Resolving the dusty cores of nearby AGN with MIR interferometry

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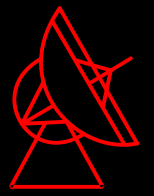
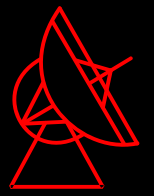
Outline



1. The nuclear dust distribution in the Circinus galaxy

2. A size – luminosity relation for AGN dust tori

Outline



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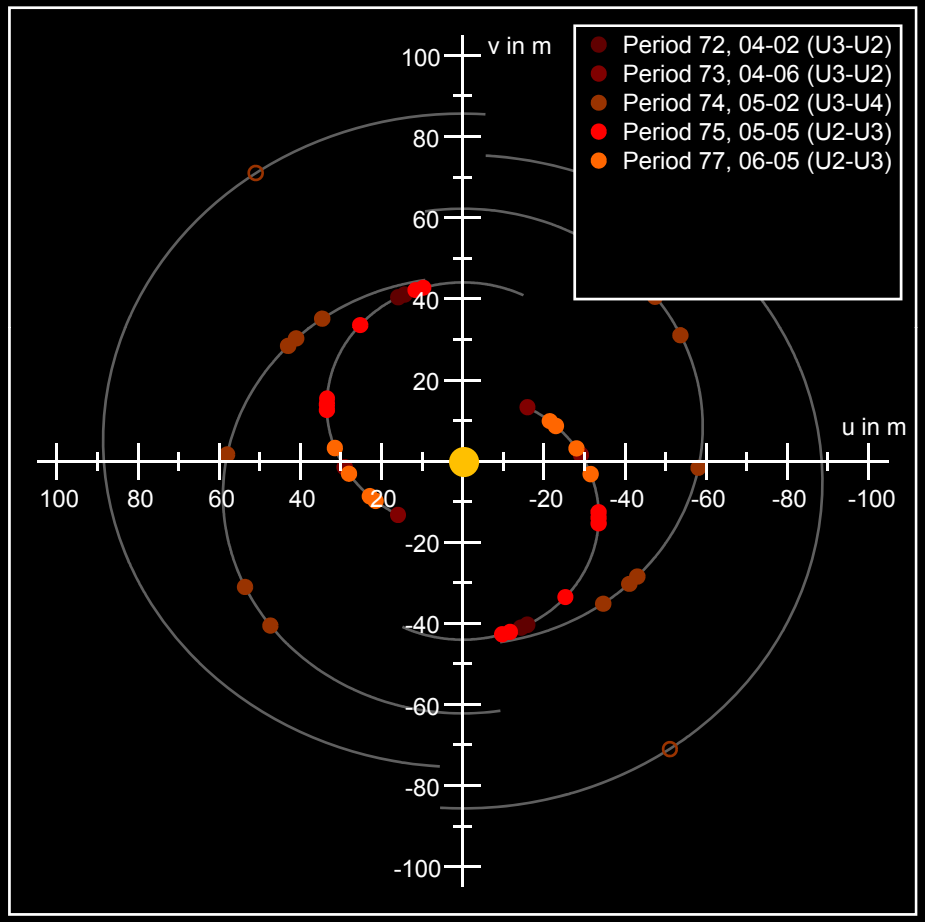
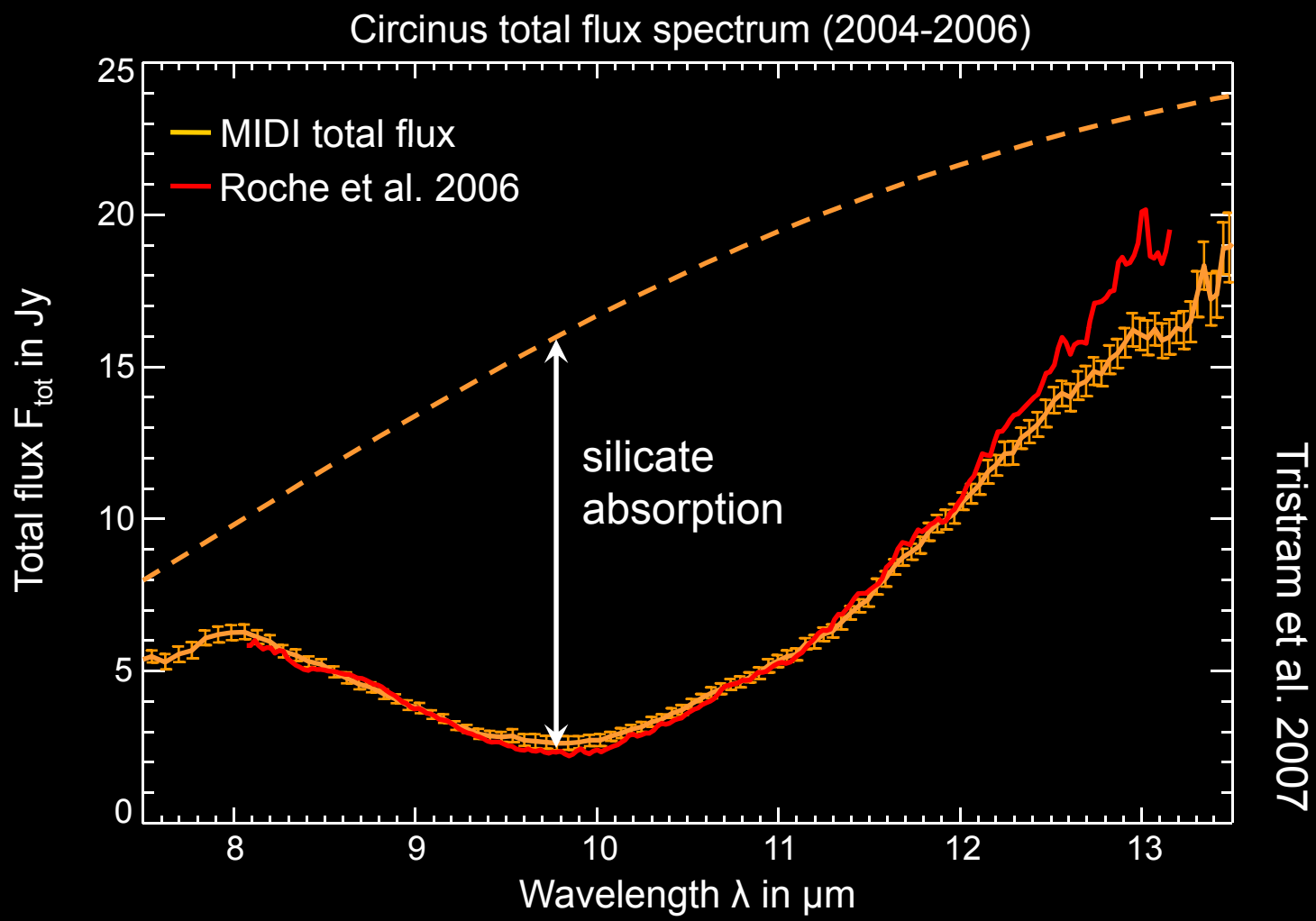
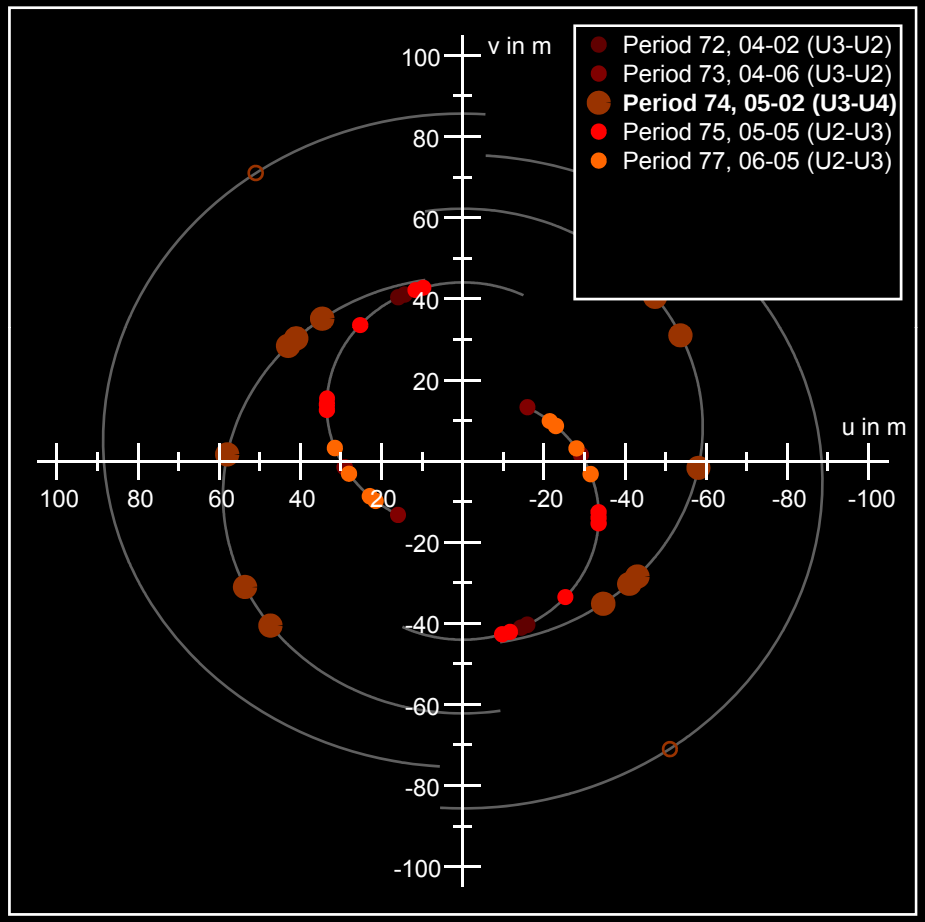
Circinus – UV coverage



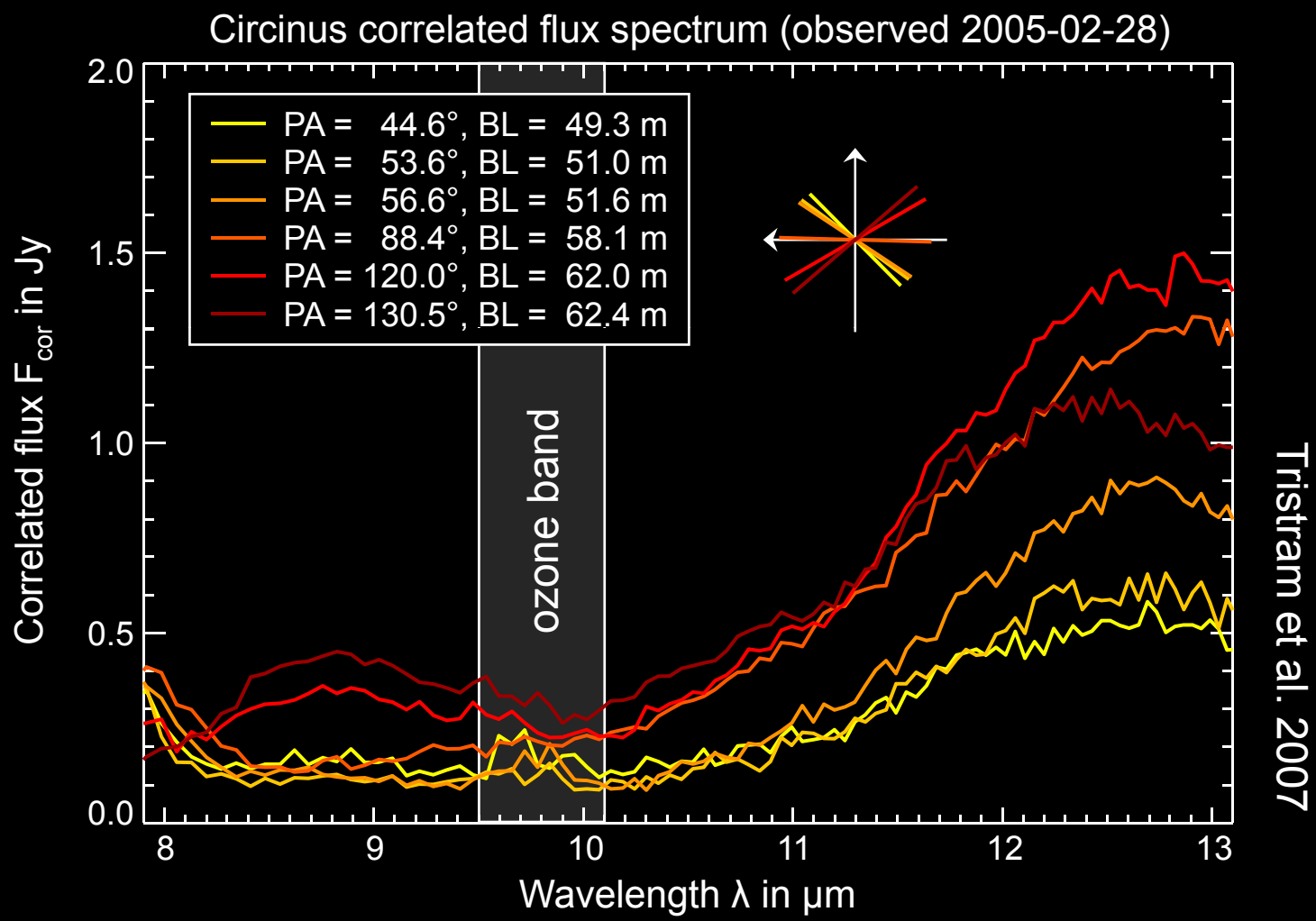
Circinus – Total flux spectrum



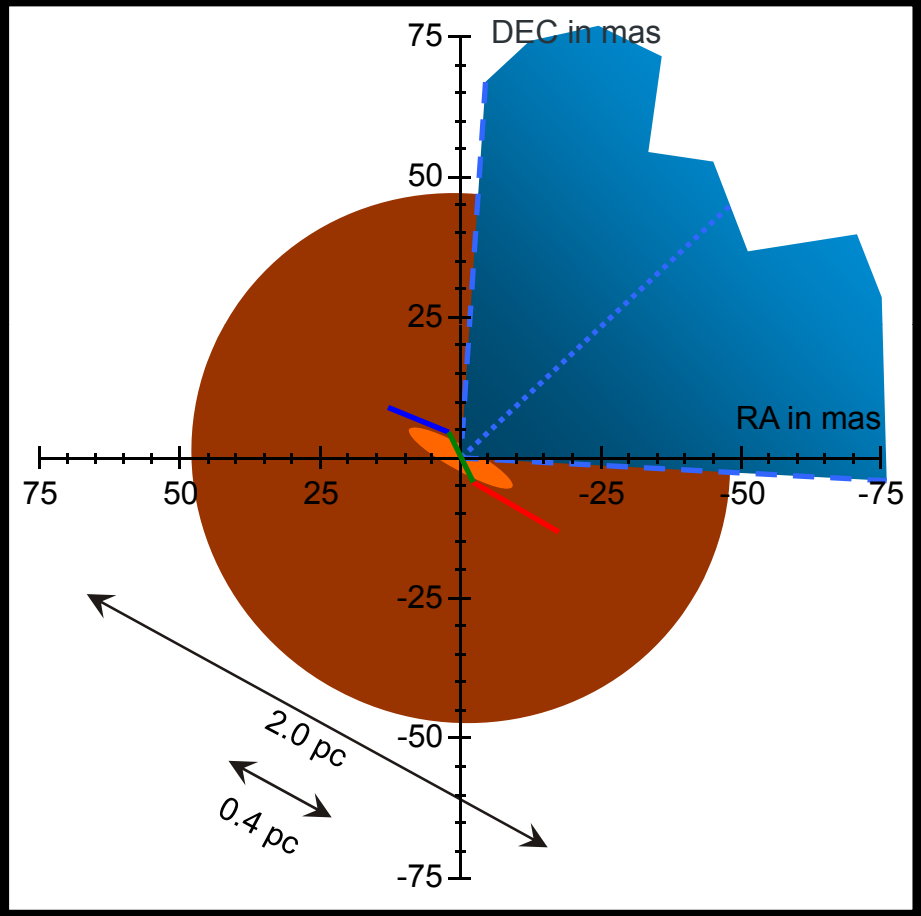
Circinus – UV coverage



Circinus – Correlated flux spectrum



Circinus – Gaussian model

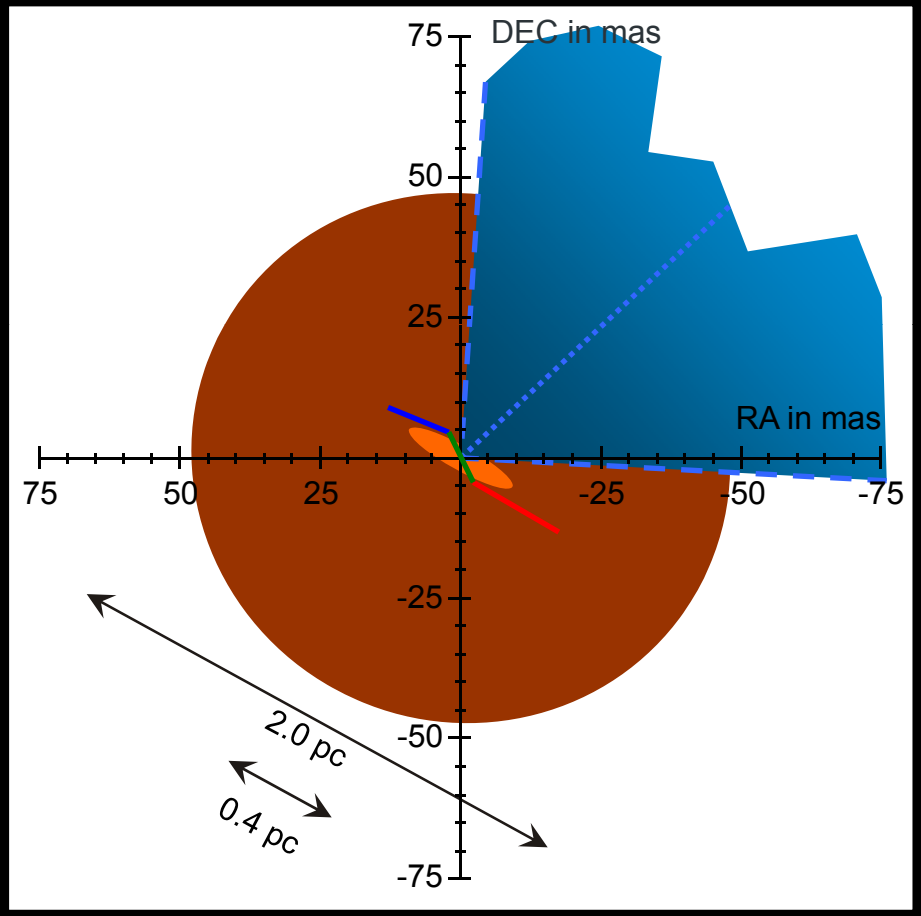


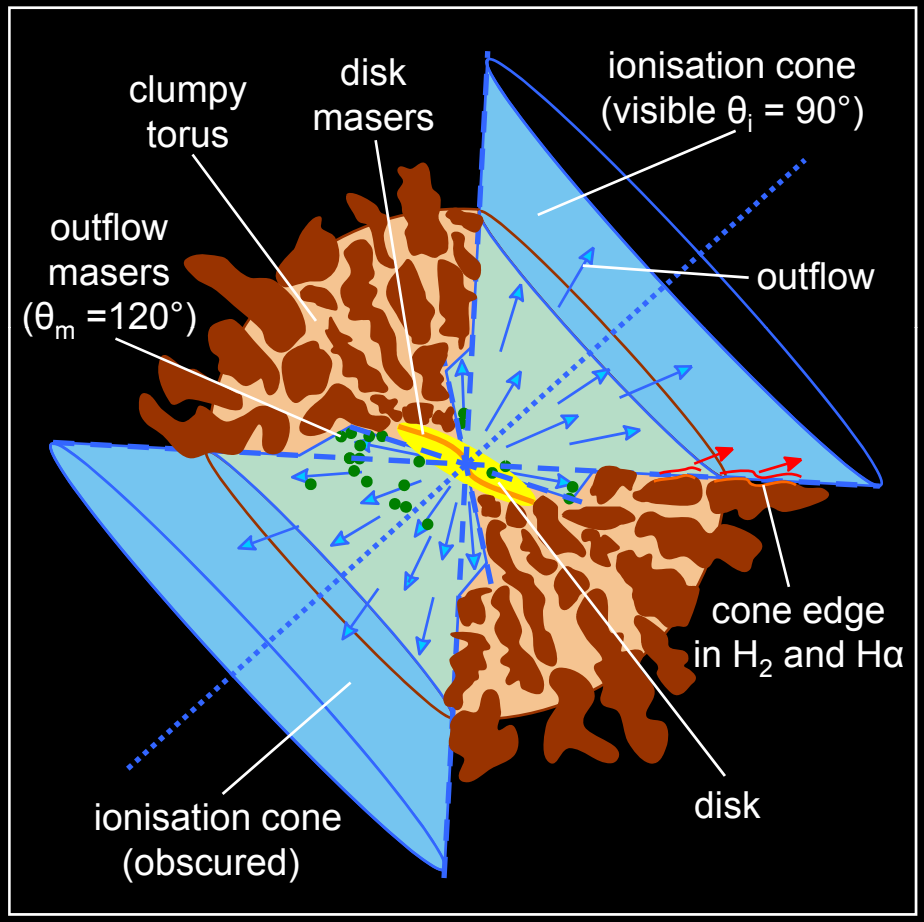
Tristram et al. 2007

Two blackbody Gaussians:

Size:	Δ_1 = 21 mas
Axis ratio:	r_1 = 0.21
Silicate depth:	τ_1 = 1.18
Temperature:	T_1 = 334 K
Covering factor:	f_1 = 1.0
Size:	Δ_2 = 97 mas
Axis ratio:	r_2 = 0.97
Silicate depth:	τ_2 = 2.21
Temperature:	T_2 = 298 K
Covering factor:	f_2 = 0.20
Position angle:	α = 61°

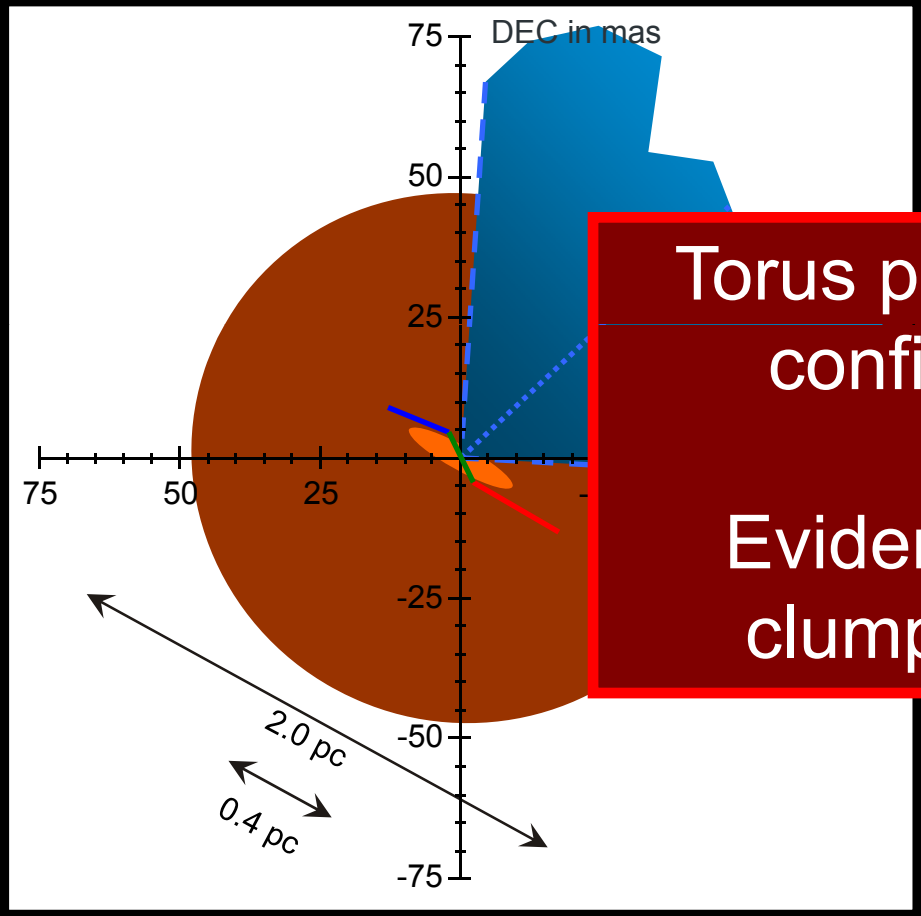
Circinus – Interpretation





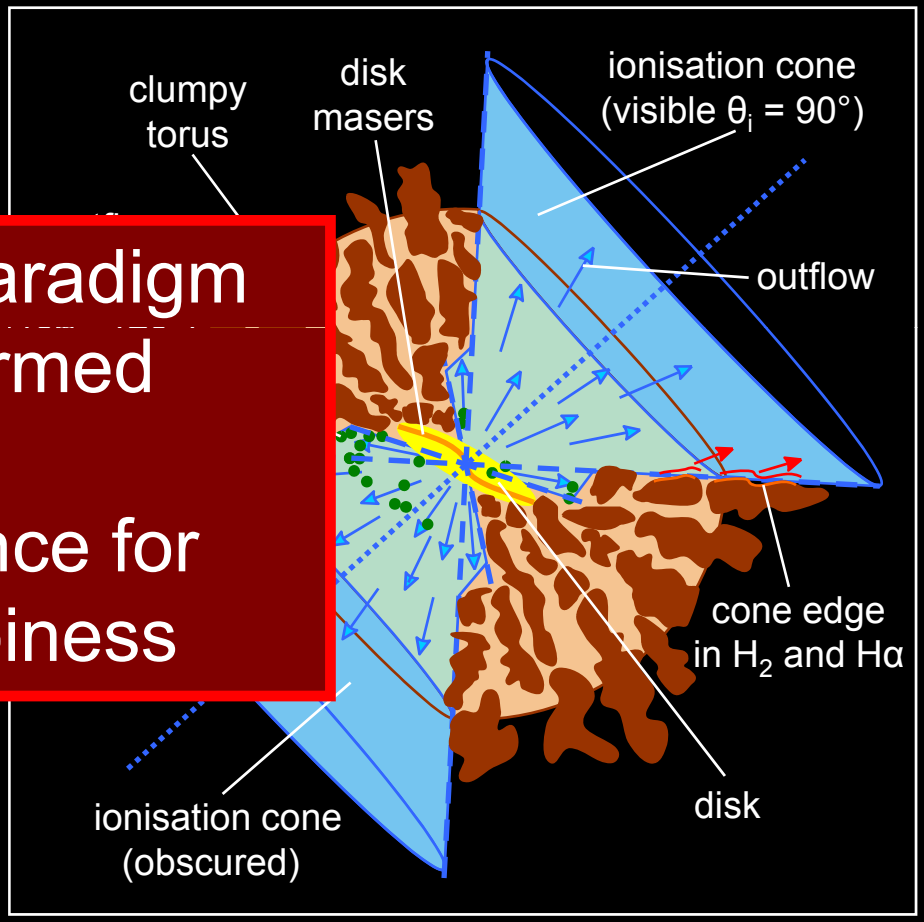
Tristram et al. 2007

Circinus – Interpretation



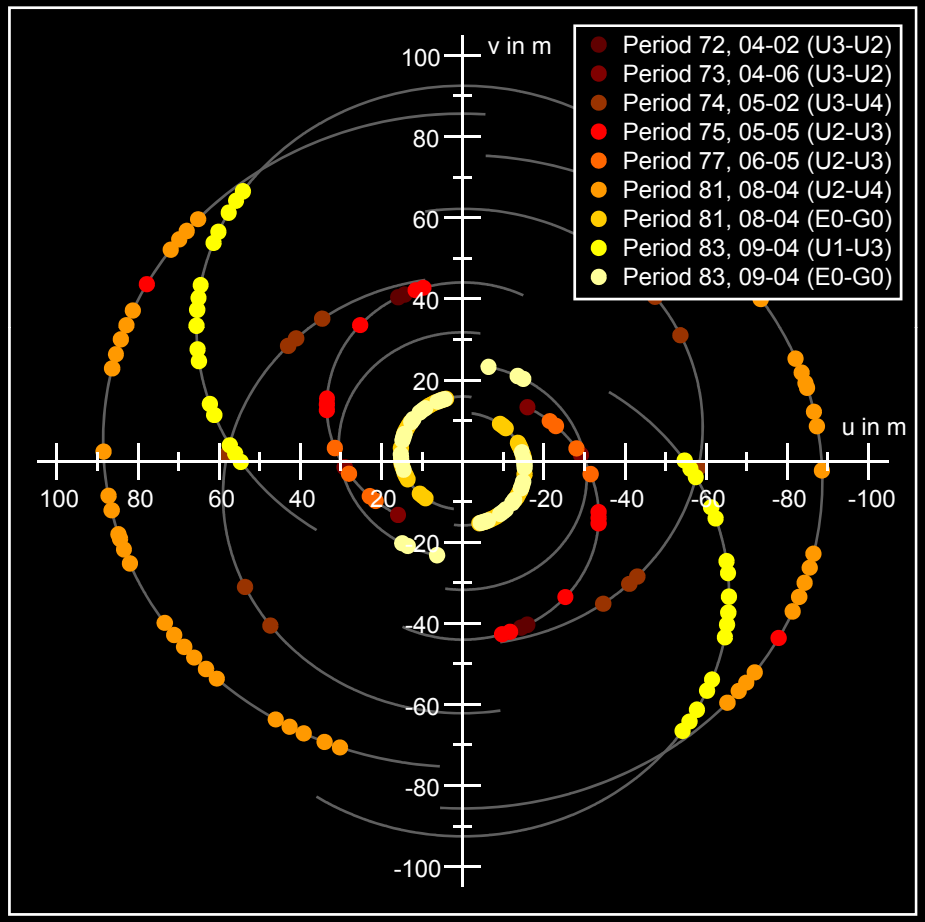
Torus paradigm confirmed

Evidence for clumpiness



Tristram et al. 2007

Circinus – New data 2008 & 2009



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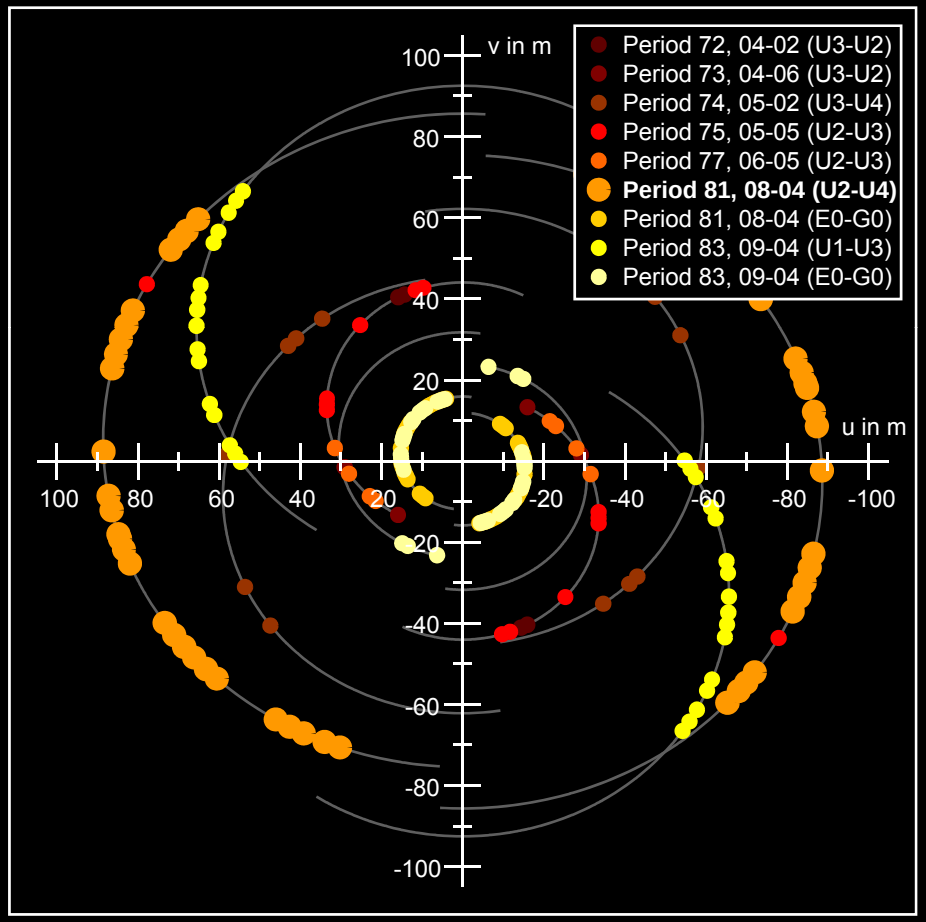

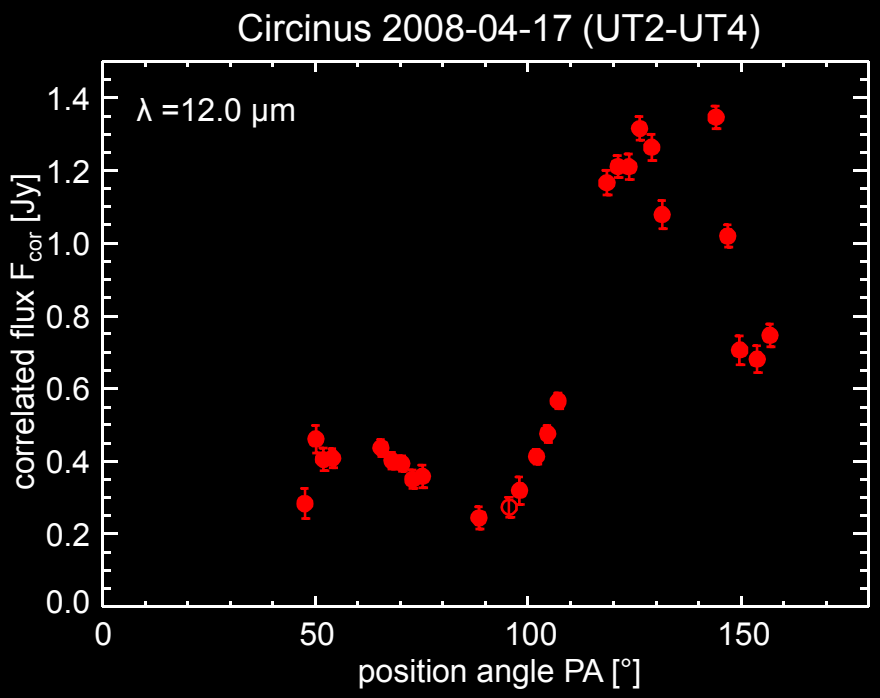

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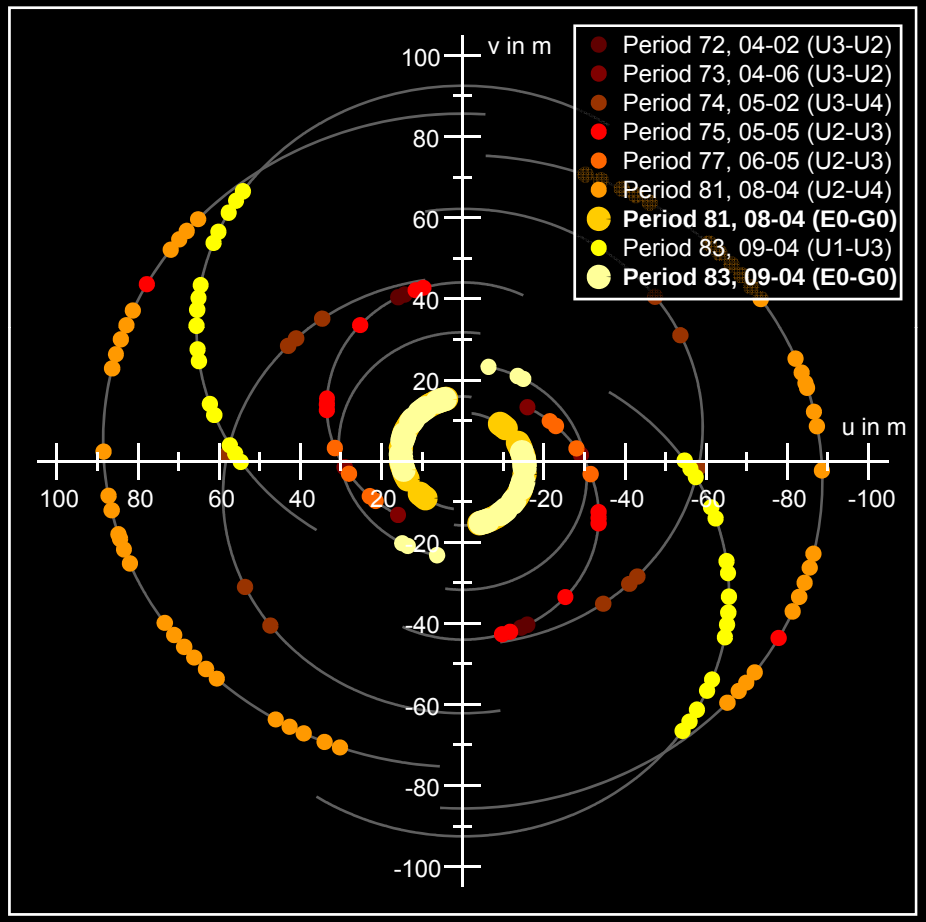
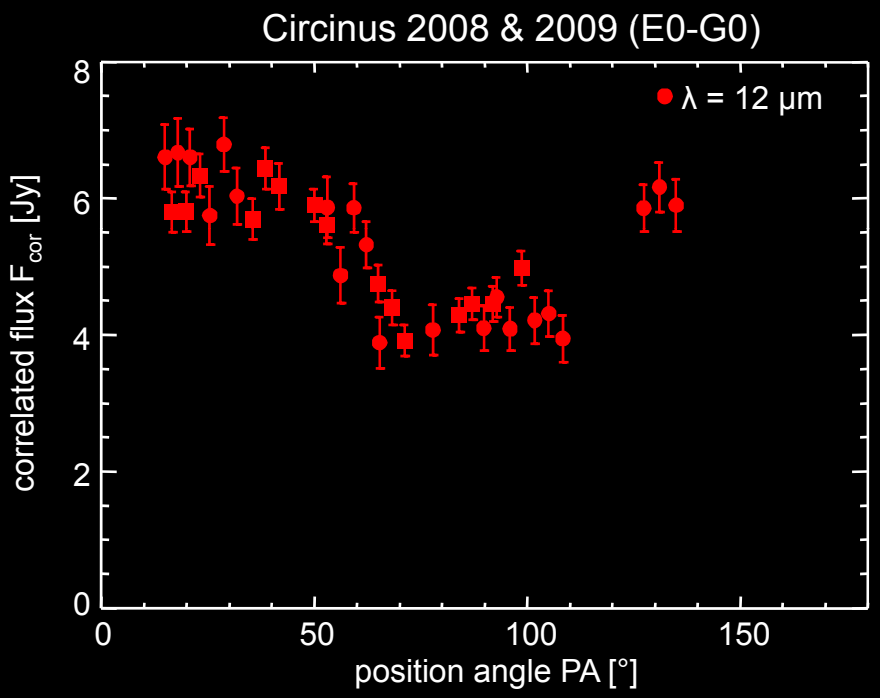
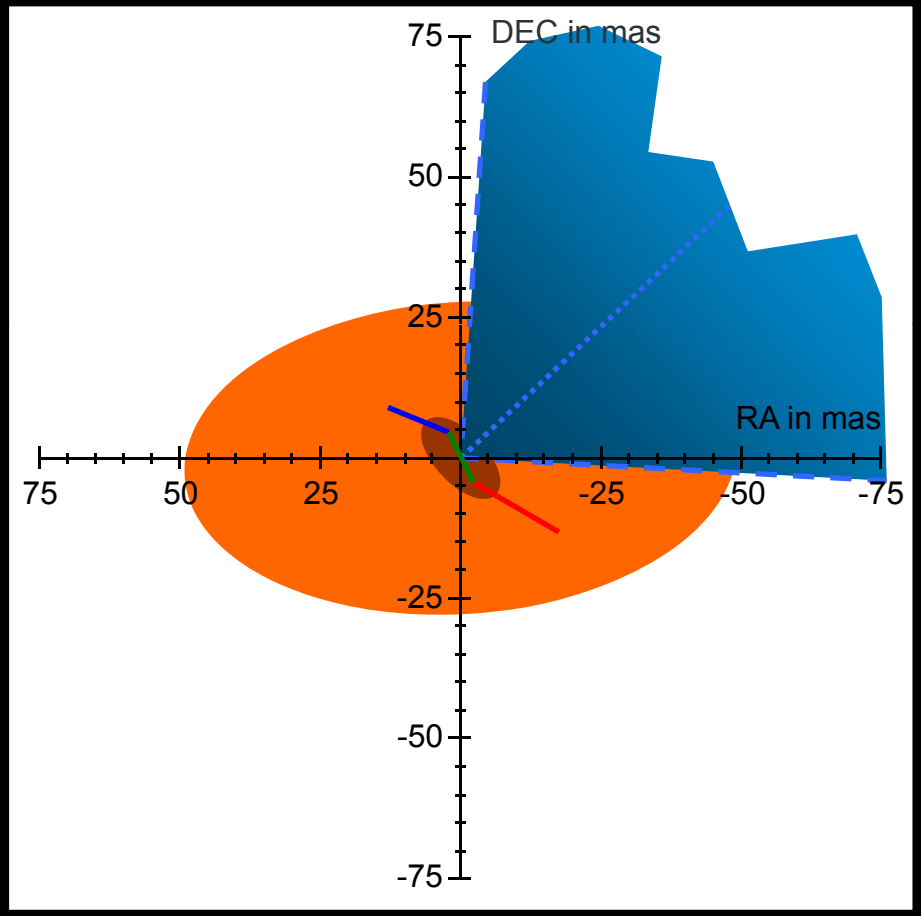




Circinus – New Gaussian model

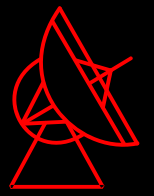


Tristram et al. in prep

Two blackbody Gaussians:

Size:	Δ_1 = 18 mas
Axis ratio:	r_1 = 0.50
Position angle	α_1 = 43°
Silicate depth:	τ_1 = 1.4
Temperature:	T_1 = 295 K
Covering factor:	f_1 = 1.0
Size:	Δ_2 = 99 mas
Axis ratio:	r_2 = 0.56
Position angle:	α_2 = 94°
Silicate depth:	τ_2 = 2.1
Temperature:	T_2 = 358 K
Covering factor:	f_2 = 0.17

Outline



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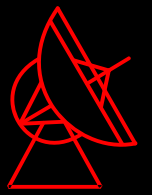
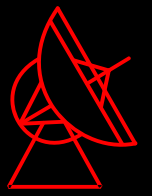
AGN observations with MIDI



	Name	AGN type	Flux (12 μm)	Result
1	NGC 1068 (M77)	Sy 2.0	16.5 Jy	well resolved (disk plus extended component)
2	NGC 1365	Sy 1.8	0.5 Jy	partially resolved (elongated)
3	IRAS 05189-2524	Sy 2.0	0.6 Jy	faint detection only (elongated?)
4	MCG -05-23-016	Sy 2.0	0.6 Jy	partially resolved
5	Mrk 1239	Sy 1.5	0.6 Jy	essentially unresolved
6	NGC 3783	Sy 1.0	0.6 Jy	partially resolved
7	NGC 4151	Sy 1.5	1.2 Jy	well resolved
8	3C 273	QSO / Sy 1.0	0.3 Jy	possibly resolved (elongated?)
9	Centaurus A	FR I	1.2 Jy	well resolved (disk plus unresolved core)
10	IC 4329A	Sy 1.2	1.0 Jy	unresolved
11	*Circinus*	*Sy 2.0*	*10.2 Jy*	*well resolved (disk plus extended component)*
12	NGC 7469	Sy 1.2	0.7 Jy	well resolved

→ Derive size estimates from the visibilities

Size – luminosity relation



- Assume Gaussian brightness distribution:

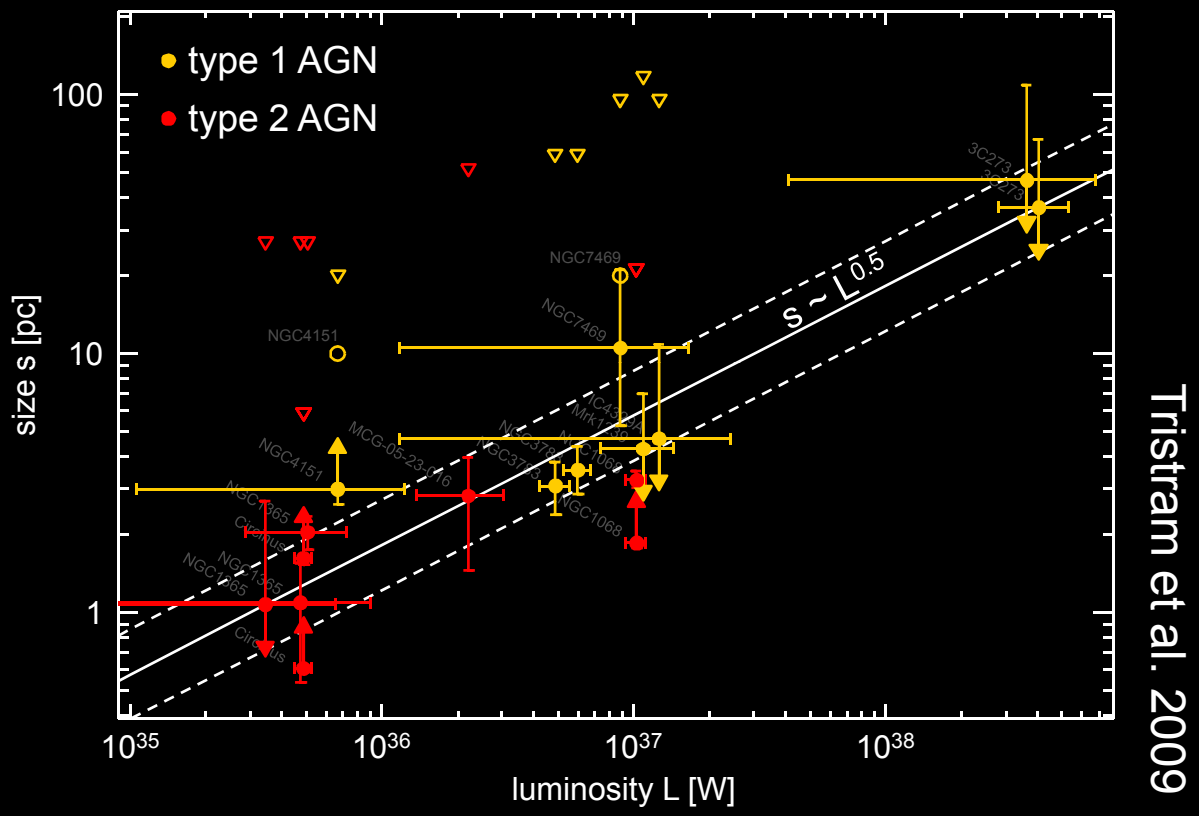
$$FWHM(\lambda) = \frac{\lambda}{BL} \cdot \frac{2}{\pi} \sqrt{-\ln 2 \cdot \ln V(\lambda)}$$

- Good estimate for size of emitter for

$$0.2 \lesssim V(\lambda) \lesssim 0.8$$

- Otherwise only upper or low limit on size

Size – luminosity relation



- Simple expectation: $s = p \cdot (L)^{0.5}$
- Find $p = (1.8 \pm 0.3) \cdot 10^{-18}$ pc $W^{-0.5}$

Size – luminosity relation

$$s = (1.8 \pm 0.3)\ (L_{36})^{0.5}\ \mathrm{pc}$$

- For a blackbody:

$$L = \pi\, s^2\, \nu\, F_{bb}(\nu, T)$$

$$\rightarrow\ s = (\pi\, \nu\, F_{bb}(\nu, T))^{-0.5} \cdot (L)^{0.5}$$

- With $T = 300$ K and $\nu = 2.5 \cdot 10^{13}$ Hz ($\lambda = 12$ µm):

$$p \sim 1.8 \cdot 10^{-18}\ \mathrm{pc\ W^{-0.5}}$$

Size – luminosity relation is consistent with optically thick dust at T ~ 300 K