 1kpc)
- IR flux (band-N) > 0.02 Jy
- Hard x-ray flux (2-10 keV) > 10^{43} erg s^{-1}



Data

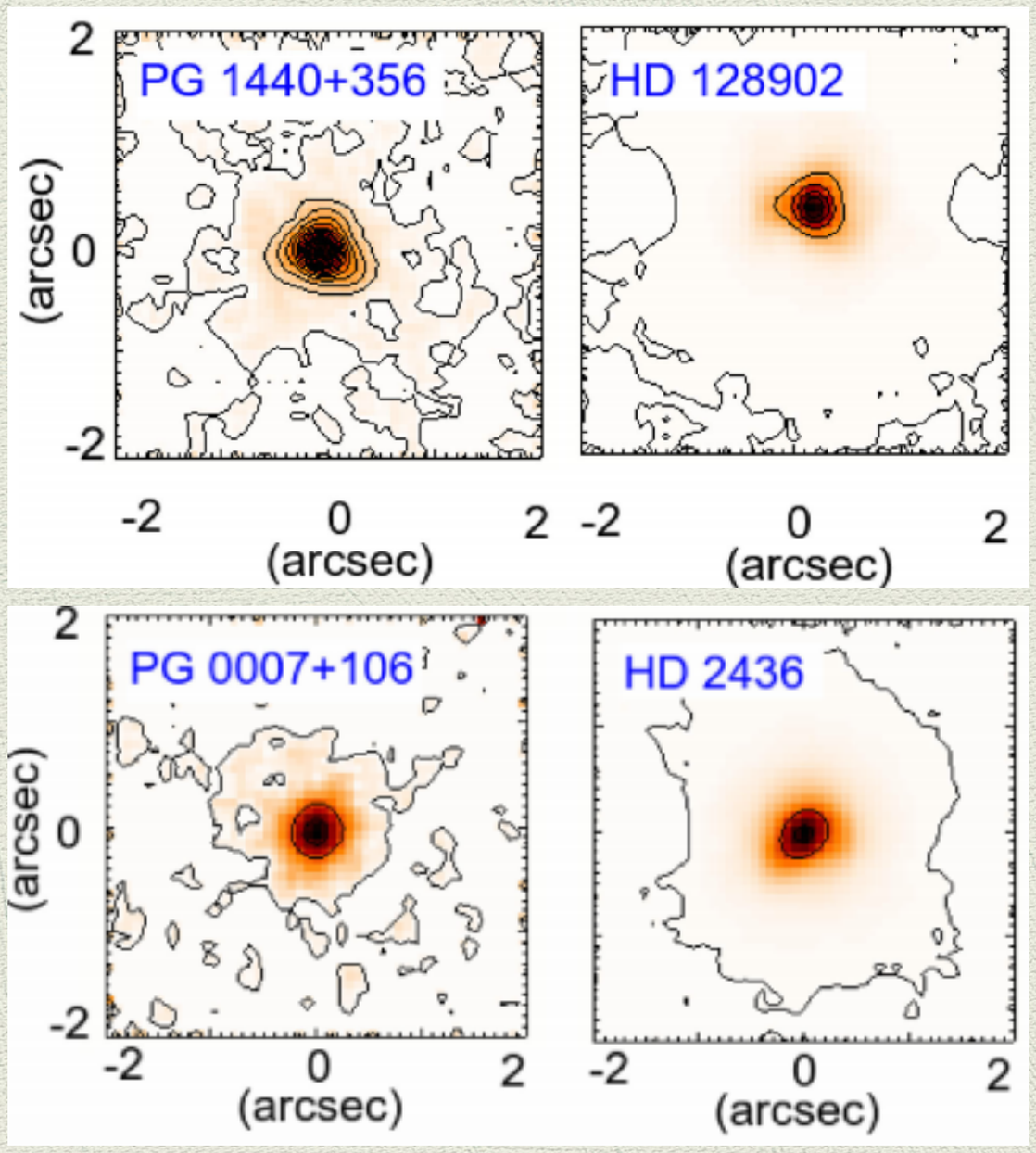
- ***CanariCam/GTC image (90%)*** *and Spectrum (65%) at Si2 band (8.7μm) .*

Ancillary data

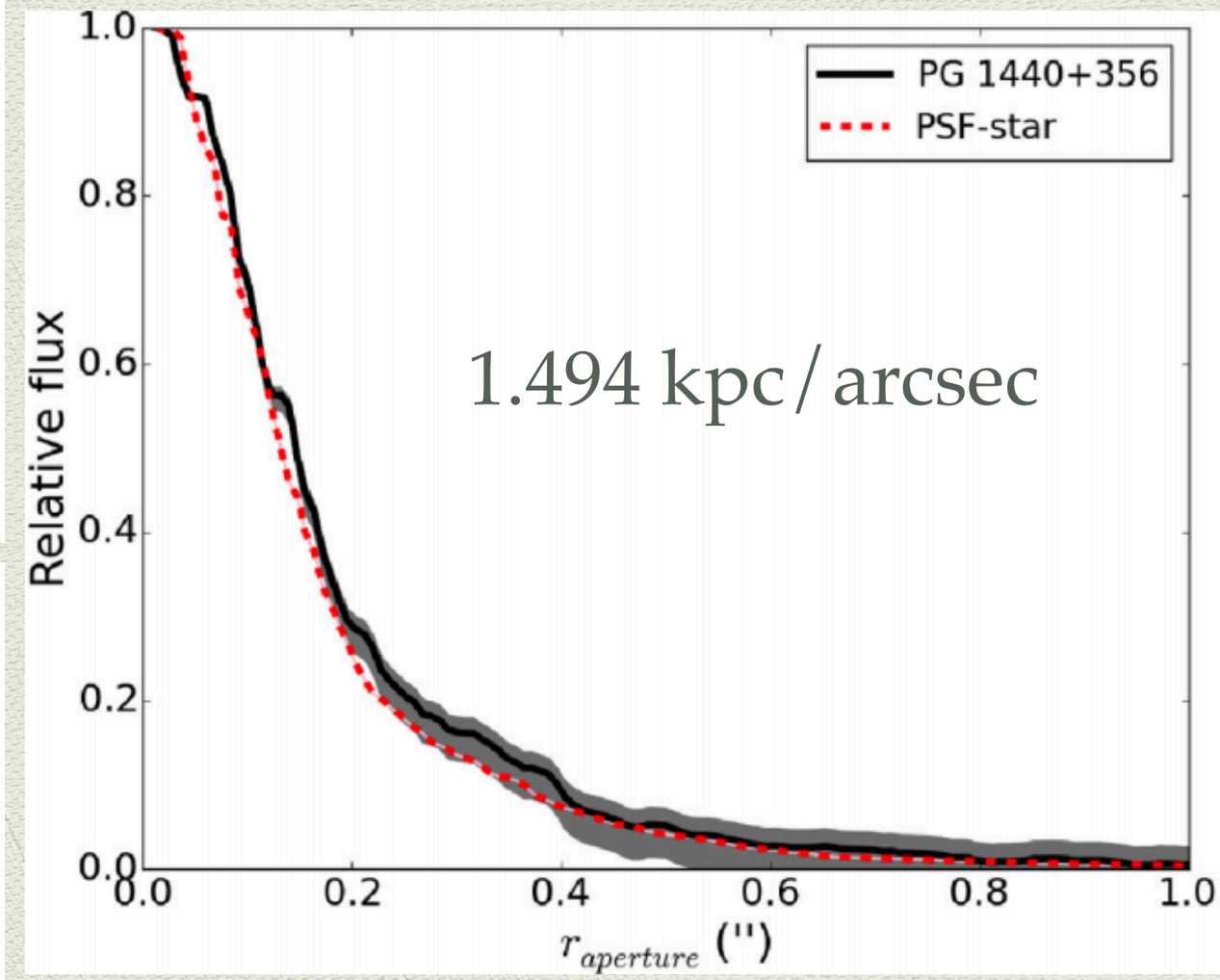
- *VISIR/8.2m Very Large Telescope: 2 objects* Honig+10 and Burtscher+13
- *NICMOS/HST, H band: 9 objects* Veilleux 2006, Veilleux et al. 2009b
- *IRS/Spitzer spectrum (5-35 μm) –> 95 %* CASSIS database

1. The inner star formation of QSOs

CanariCam images at Si2 band (8.7μm)



Radial profile



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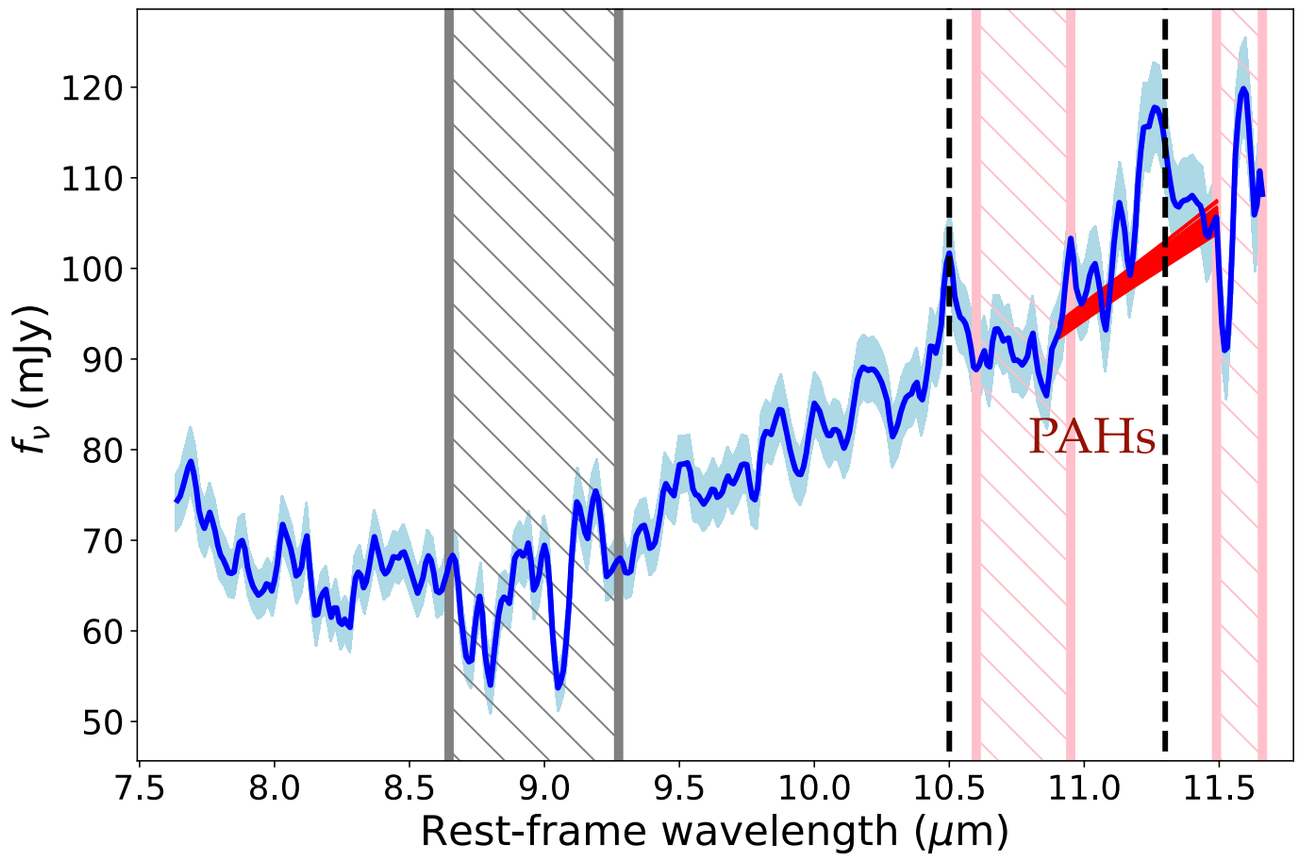
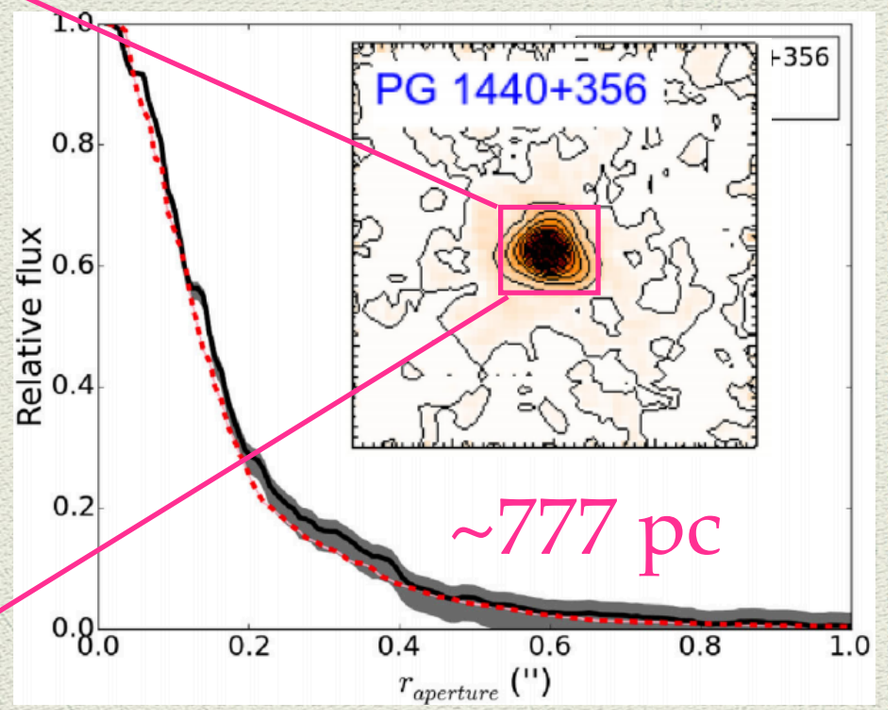
The high angular resolution nuclear spectrum at N band (~7.5-12.5 μm)

- We measure the flux and EW of the PAH at 11.3 μm by generating fiducial mean values of each continuum band by bootstrapping on the measured fluxes.

The nuclear spectrum at N band (~7.5-12.5 μm)



PG 1440+356/MRK 478



Si2 band (8.7um)

The stacked nuclear spectrum at N band (~7.5-12.5 μm)

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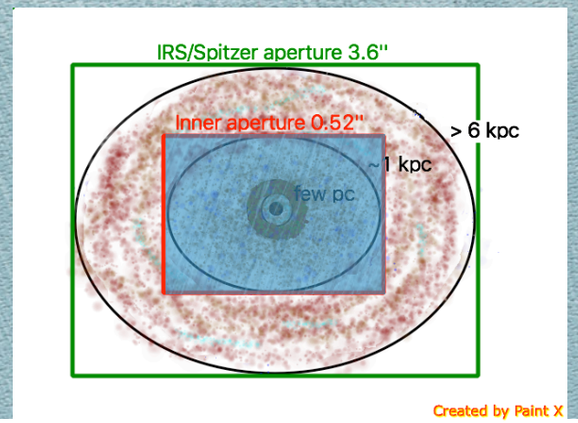
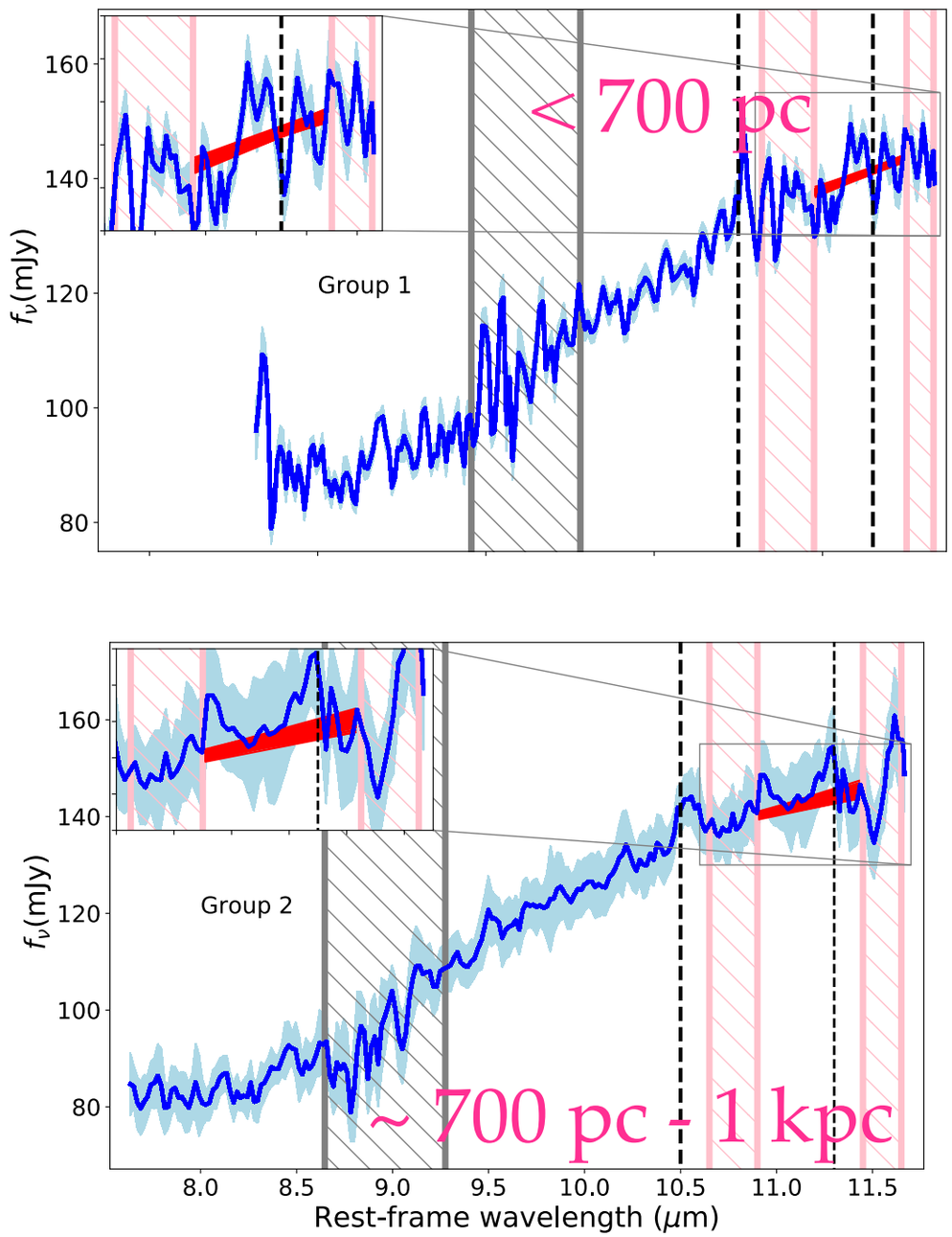


Name	Grou	Physical Scale pc	Nuclear Spectrum?
PG 1501+106/MRK 841	1	376	CC/GTC
MRK 509	1	514	VISIR/VLT
PG 2130+099/IIZw136	1	631	CC/GTC
PG 1229+204/MRK 771	1	631	CC/GTC
PG 0844+349	1	640	CC/GTC
MR 2251-178	1	640	CC/GTC
PG 0003+199/MRK 335	1	670	CC/GTC
PG 1440+478/MRK 478	2	777	CC/GTC
PG 1211+143	2	793	CC/GTC
PG 1426+015/MRK 1383	2	843	CC/GTC
PG 1411+442	2	846	CC/GTC
PG 0050+124/IZw1	2	854	VISIR/VLT
PG 0804+761	2	959	CC/GTC
PG 1448+273	...	...	...
PG 1534+580	...	...	...
PG 1535+547	...	...	...
PG 2214+139	...	...	....
PG 0923+129	...	...	...
PG 1351+640	...	...	...
PG 0007+106/MRK 1501	...	...	...



The stacked IRS/Spitzer spectrum

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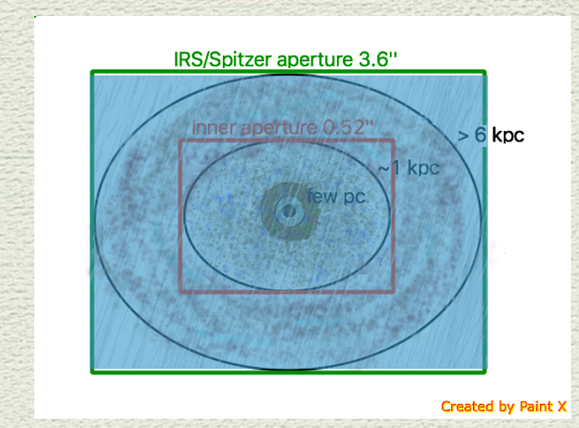
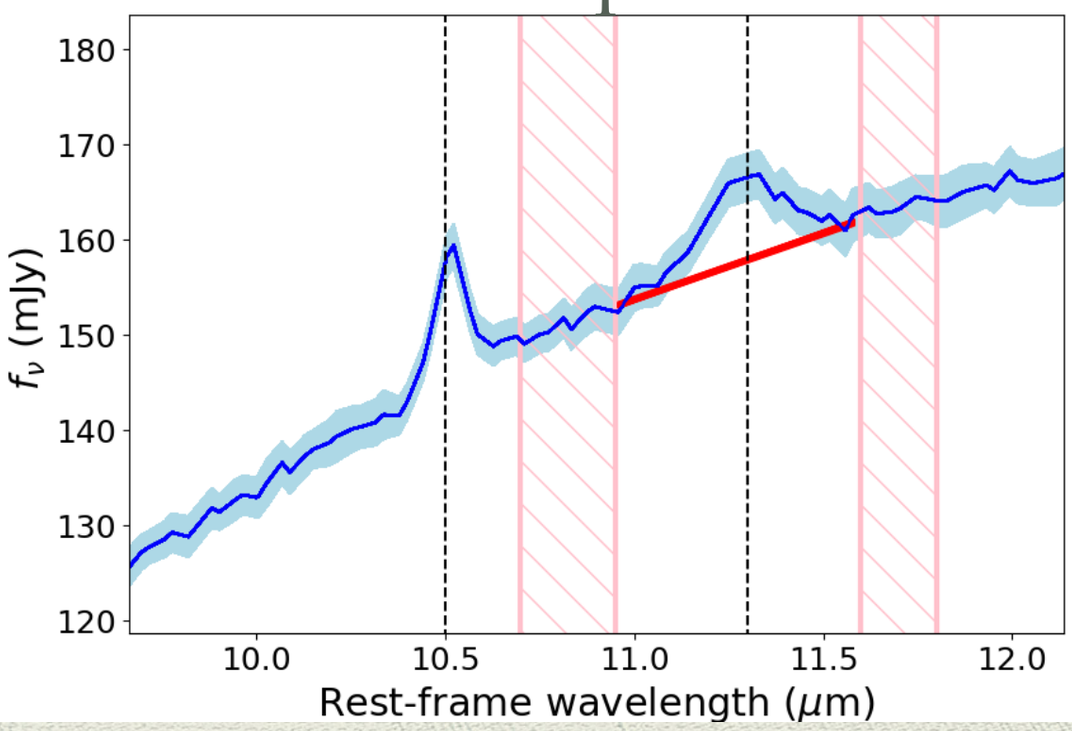
- PAH on larger apertures



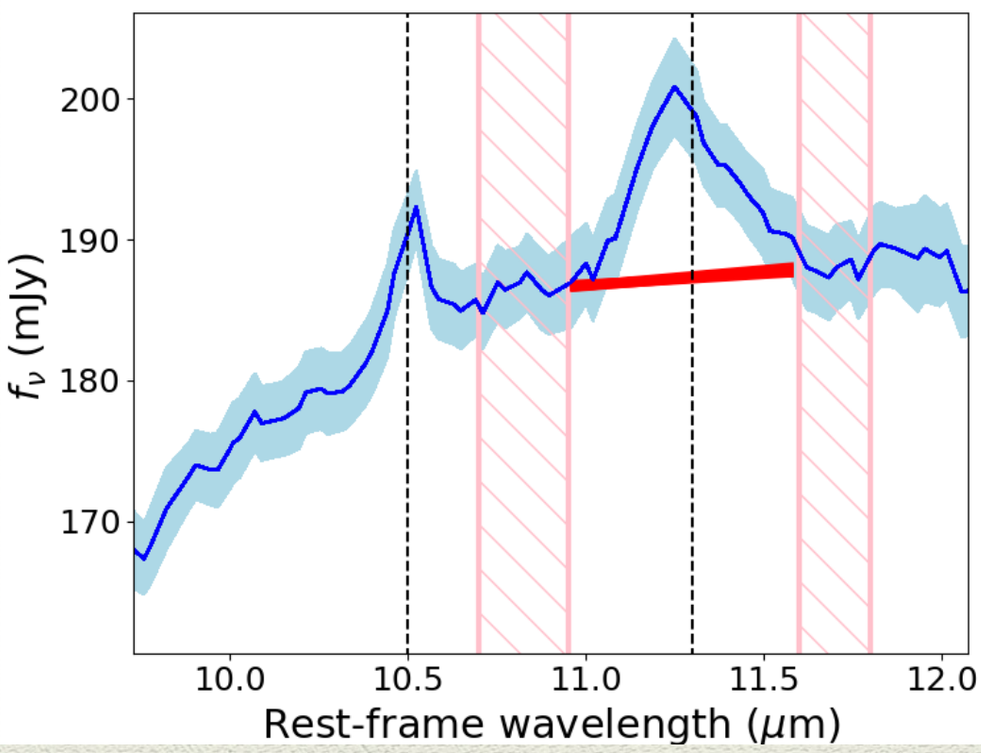
< 3 kpc

~3 - 6 kpc

Group 1



Group 2



The inner and larger aperture SFR

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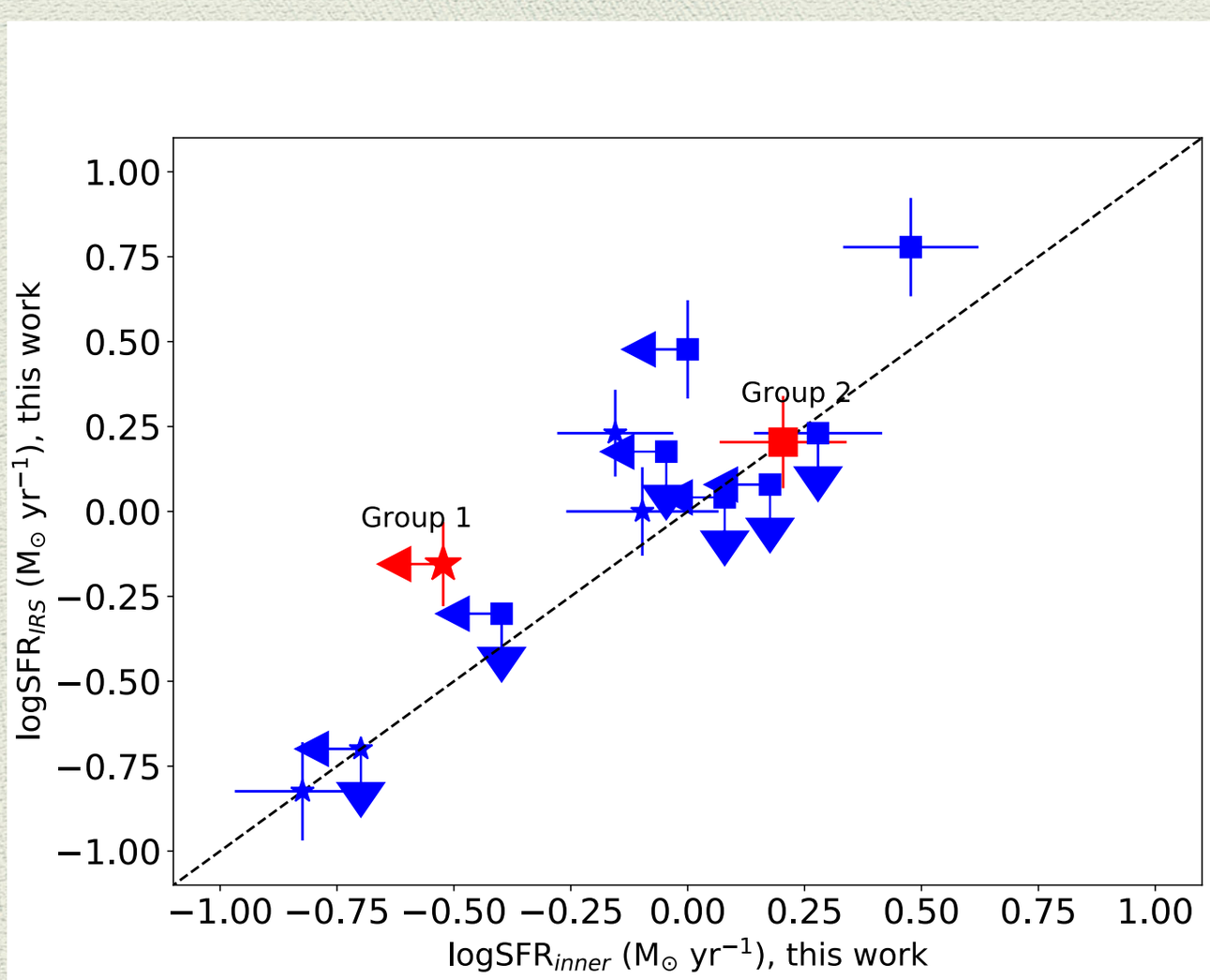
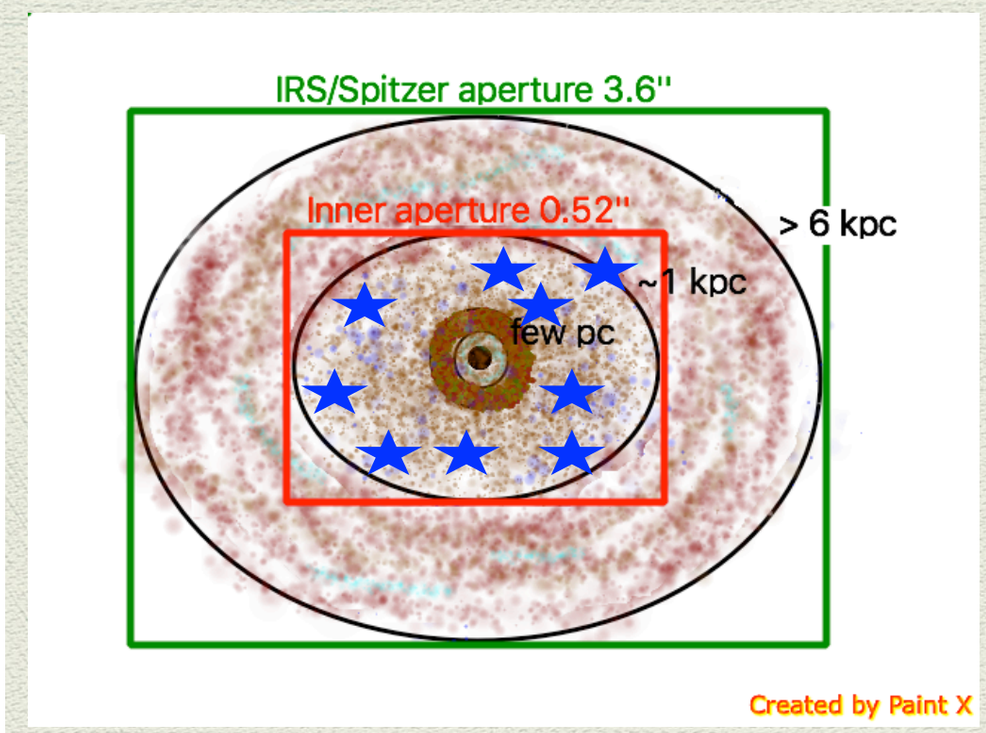
$$LogSFR(M_{\odot}yr^{-1}) = (-44.14 \pm 0.08) + (1.06 \pm 0.03) \times LogL_{11.3\mu\,\mathrm{m}}(ergs^{-1})$$

Shipley et al. (2016)





It is likely that the star formation activity detected on larger scales is mainly concentrated within the central kpc.

AGN and spatial Star formation activity

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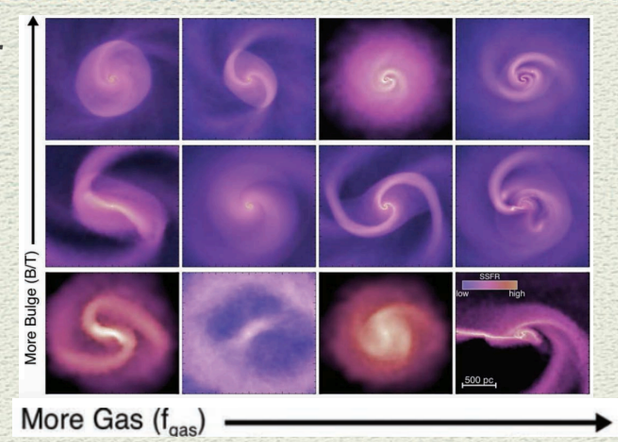
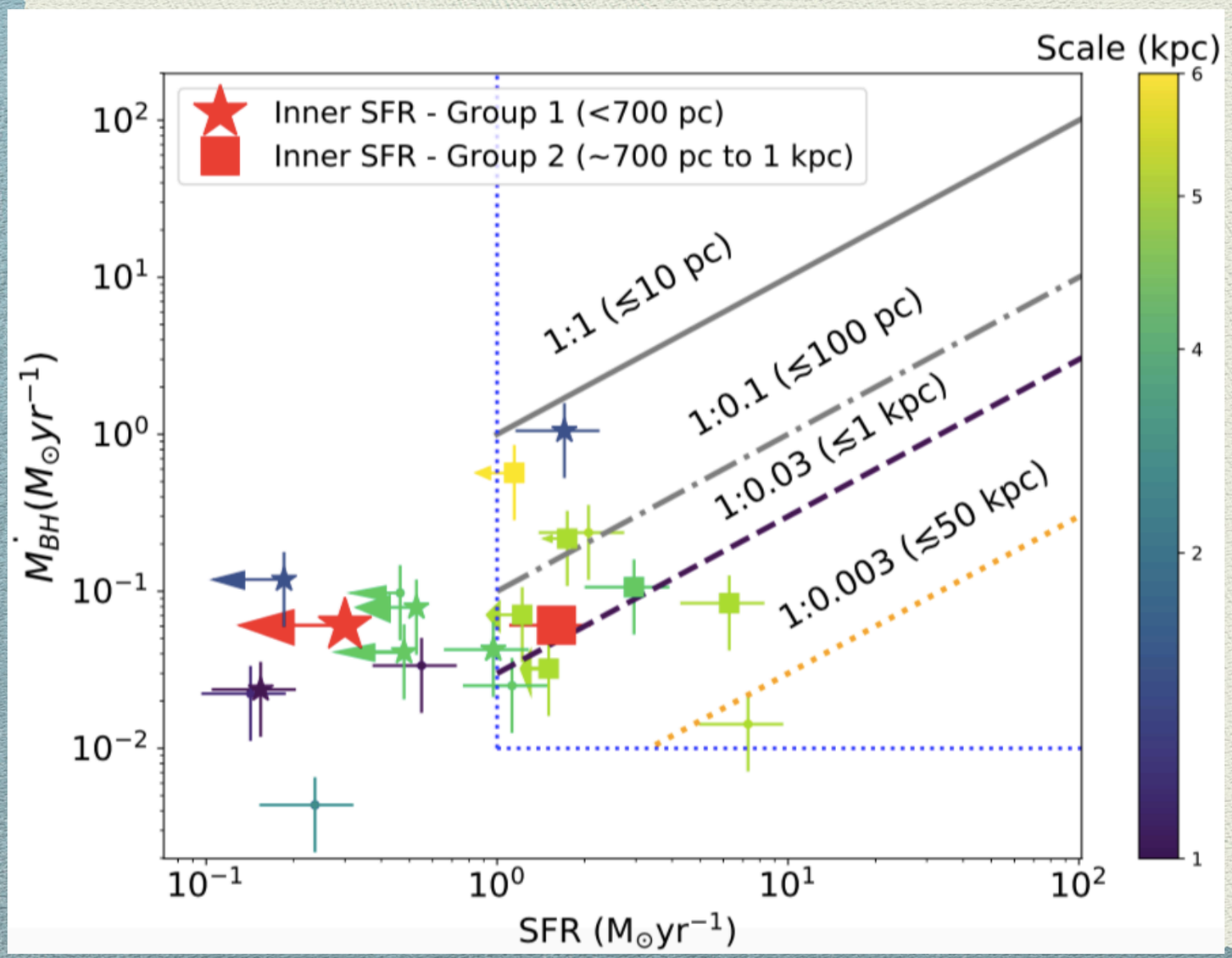
$$\dot{M}_{BH}(M_{\odot}yr^{-1}) = 0.15\frac{0.1}{\epsilon}\frac{L_{bol}}{10^{45}}$$

Alexander & Hickox (2012)

, ϵ = 0.1 is the typical value for the mass-energy conversion efficiency in the local Universe (Marconi et al. 2004)



P. F. Hopkins and E. Quataert (2010)



1. The QSOs evolutionary stage is not well accounted for in their simulations.

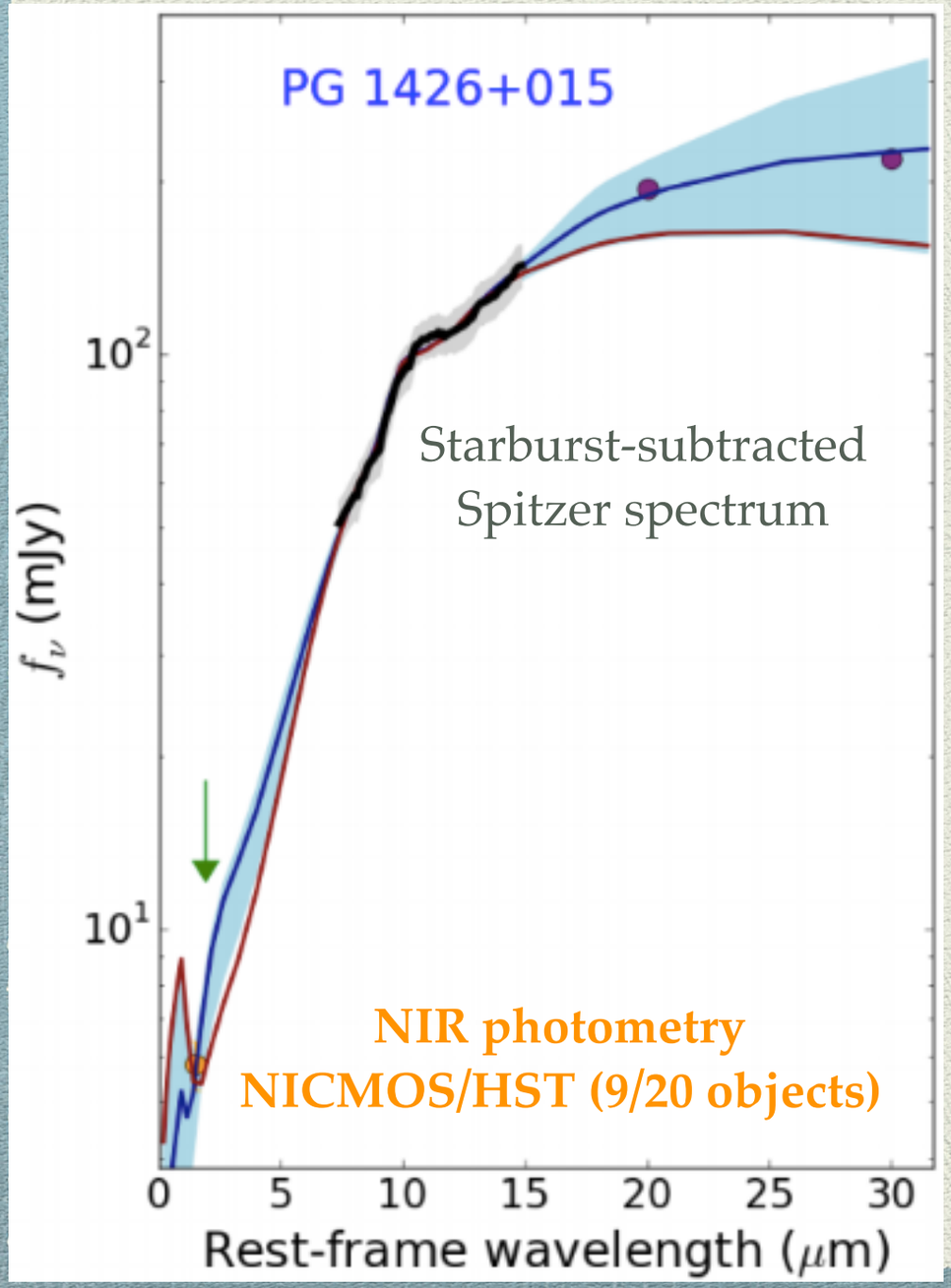
2. The star formation efficiency in the host of QSOs could be quenched.

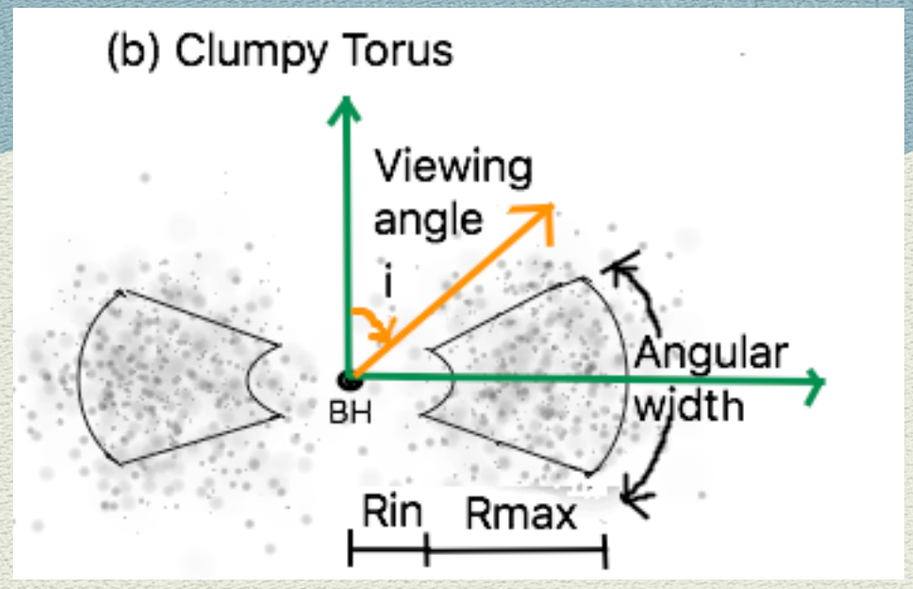
3. PAHs in QSOs are not effectively tracing the star formation within few kpc.

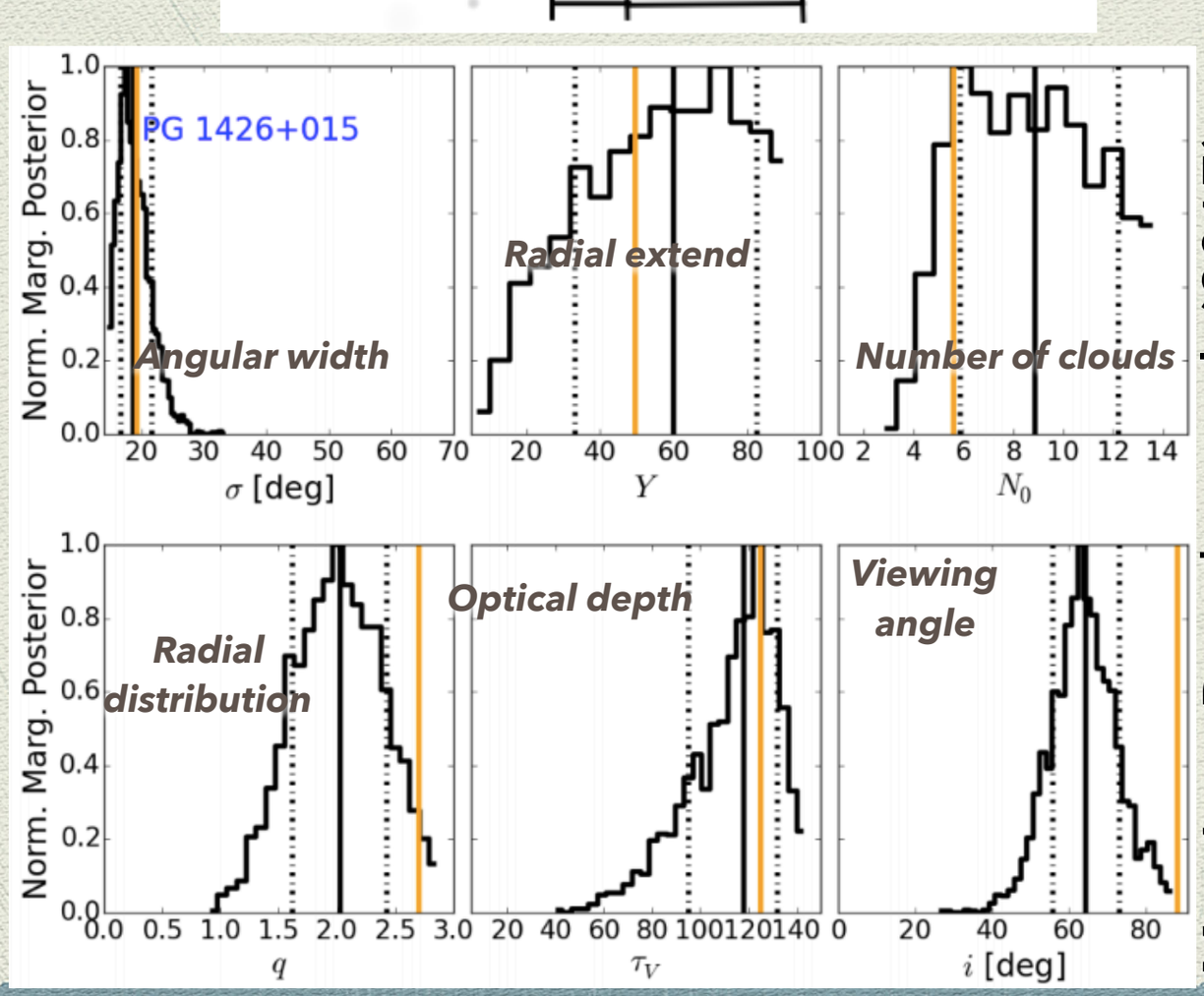
2. The properties of the dusty torus of QSOs

Martinez-Paredes et al. (2017)

Clumpy torus modeling of Nenkova et al. (2008)





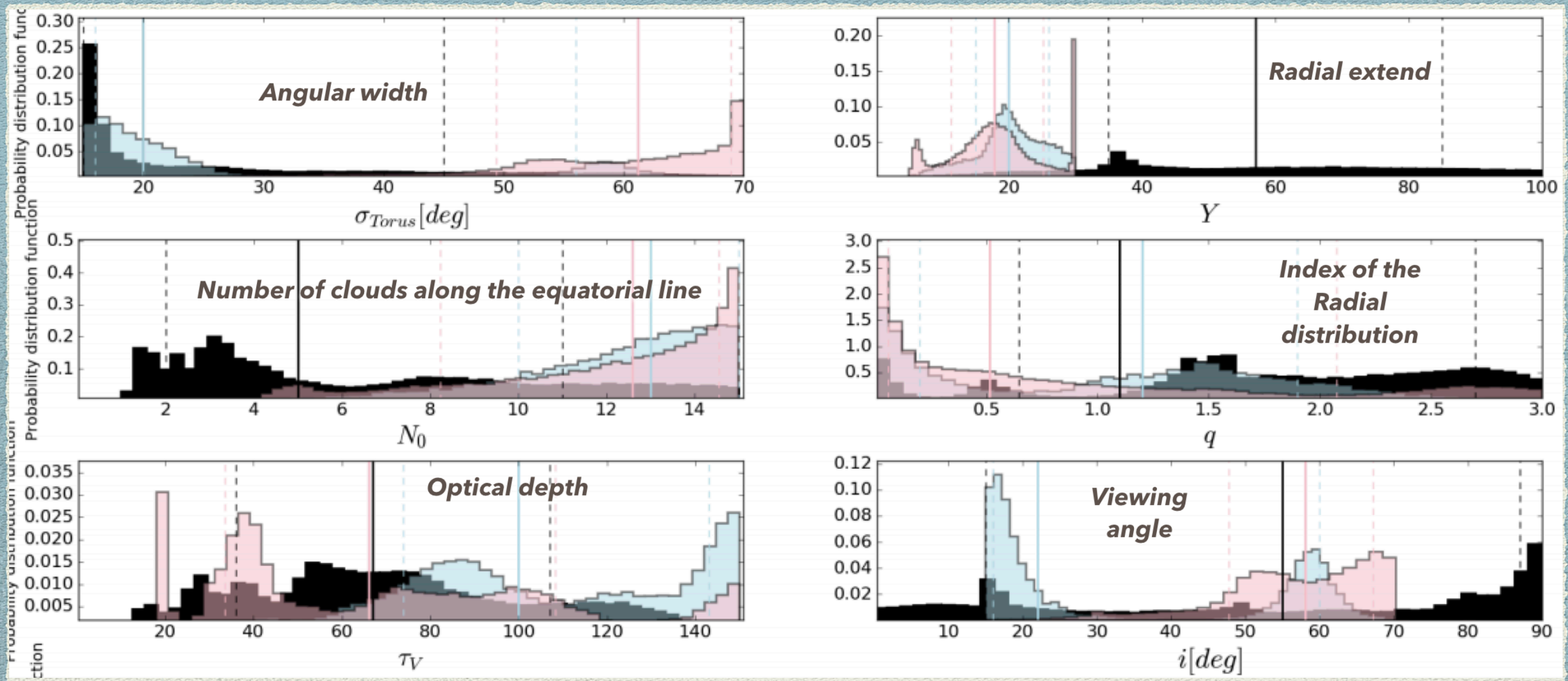


Martínez-Paredes et al. (2017)

Dusty torus in local QSOs and Seyferts

*Martínez-Paredes et al. (2017) –> distributions in black (**QSOs**)*

*Ichikawa et al. (2015) –> Distributions in blue (**Seyfert 1**), and pink (**Seyfert 2**)*



* The combination of the σ_{torus}, N_o and i results in escape probabilities P_{esc} >5 per cent, which is consistent with the optical classification of QSOs as type 1 AGN.

* Lower number of clouds, steeper radial distribution and less optically thick clouds in QSOs can be interpreted as dusty structures that have been partly evaporated and piled up by the higher intensity radiation field in QSOs, as proposed by a receding torus scenario.

Conclusions

- The NIR and MIR emission of local QSOs is unresolved on scales of few hundred pc.
- The dusty torus in QSOs is intrinsically different to the dusty torus in Seyfert galaxies.
- Star formation activity is present in the most nearby QSOs at scales of hundred pc-implying the survival of PAH at 11.3μm to the strong radiation of the AGN.
- The SF activity in QSOs is more centrally concentrated as predicted by simulations.
- SFRs measured on few kpc scales are lower than predicted by simulations: evolution, quenching, or calibrator?.