



The dusty core of the Circinus galaxy

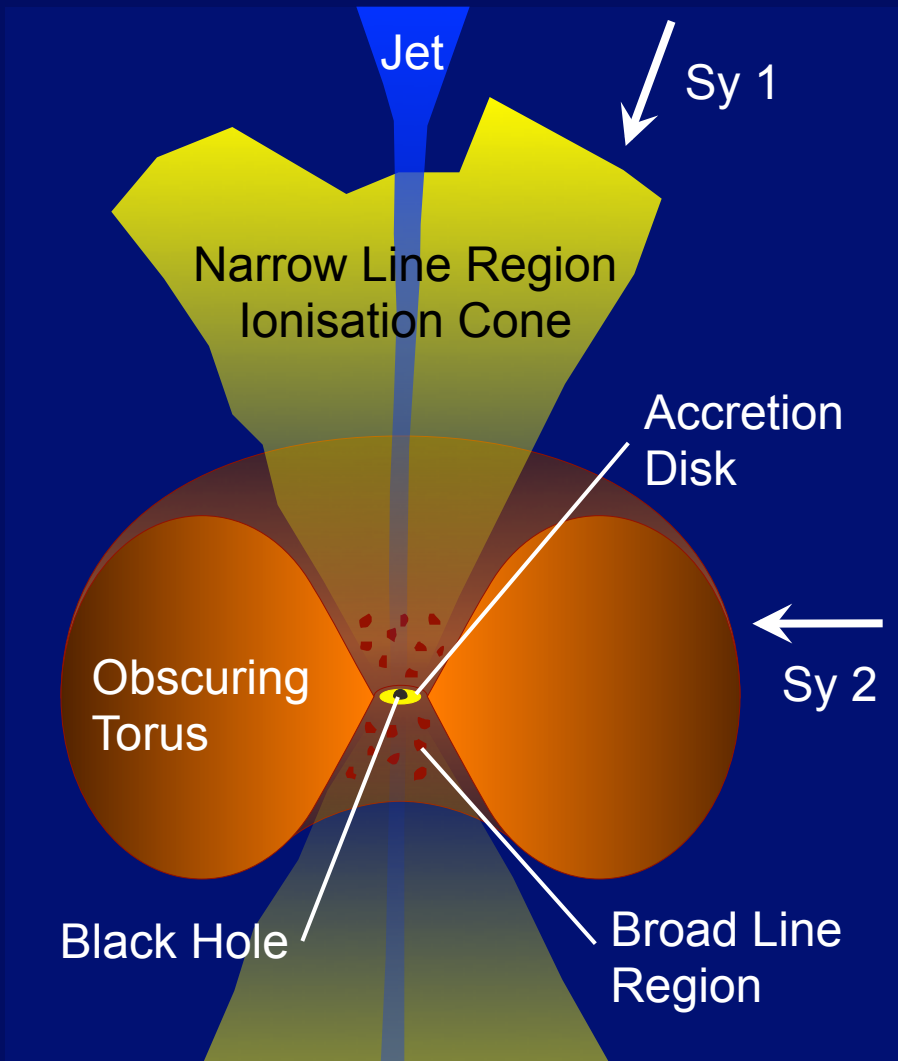
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and the MIDI Science Group

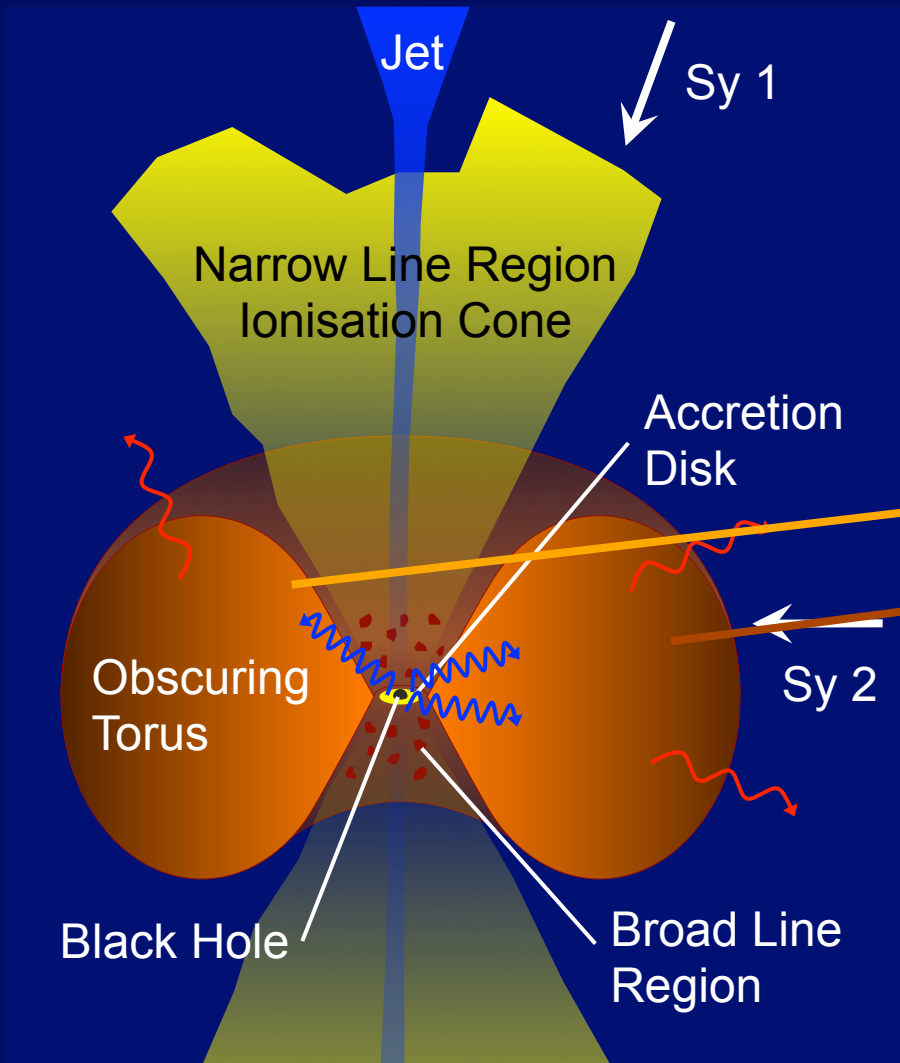
Introduction: the dusty torus in AGN



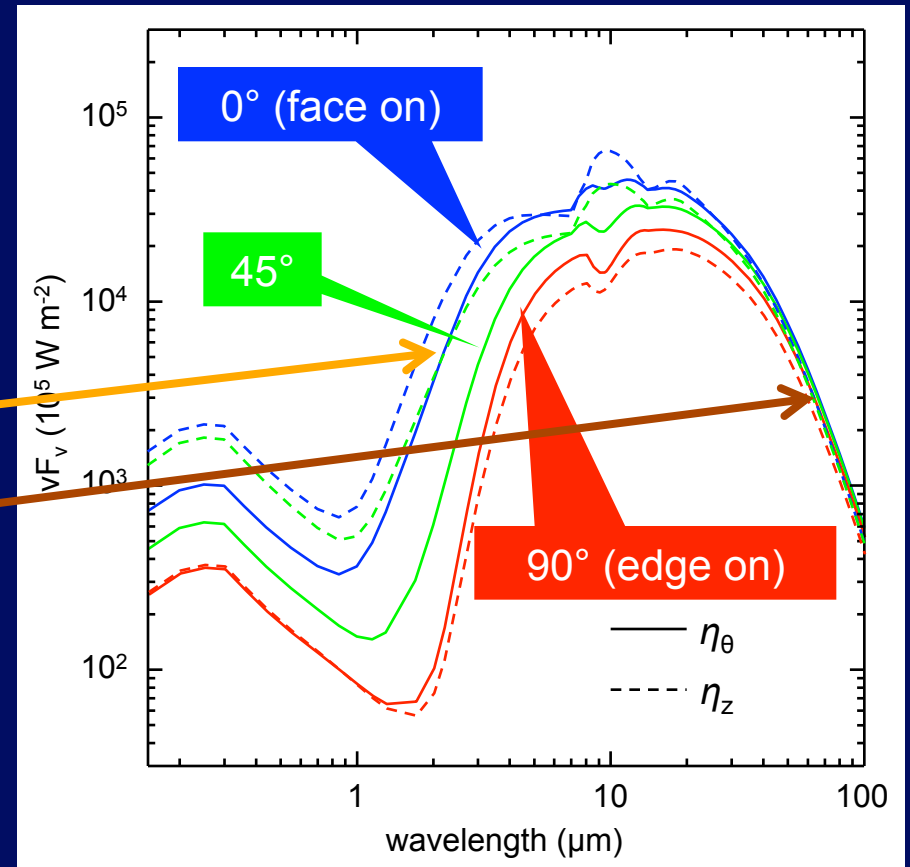
Open questions:

- How true is this picture?
- Do Sy1 and Sy2 have the same tori?
- Geometry of the torus
- What keeps the torus thick?
- Dynamics in the torus (inflow / outflow / ...)

Introduction: The torus emission



Torus SED:

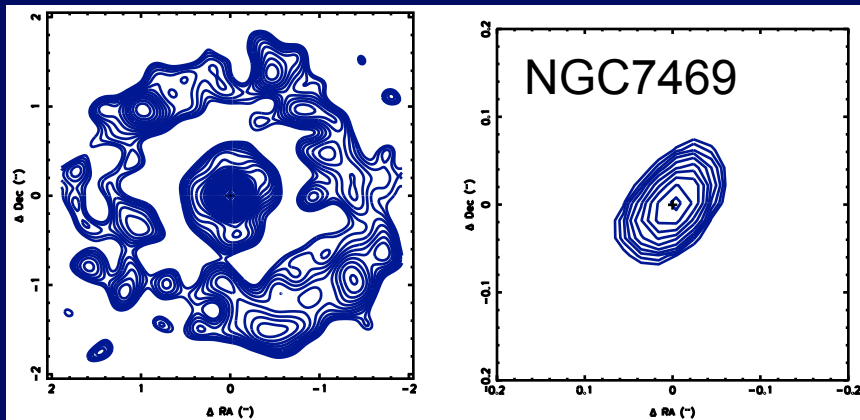
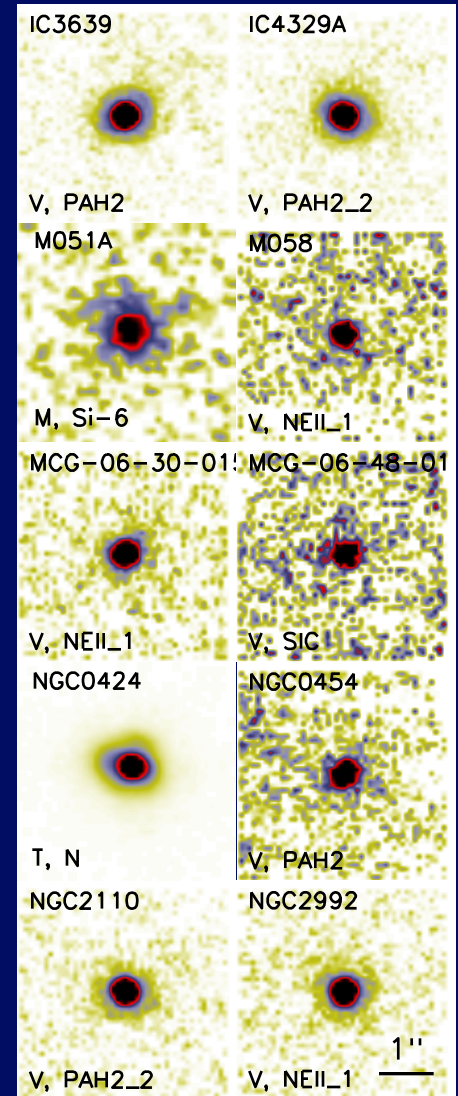


Hönig & Kishimoto 2010

Introduction: Single dish observations



Prieto et al. 2004: NIR
(NACO@VLT: $\sim 0.1'' = 2$ pc)



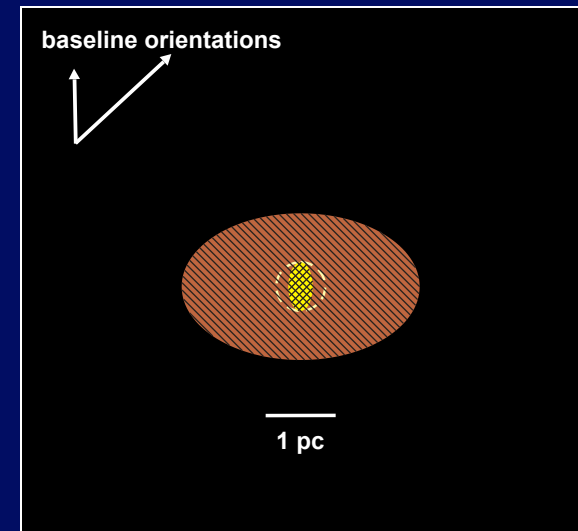
Soifer et al. 2003: MIR
(LWS@Keck: $\leq 0.1''$)

Asmus et al. 2013: MIR
(VISIR/MICHELLE/T-ReCS: $< 0.35''$)

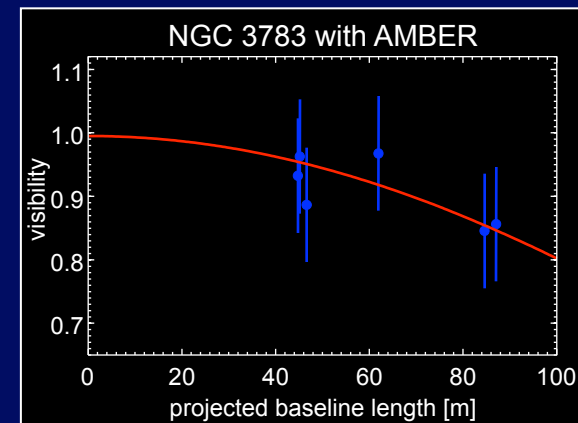
Overview: AGN infrared interferometry



- so far, main work in the mid-infrared with MIDI:
 - individual sources (Circinus, ...)
 - samples of AGN: snapshot survey, AGN LP, Seyfert 1s)
- near-infrared with the Keck
 - three studies of NGC4151
 - two studies of type 1 samples
- near-infrared with the VLTI
 - VINCI observation of NGC1068
 - AMBER observations of type 1
 - PIONIER observations



Jaffe et al. 2004



Weigelt et al. 2012

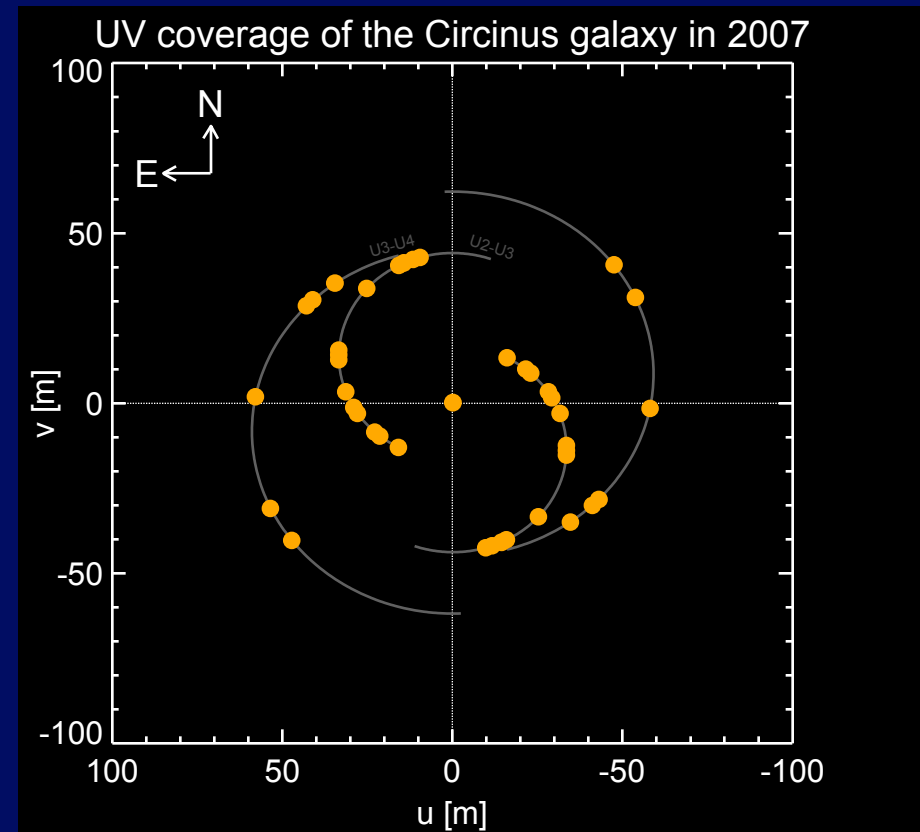
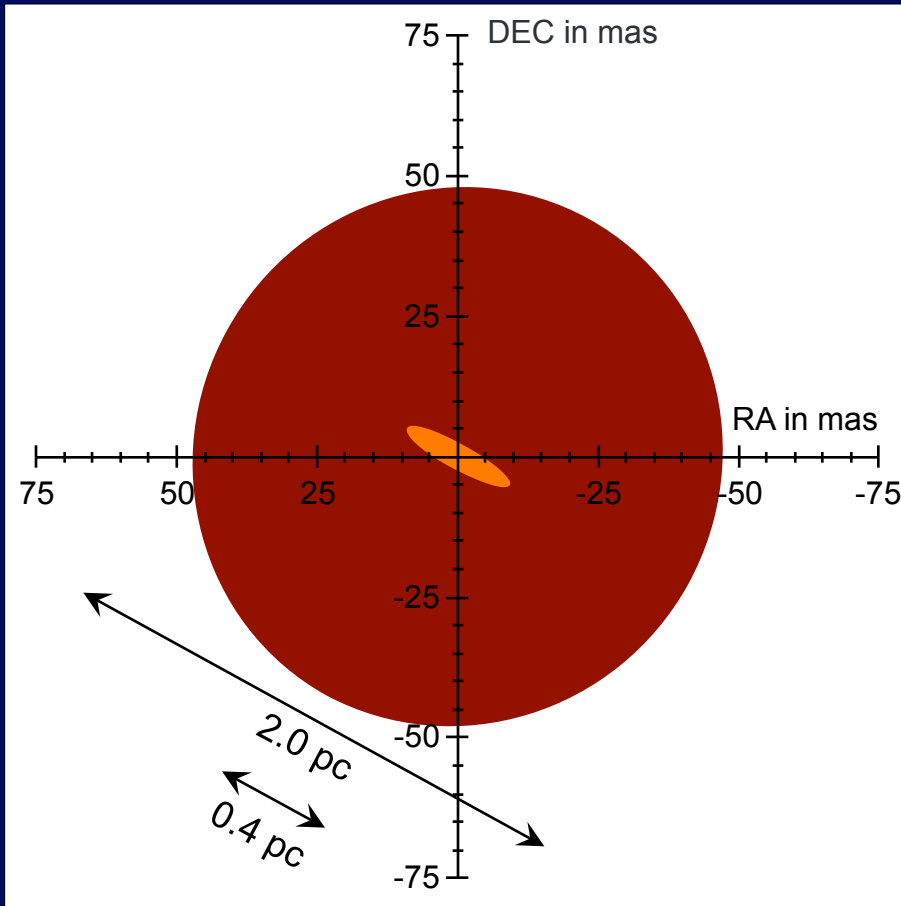
Circinus: General properties



- Spiral galaxy SA(s)b, $i = 65^\circ$
- Seyfert type 2
- $4 \times 10^6 M_\odot$ nucleus
- Distance ~ 4 Mpc
→ $50 \text{ mas} \sim 1 \text{ pc}$
- Circumnuclear starburst

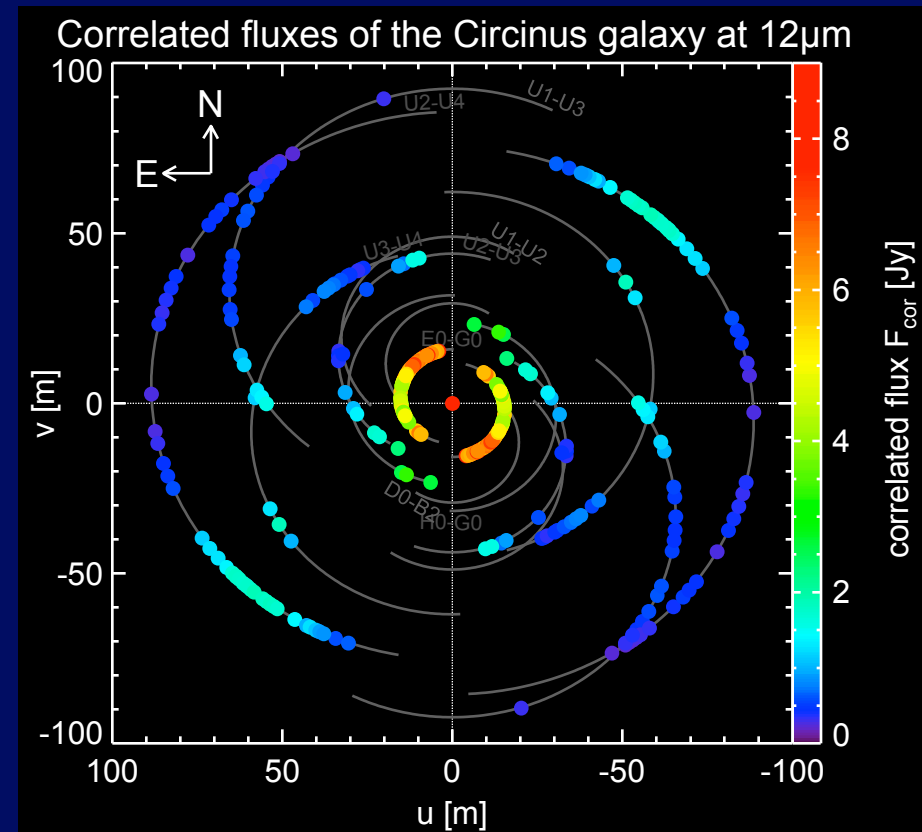
2MASS J, H, K_s colour mosaic

Circinus: Old results

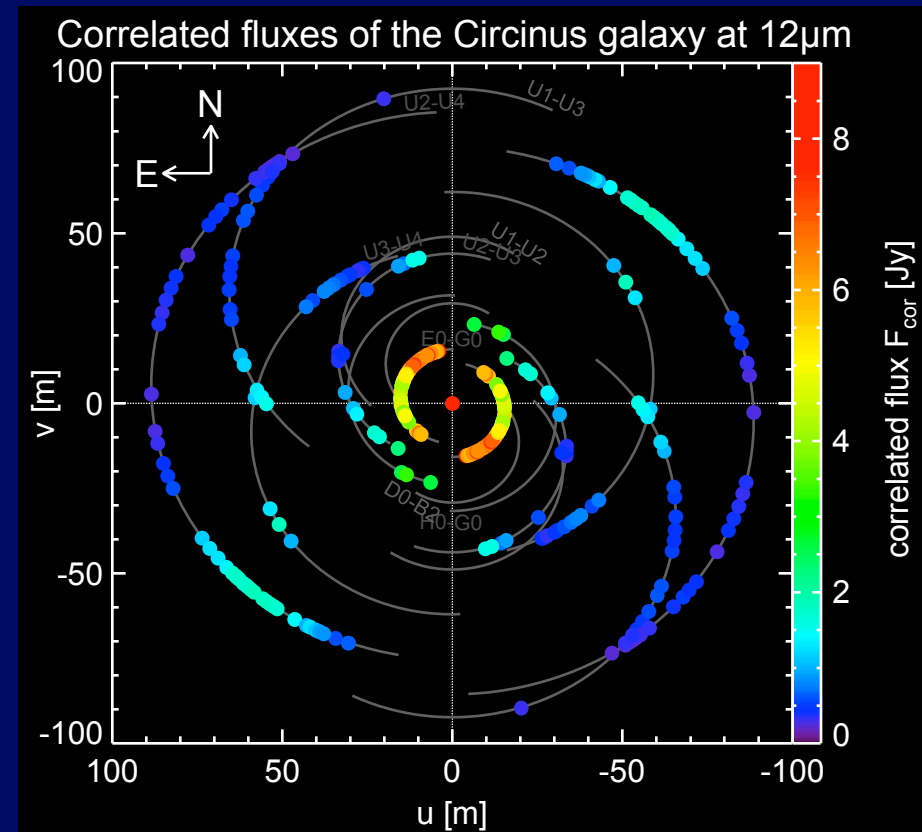
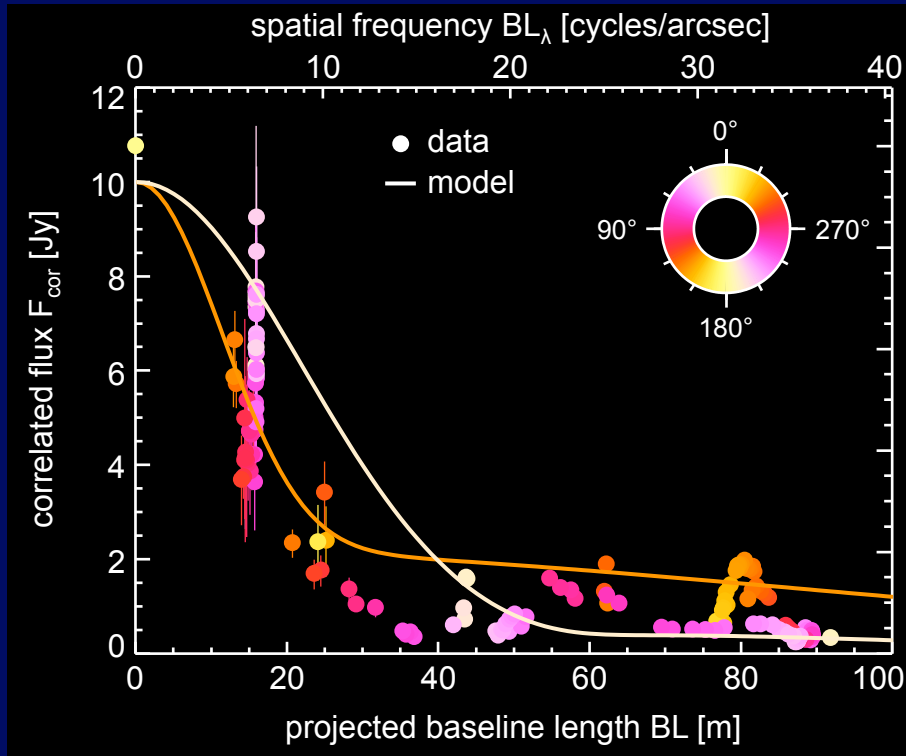


Tristram et al. 2007

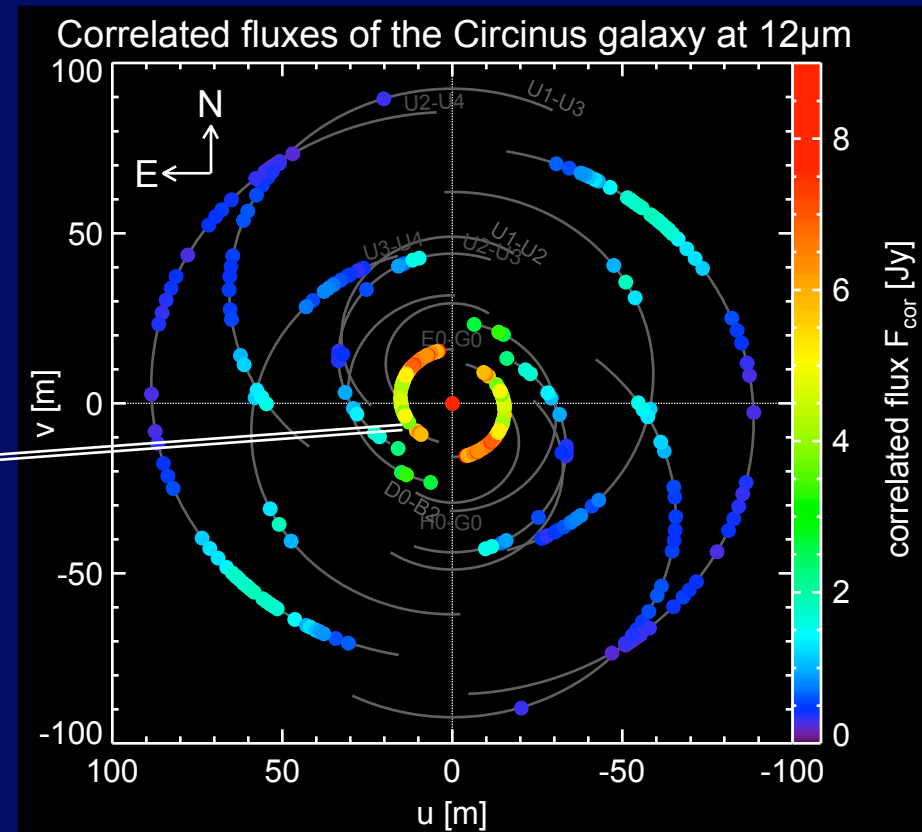
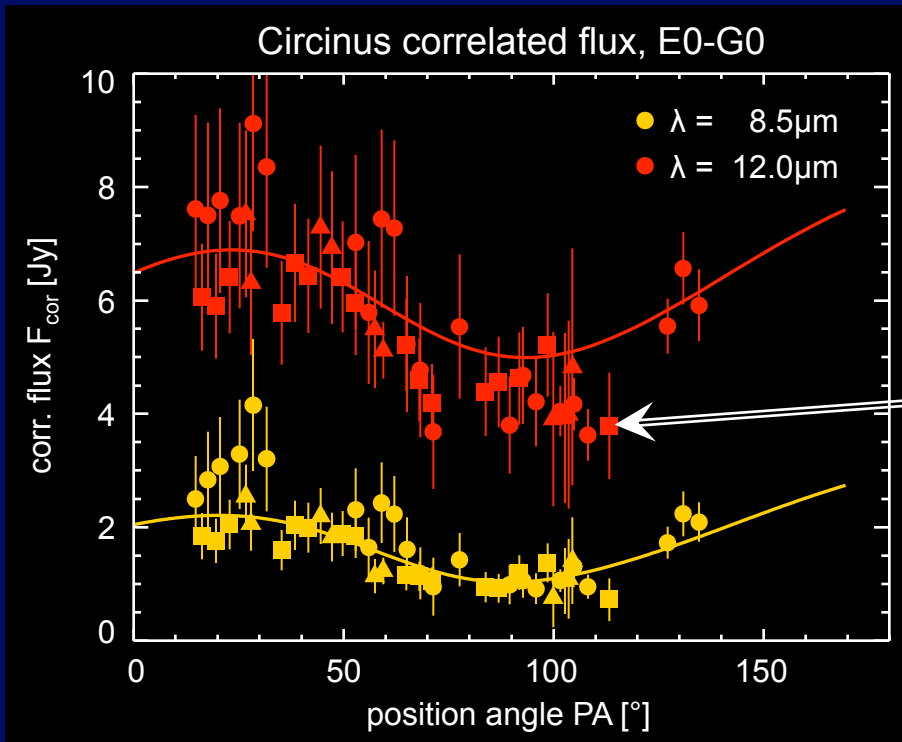
Circinus: New UV coverage



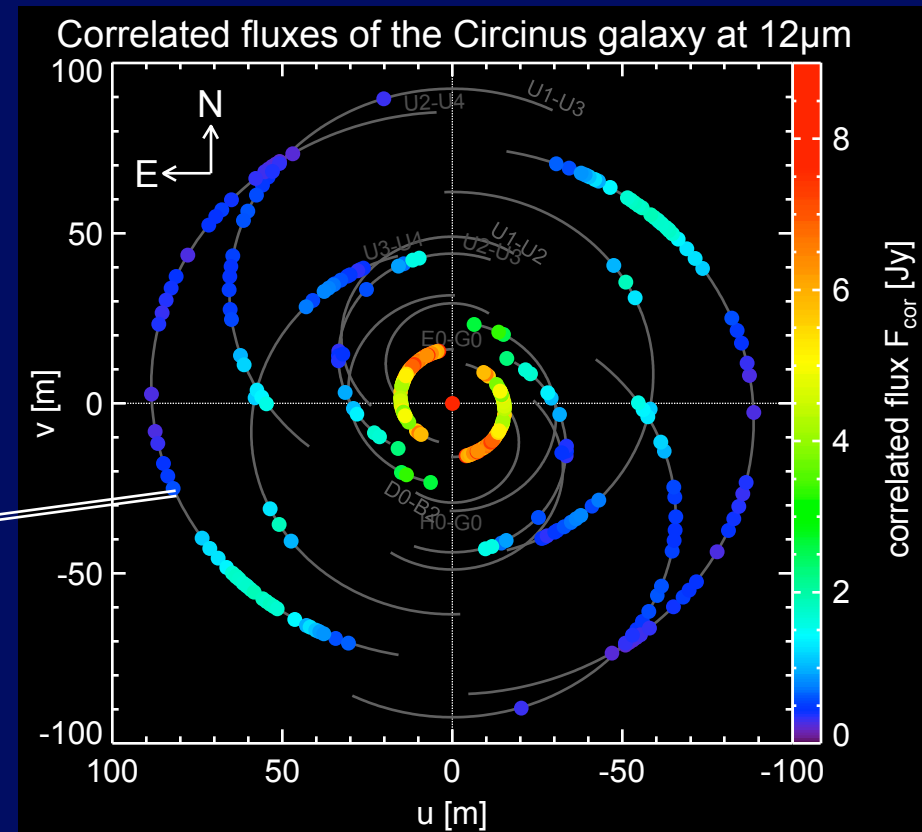
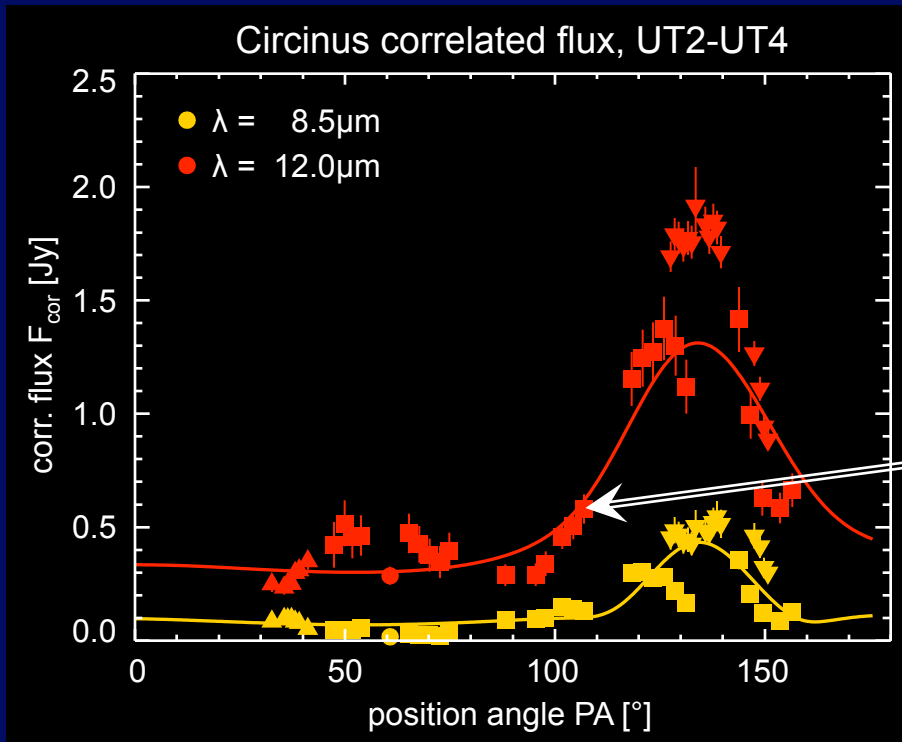
Circinus: Radial dependency



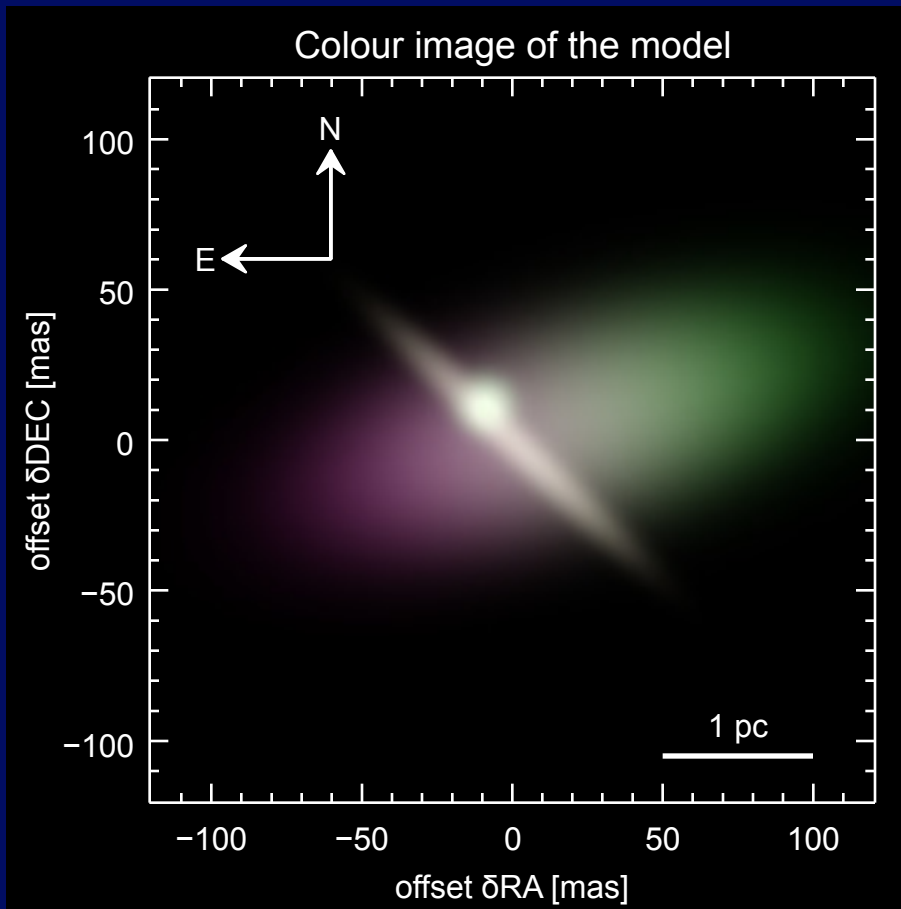
Circinus: Shortest baseline



Circinus: Longest baseline



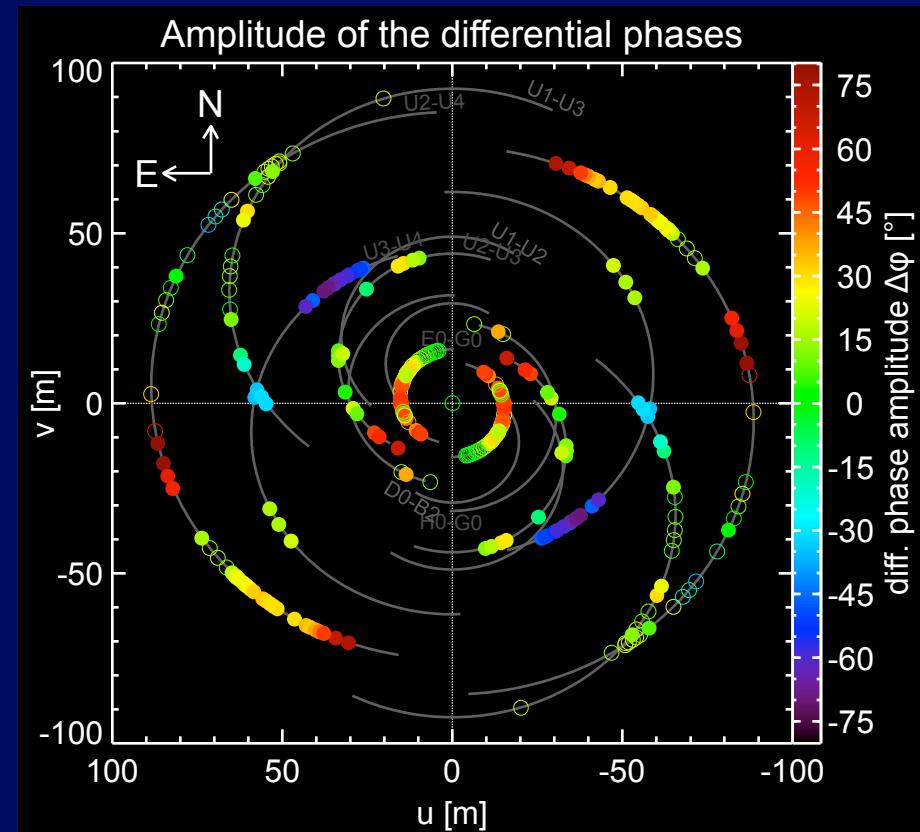
Circinus: modelling (3BB Gaussians)



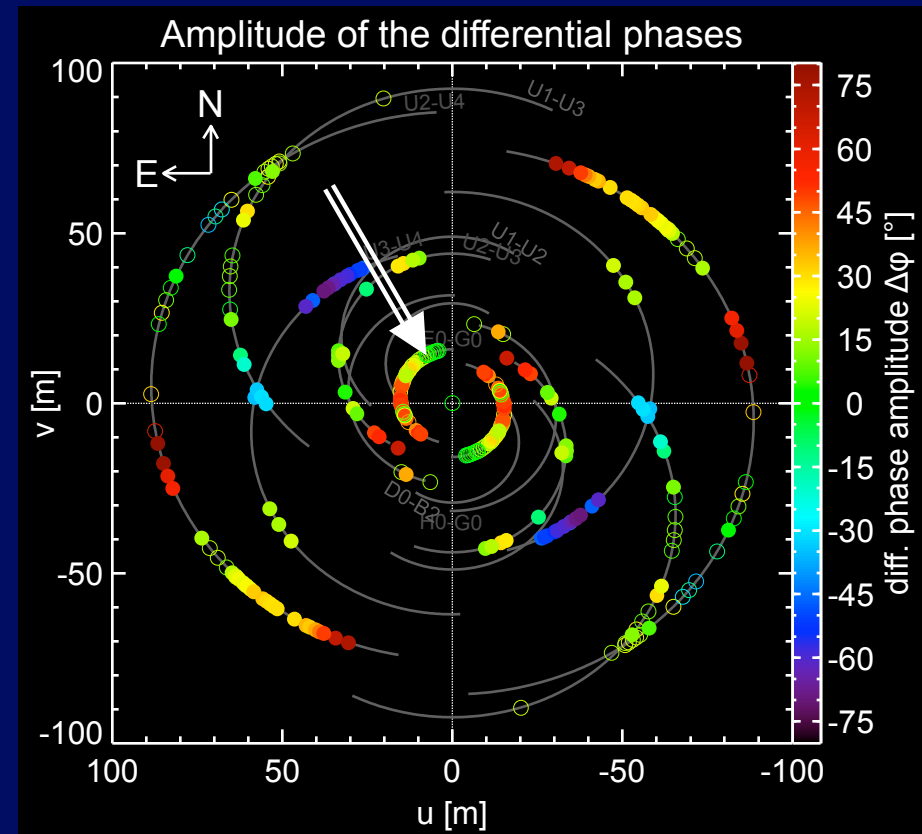
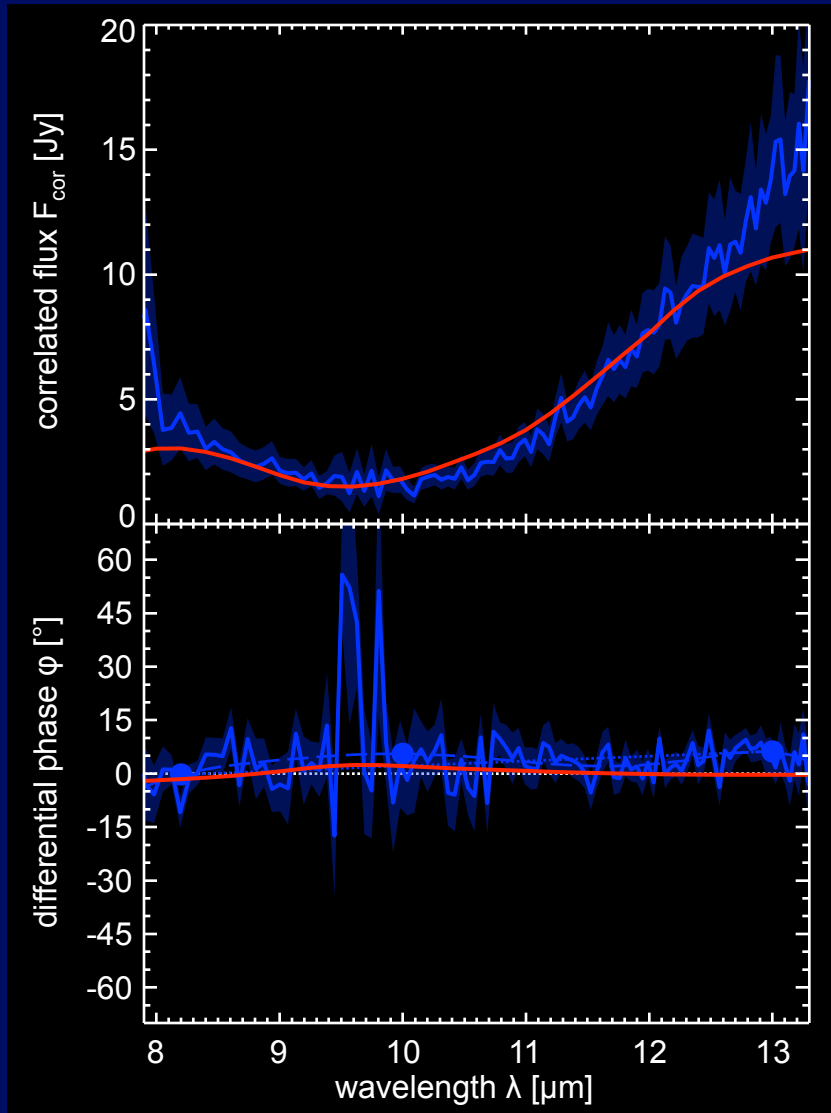
Three Blackbody Gaussians:

Size:	$\Delta_1 = 12 \pm 2$ mas
Silicate depth:	$\tau_1 = 1.2 \pm 0.2$
Temperature:	$T_1 = 317 \pm 22$ K
Covering factor:	$f_1 = 0.5 \pm 0.3$
Size:	$\Delta_2 = 57 \pm 15$ mas
Axis ratio:	$r_2 = 0.16 \pm 0.04$
Position angle:	$\alpha_2 = 46 \pm 3^\circ$
Silicate depth:	$\tau_2 = 1.9 \pm 0.4$
Temperature:	$T_2 = 290 \pm 22$ K
Covering factor:	$f_2 = 0.6 \pm 0.3$
Size:	$\Delta_3 = 93 \pm 12$ mas
Axis ratio:	$r_3 = 0.45 \pm 0.07$
Position angle:	$\alpha_3 = 107 \pm 8^\circ$
Silicate depth:	$\tau_3 = 2.4 \pm 0.6$
Temperature:	$T_3 = 304 \pm 30$ K
Covering factor:	$f_3 = 0.3 \pm 0.2$

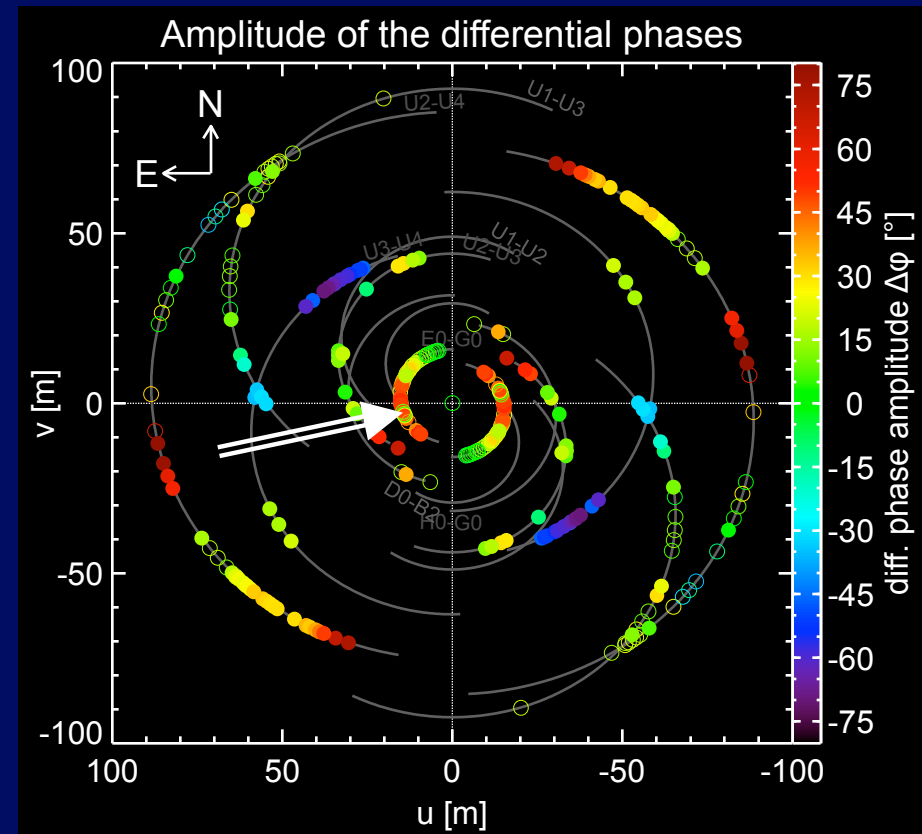
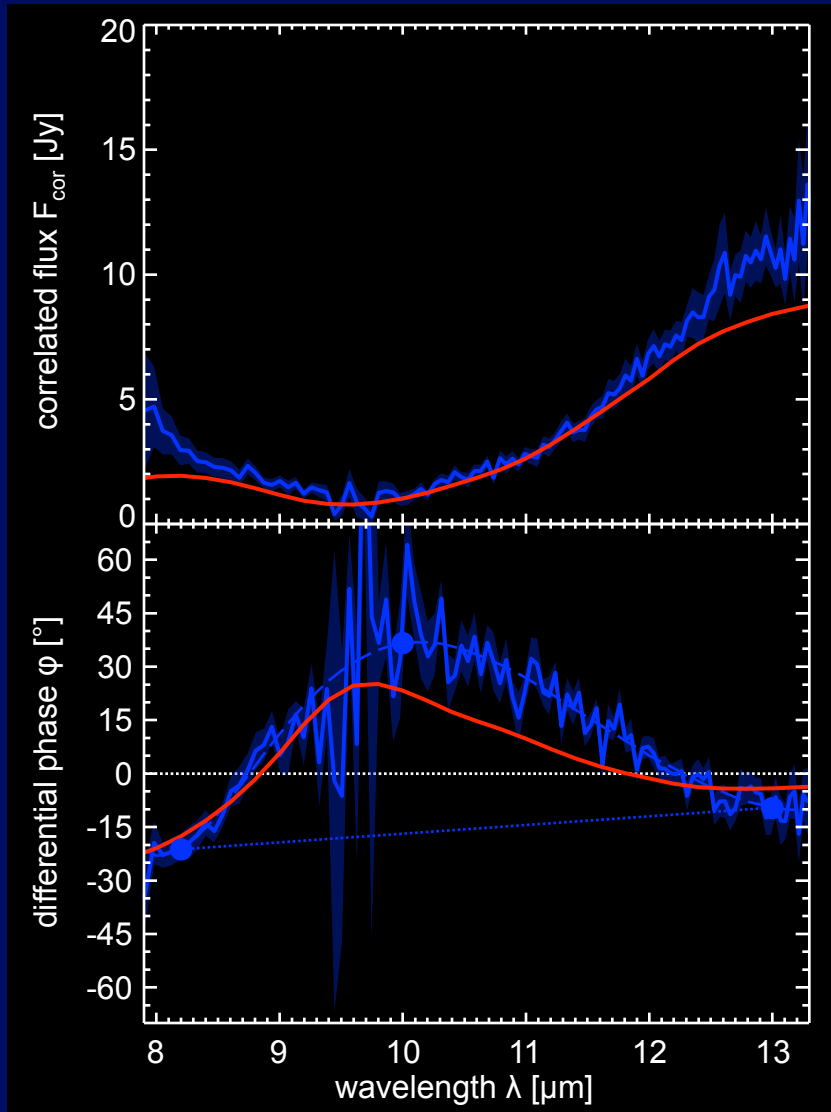
Circinus: differential phases



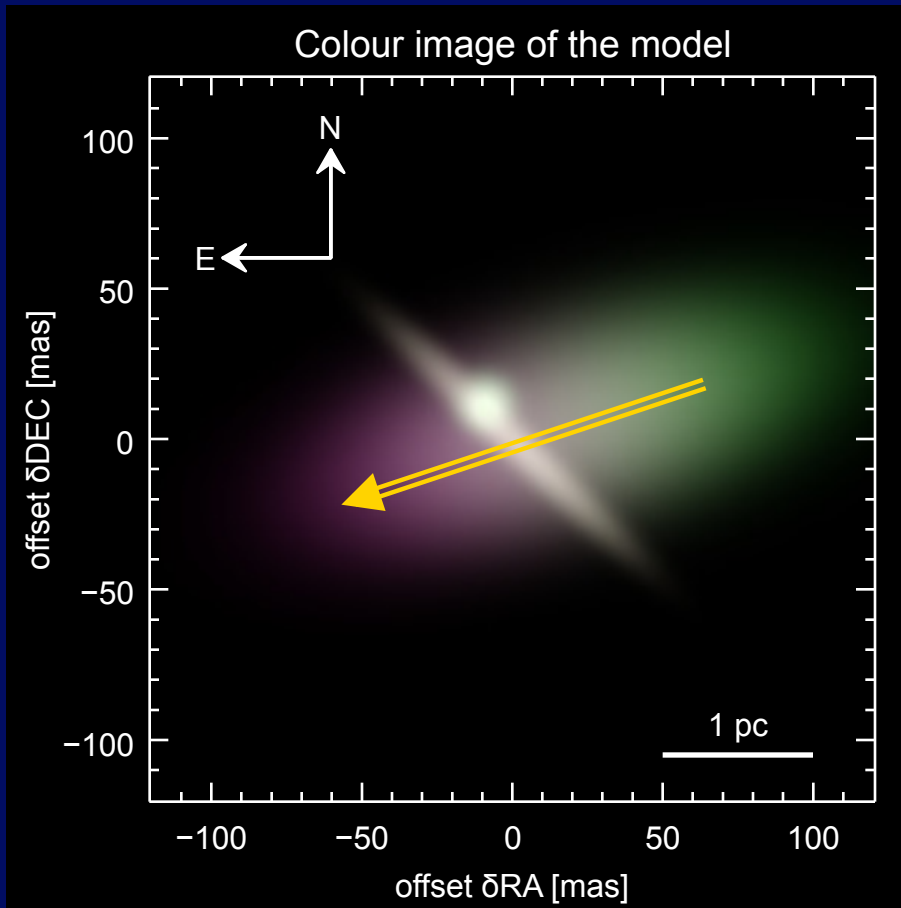
Circinus: example phases (4)



Circinus: example phases (5)

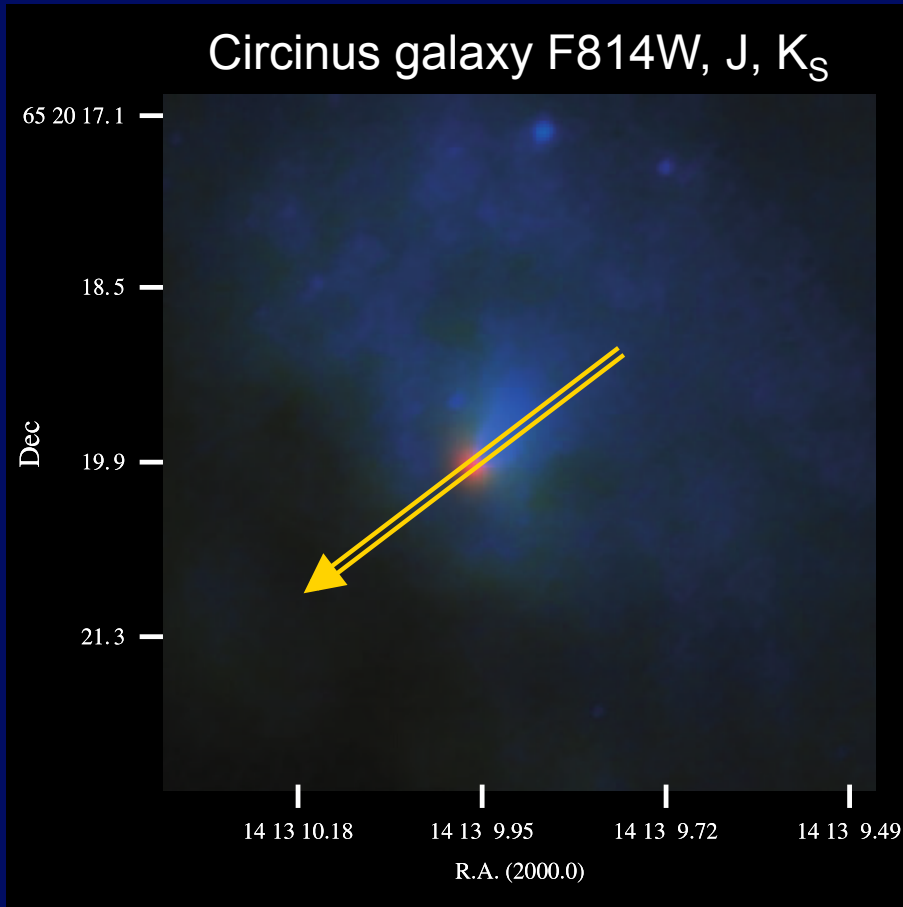


Circinus: silicate gradient

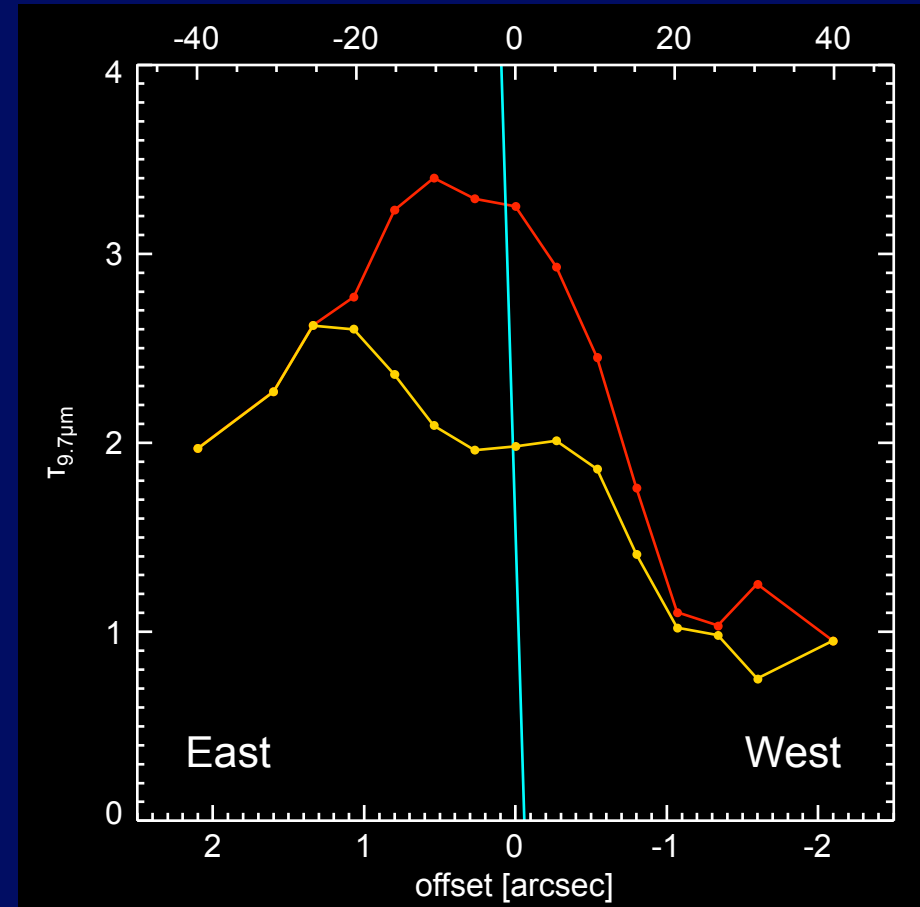


increasing
silicate absorption:
 $\xi = 27 \text{ arcsec}^{-1}$

Circinus: silicate gradient

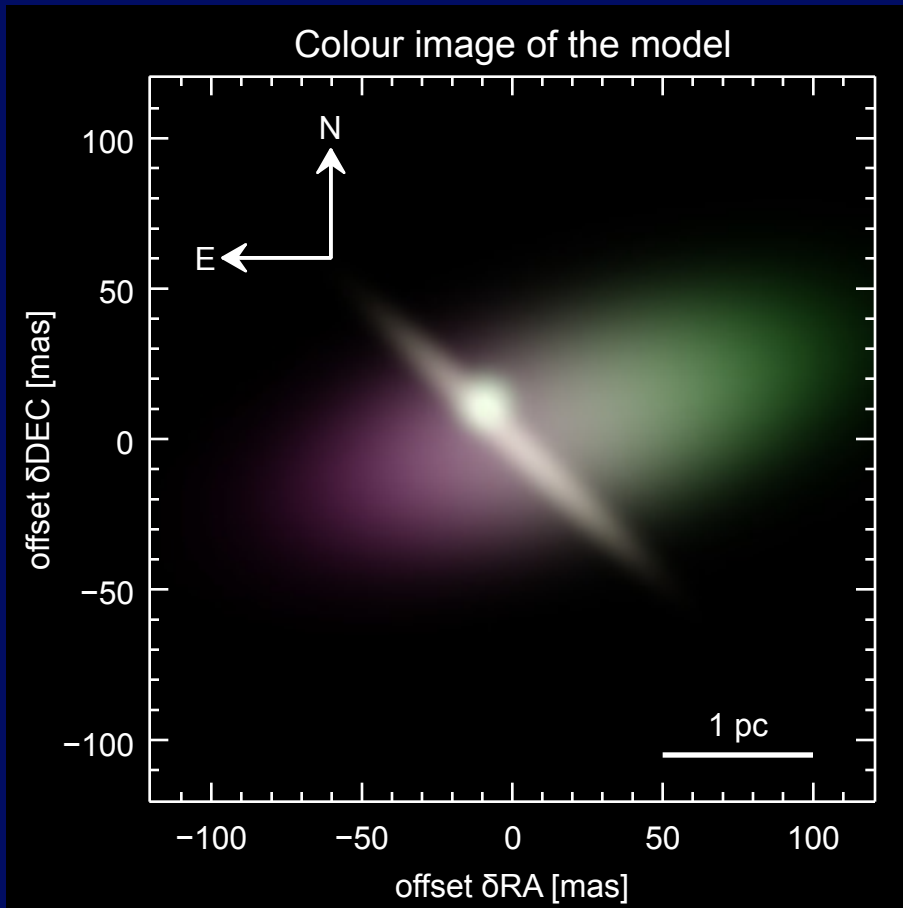


Prieto et al. 2004

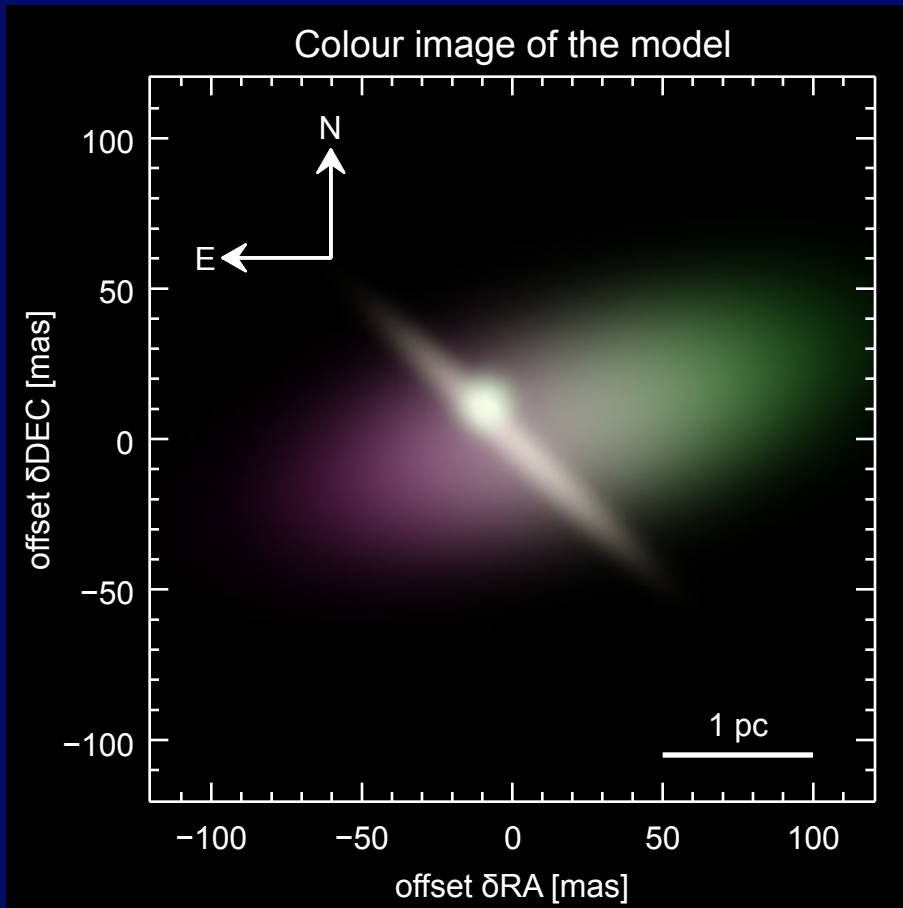


Roche et al. 2006

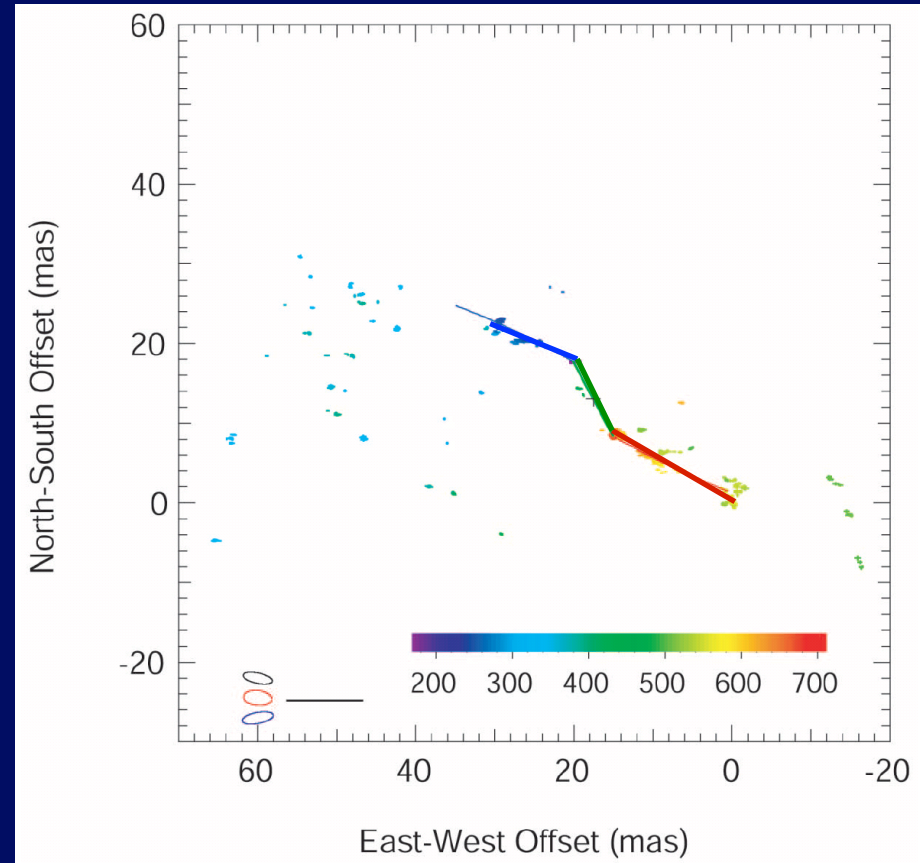
Circinus: torus geometry



Circinus: torus geometry

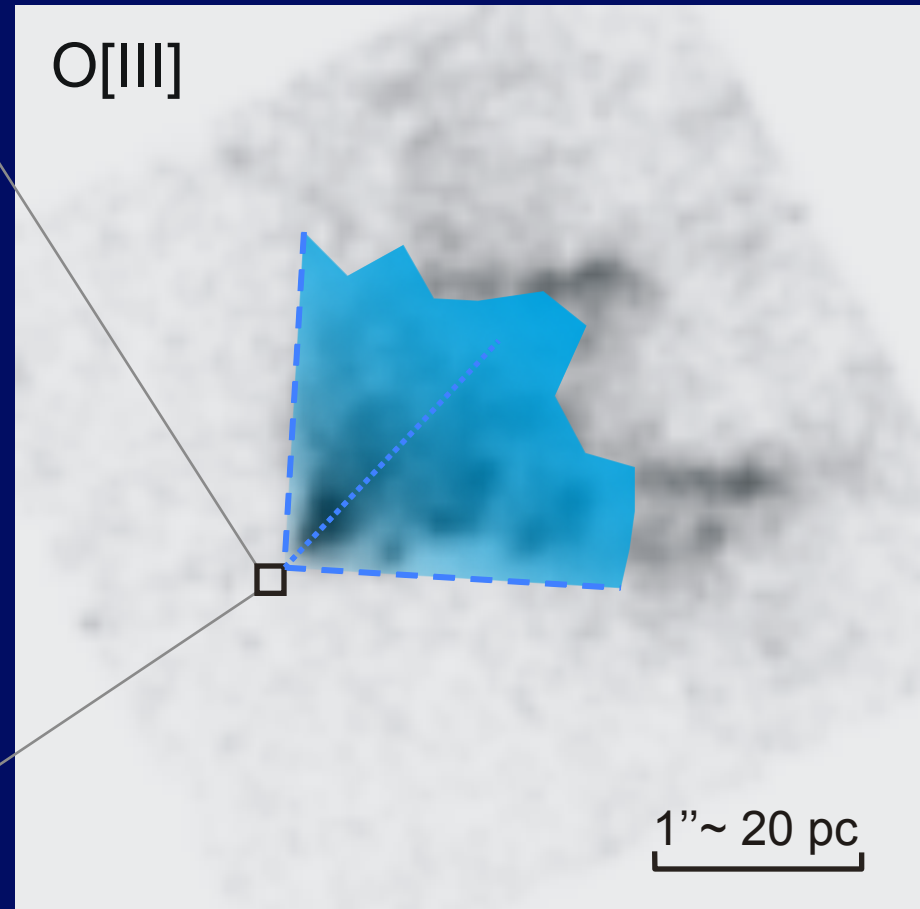
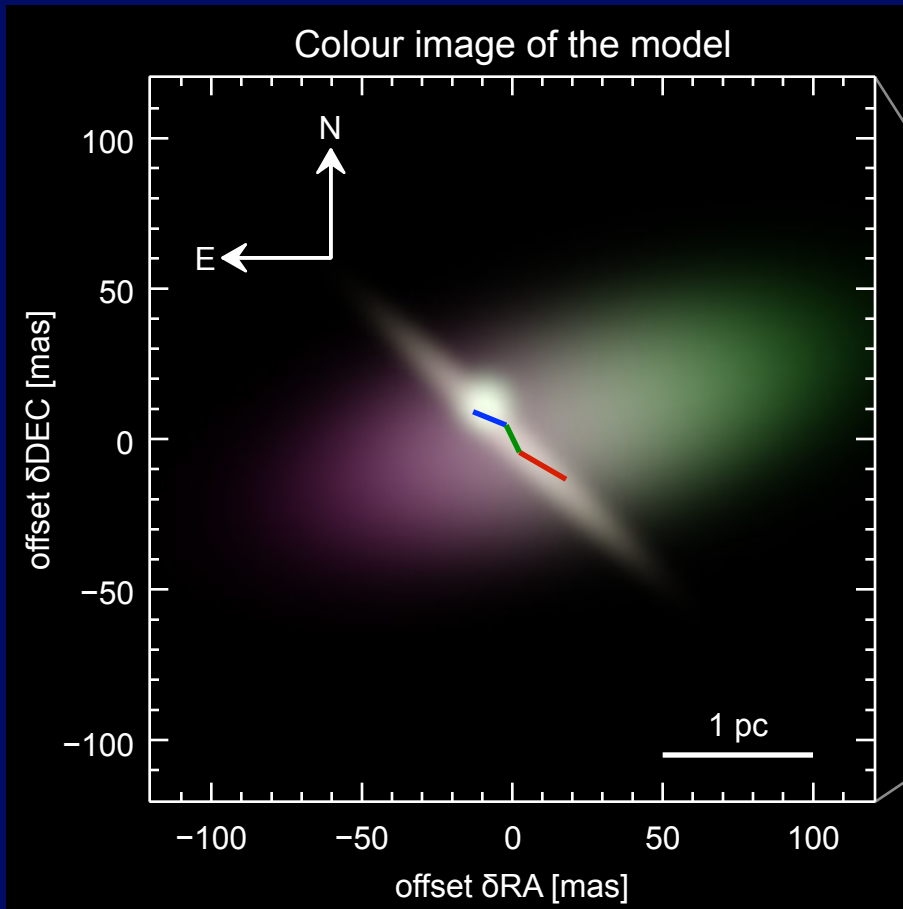


H₂O maser disk:



Greenhill et al. 2003

Circinus: torus geometry

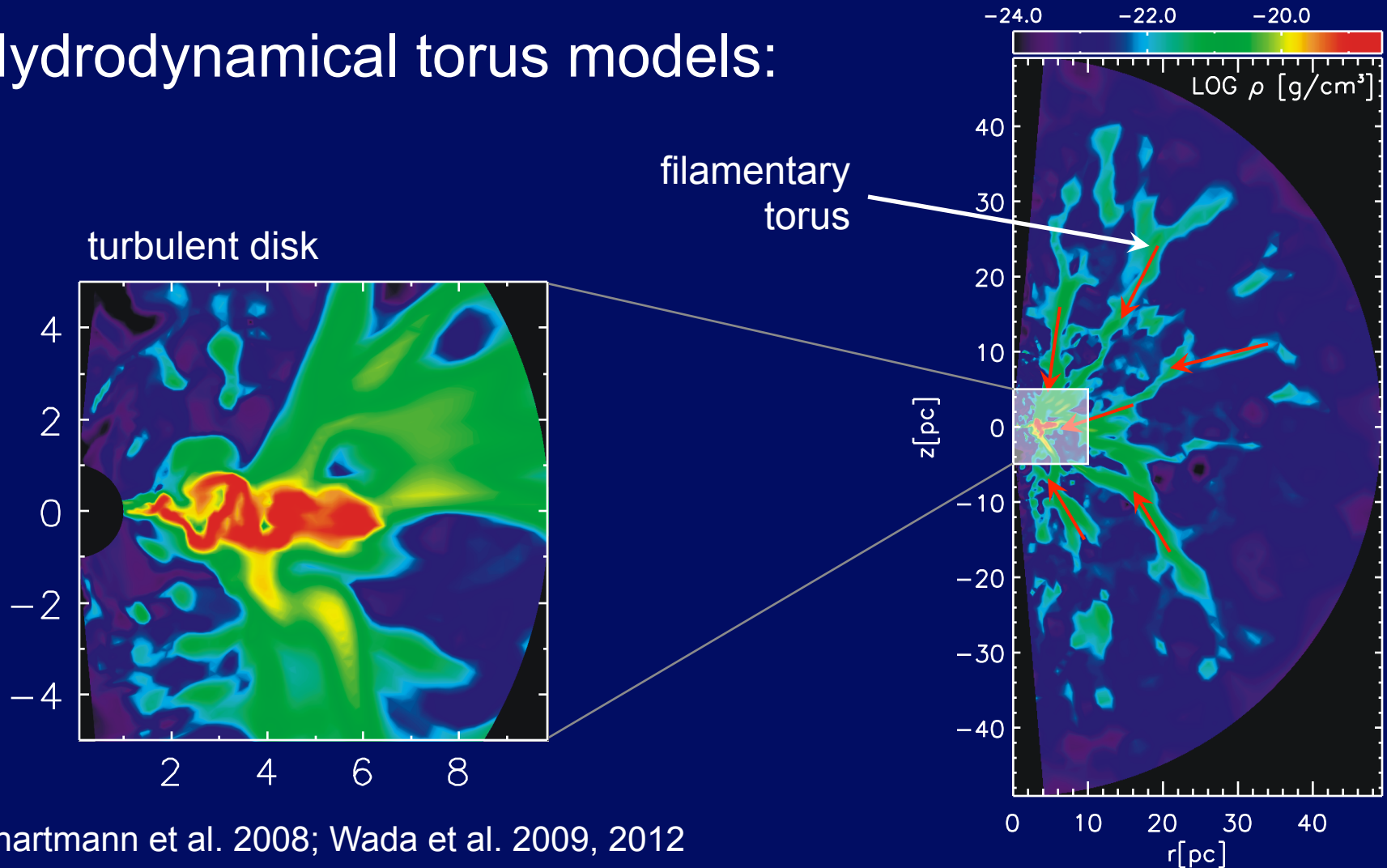


Wilson et al. 2000

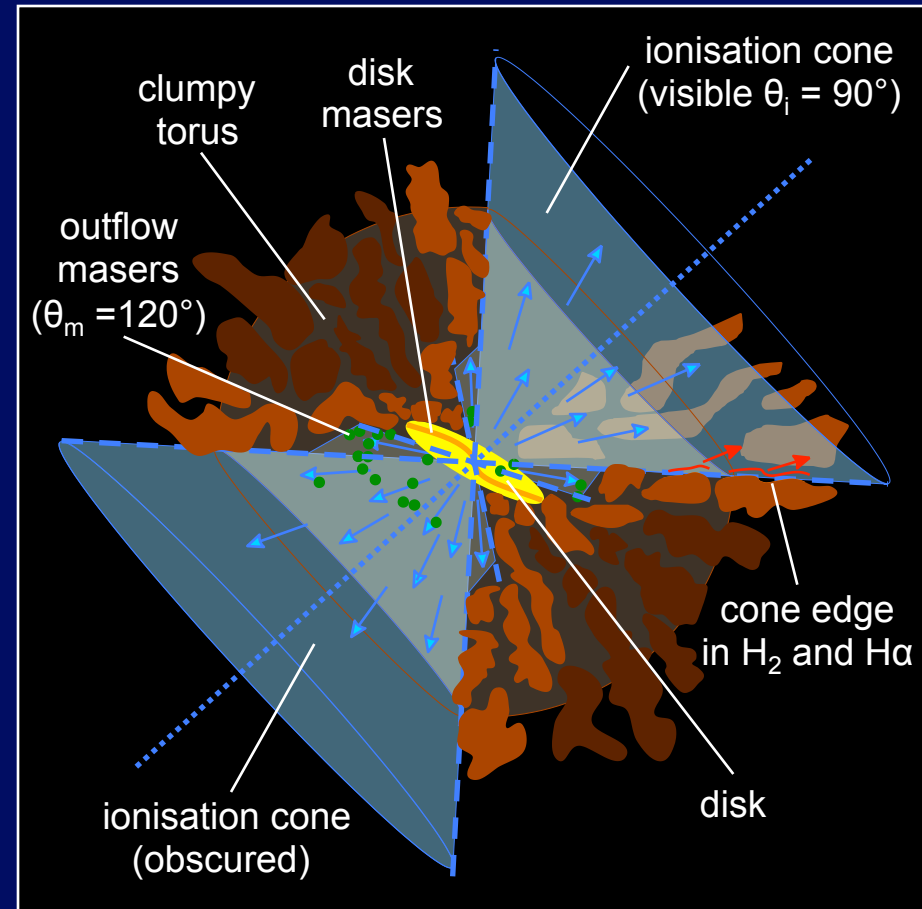
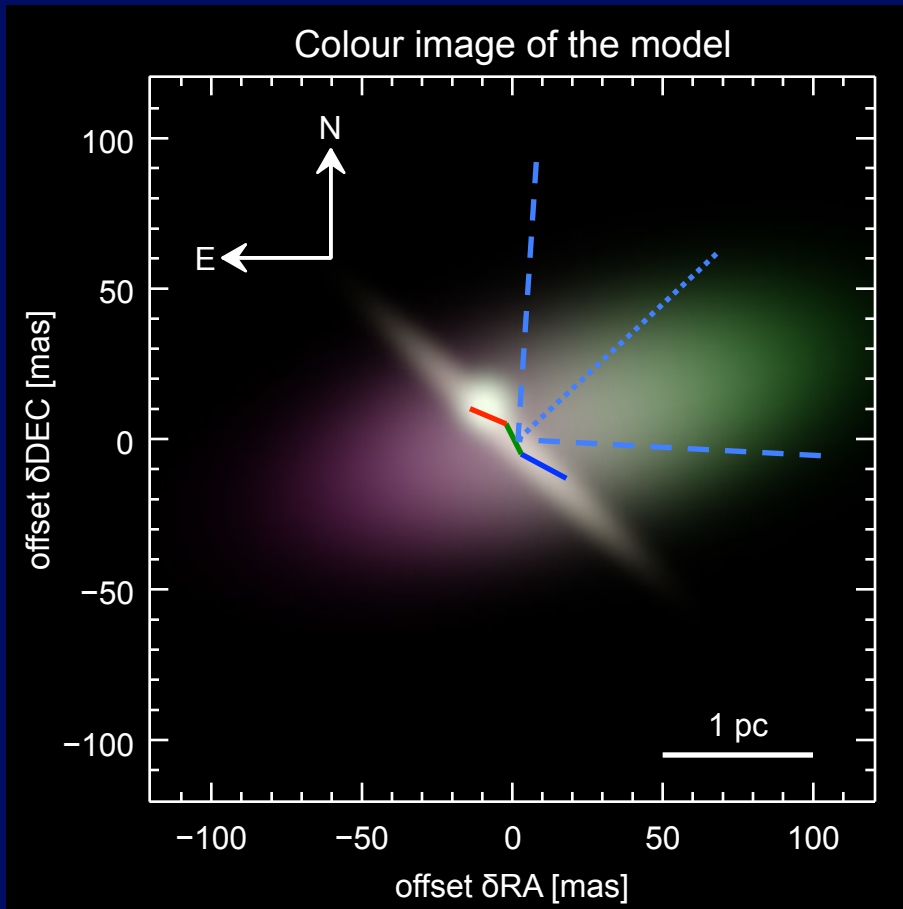
Circinus: Interpretation



Hydrodynamical torus models:



Circinus: interpretation



2. Comparison of well studied AGN



	<u>Circinus</u>	<u>NGC1068</u>	<u>NGC424</u>	<u>NGC3783</u>
disk + extended:	yes	yes	?	possibly
size (extended)	1.6 pc	3.0 pc	2.0 pc	4.2 pc
ratio disk/ext.	0.2	?	?	?
maser disk:	yes	yes	no	no
polar dust:	yes	yes	yes	yes
hot dust:	no	hot disk	?	yes
silicate feature:	gets shallower	gets deeper	no change	no change

Conclusion



- AGN dust distributions are parsec-sized
 - ↳ need interferometry to study them
- Circinus: warm disk + warm torus + dust in cone, silicate gradient & asymmetries
- MIDI Science Group like scientific family reunion

