

Resolving the mid-infrared cores of
local Seyfert galaxies
高空間分解赤外線観測で分かる近
傍セイファート銀河中心の物理

Poshak Gandhi (ガンディ ポシヤク)

JAXA 究員

with

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**Astronomy
&
Astrophysics**

Resolving the mid-infrared cores of local Seyferts[★]

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ABSTRACT

We present new photometry of 16 local Seyferts including 6 Compton-thick sources in *N*-band filters around 12- μ m, obtained with the VISIR instrument on the 8 m Very Large Telescope. The near diffraction limited imaging provides the least contaminated core fluxes for these sources to date. Augmenting these with our previous observations and with published intrinsic X-ray fluxes, we form a total sample of 42 sources for which we find a strong mid-infrared:X-ray (12.3 μ m:2–10 keV) luminosity correlation. Performing a physically-motivated subselection of sources in which the Seyfert torus is likely to be best-resolved results in the correlation $L_{\text{MIR}} \propto$

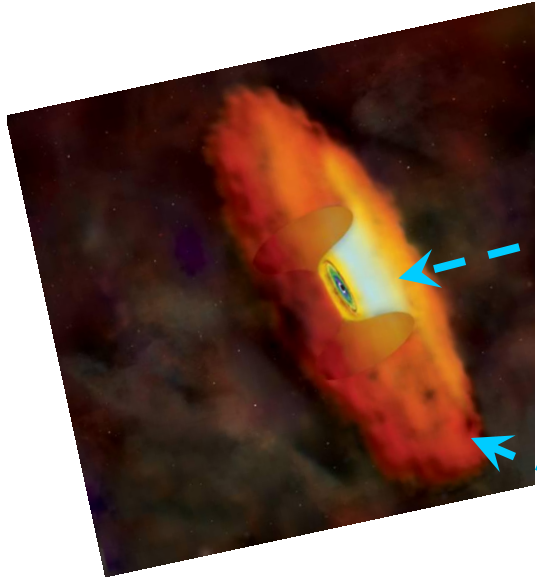
Unified AGN schematic picture

AGN 統一モデル



Dusty torus clouds absorb and thermalize intrinsic AGN emission
=> Observed **Infrared** \propto Intrinsic emission (e.g. **X-rays**)

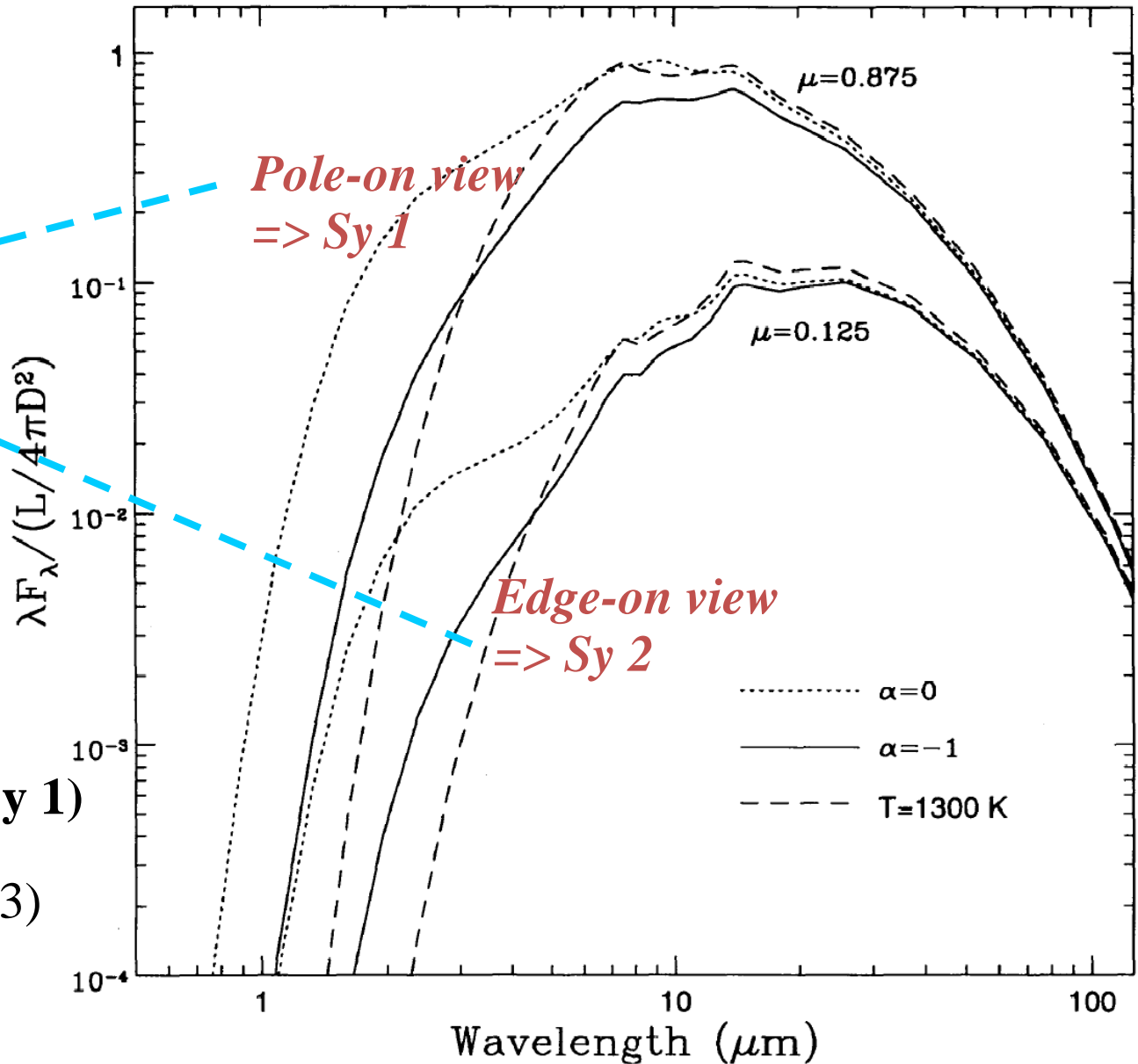
Mid-IR difference between obscured / unobscured AGN 一般的なスムーズダスティートーラスモデル



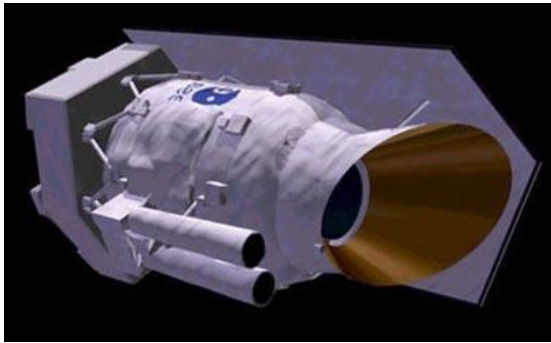
Usual Models :

Same $L_{X\text{-ray}} \Rightarrow$
 $L_{\text{MIR}} (\text{Sy 2}) \ll L_{\text{MIR}} (\text{Sy 1})$

(e.g., Pier & Krolik '93)

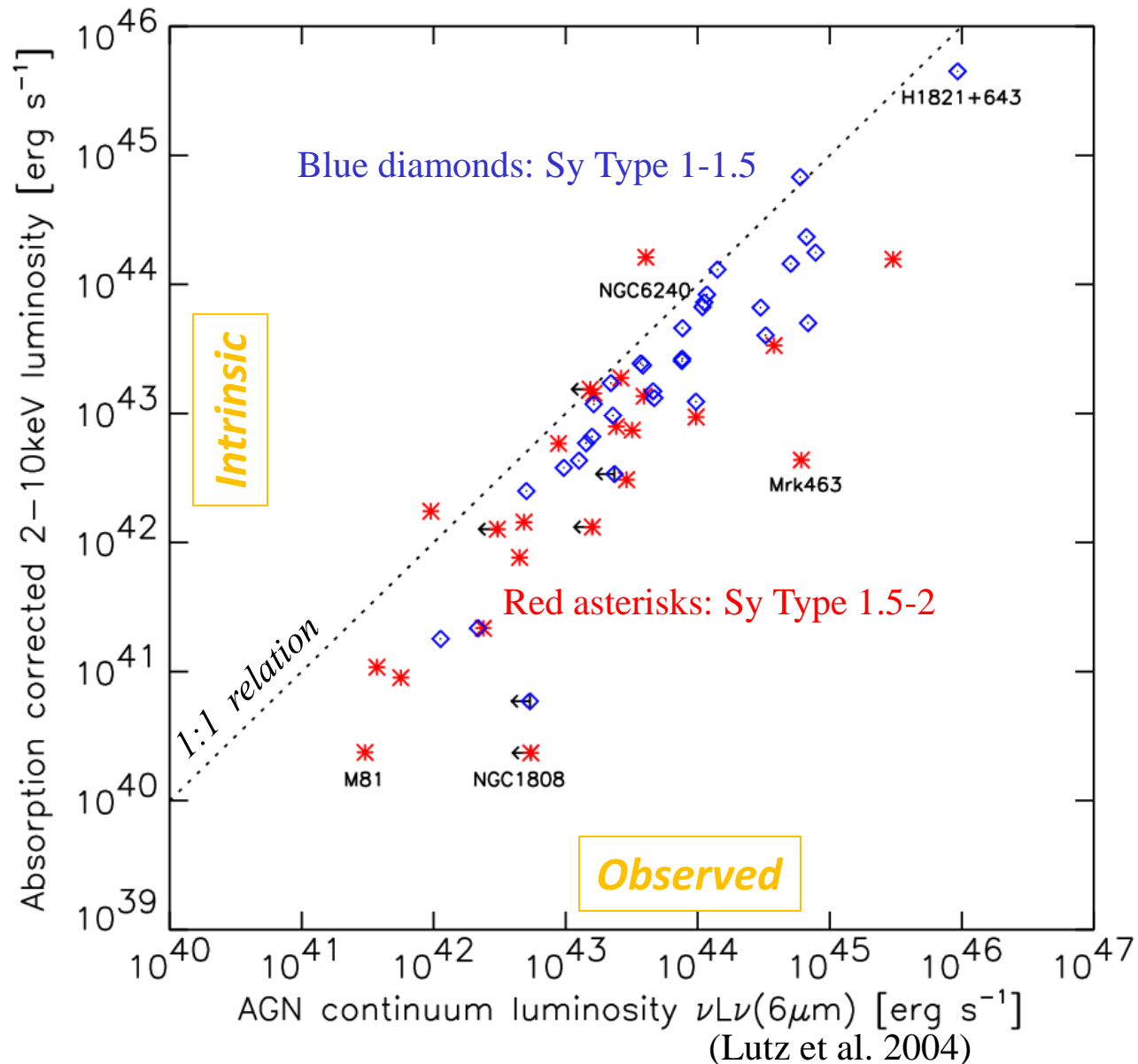


Mid-IR/X-ray relation for local Seyferts



ISO/ Spitzer/Akari
have studied this,

But significant
contamination from
unresolved star-
formation

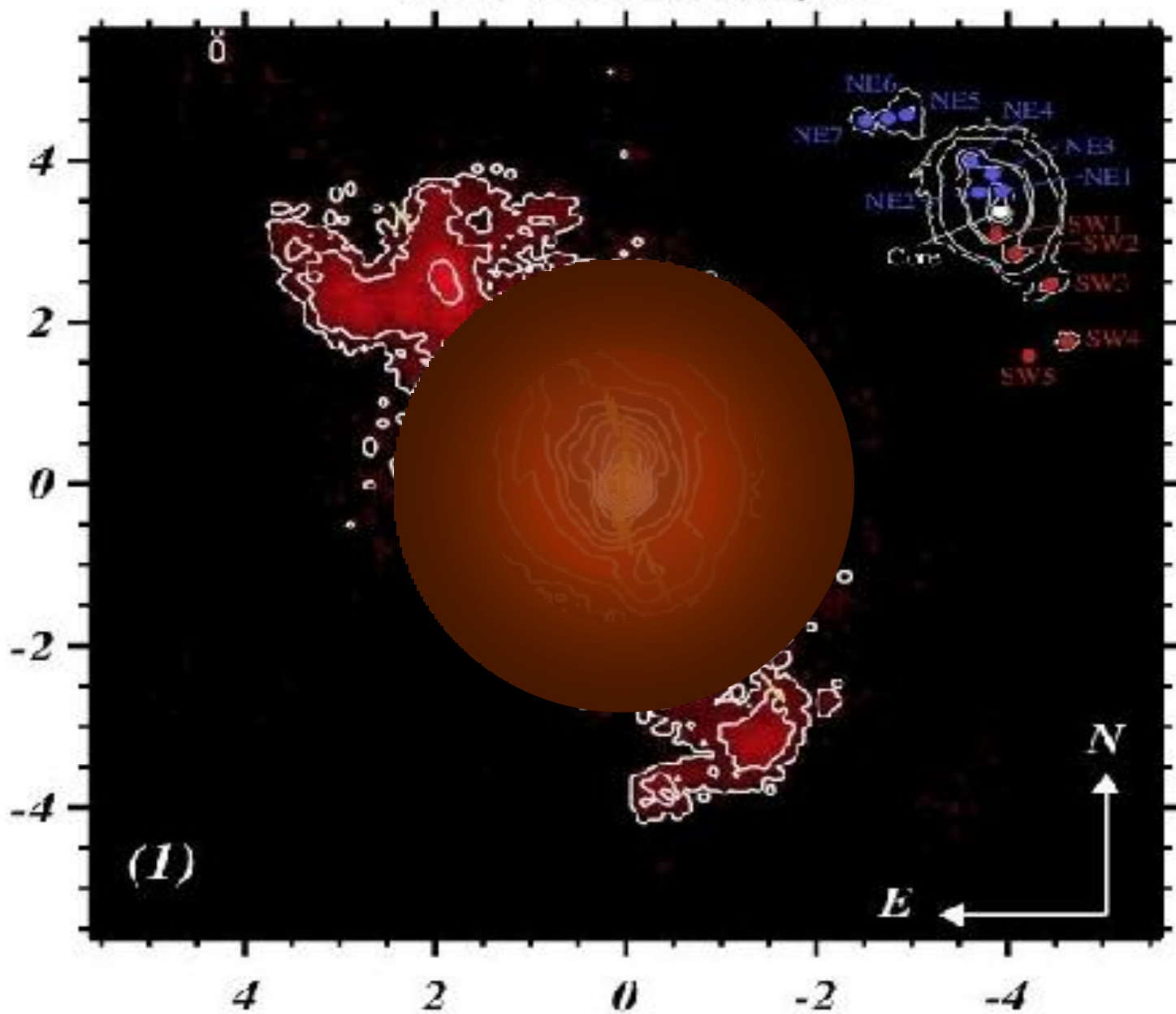


NGC1068

VLT/VISIR, 12.8 μ m

Jy/arcsec²

115.18



84.63

58.77

37.62

21.17

9.42

2.37

0.02

(Galliano et al. 2004)



Large ground telescopes

地上巨大望遠鏡

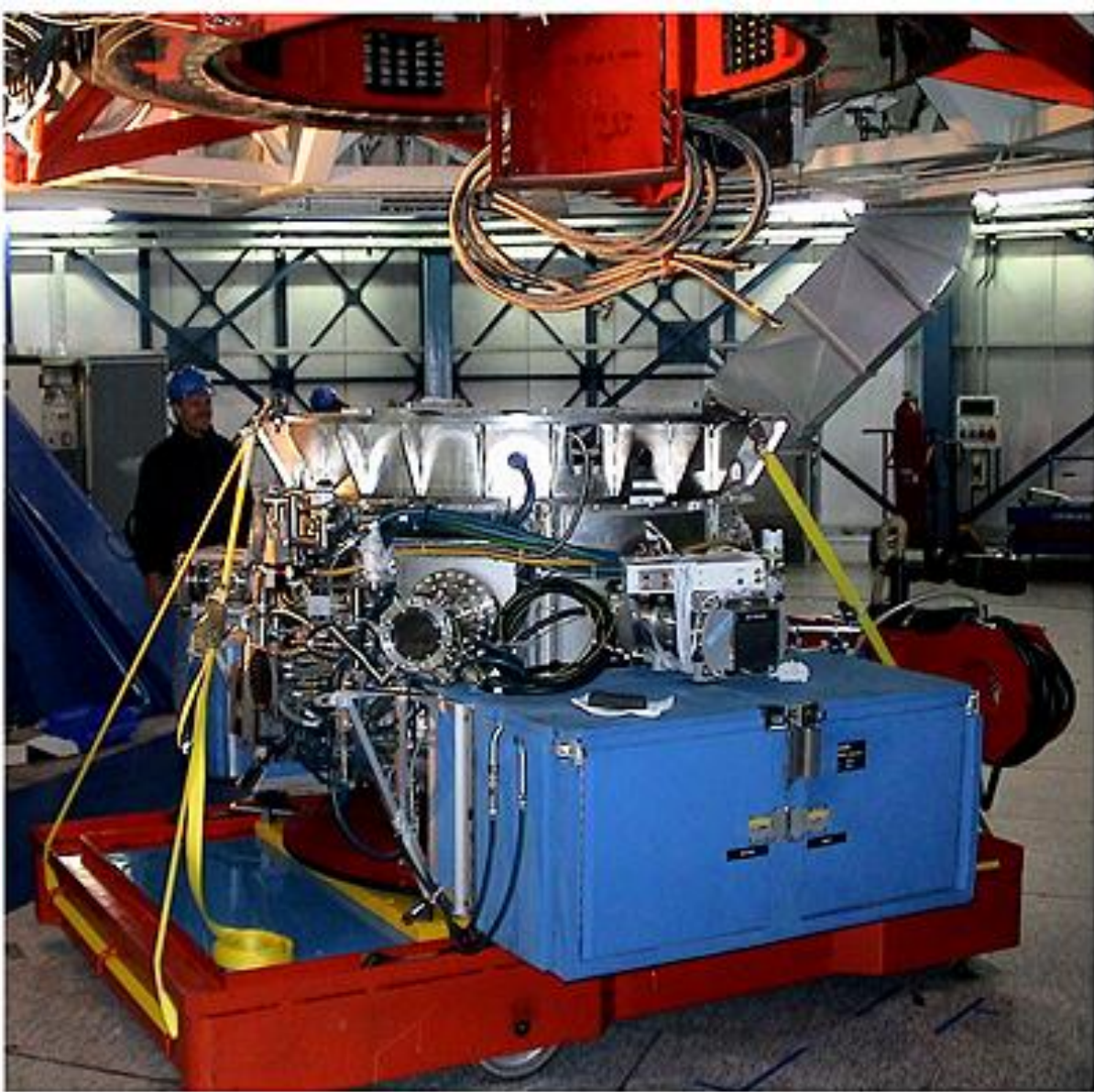
Very Large Telescope (VLT) 8.2 m diameter mirror

VLT is diffraction limited ($\sim 0''.3$ at $10\ \mu\text{m}$)



VLT Imager & Spectrograph for the mid IR (VISIR)

- MIR imaging/spectrograph 8-13 and 17-24 μm
- FOV: 19"x19" or 32"x32"
- Diffraction-limited imaging.
- Spectral resolutions of ~350, 3200 and 25000



VISIR under the Cassegrain Focus of the 8.2-m VLT Melipal Telescope

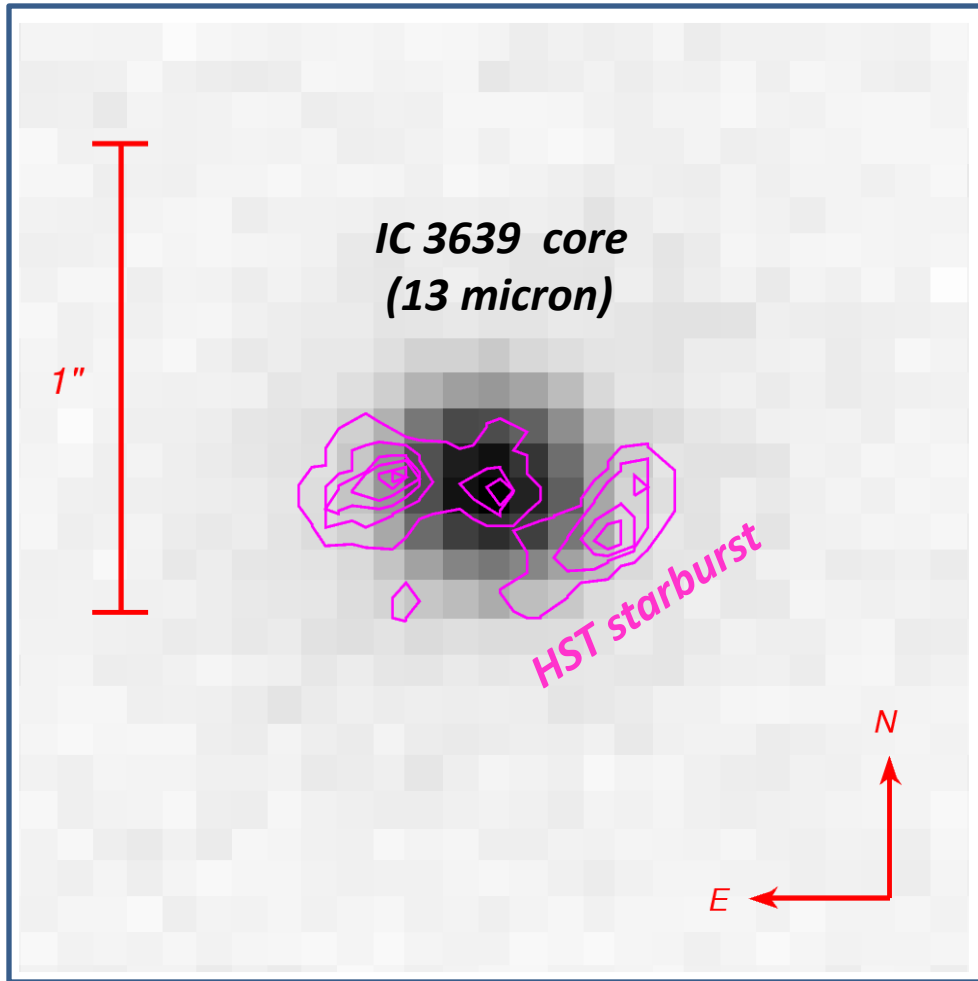
VISIR imaging sensitivity

Imaging Filter	central wavelength [μm]	half-band width [μm]	median sensitivity (SF) [mJy 10σ/h]
PAH1	8.59	0.42	5
ArIII	8.99	0.14	6
SIV_1	9.82	0.18	30
SIV	10.49	0.16	8
SIV_2	10.77	0.19	9
PAH2	11.26	0.59	6
SiC	11.85	2.34	7
PAH2_2	11.88	0.37	7
Nell_1	12.27	0.18	12
Nell	12.80	0.21	12
Nell_2	13.03	0.22	15
Q1	17.65	0.83	50
Q2	18.72	0.88	50
Q3	19.50	0.40	100

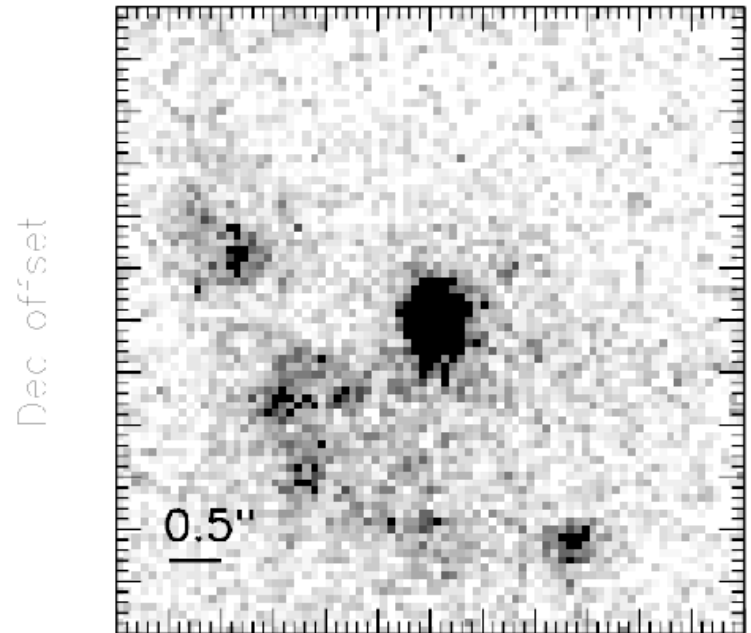
Local Seyfert survey

近傍セイファート銀河サーベイ

(Collaboration: D. Asmus, W.J. Duschl, P. Gandhi, S. F. Hönig, H. Horst, A. Smette)



VISIR/VLT:
Gandhi+2009, Horst+09+08+06



RA offset
NGC 5135
(13 micron)

Mid-IR/X-ray relation for local Seyferts

VISIR/VLT:

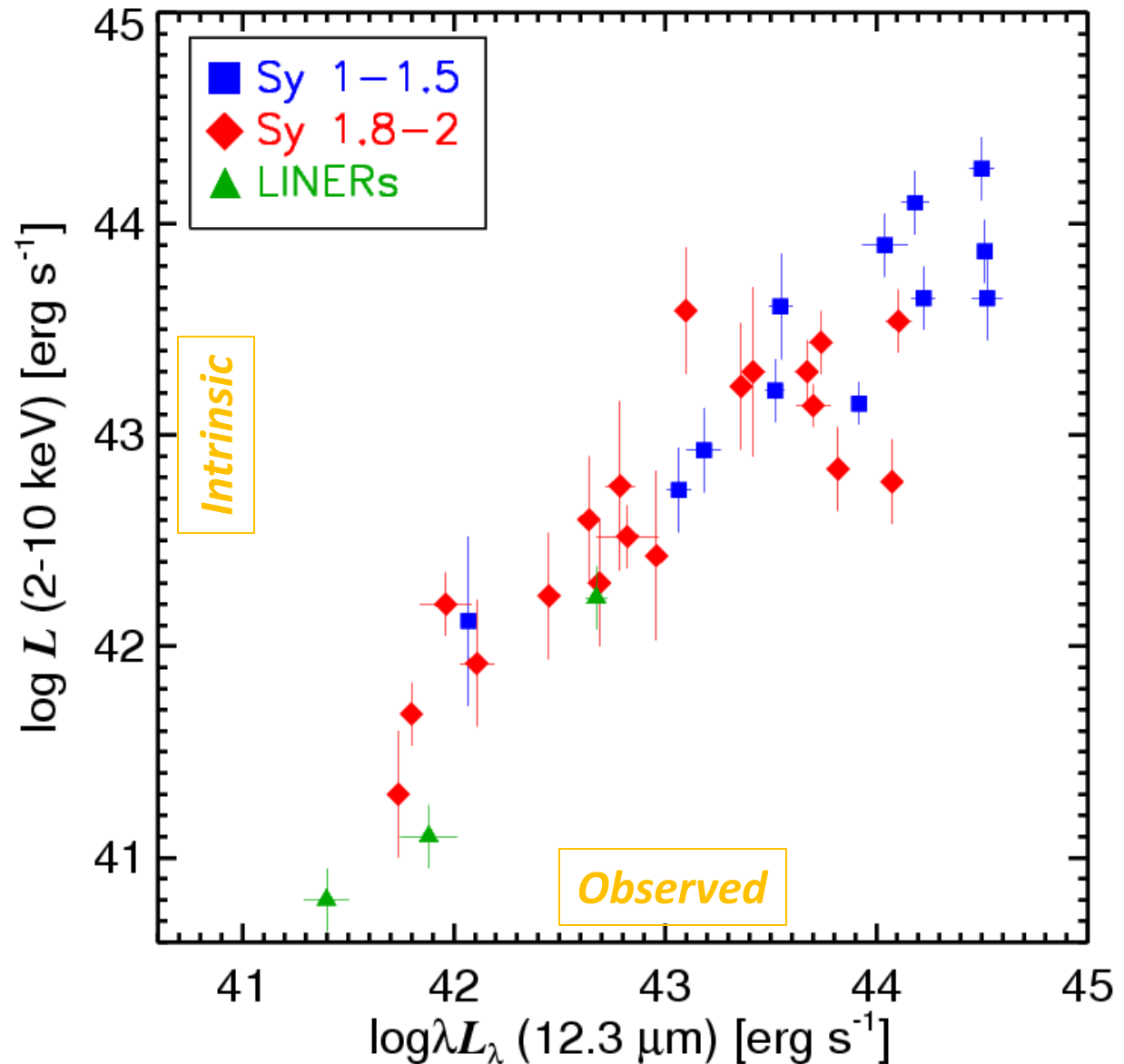
Gandhi+09, Horst+2008



Results:

- $L_{\text{IR}} \propto L_{\text{X}}$

(as expected in
Unification)



Mid-IR/X-ray relation for local Seyferts

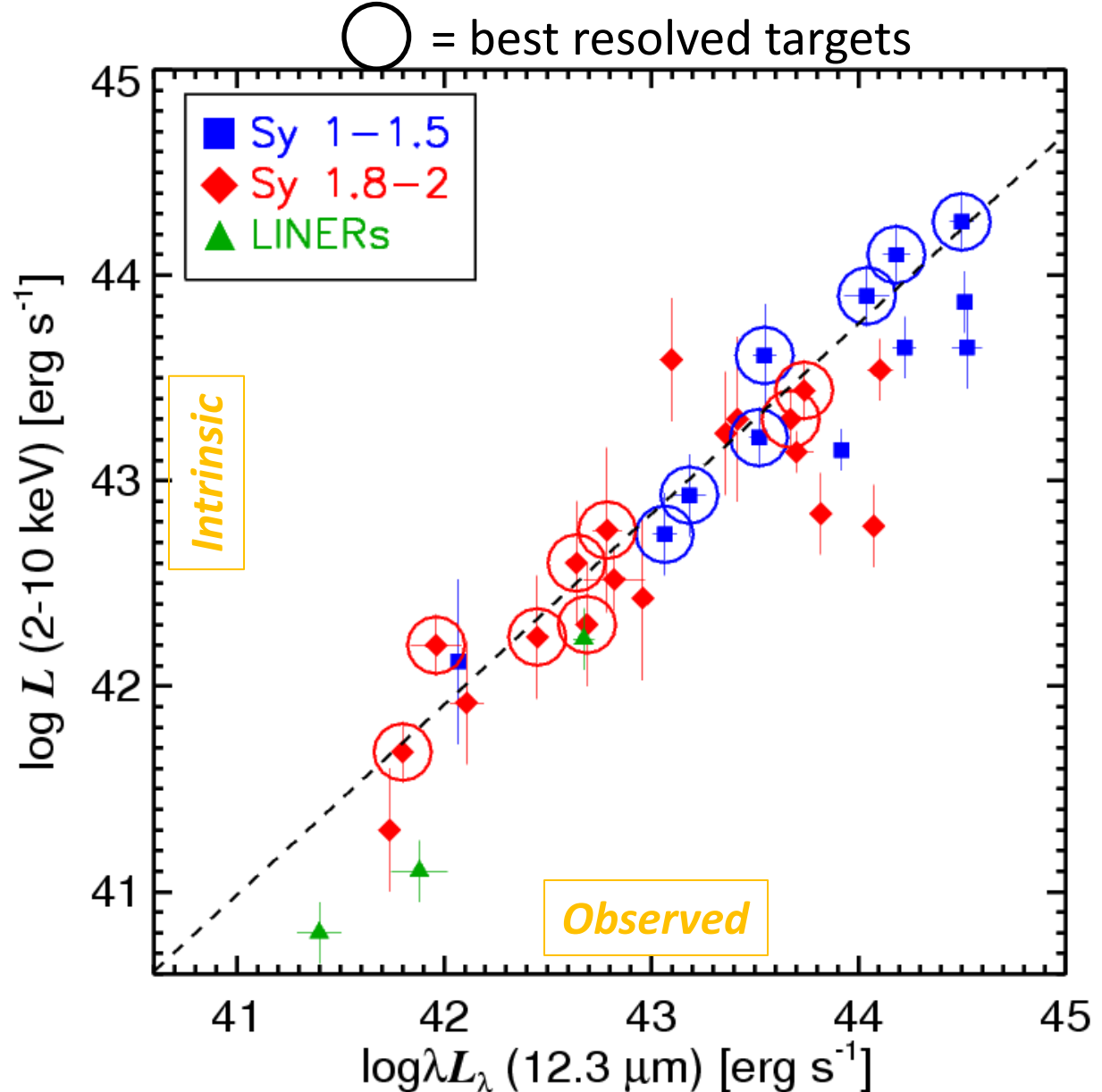
VISIR/VLT:

Gandhi+09, Horst+2008

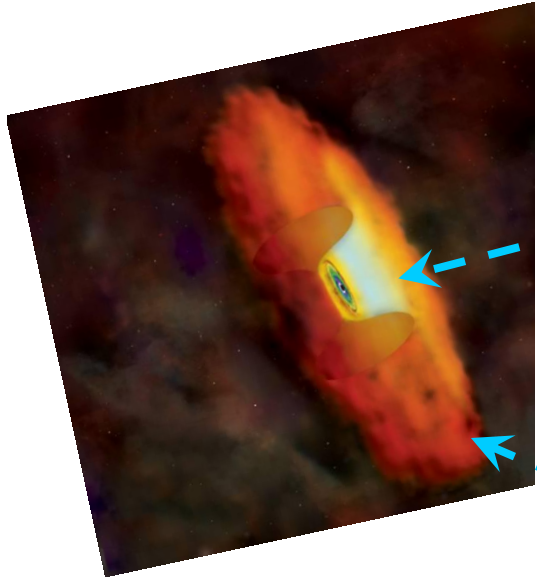


Results:

- Small dispersion in L_X/L_{IR} relation
- Type 1 and Type 2 follow same relation



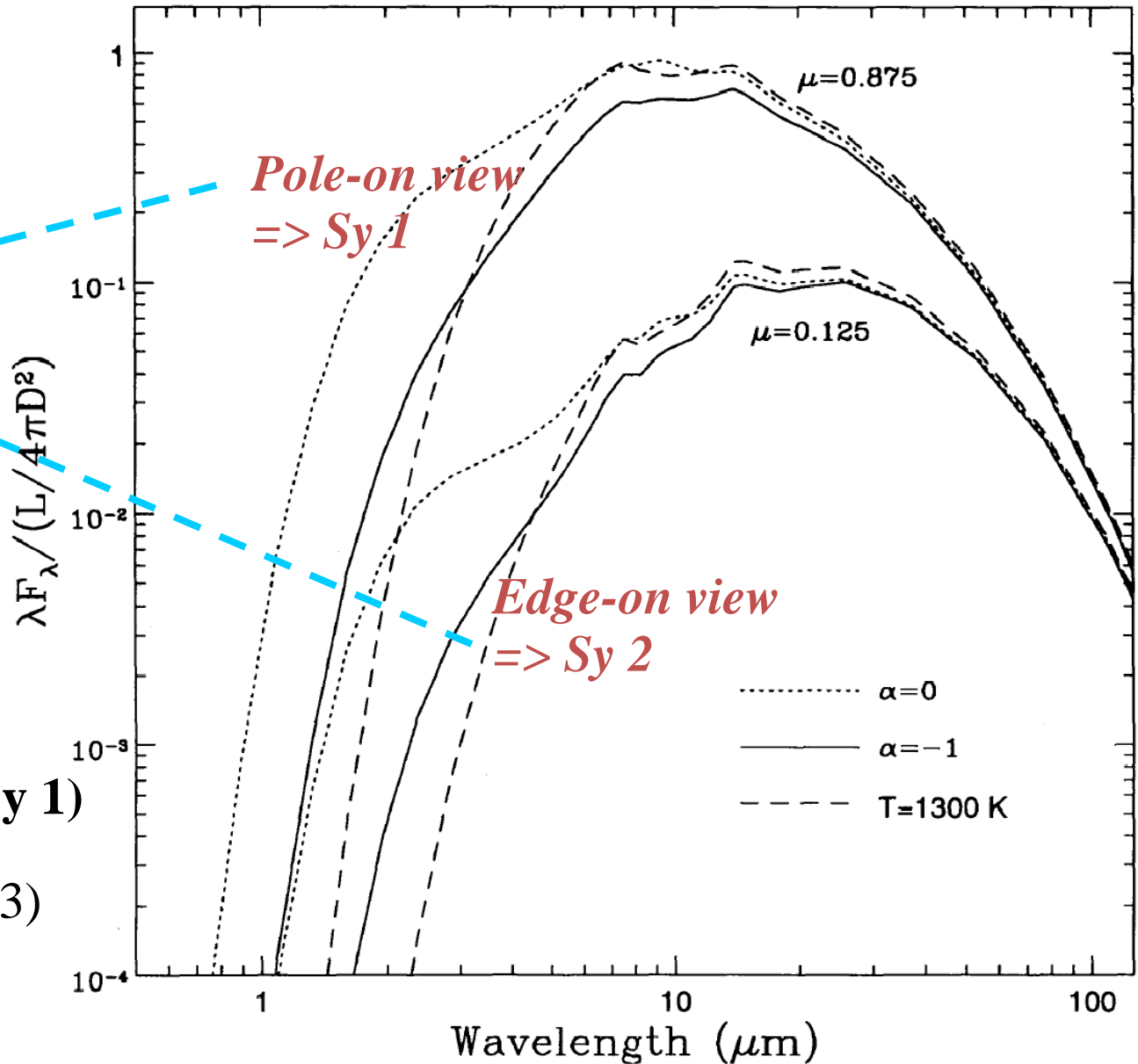
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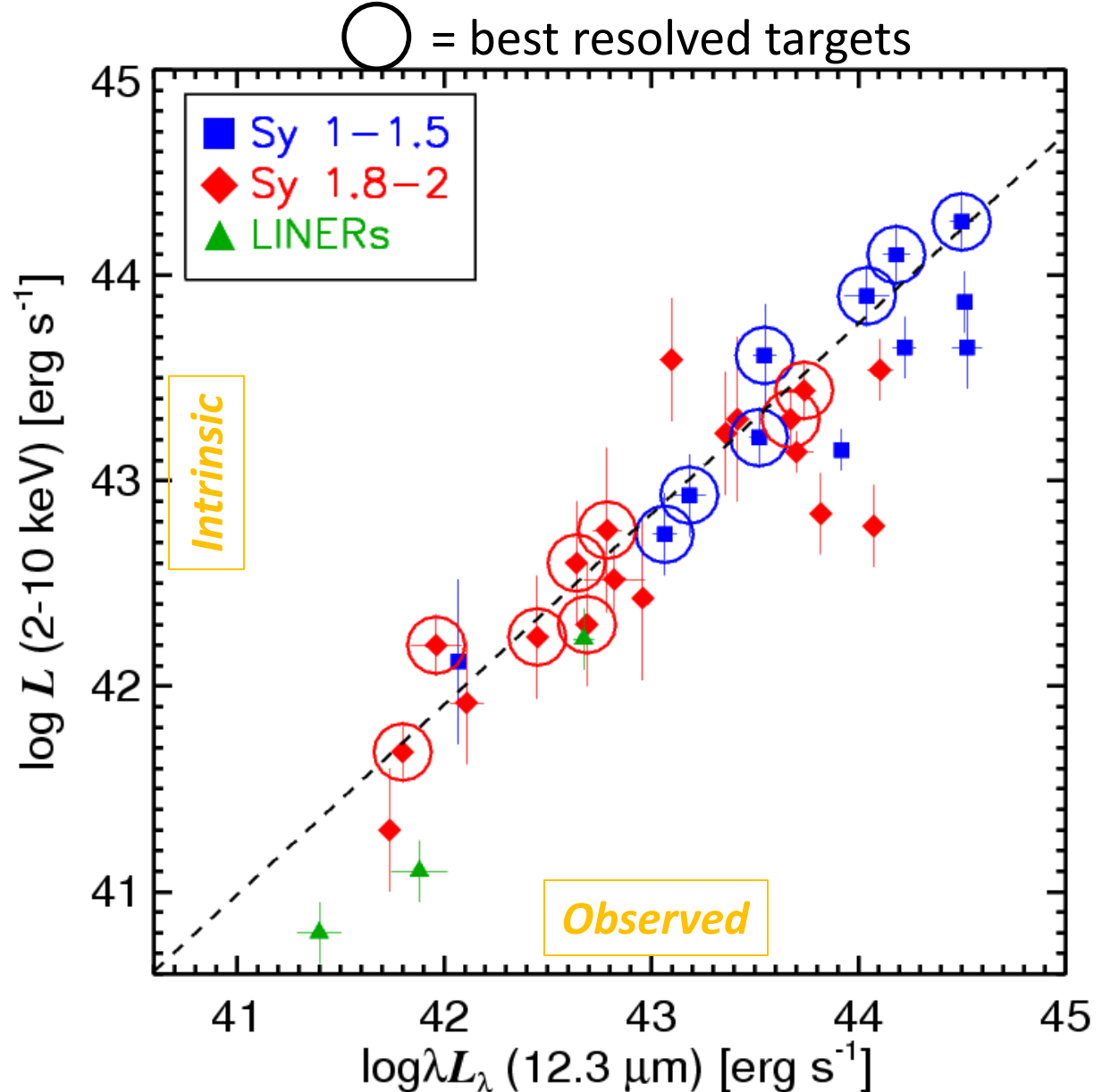
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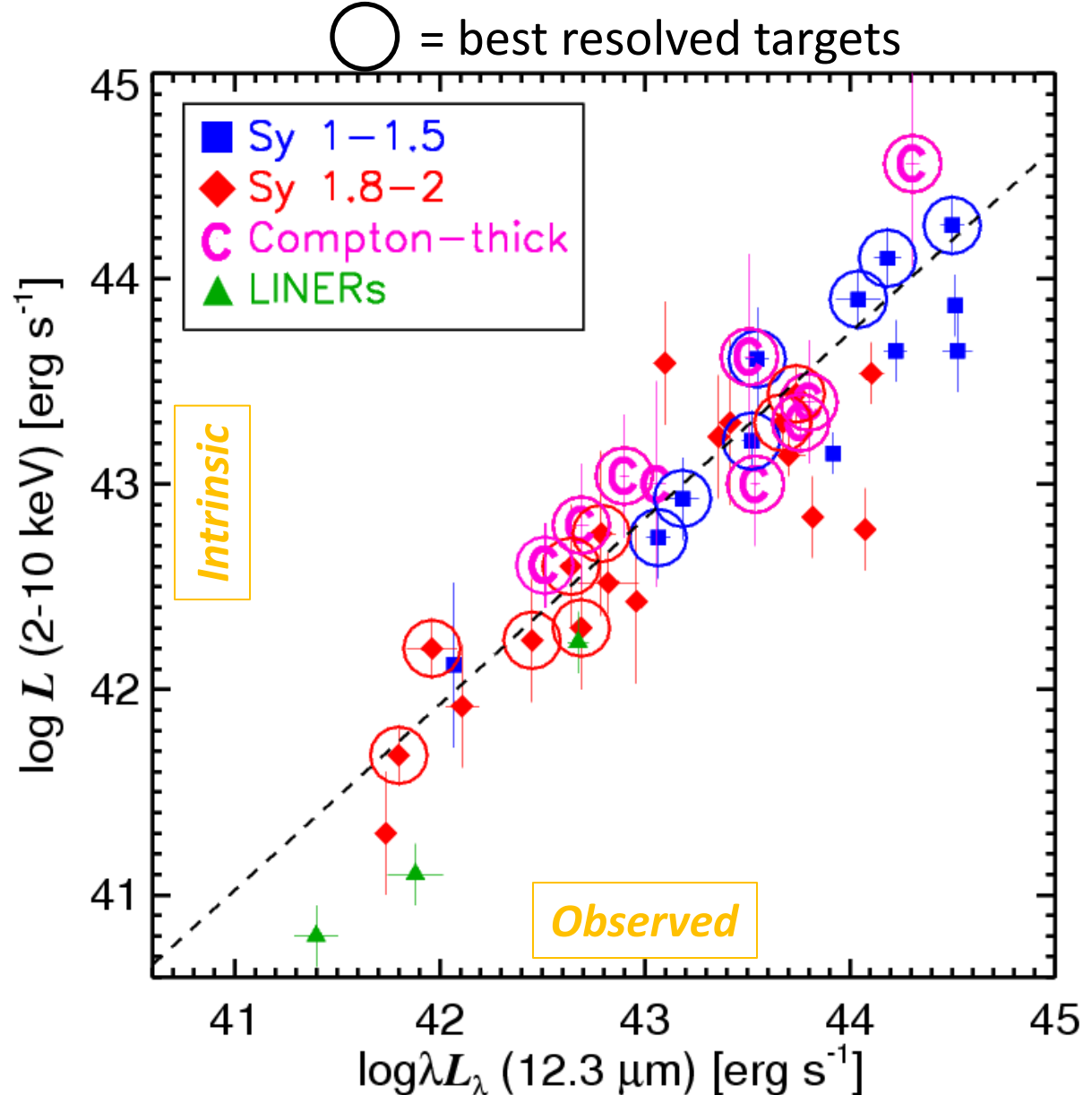
VISIR/VLT:

Gandhi+09, Horst+2008



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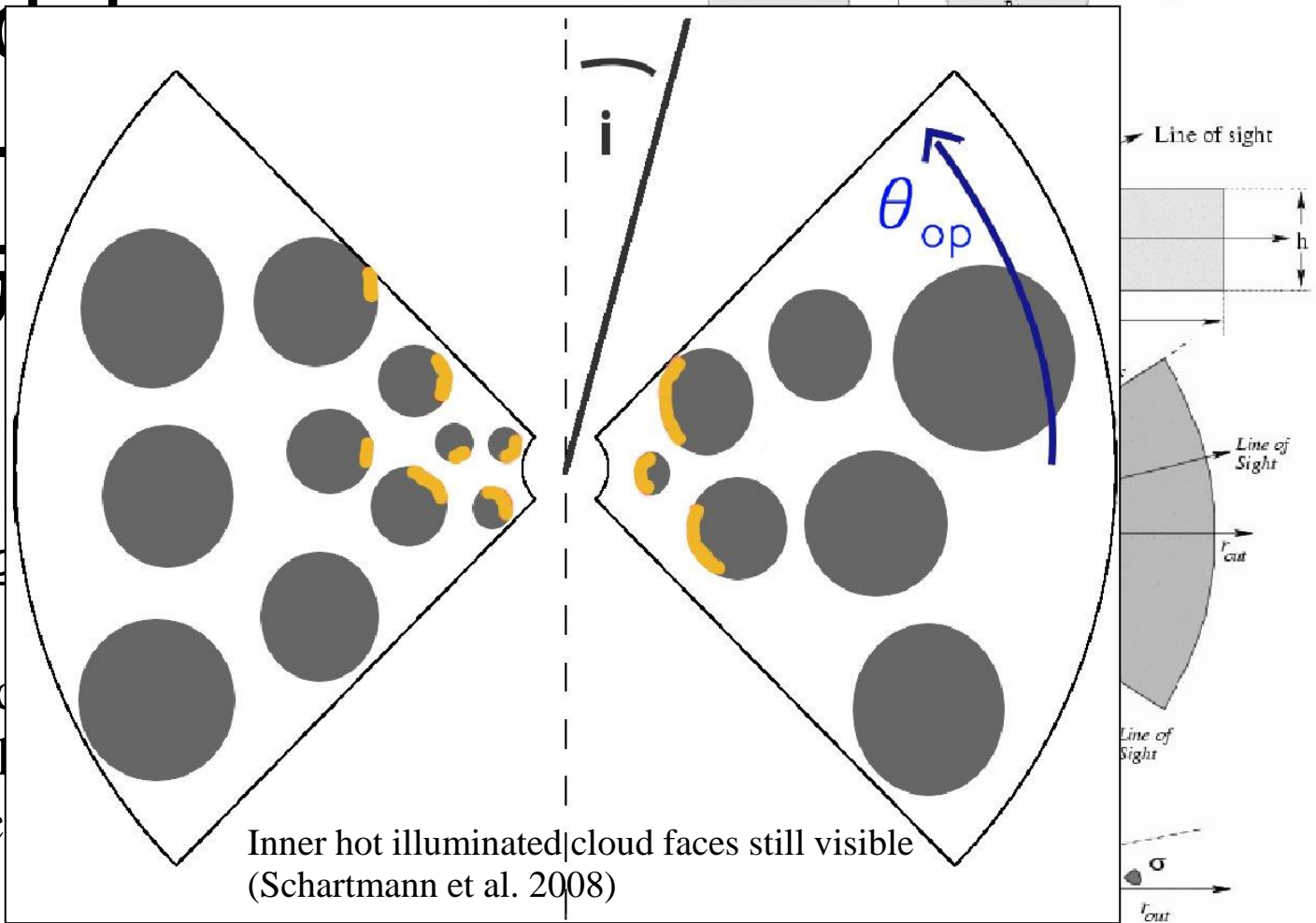
Torus

Model

ト
モ

Clumpy torus

Decreased
IR optical
towards c



(e.g., Hoenig et al. 2006,
Nenkova et al. 2008)

Picture from : Ibar & Lira (2006)

Mid-IR/X-ray relation for local Seyferts

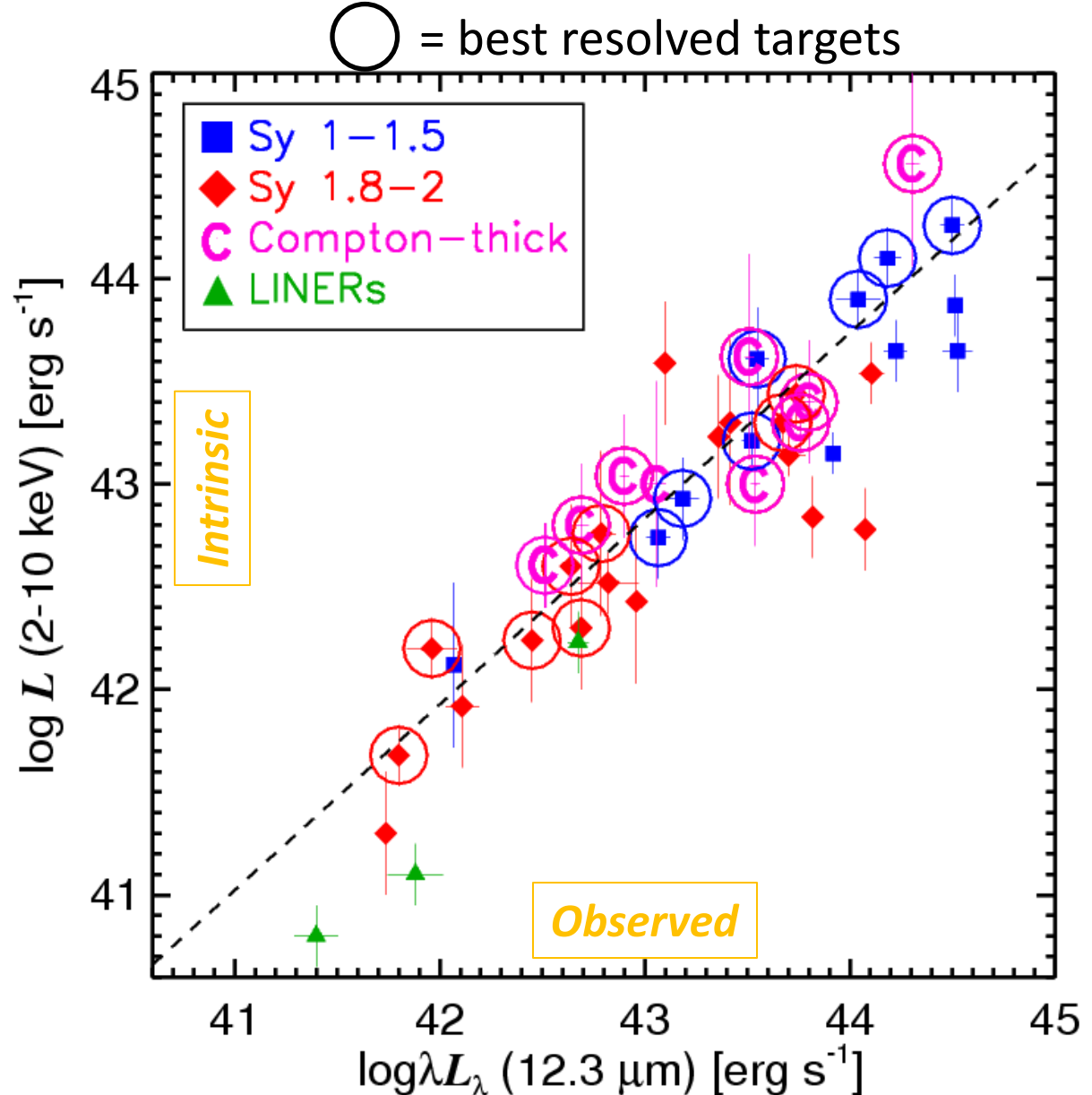
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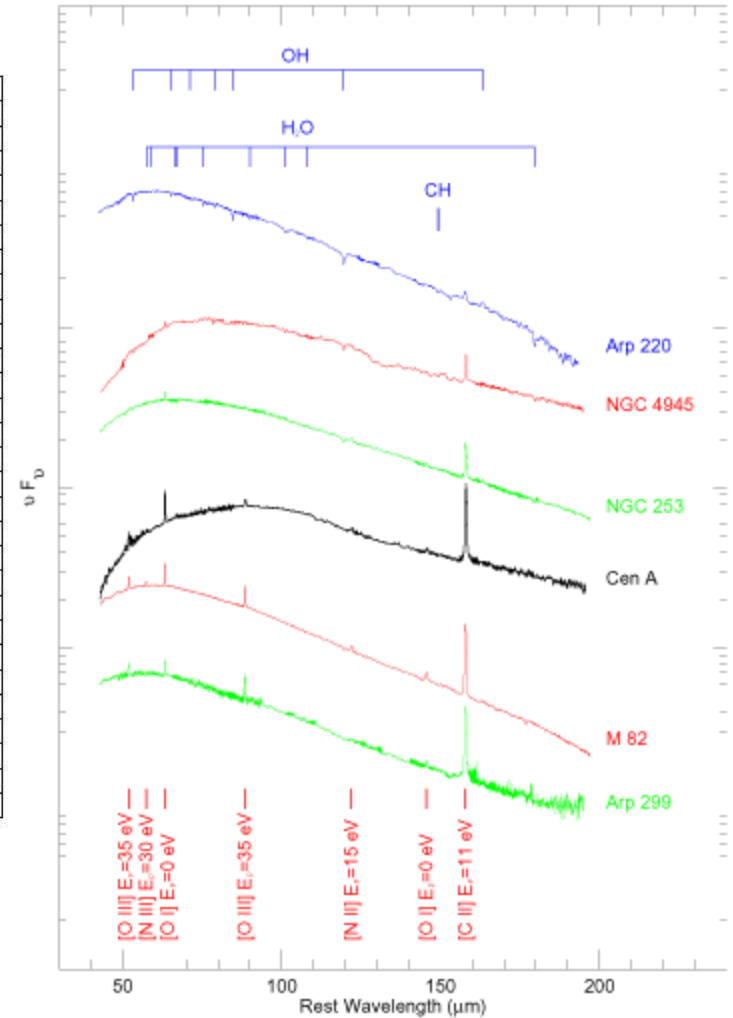
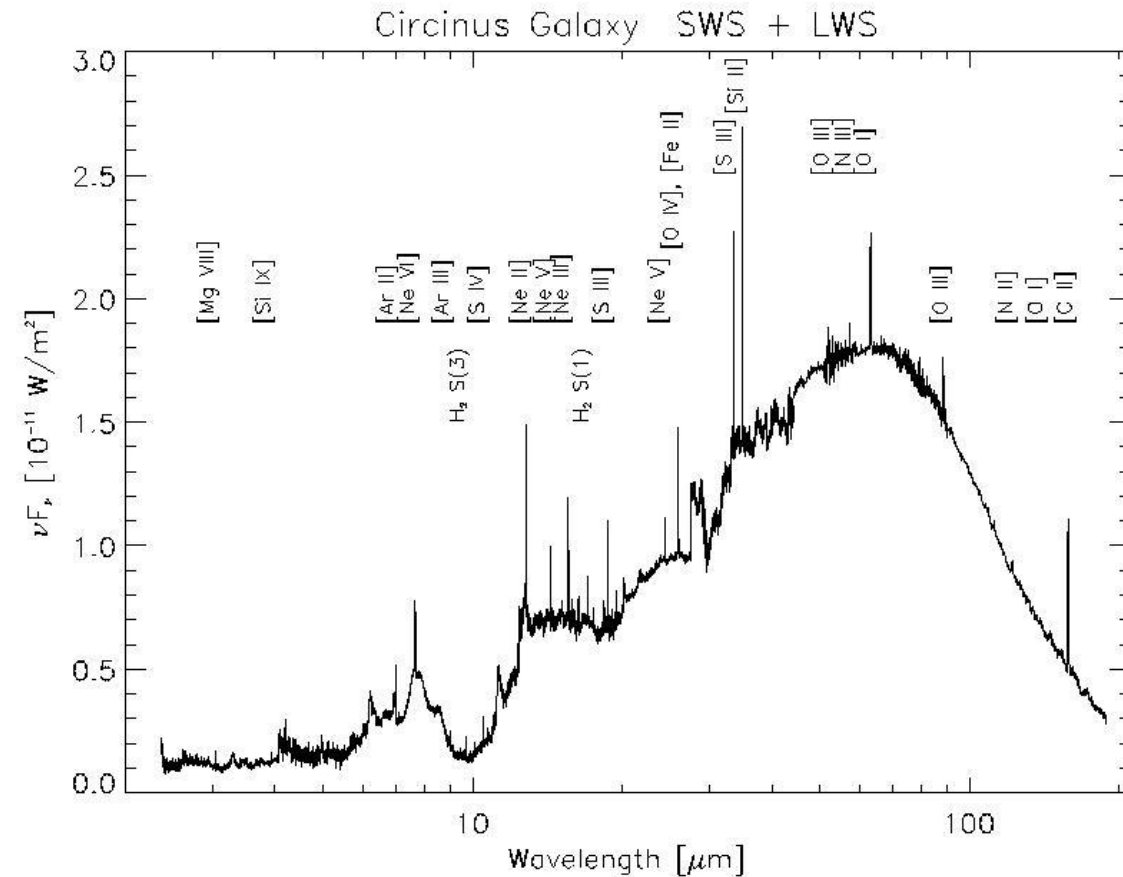


Using SPICA to probe clumpy tori



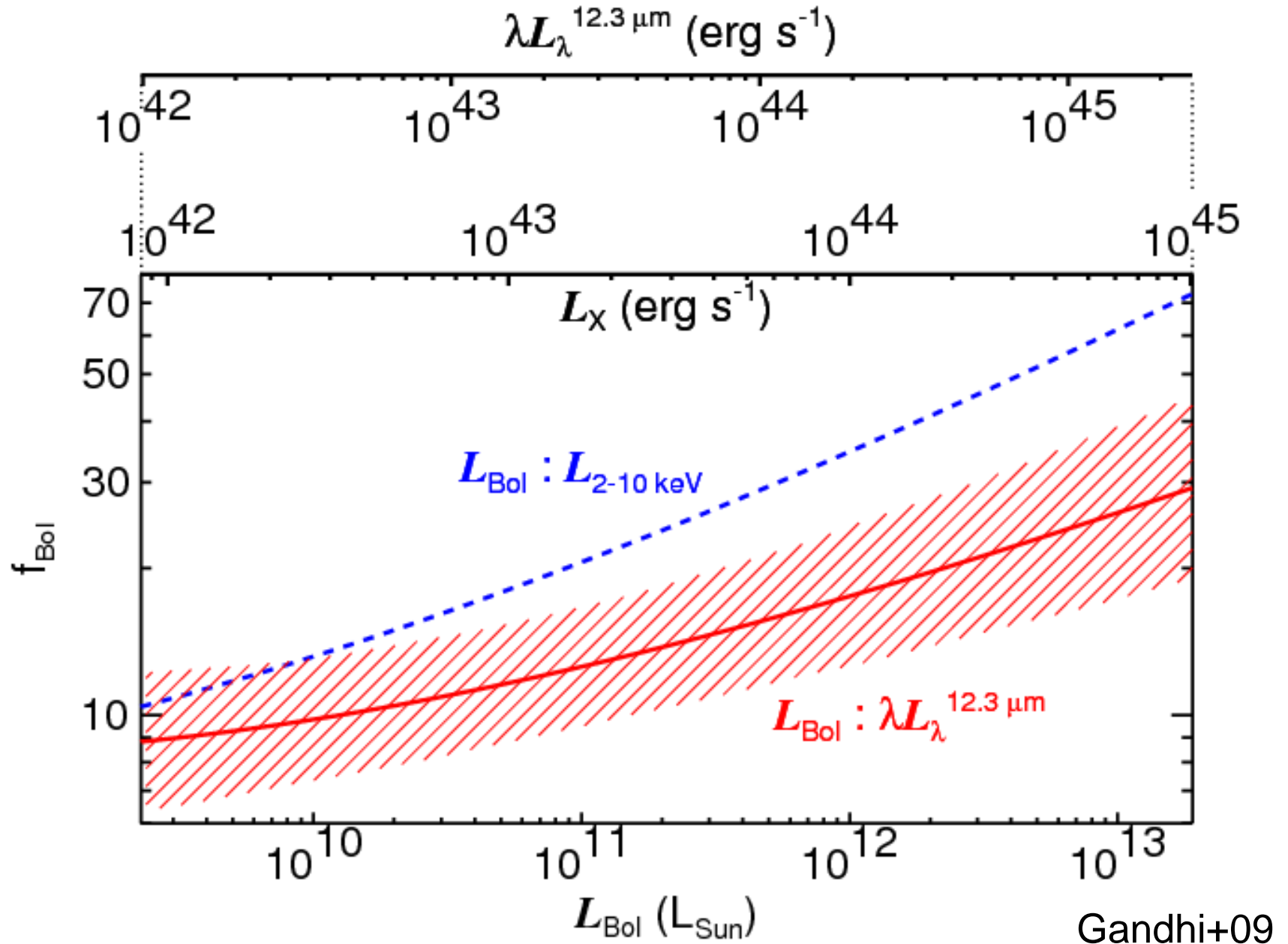
Far-infrared AGN spectra

J. FISCHER ET AL.

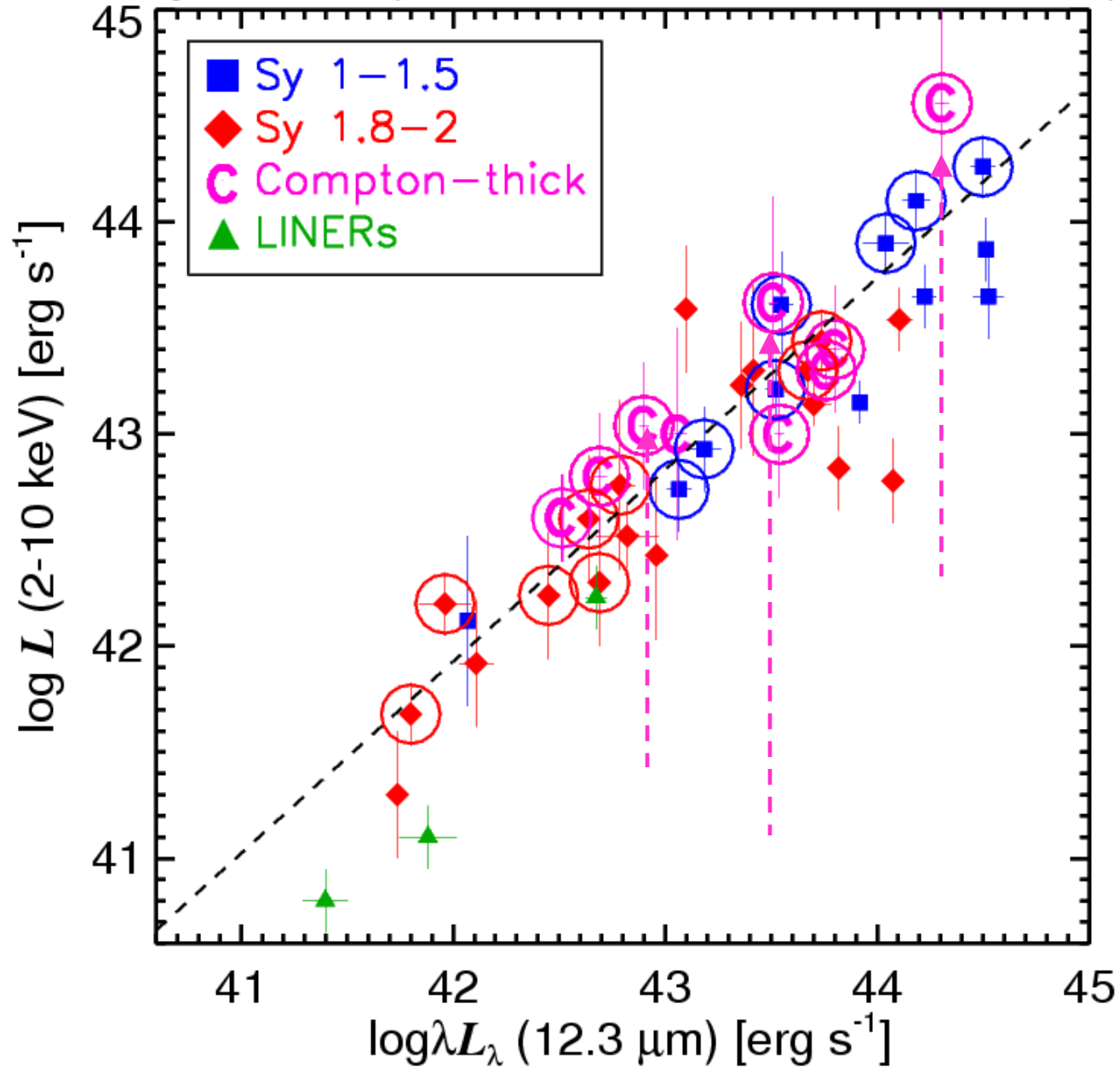


ISO studies (Moorwood+97, Fischer+00)

Mid IR: good proxy of intrinsic AGN power

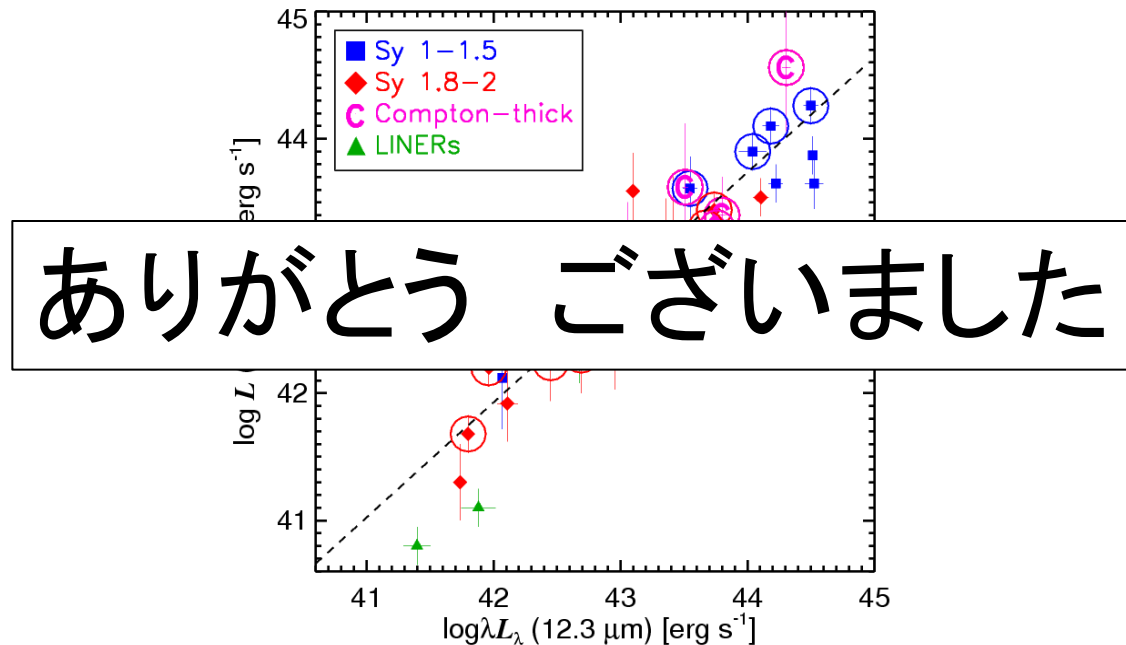


Estimating Compton-thick intrinsic powers



Summary (まとめ)

- X-ray + high resolution Mid-IR observations => Seyfert tori may be highly clumpy



ありがとうございました

- SPICA can directly measure physical properties of tori in the nearby Universe to constrain clumpiness.