Active Galactic Nuclei: the VLTI view

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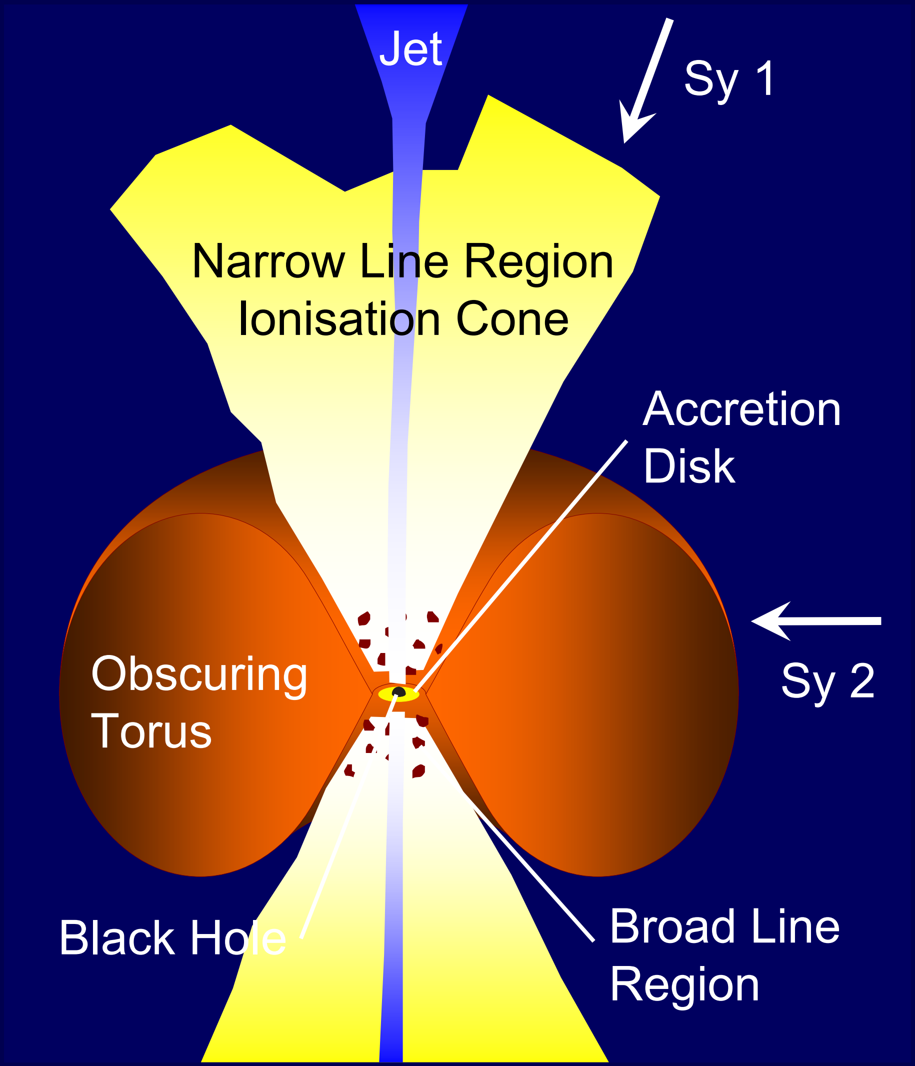
Current and former AGN VLTI interferometrists:

D. Asmus, Th. Beckert, L. Burtscher, S.F. Hönig, W. Jaffe, M.Kishimoto, N. López-Gonzaga, K. Meisenheimer, A. Poncelet, J.-U. Pott, D. Raban. G. Weigelt, M. Wittkowski

Overview

- Introduction: the dusty torus in AGN
- Overview over optical interferometry of AGN
- Individual sources:
  - NGC1068, the Circinus galaxy, Centaurus A
  - NGC3783, NGC424
  - Comparison of the individual sources
- Small surveys:
  - AGN Large Programme
  - Sample of type 1 sources
- Conclusions

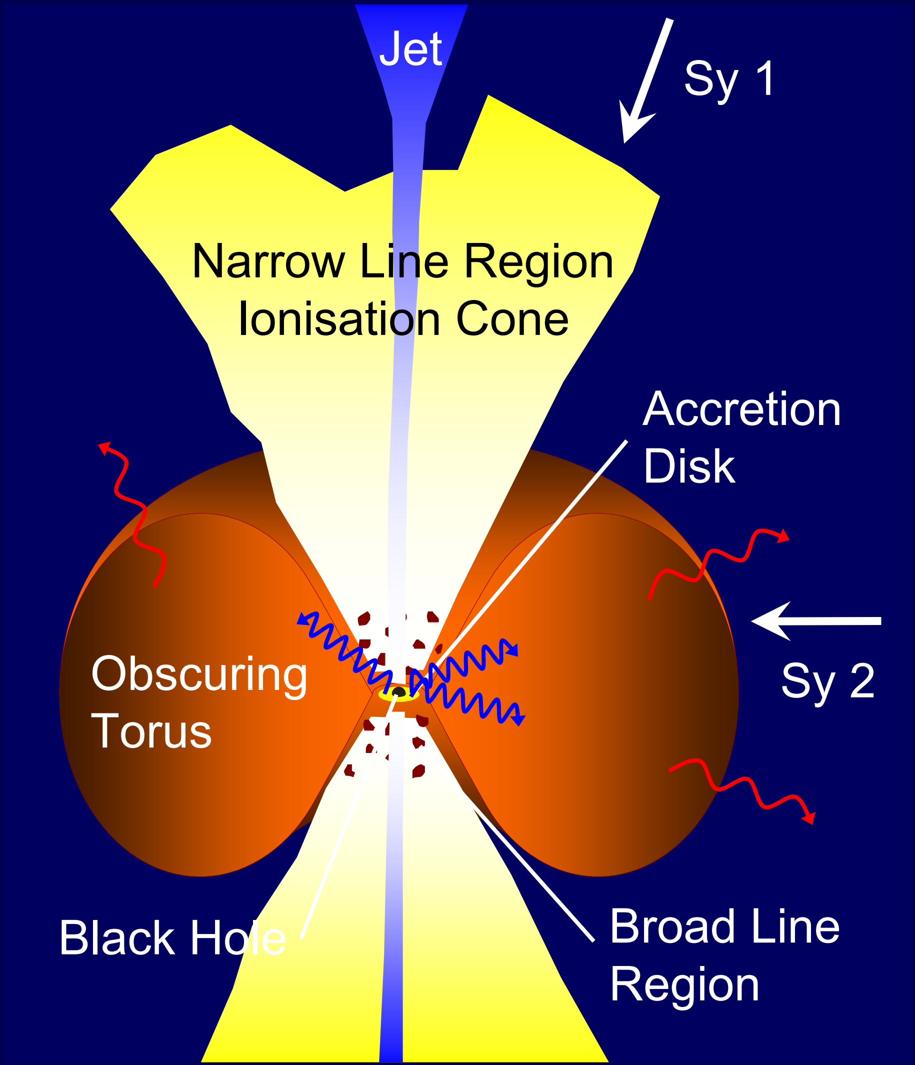
1. Introduction: the dusty torus in AGN

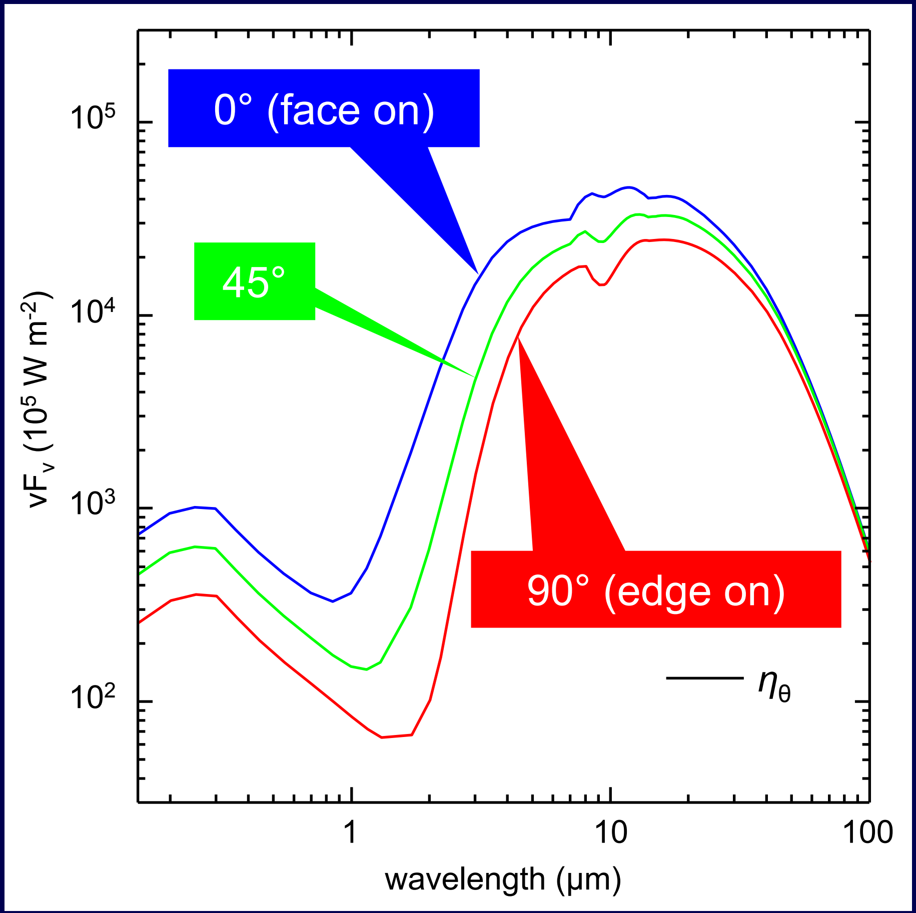


Open questions:

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

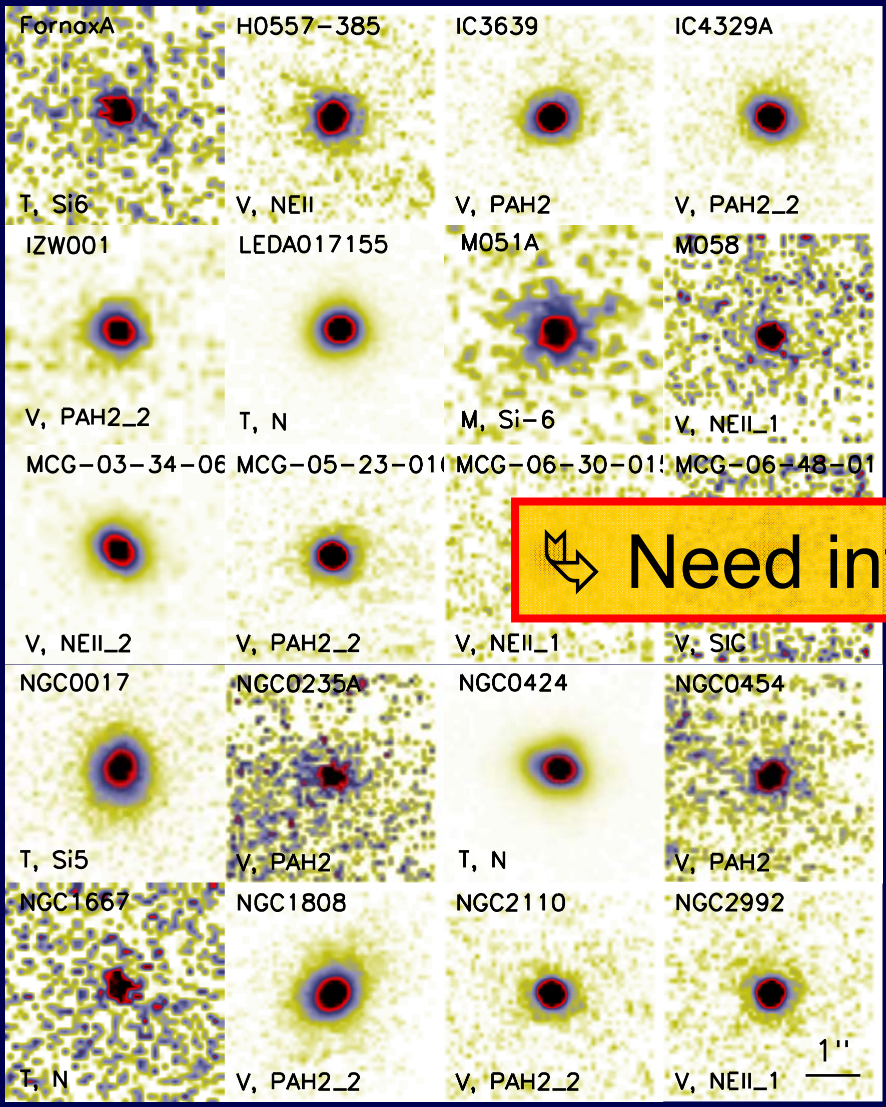
1. Introduction: the dusty torus in AGN



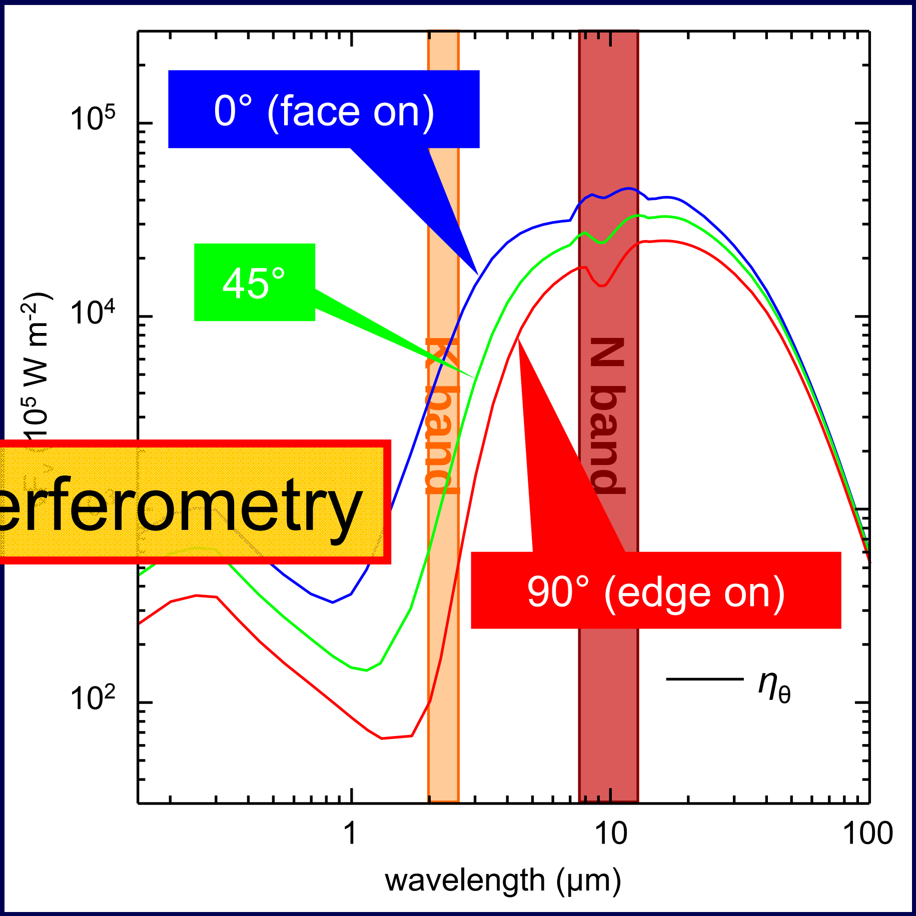


Hönig & Kishimoto 2010

1. Introduction: observing the torus



Asmus et al. 2014



Hönig & Kishimoto 2010

Need interferometry

2. Overview: AGN optical interferometry

- main work in the MIR with MIDI:
  - individual sources (NGC1068, …)
  - samples of AGN: snapshot survey, AGN LP, Seyfert 1s)
- near-infrared (Keck Interferometer)
  - 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


ESO PR 30c/02

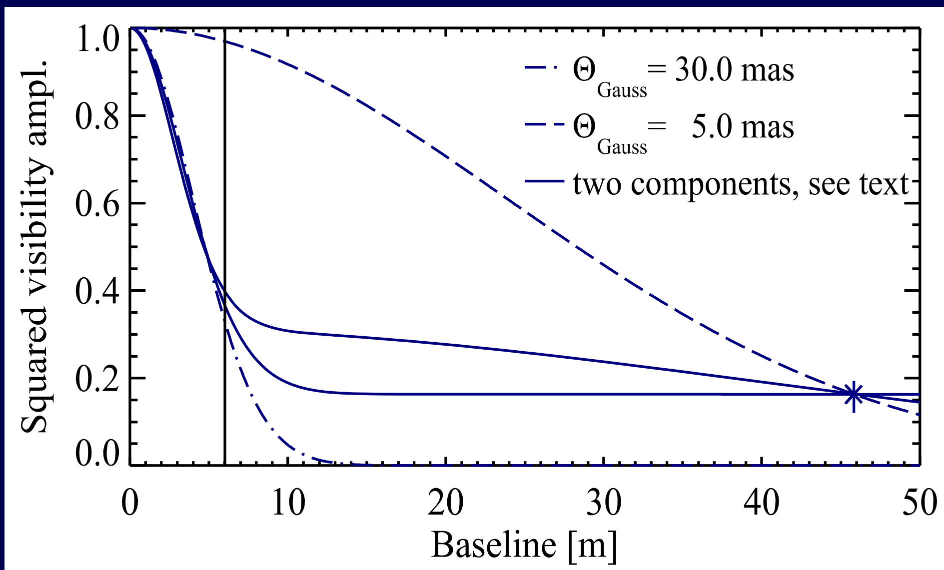

NASA/JPL


ESO/G.Hüdepohl

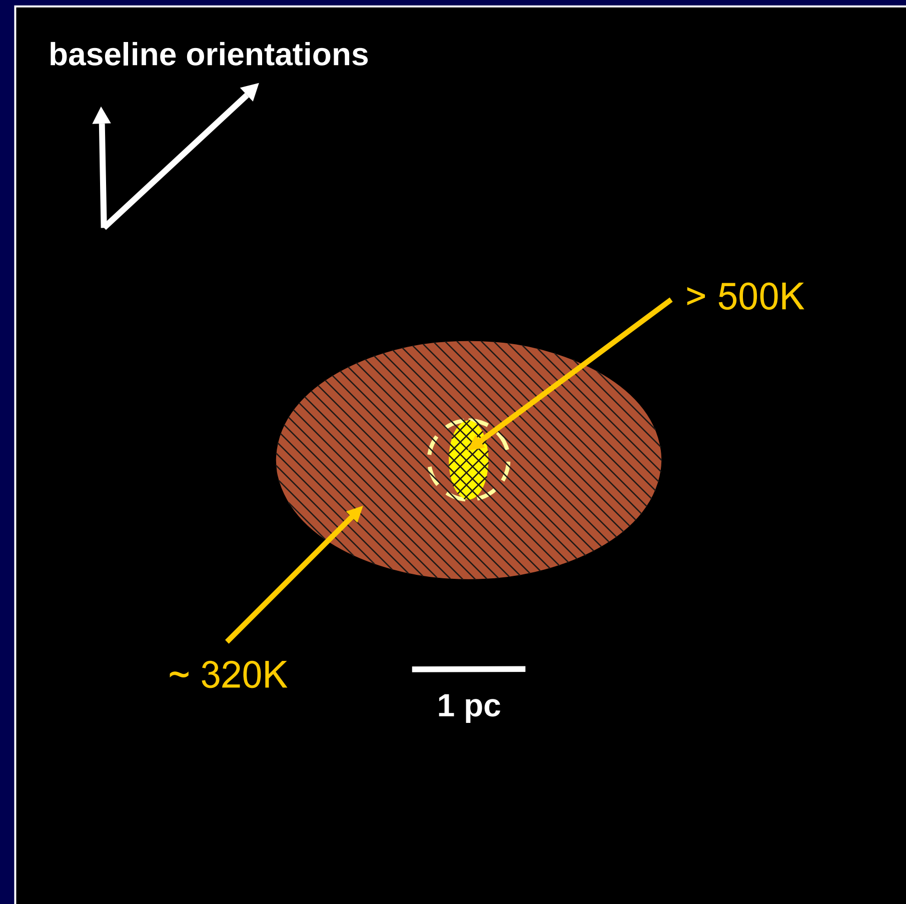
3. Individual sources: NGC1068

MIDI:

VINCI:



Wittkowski et al. 2004: ~ 3 pc and ≤ 0.4 pc

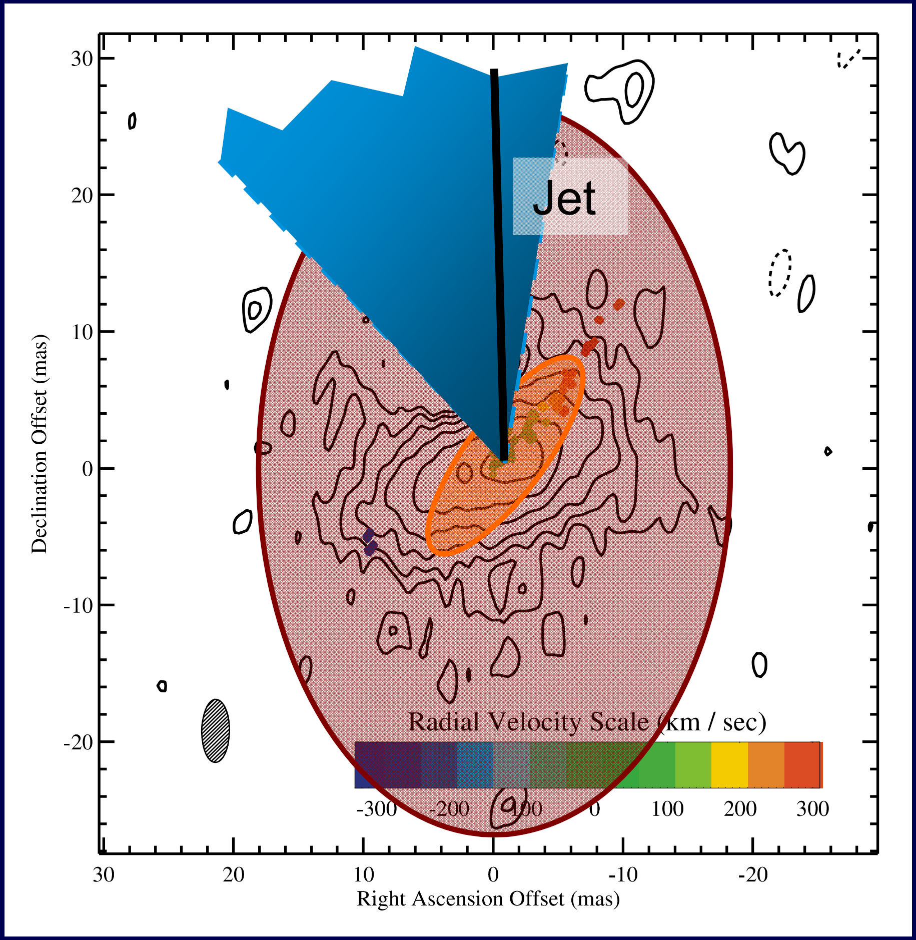


Jaffe et al. 2004

3. Individual sources: NGC1068

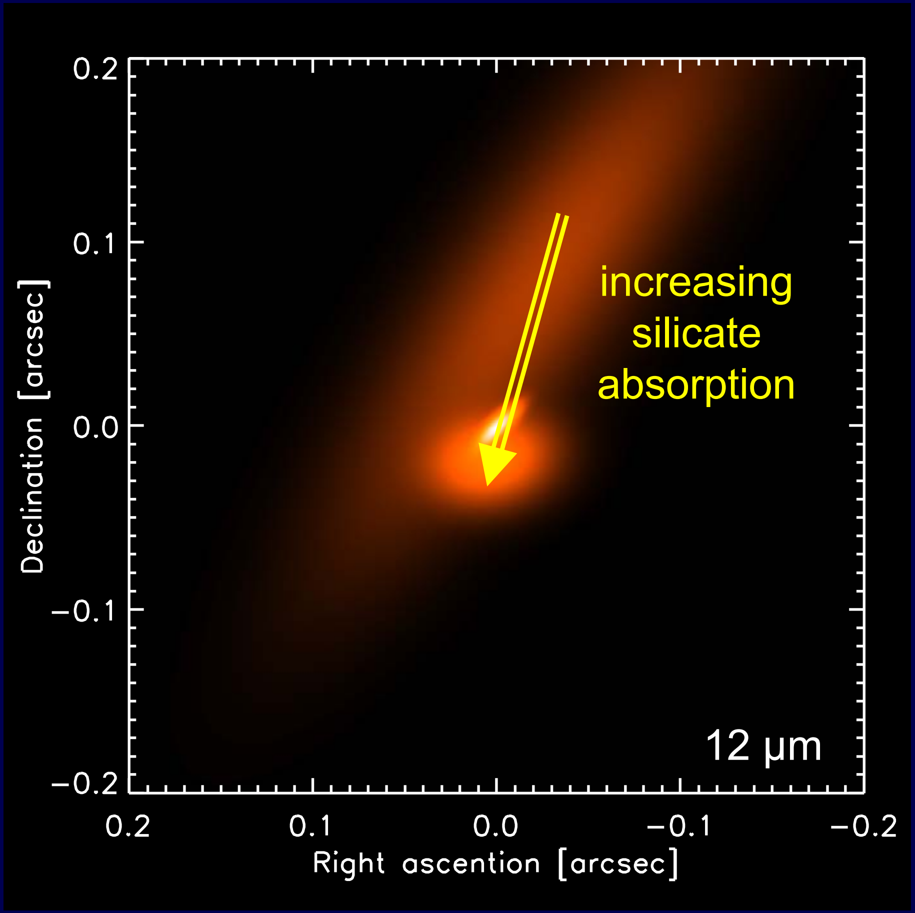
Two Blackbody Gaussians:

FWHM major:	Δ_1 =	20±3 mas
FWHM minor:	δ_1 =	6±1 mas
Position angle	α_1 =	42±2°
Silicate depth:	τ_1 =	1.9±0.5
Temperature:	T_1 =	800±150 K
Covering factor:	f_1 =	0.25±0.07
FWHM major:	Δ_2 =	56±5 mas
FWHM minor:	δ_2 =	42±5 mas
Position angle:	α_2 =	0±50°
Silicate depth:	τ_2 =	0.42±0.2
Temperature:	T_2 =	290±10 K
Covering factor:	f_2 =	0.64±0.15



Raban et al. 2008

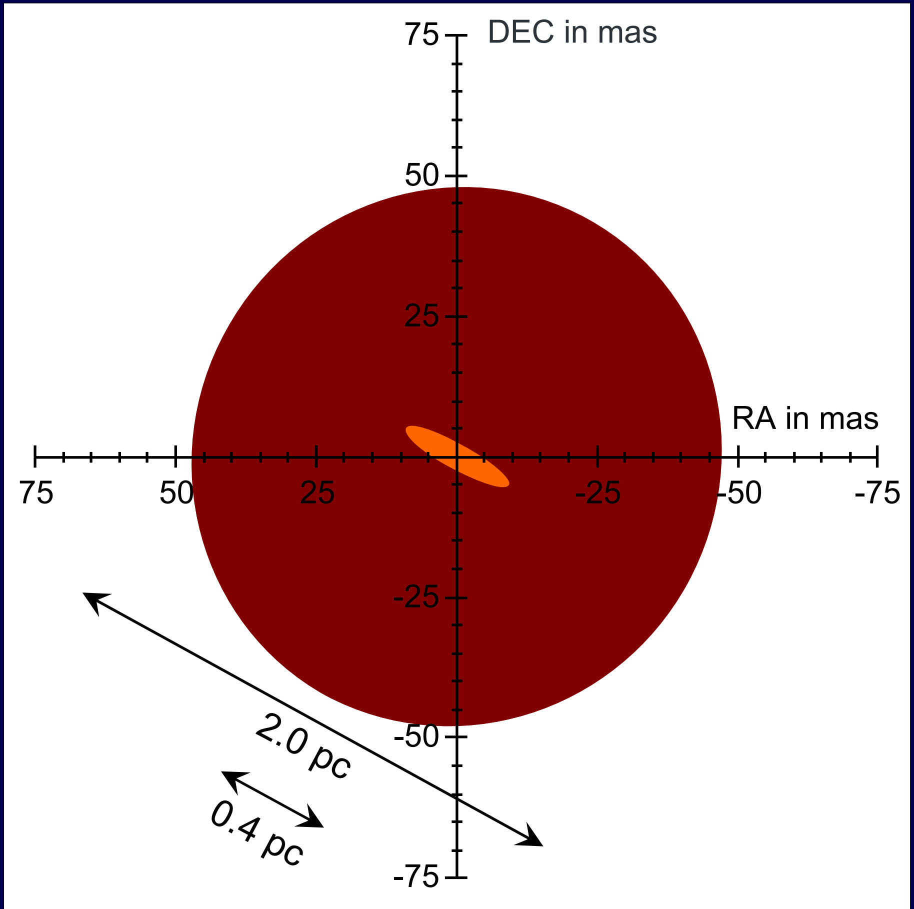
3. Individual sources: NGC1068

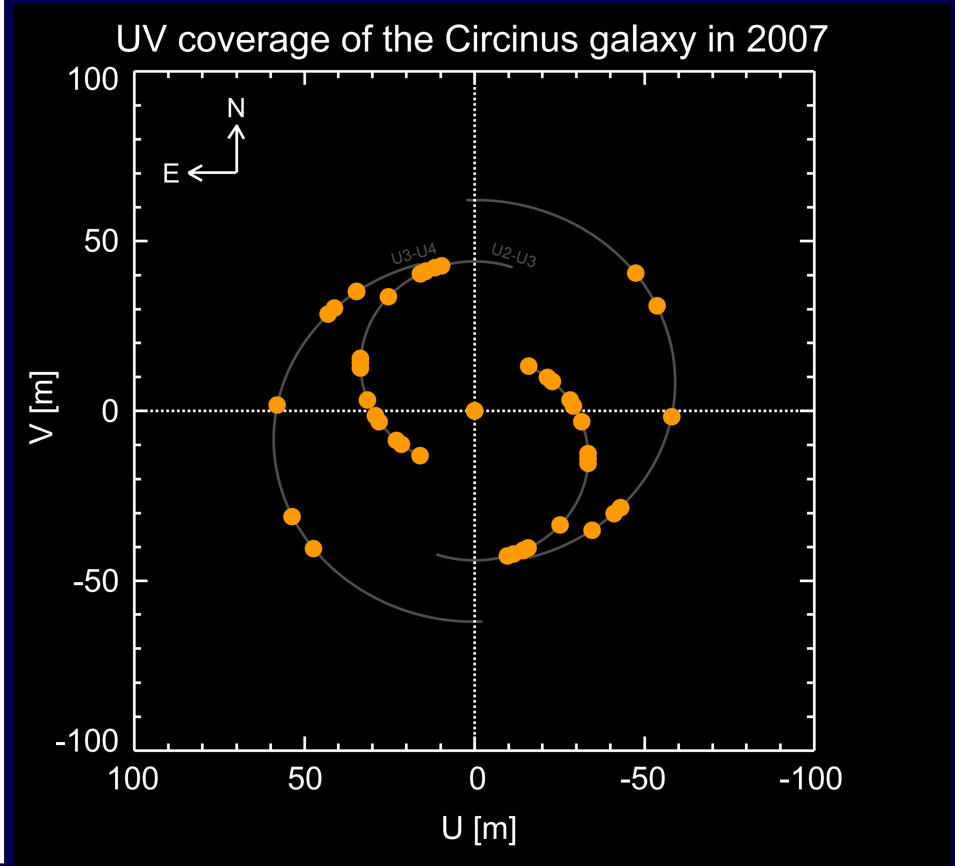


Lopéz Gonzaga et al. 2014

- three blackbody Gaussians with offsets
- fit to 30 correlated fluxes and phases (ATs and UTs)
- interpretation as inner wall of a dusty cone

3. Individual sources: the Circinus galaxy





Tristram et al. 2007

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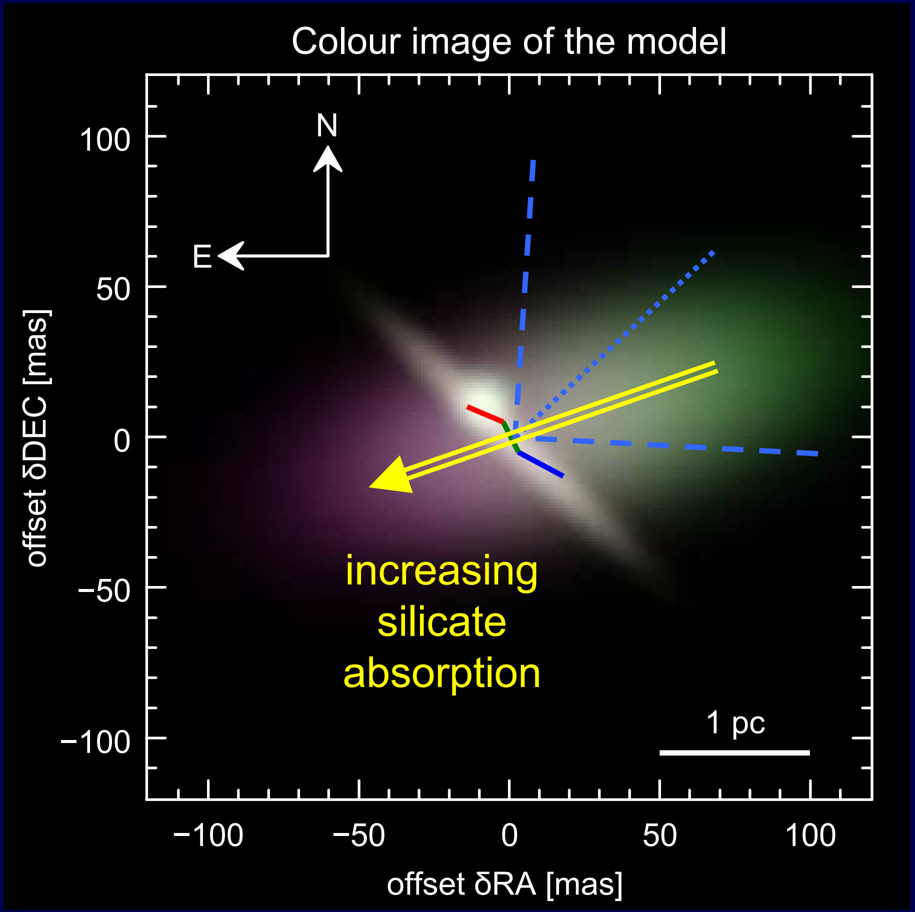
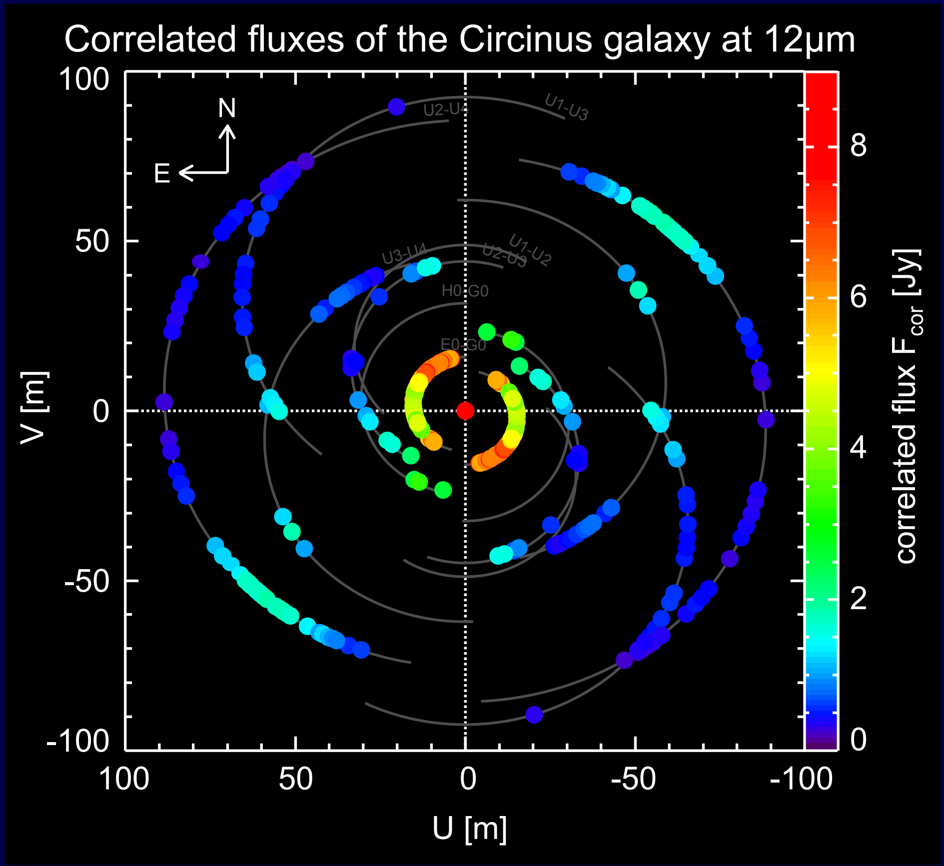
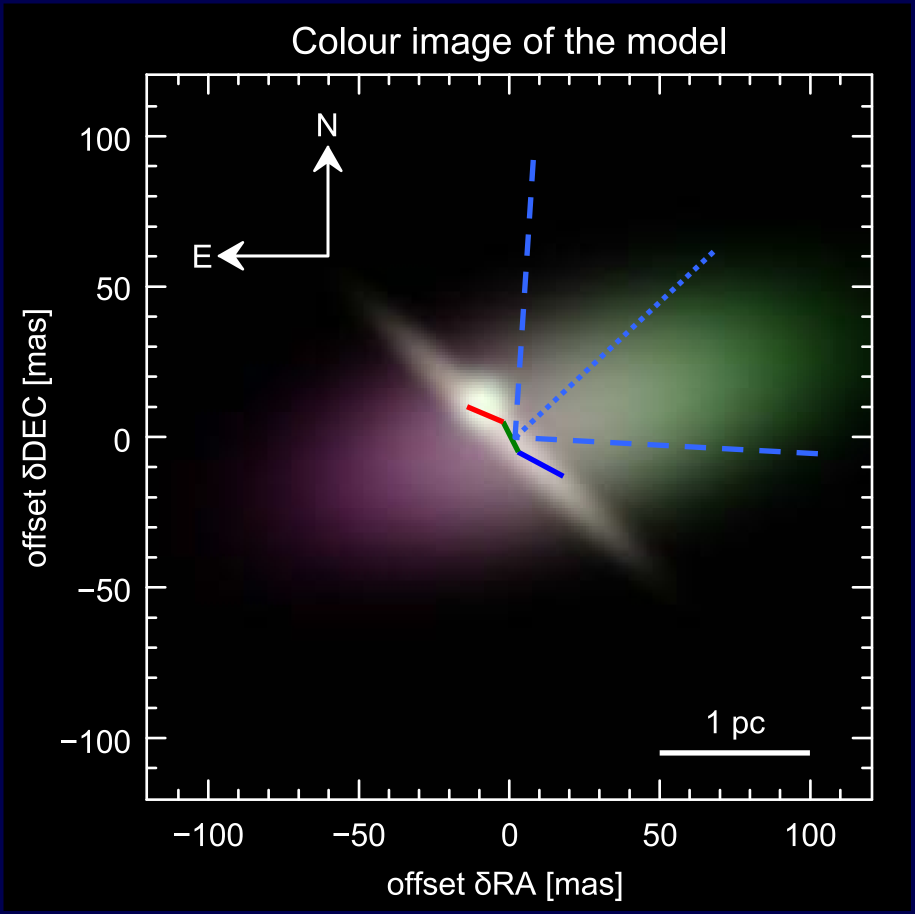
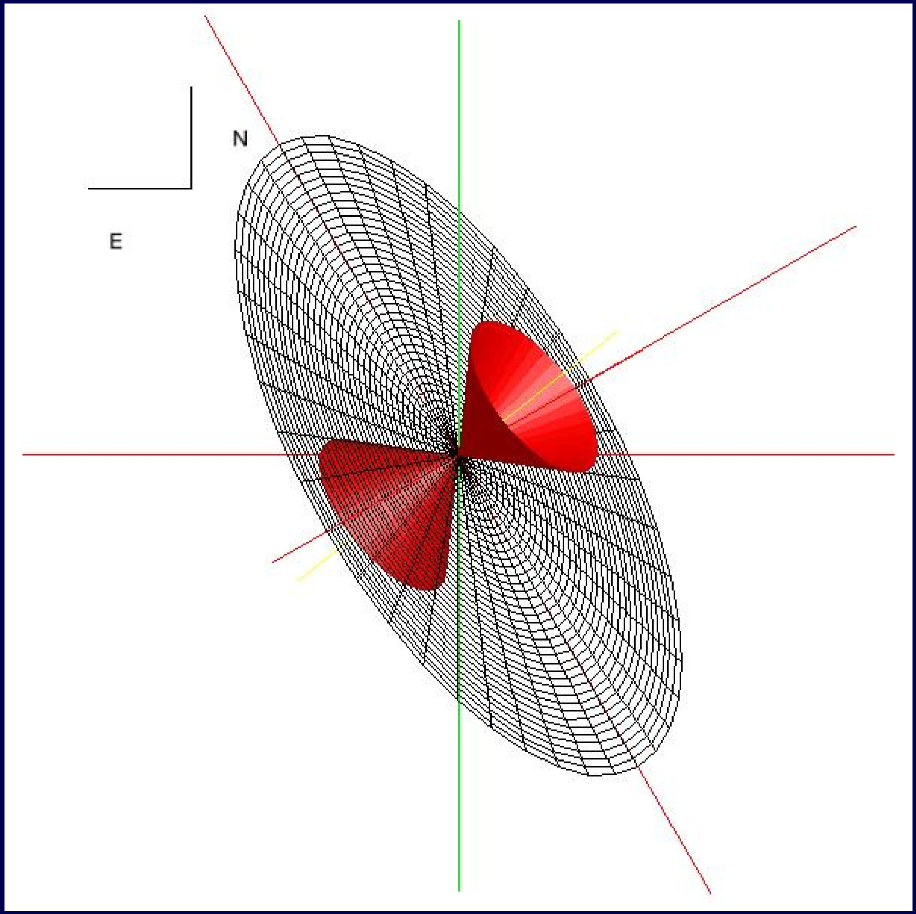




Tristram et al. 2014

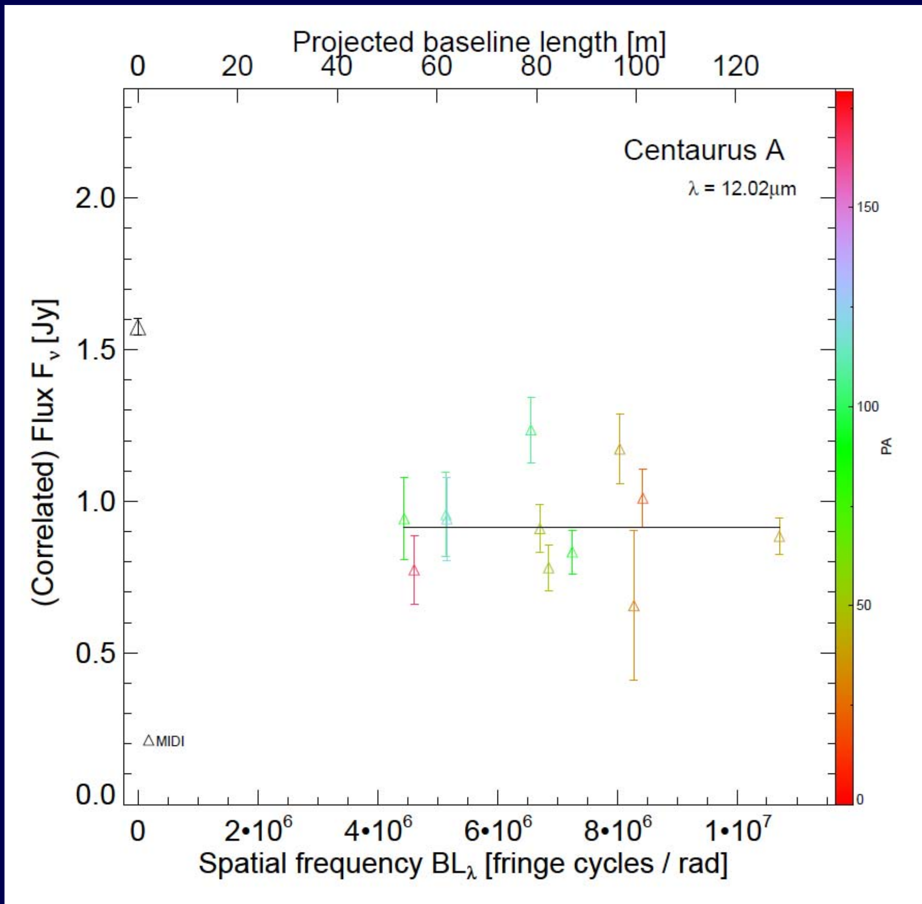
Circinus: interpretation



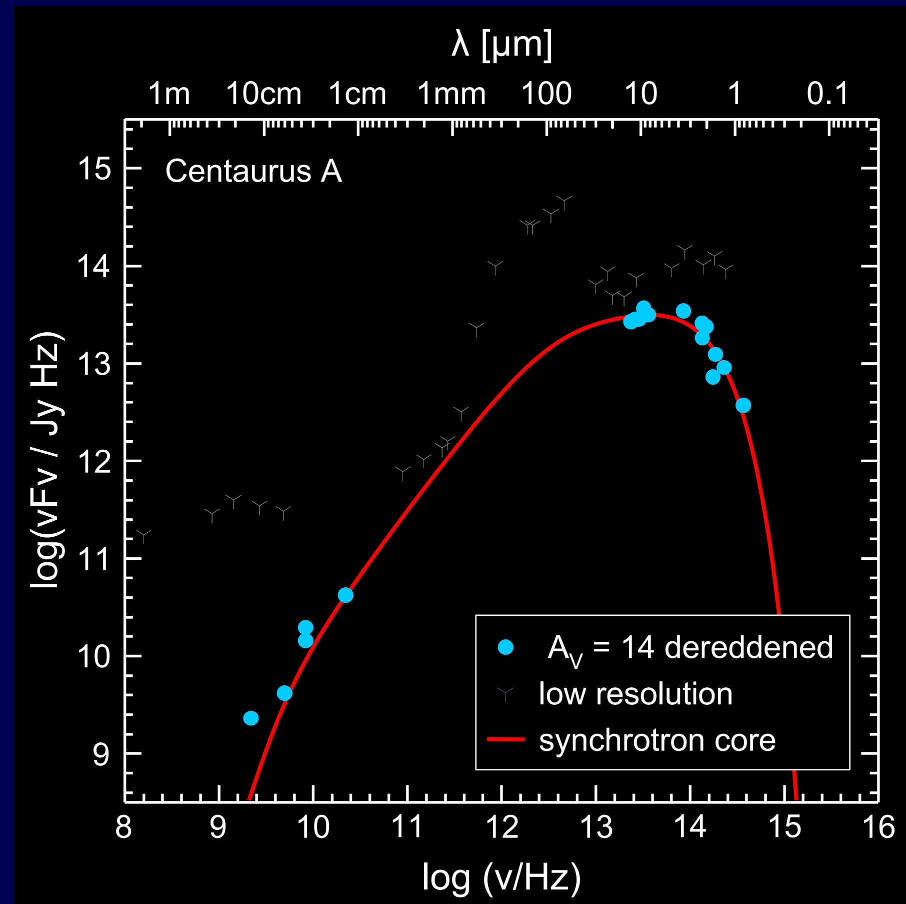


Fischer et al. 2013

3. Individual sources: Centaurus A



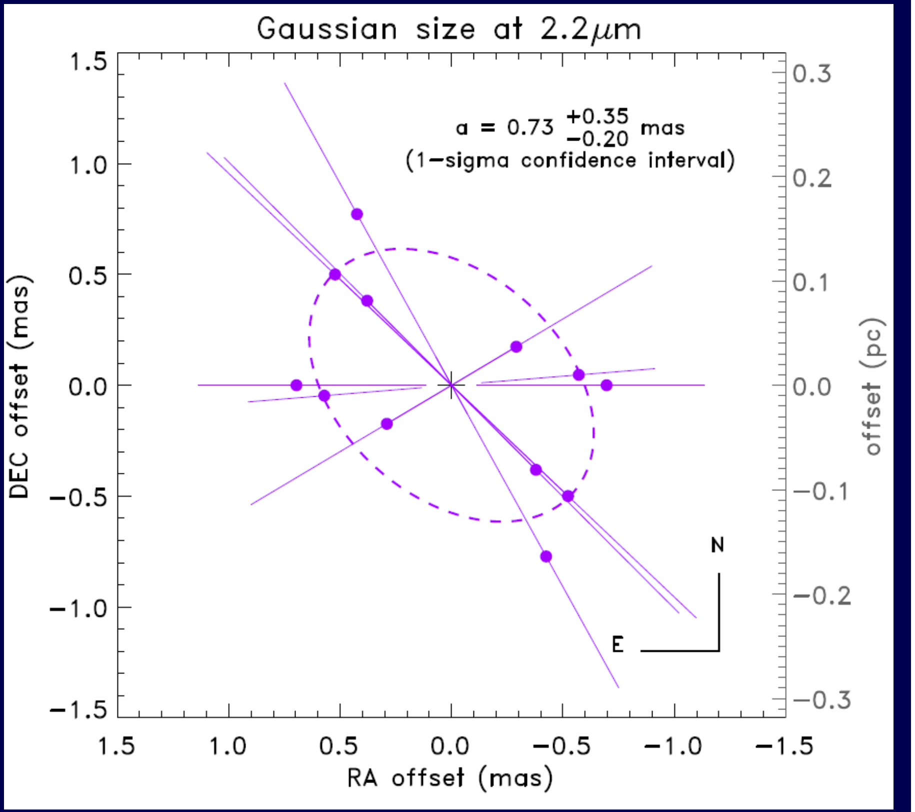
Burtscher et al. 2013

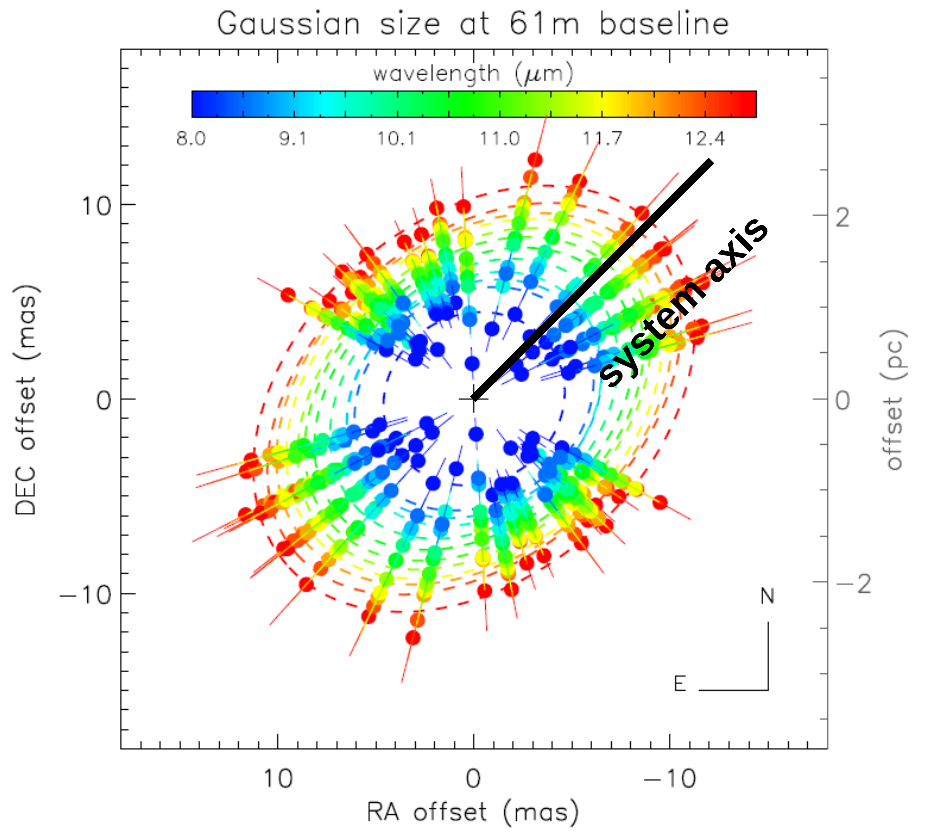


Meisenheimer et al. 2007

↳ unresolved flux: synchrotron emission from the jet

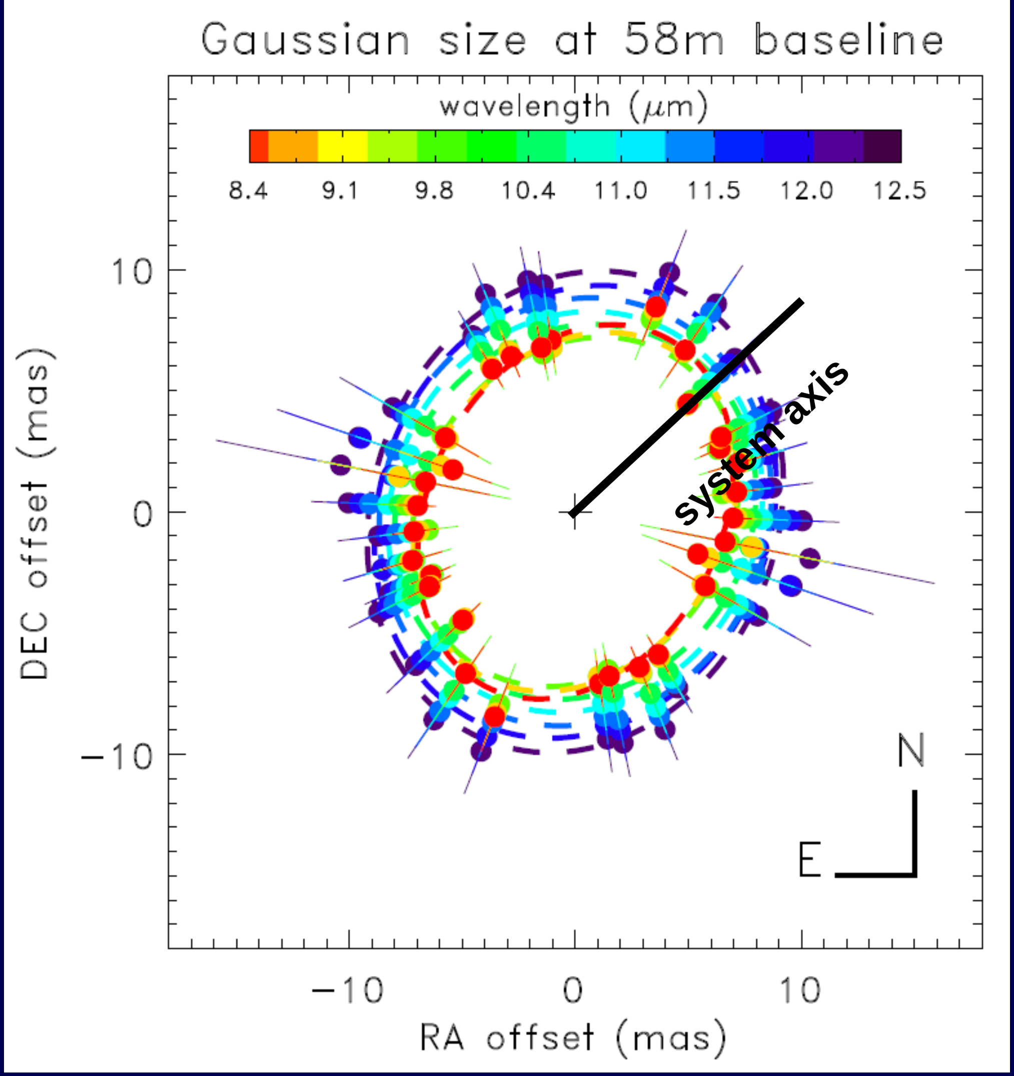
3. Individual sources: NGC3783





Hönig et al. 2013

3. Individual sources: NGC424

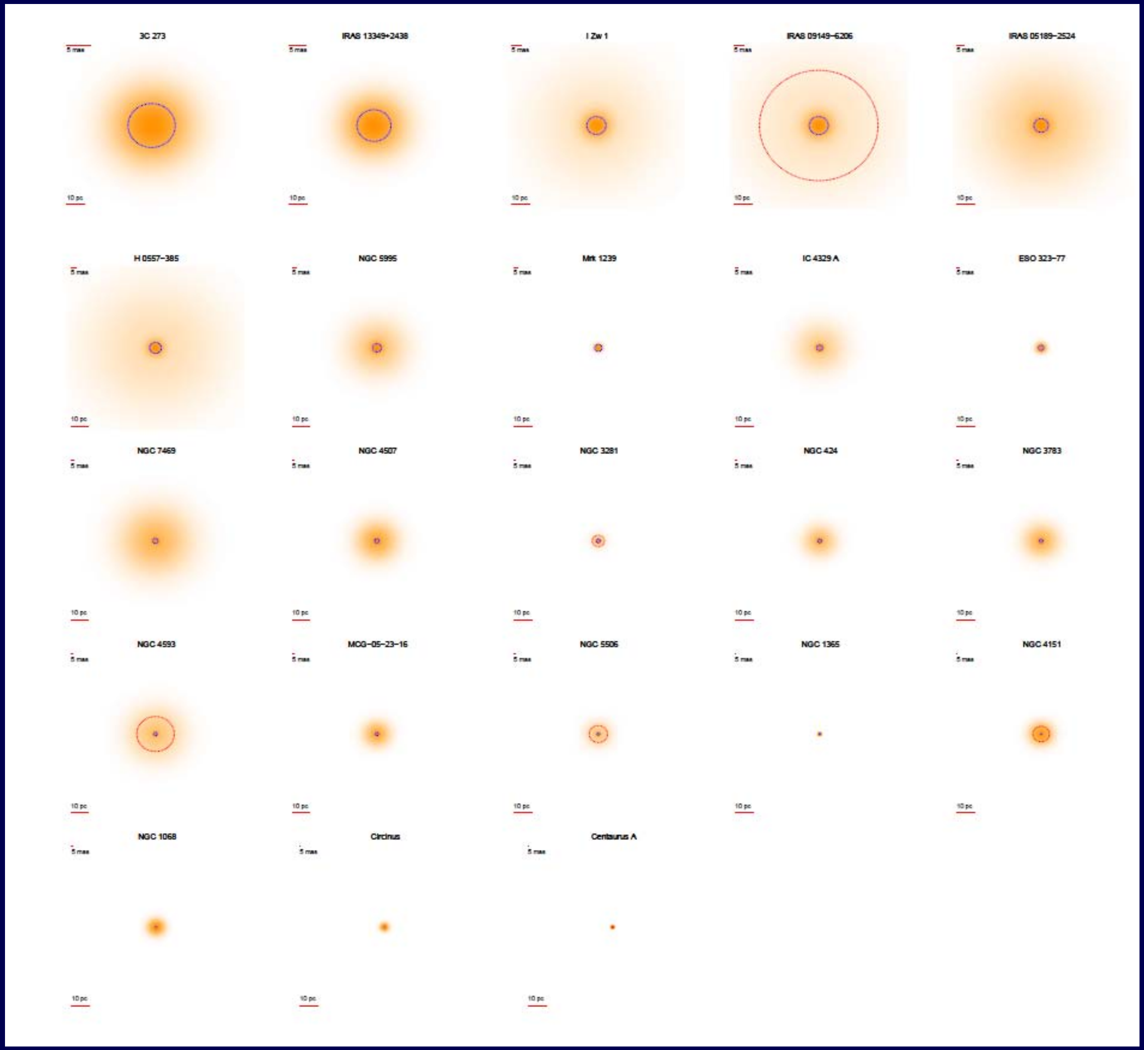


Hönig et al. 2012

3. Individual sources: Comparison

	Circinus	NGC1068	NGC424	NGC3783
polar extension:	yes	yes	yes	yes
size (extended)	1.6 pc	3.0 pc	2.0 pc	4.2 pc
disk + extended:	yes	yes	?	possibly
disk contribution	20%	15 – 40%	?	10 – 40%
maser disk:	yes	yes	no	no
hot dust:	no	hot disk	?	yes
silicate feature:	gets shallower	gets deeper	no change	no change

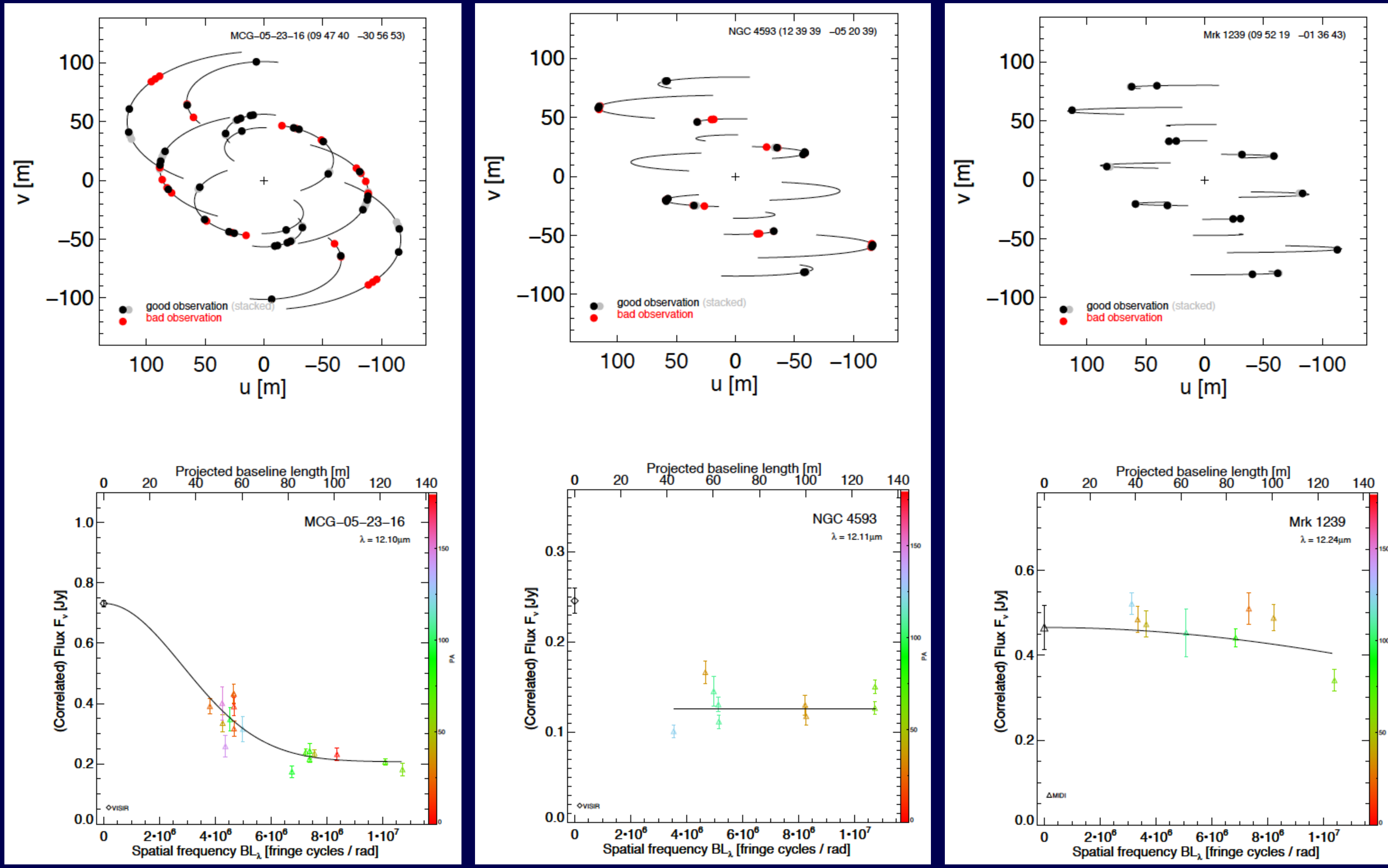
4. Surveys: the AGN Large Programme



- 23 detections
- 9 non-detections
- find point-source components plus (over-)resolved emission

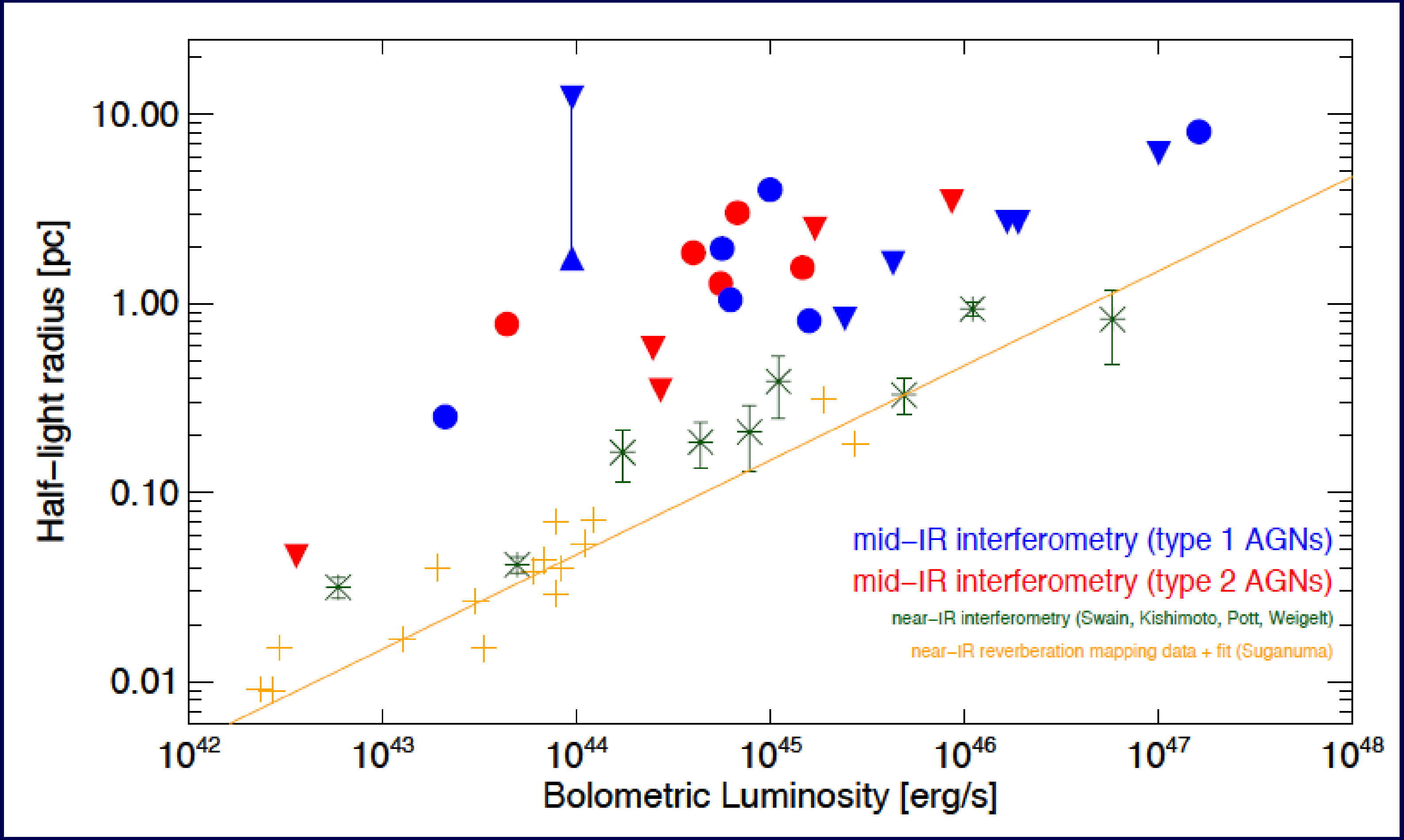
Burtscher et al. 2013

4. Surveys: the AGN Large Programme



Burtscher et al. 2013

4. Surveys: the AGN Large Programme

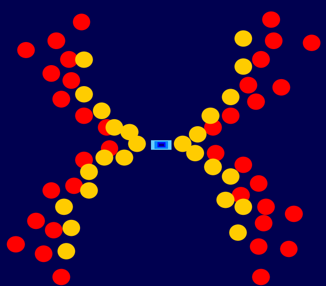


Burtscher et al. 2013

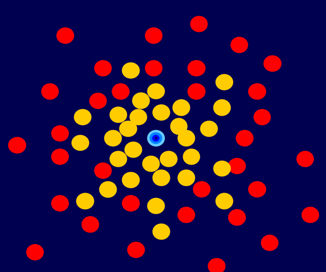
↳ large scatter in the AGN size luminosity relation

4. Surveys: type 1 sources

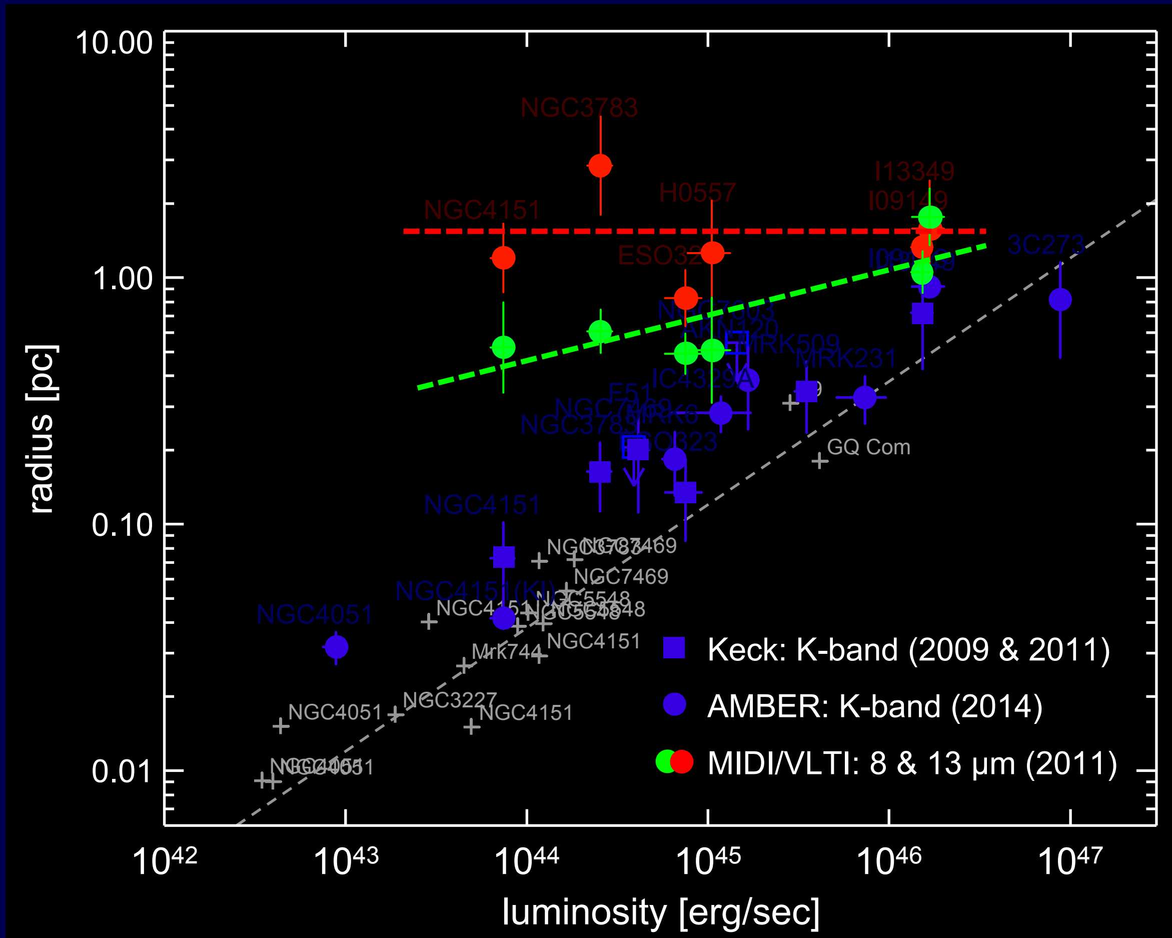
edge-on view:



face-on view:

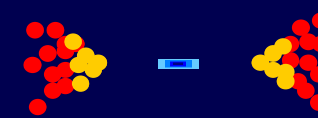


lower L or L_{edd}

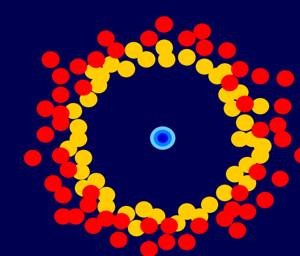


Kishimoto et al. 2011, 2013

edge-on view:



face-on view:



higher L or L_{edd}

↳ possible change in the radial dust distribution

5. Summary and Conclusions

Great step forward by VLTI interferometry:

- size-luminosity relation of AGN tori:
  - centrally heated dust parsec-sized,
  - quite large scatter,
  - no difference between type 1 and type 2 sources
- Point source component
- disk-like + polar elongated dust component

Wishlist:

- Imaging
- Higher sensitivity
- Longer baselines