

Blue excess Hot DOGs and their link to local AGN

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of the Republic of Serbia



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GENT



Illustration: Monika Lang

Outline

PART 1: A (very) brief intro of active galactic nuclei

PART 2: high z ($\sim 2-4$), hyperluminous, obscured QSOs (blue Hot DOGs)

Assef, Stalevski et al. (2025, 2026)

PART 3: low z (0.0015), low luminous Seyfert 2 (Circinus AGN)

Stalevski et al. (2017, 2019, 2023)

PART 1: Active galactic nuclei (AGN)

AGN unification-by-orientation

Relativistic jet
Radio-loud half (above)

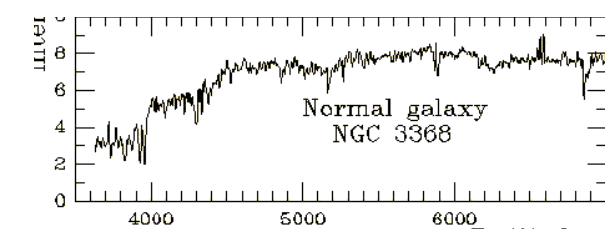
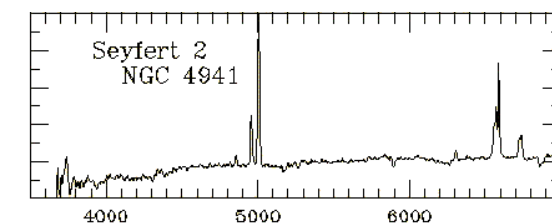
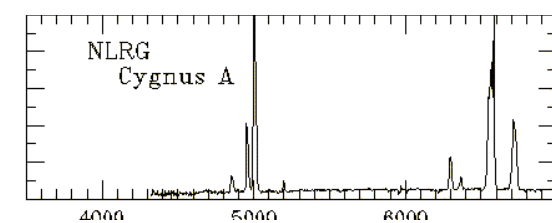
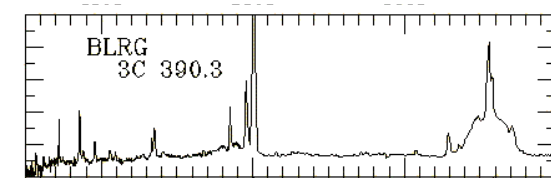
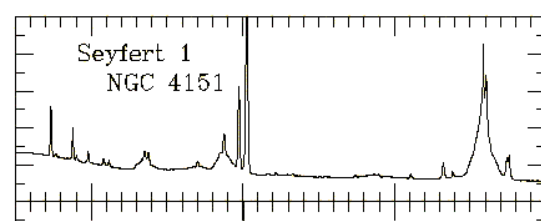
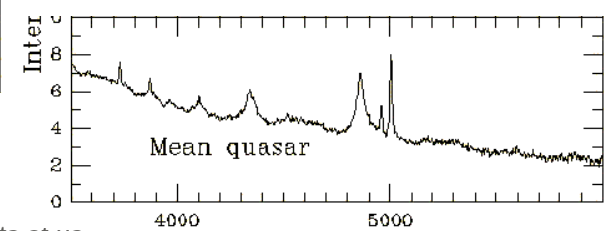
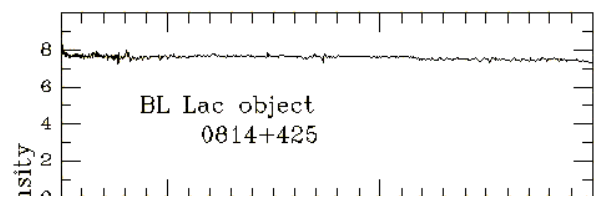
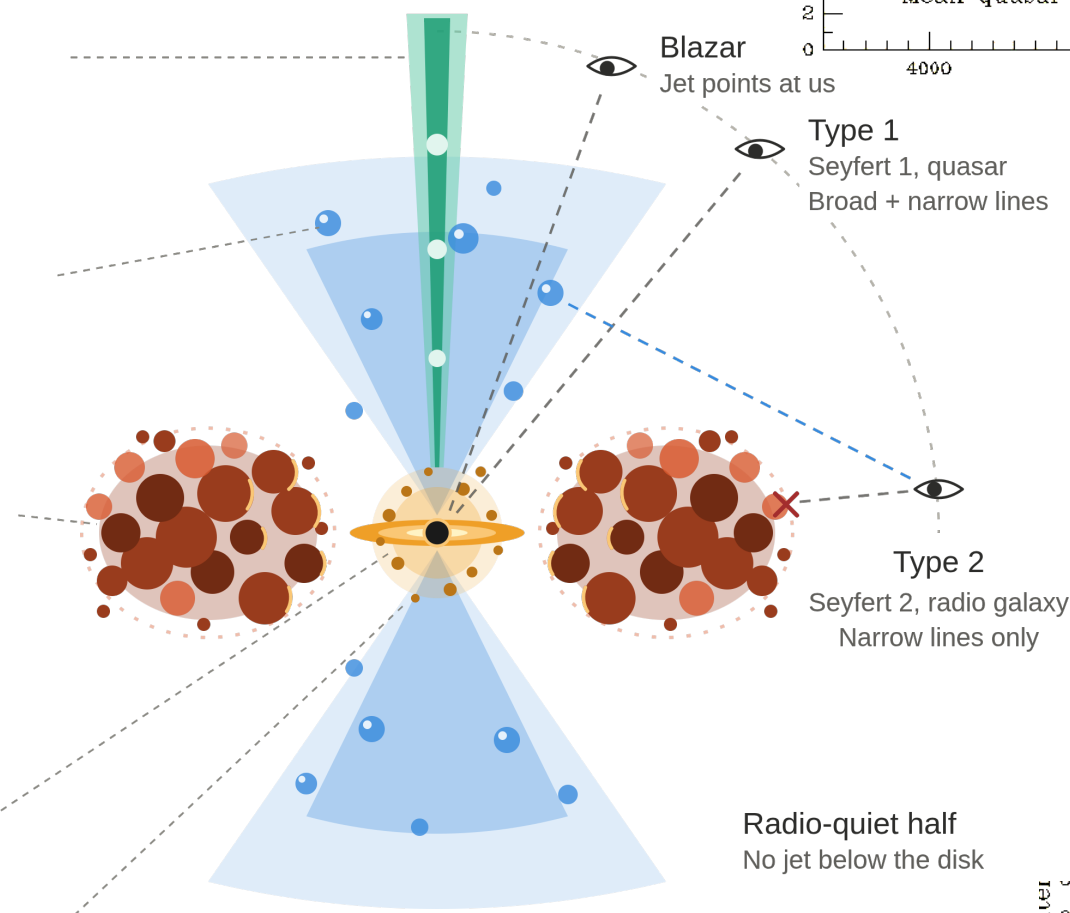
Narrow-line region
Distant, slow clouds

Dusty torus
Clumpy, blocks edge-on

Black hole + disk
Hot accretion disk

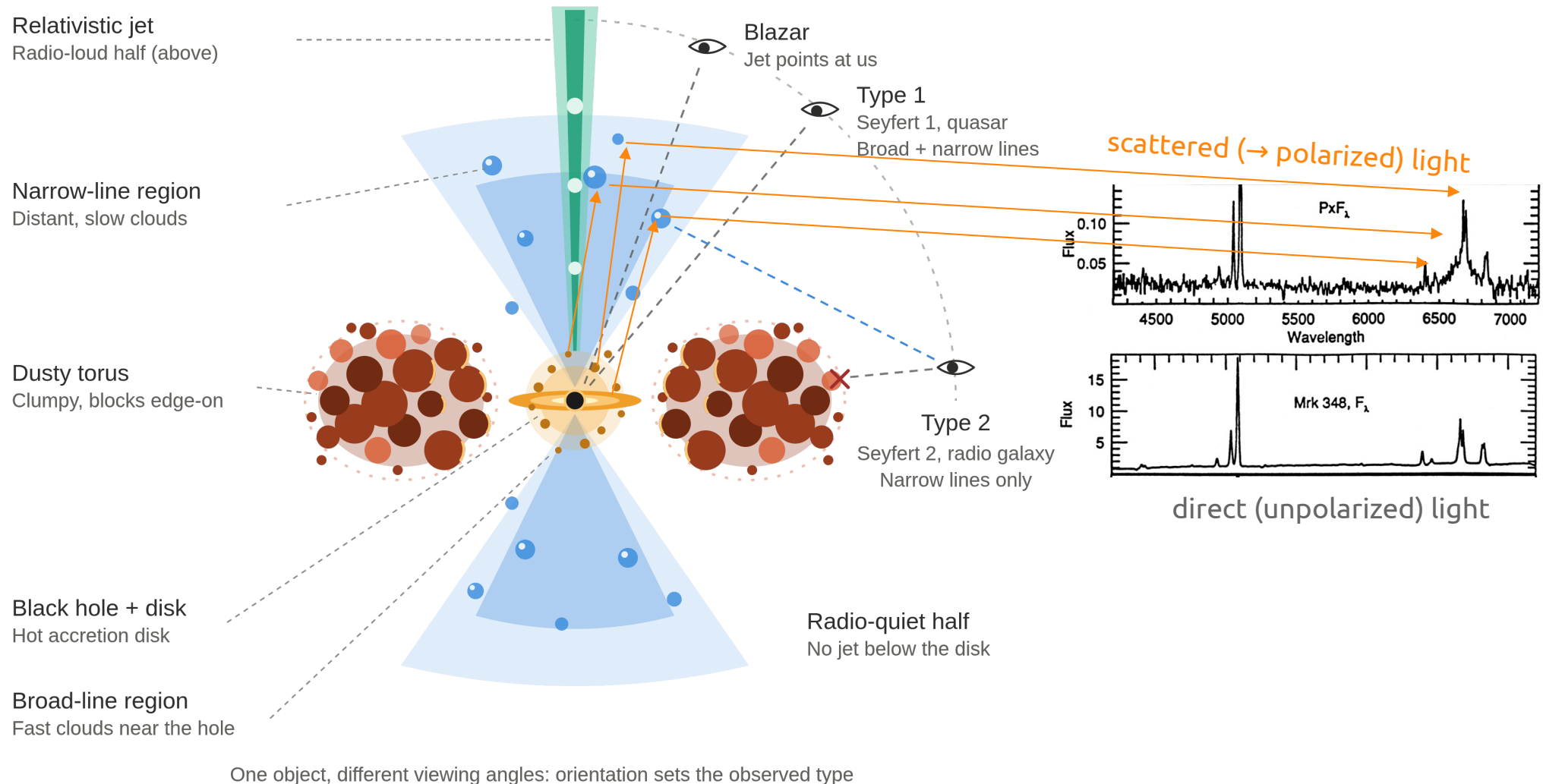
Broad-line region
Fast clouds near the hole

One object, different viewing angles: orientation sets the observed type



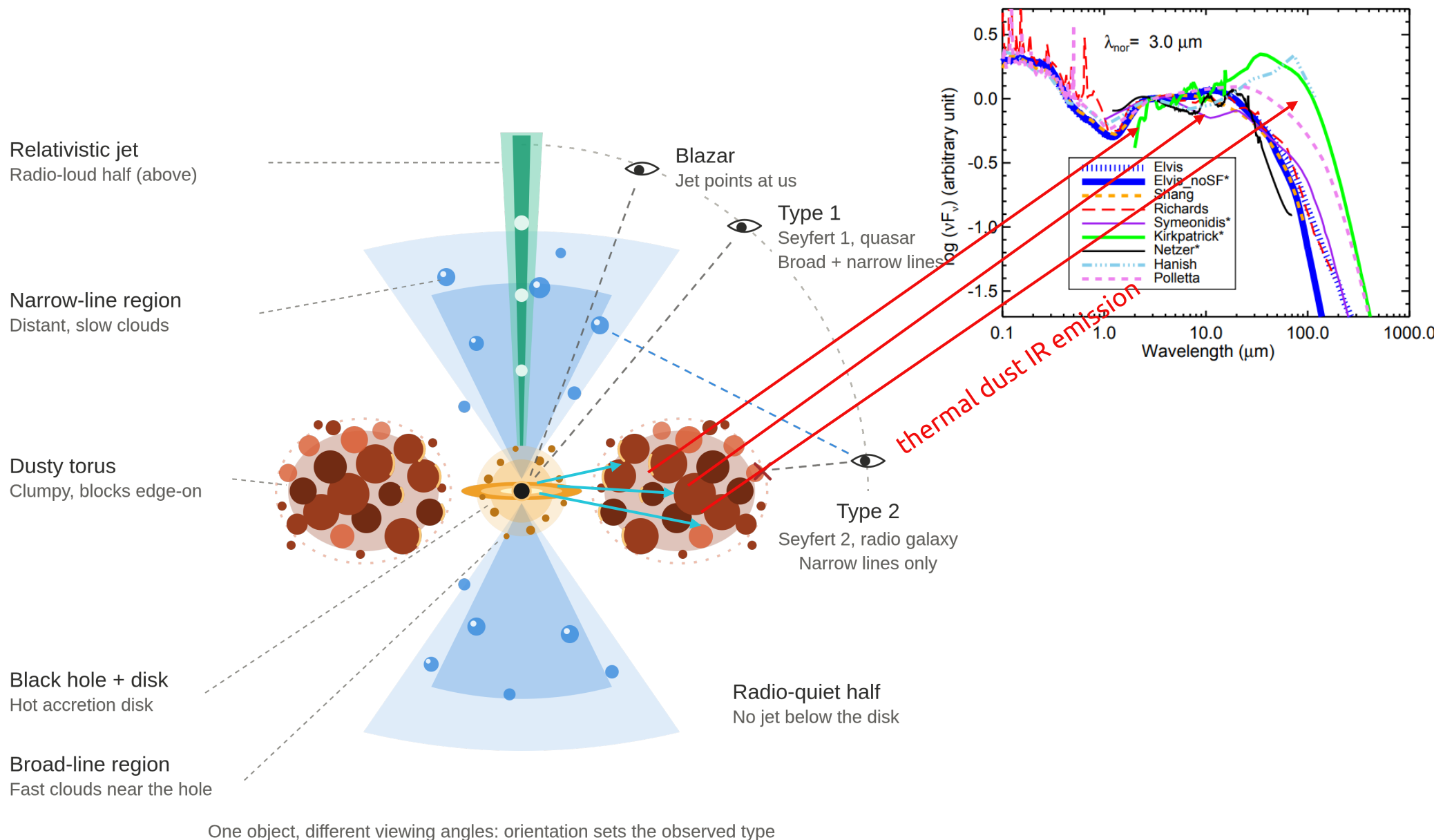
(+ evolution, environment, accretion rate, dust covering factor...)

AGN unification-by-orientation



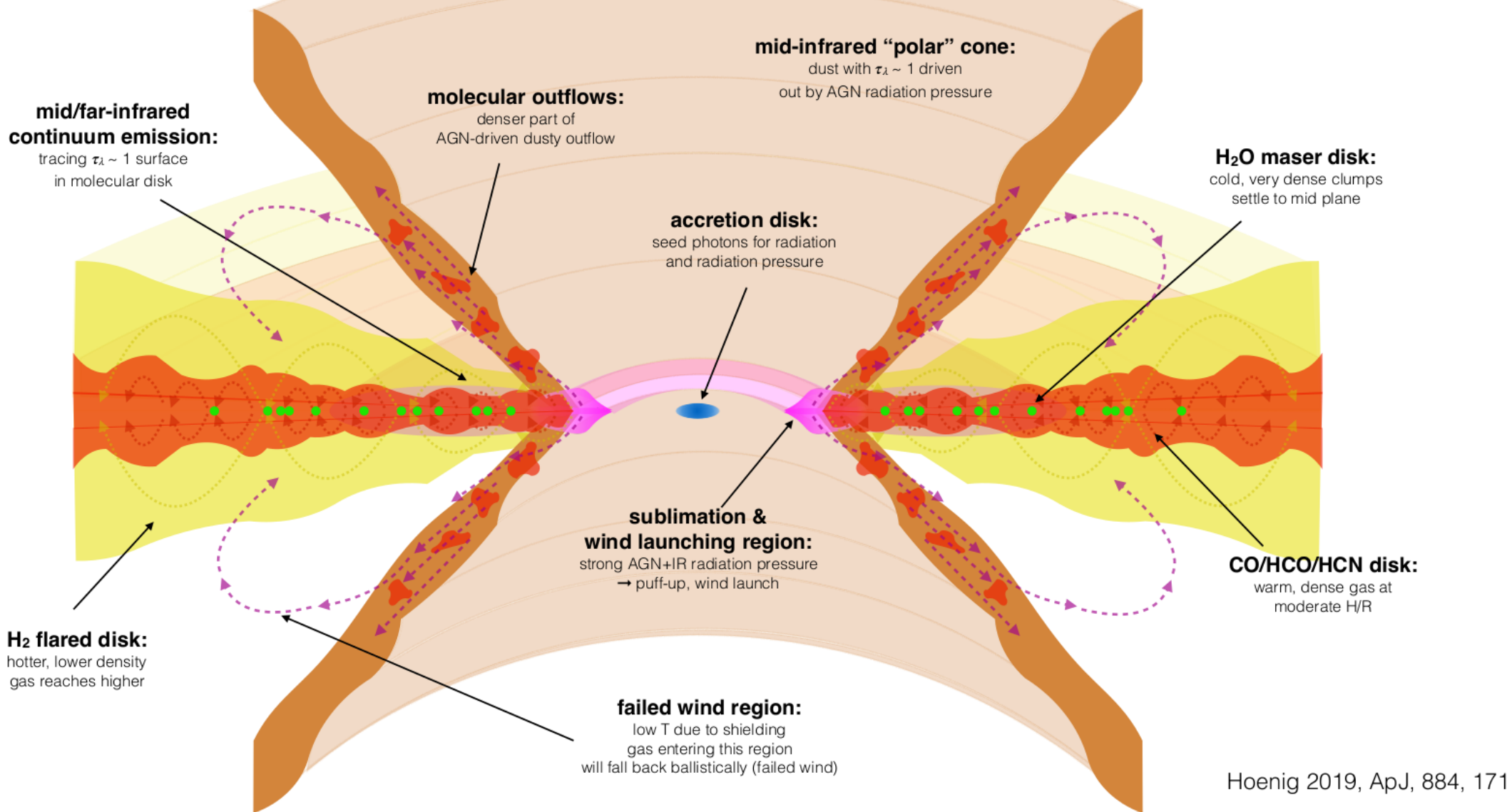
(+ evolution, environment, accretion rate, dust covering factor...)

AGN unification-by-orientation



(+ evolution, environment, accretion rate, dust covering factor...)

Multiphase torus: the full picture



PART 2: Blue Hot DOGs

Hot DOGs



Hot Dust Obscured Galaxies (Hot DOGs):

Hyperluminous ($L_{\text{bol}} > 10^{13} L_{\text{sol}}$; 10% $> 10^{14} L_{\text{sol}}$)

Selected by extremely red WISE colors

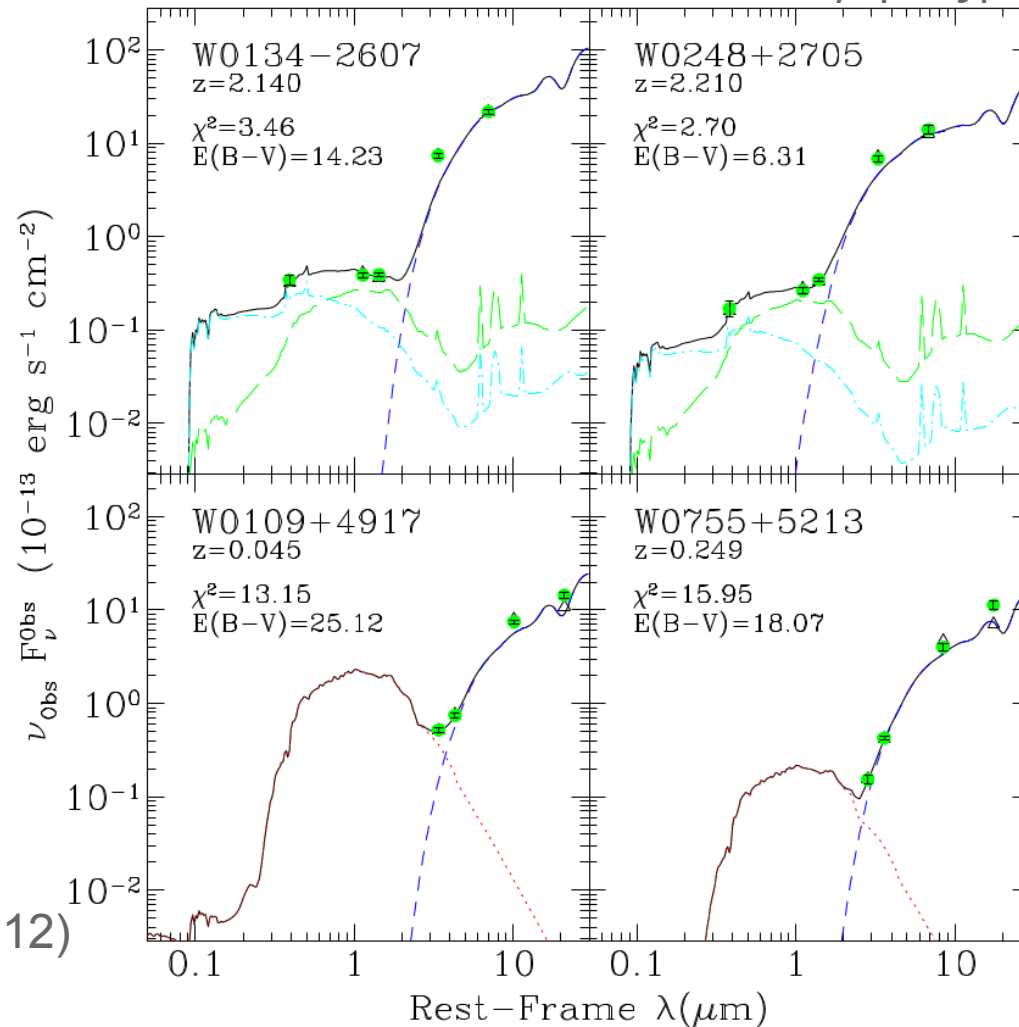
heavily obscured (around or Compton thick)

IR: highly obscured AGN

QSOs

UV/opt: typical galaxy

redshift $\sim 2 - 4$



Eisenhardt et al. (2012)

Wu et al. (2012)

Tsai et al. (2015)

Assef et al. (2015)

Blue Hot DOGs



Hot Dust Obscured Galaxies (Hot DOGs):

Hyperluminous ($L_{\text{bol}} > 10^{13} L_{\text{sol}}$; 10% $> 10^{14} L_{\text{sol}}$)

Selected by extremely red WISE colors

heavily obscured (around or Compton thick)

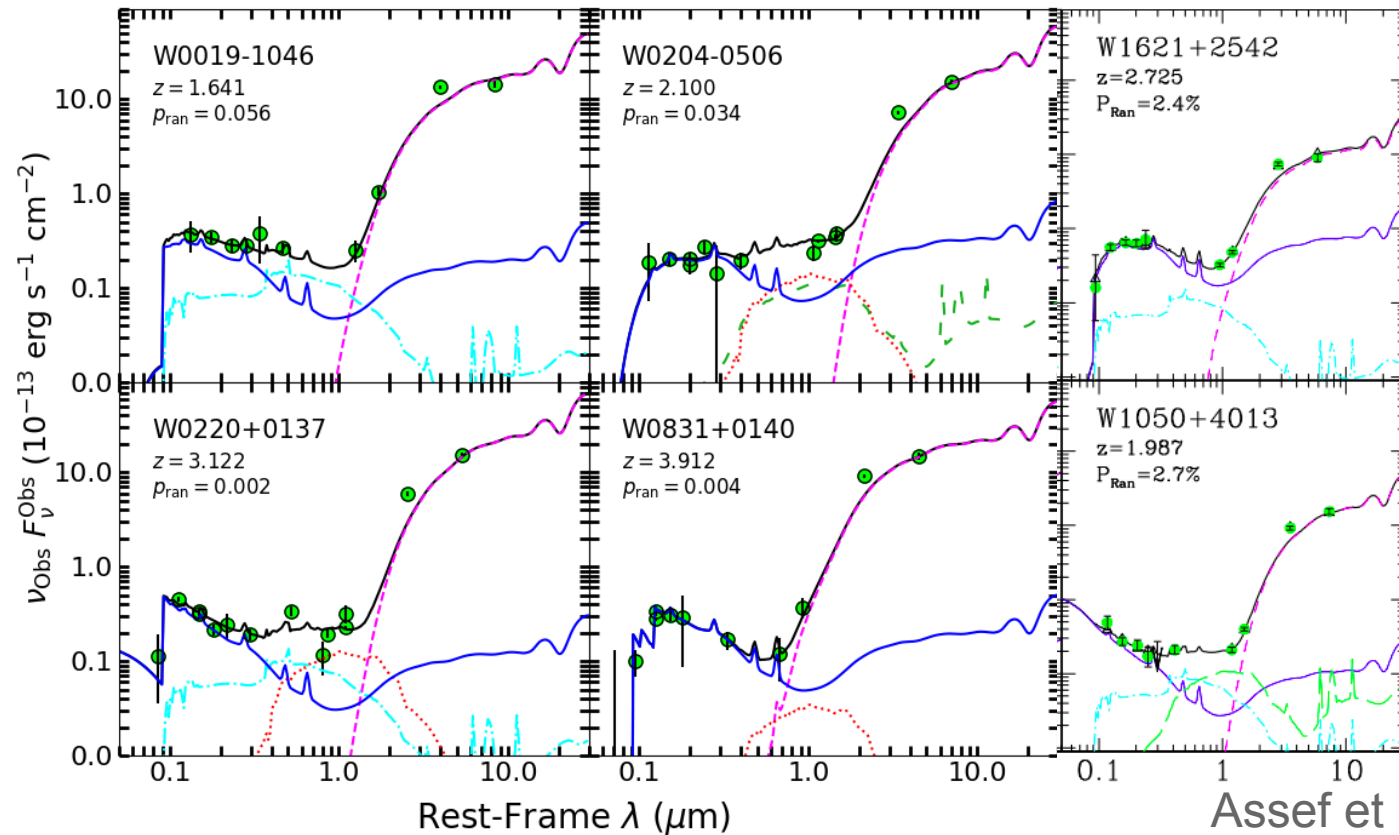
IR: highly obscured AGN

QSOs

UV/opt: typical galaxy

Blue excess Hot DOGs:

$\approx 25\%$ of Hot DOGs: blue unobscured AGN continuum



Assef et al. (2016, 2020, 2022)

Blue Hot DOGs



Hot Dust Obscured Galaxies (Hot DOGs):

Hyperluminous ($L_{\text{bol}} > 10^{13} L_{\text{sol}}$; 10% $> 10^{14} L_{\text{sol}}$)

heavily obscured (around or Compton thick)

QSOs

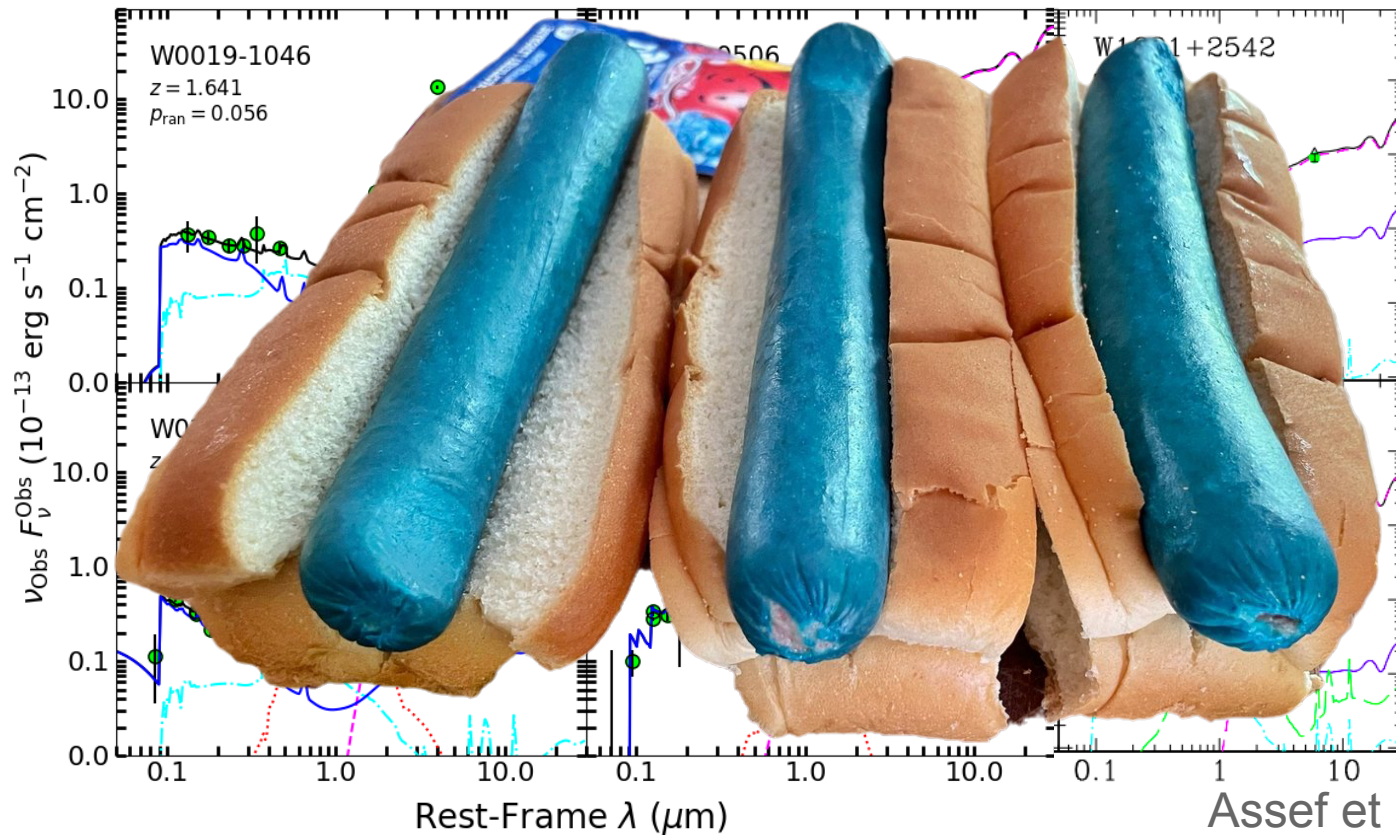
Selected by extremely red WISE colors

IR: highly obscured AGN

UV/opt: typical galaxy

Blue excess Hot DOGs:

$\approx 25\%$ of Hot DOGs: blue unobscured AGN continuum



Assef et al. (2016, 2020, 2022)

Origin of the blue excess?

Second AGN?

Excluded

(Inconsistent with X-rays – lacking soft)

(Inconsistent with morphology – centrally concentrated, undisturbed)

Starformation?

Plausible, but less likely

(worse fits or extreme SFR)

(broad NV, CIV and the OVI+Lybeta)

AGN leaking?

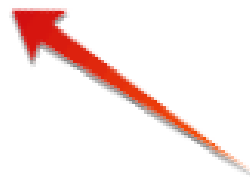
Unlikely

(geometry + SED shape)

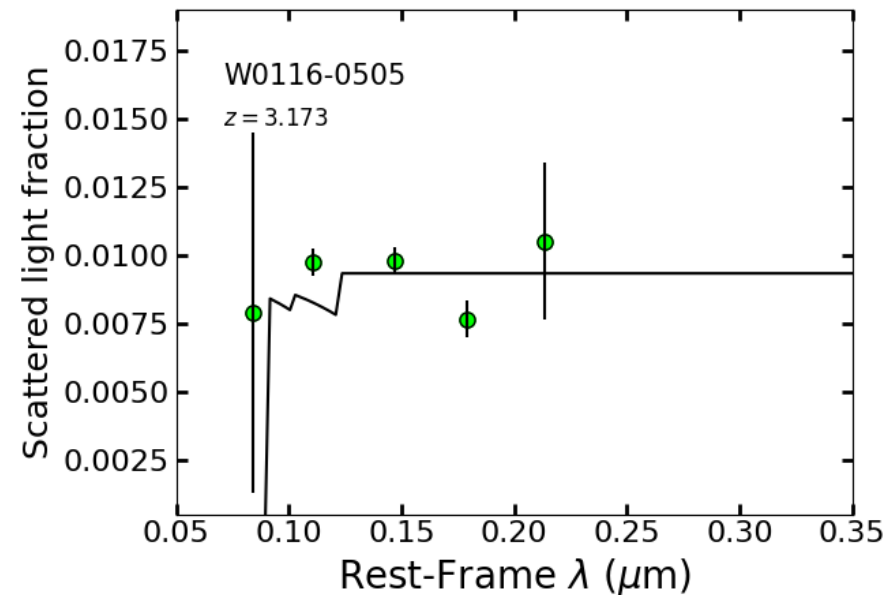
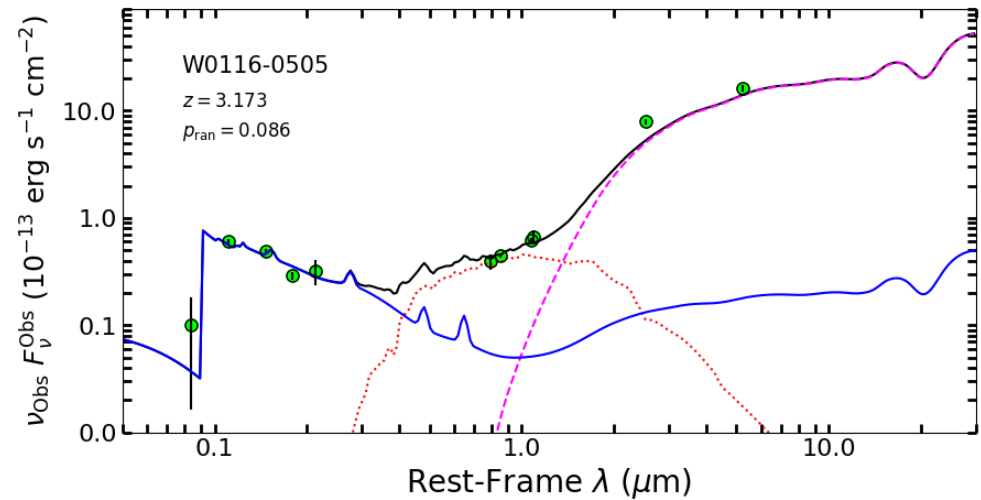
AGN scattered light?

Consistent

(1% scattered light)



Test with polarimetry!

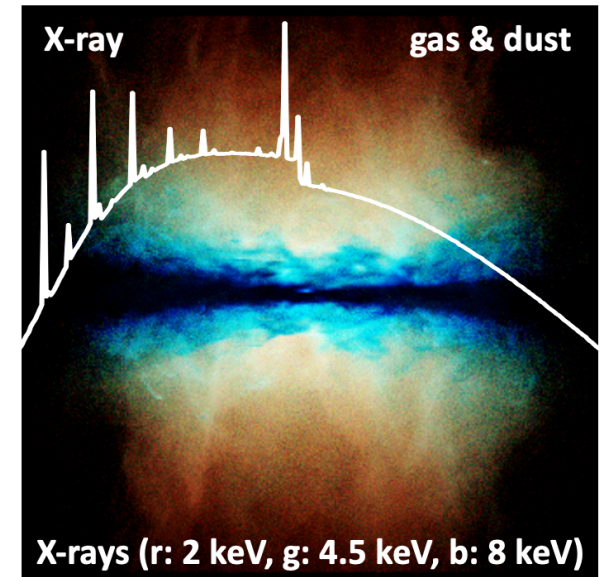
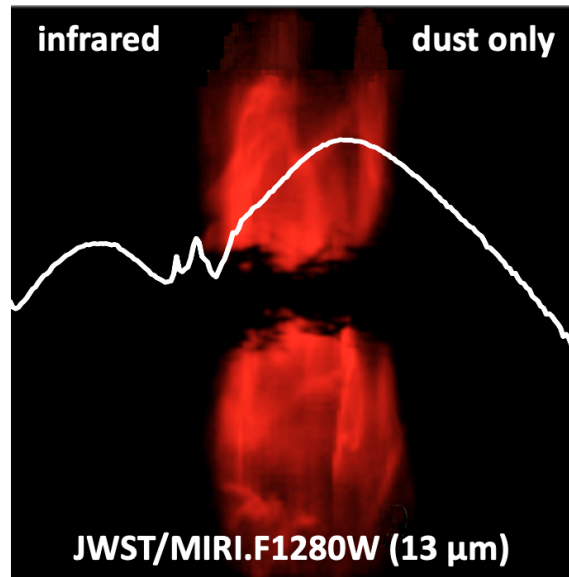
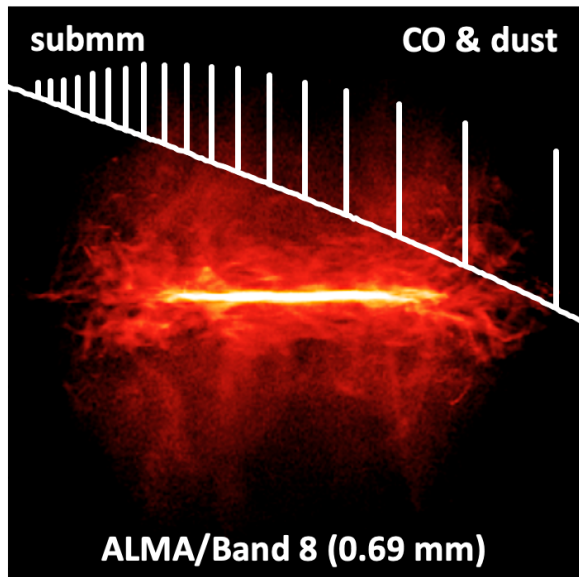
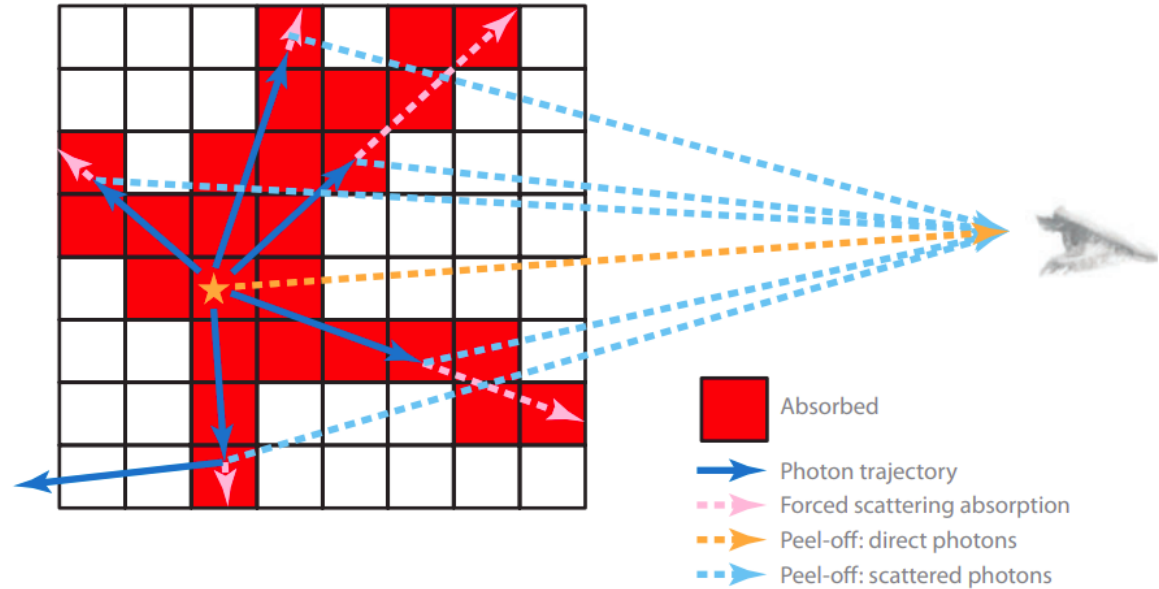


Assef et al. (2016, 2020, 2022)

Digression: Monte Carlo Radiative Transfer (MCRT)

MCRT with
SKIRT
<http://www.skirt.ugent.be>

Baes et al. (2011)
Baes & Camps (2015)
Camps & Baes (2015)

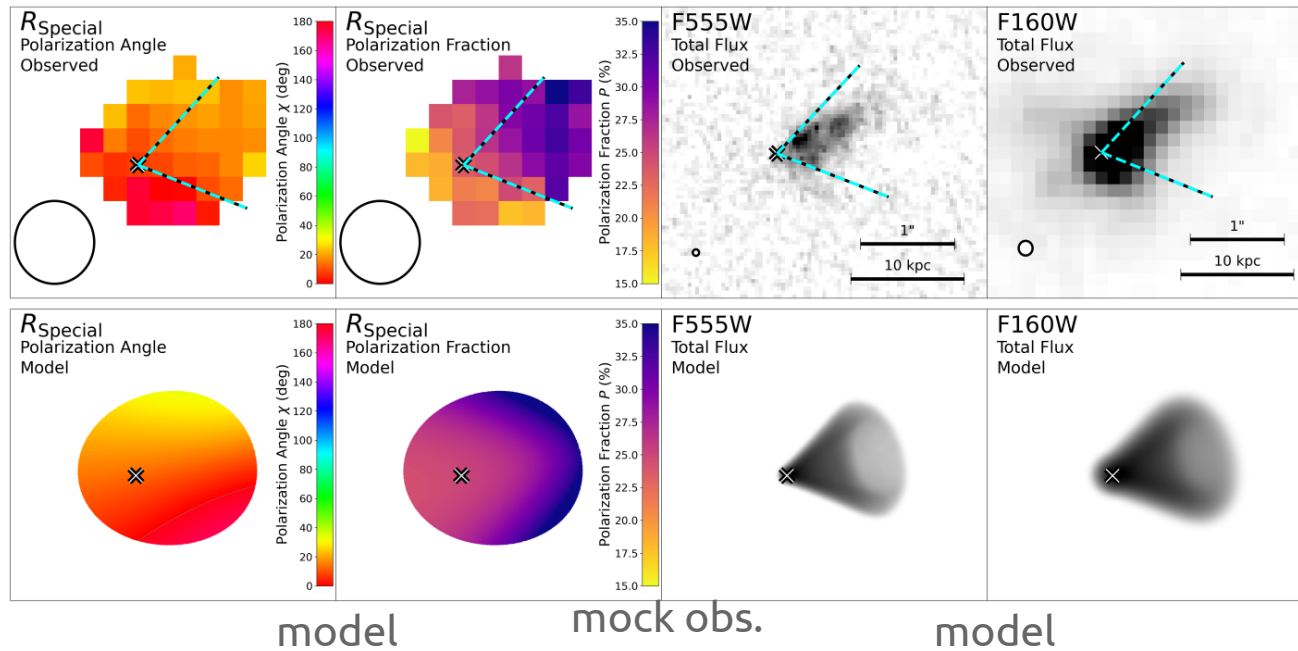


Matsumoto et al. (2023), Vander Meulen et al. (2024)

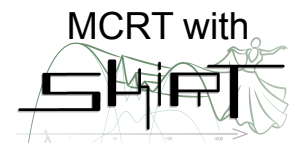
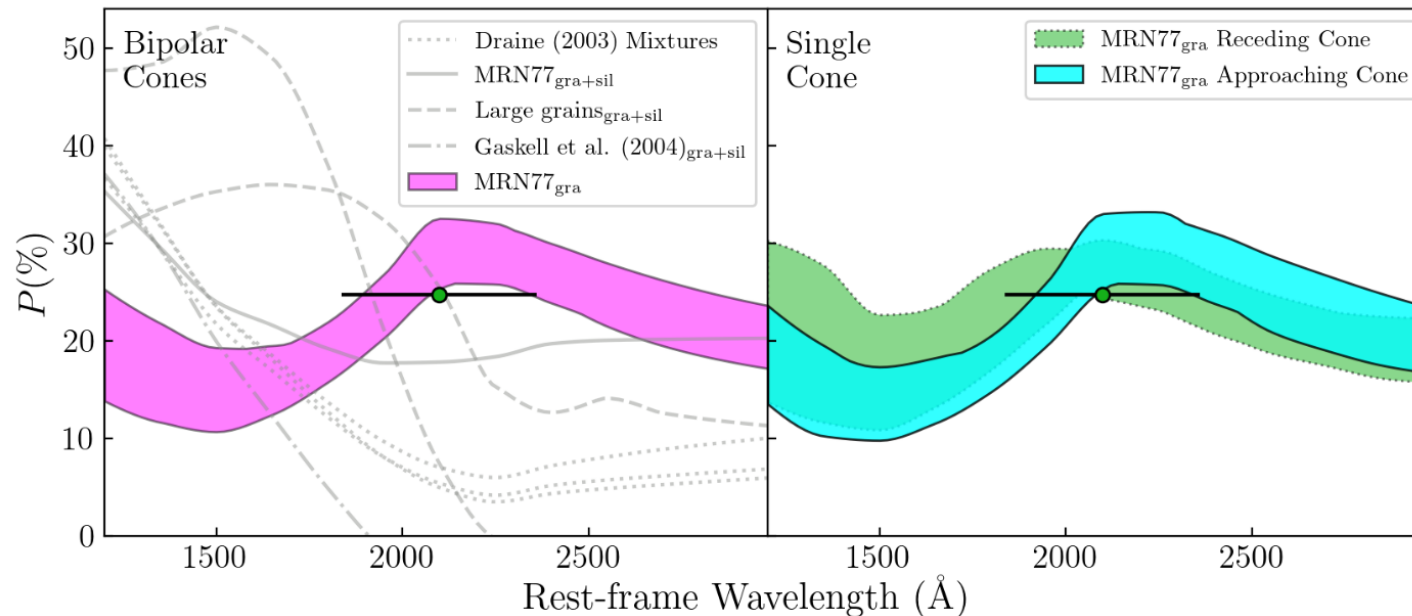
W0204-0506: MRN77 (graphite or large grain sil+gra)

VLT/FORS2

HST

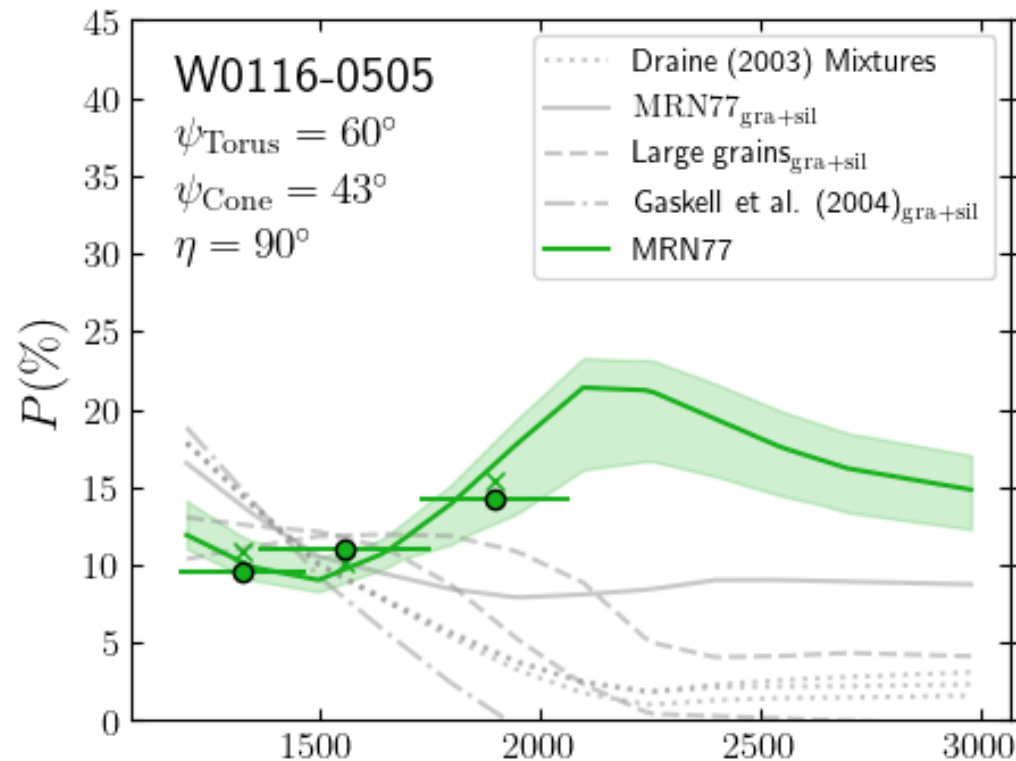
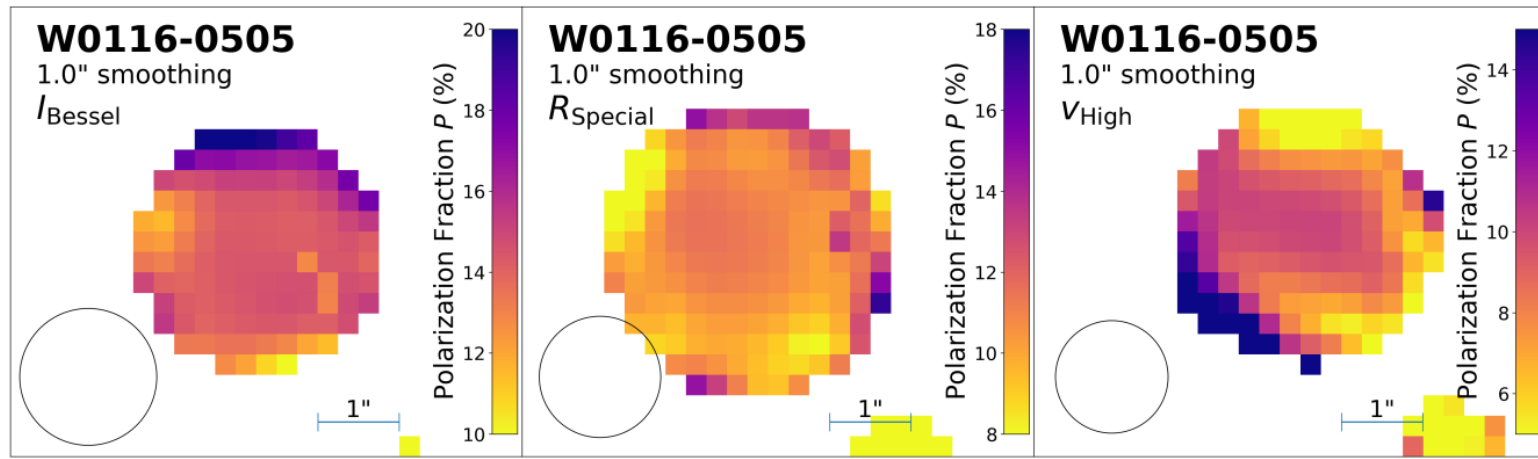


model sketch

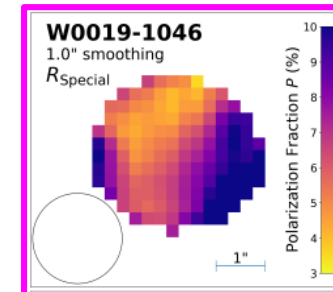
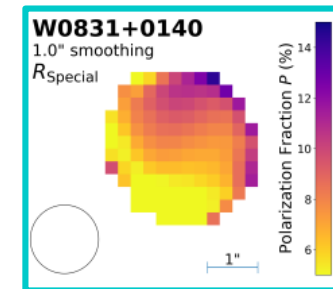
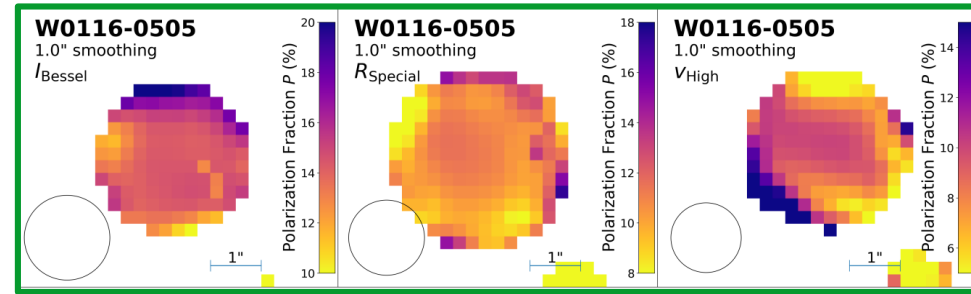
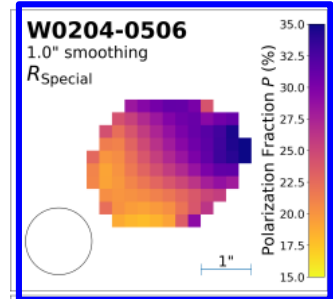
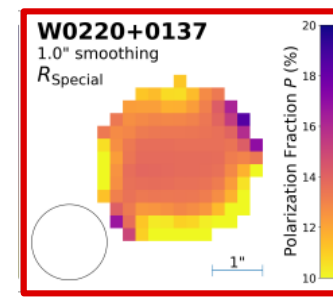
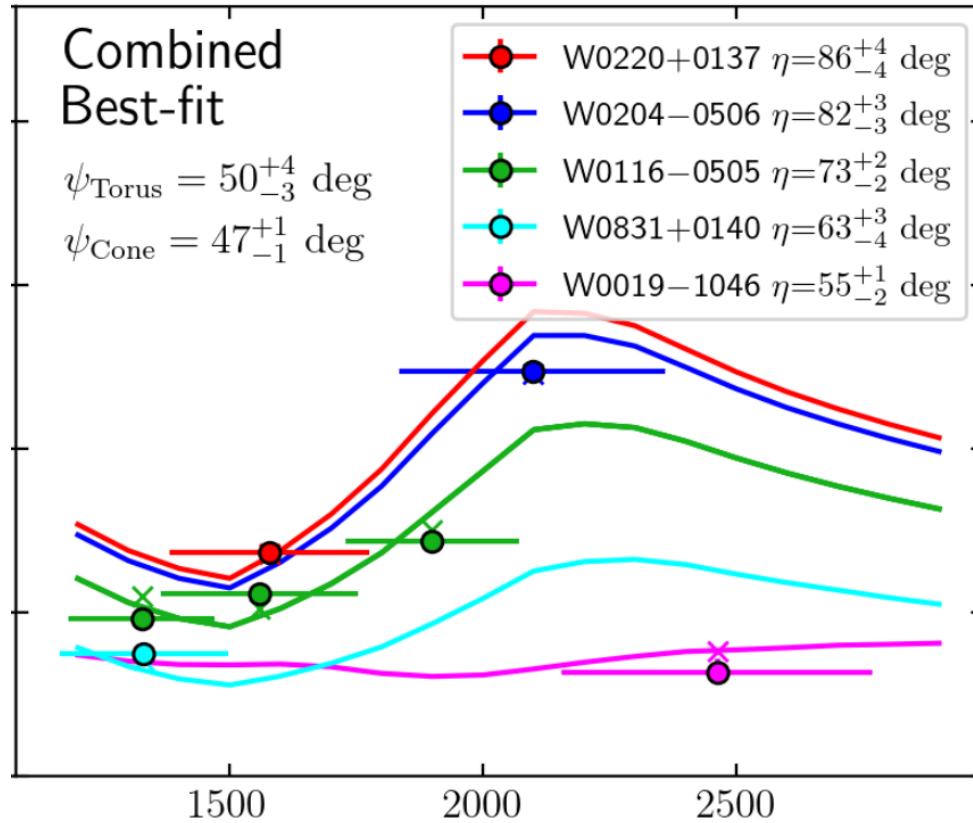


<http://www.skirt.ugent.be>

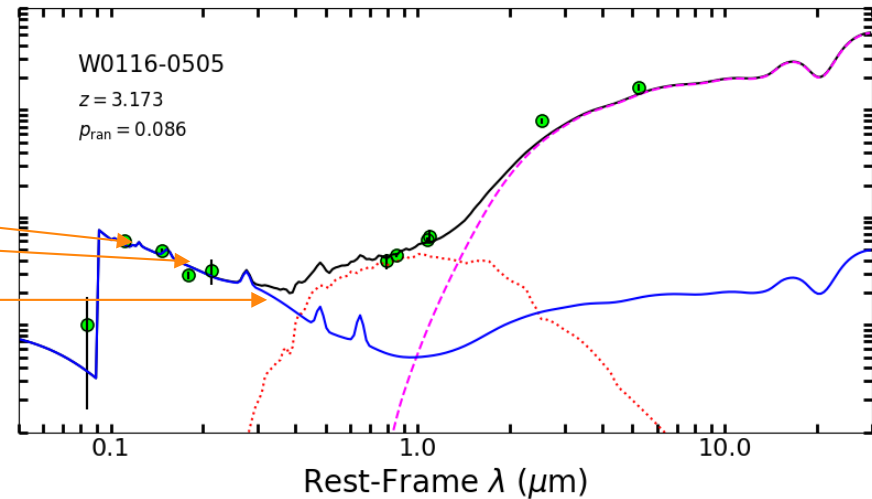
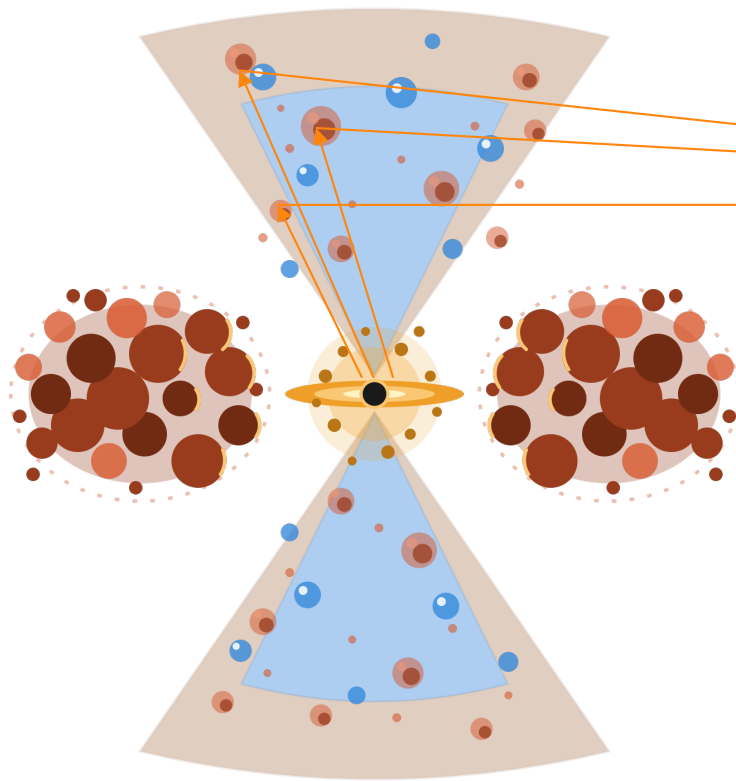
W0116-0505: MRN77 graphite



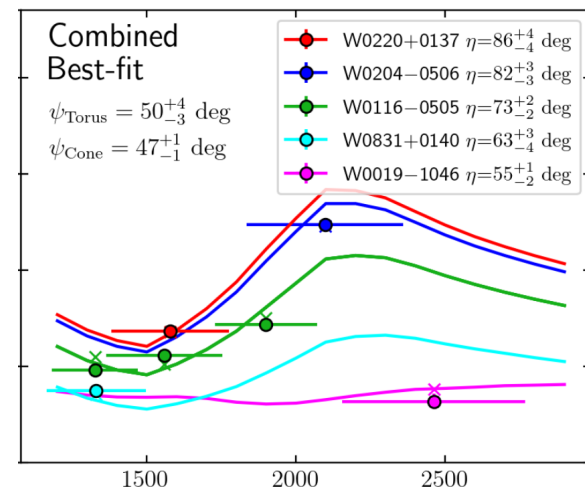
Blue Hot DOGs: universal structure?



Blue continuum is QSO scattered light!



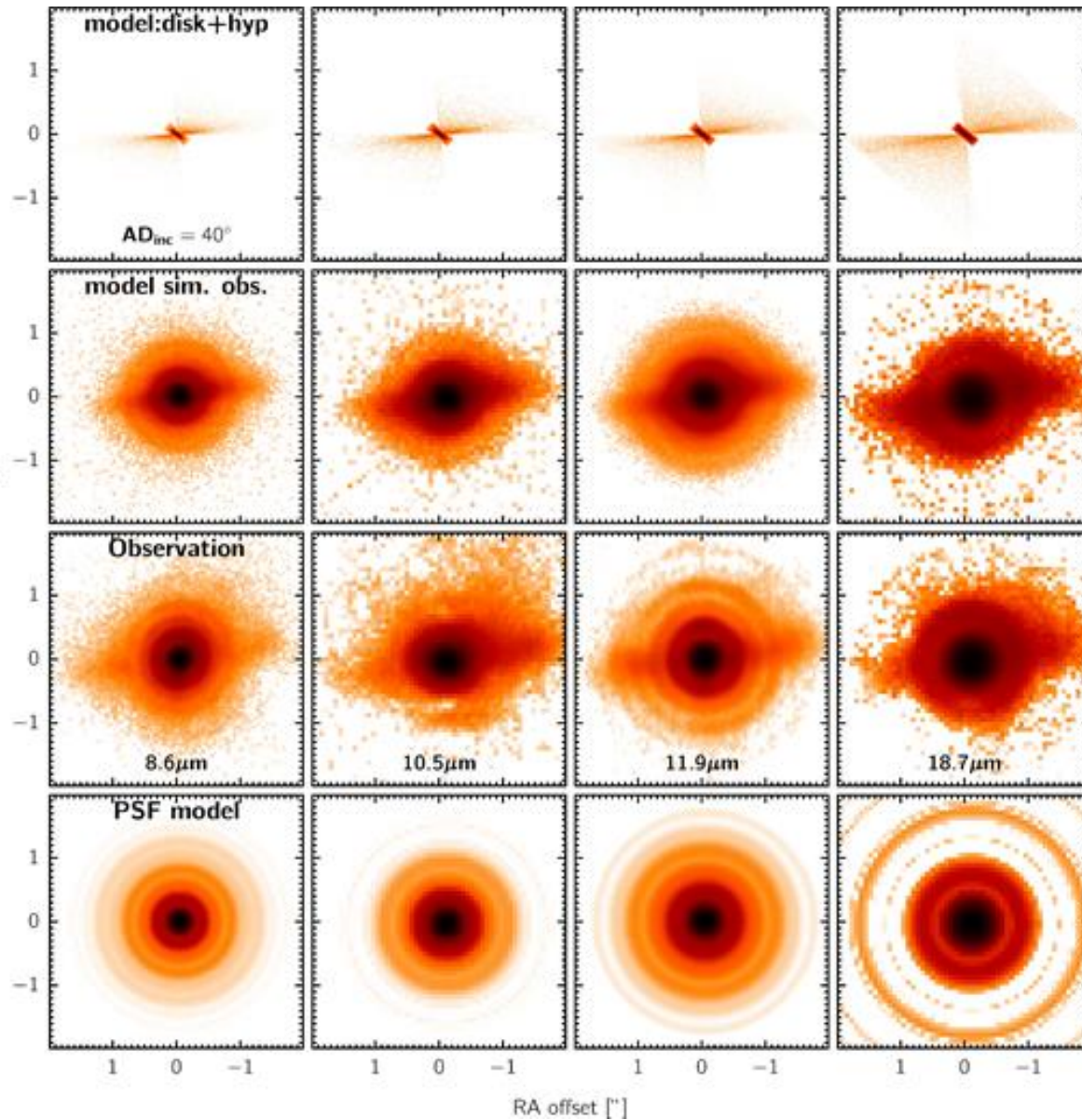
scattered light $\rightarrow$ highly polarized light



PART 3: Circinus AGN

Circinus: nearest, low L Seyfert 2

VLT/VISIR



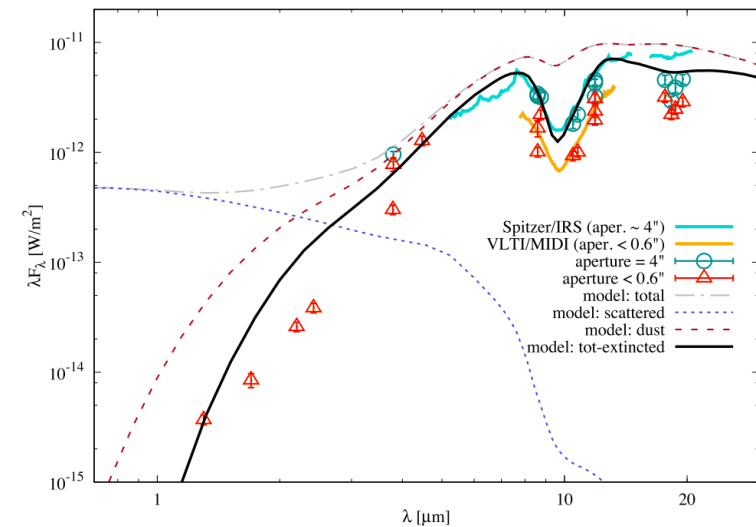
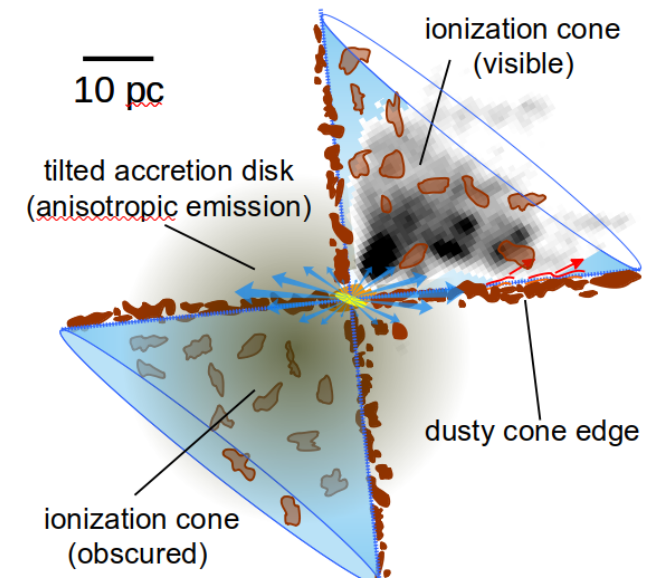
Stalevski et al. (2017)

Model RT
image

Synthetic obs.
of the model

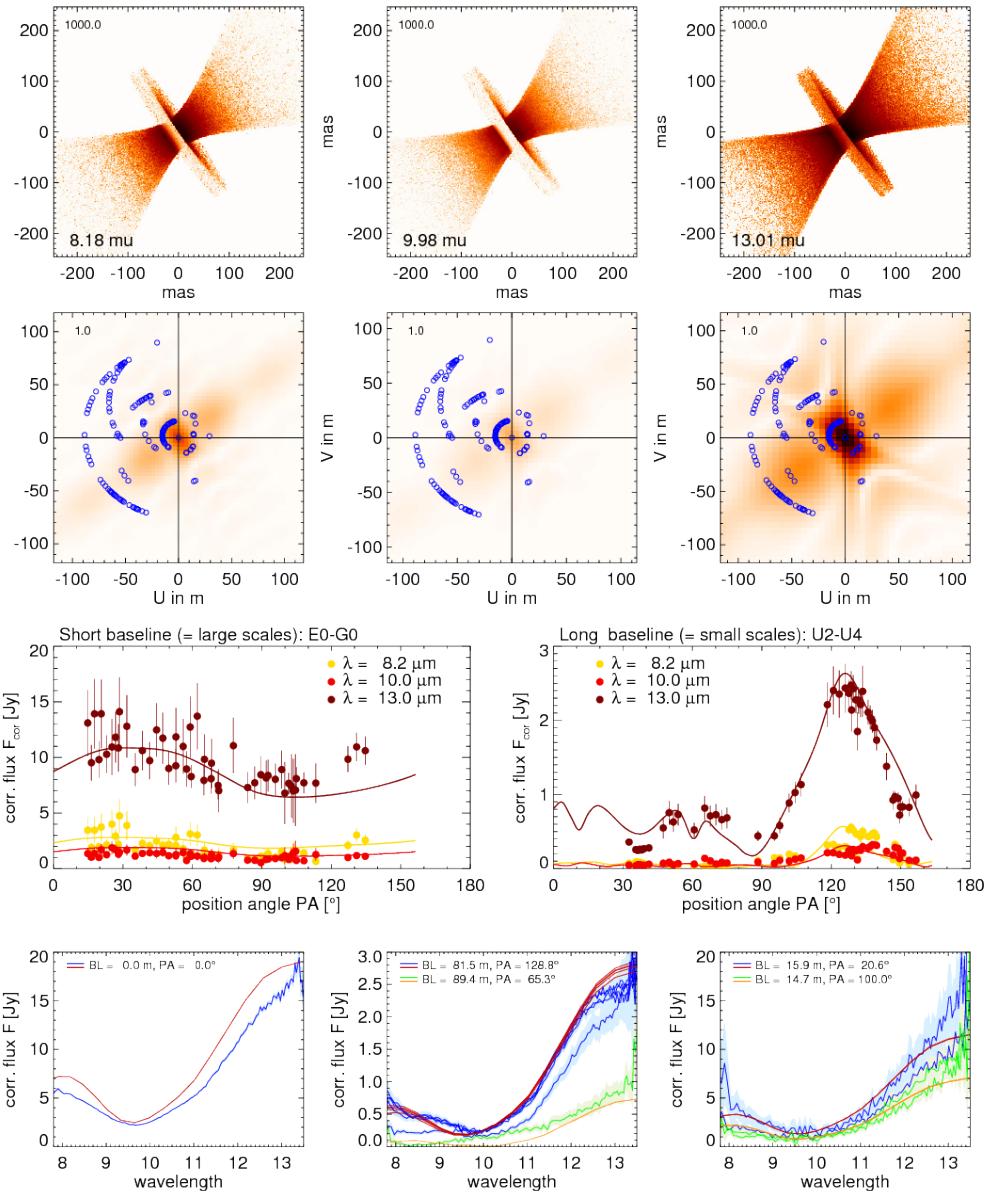
Observed
images

PSF



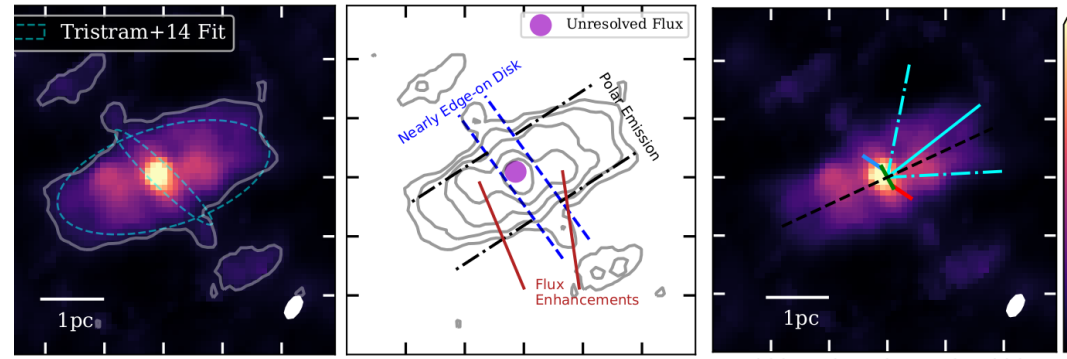
Circinus: nearest, low L Seyfert 2

VLTI/MIDI

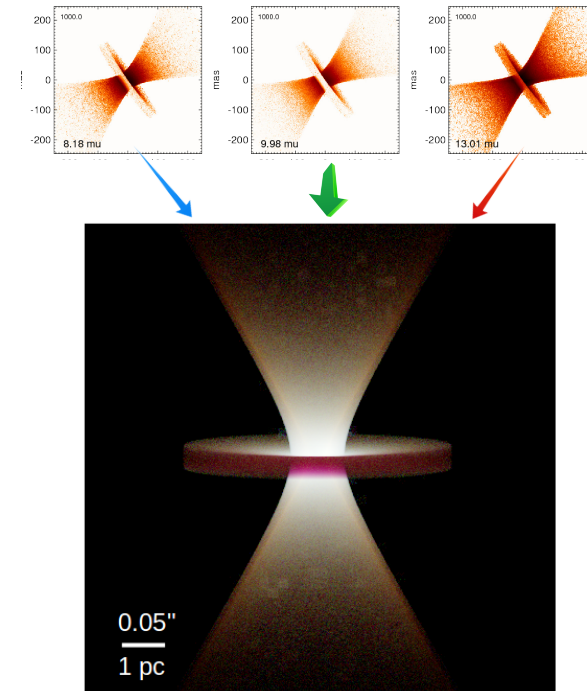


Stalevski et al. (2019)

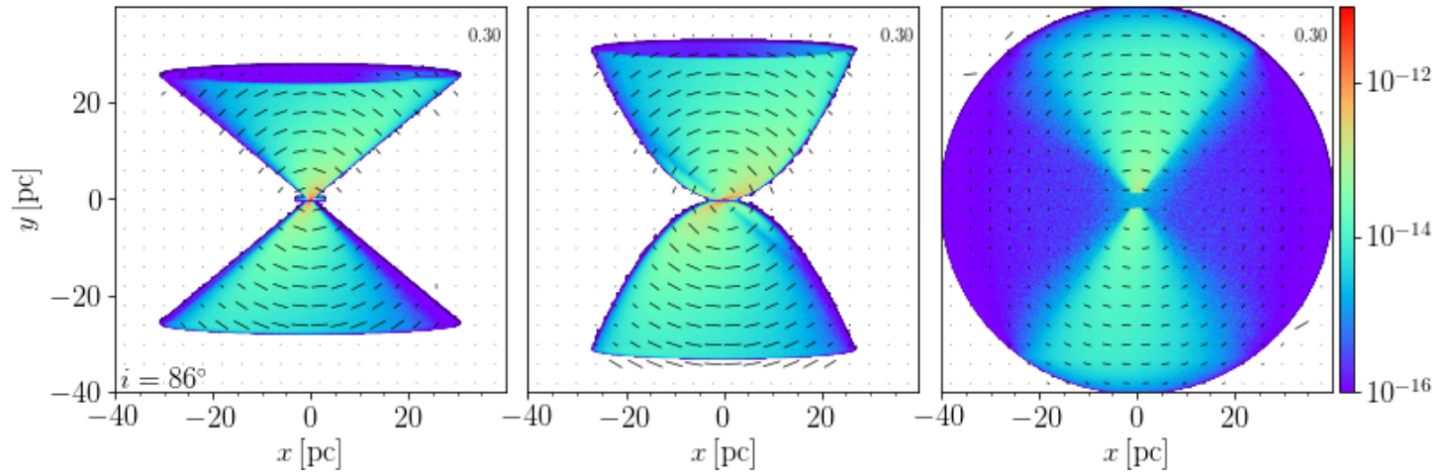
VLTI/MATISSE



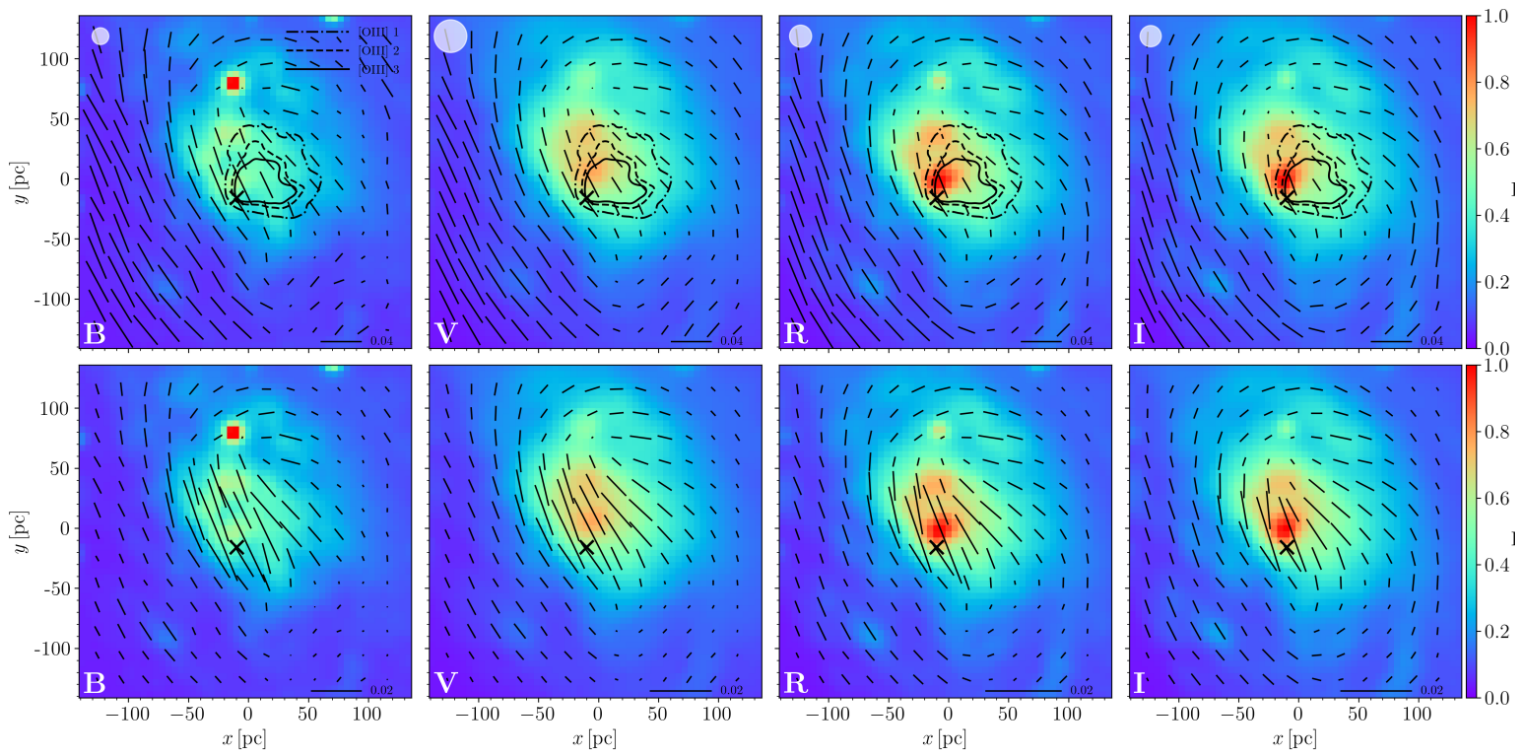
Isbell et al. (2022, 2023) (w/ MS)



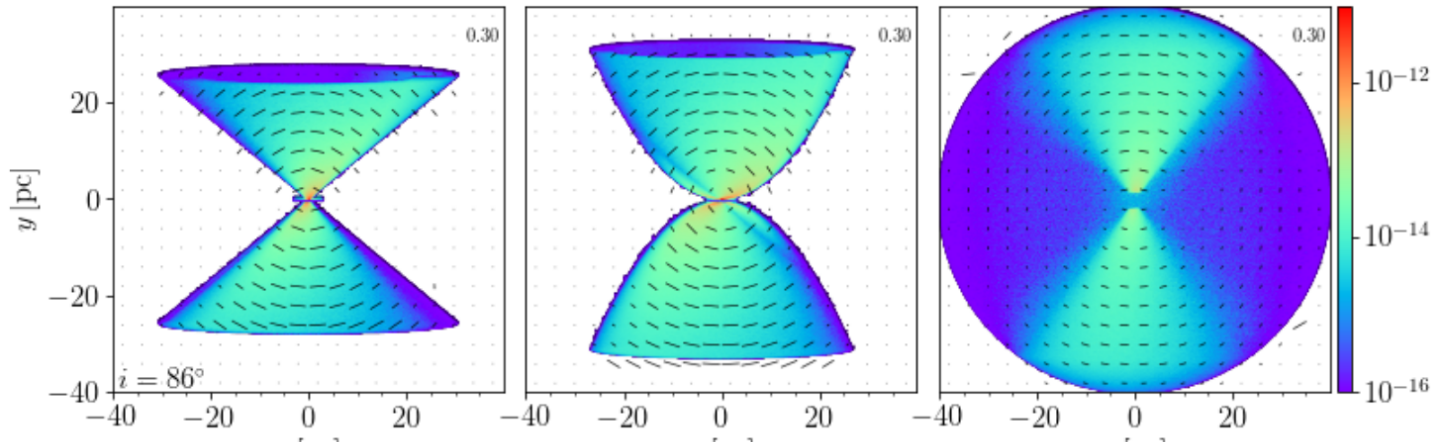
VLT/FORS2 confirms disk+hyp w/ tilted AD



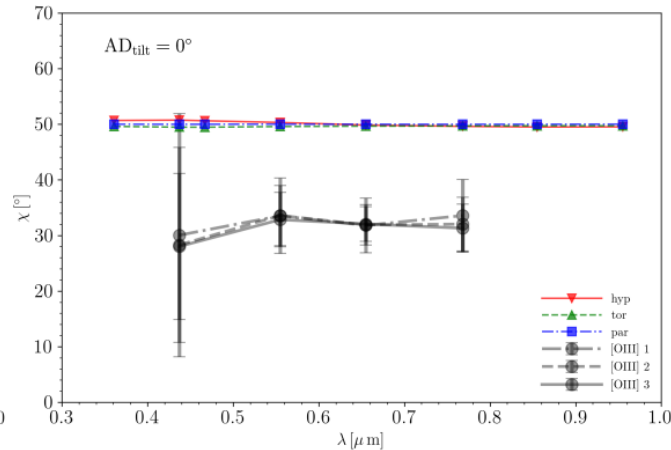
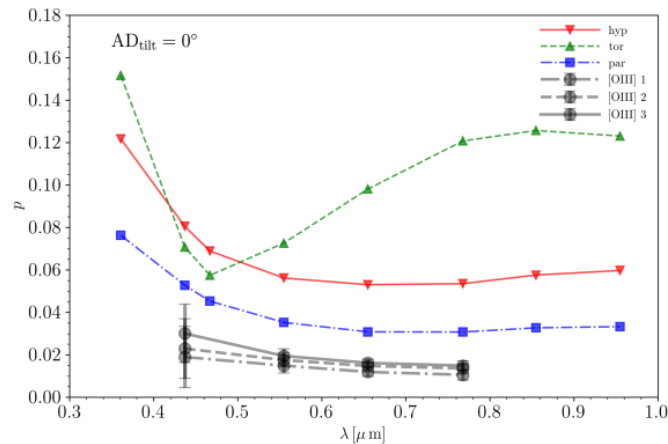
MCRT with
SHIFT
<http://www.skirt.ugent.be>



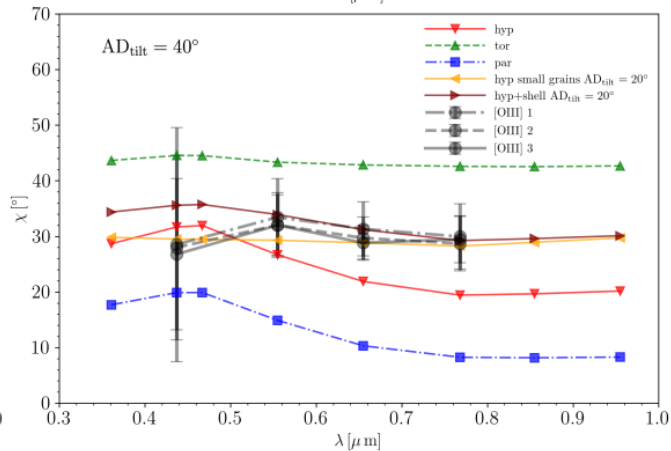
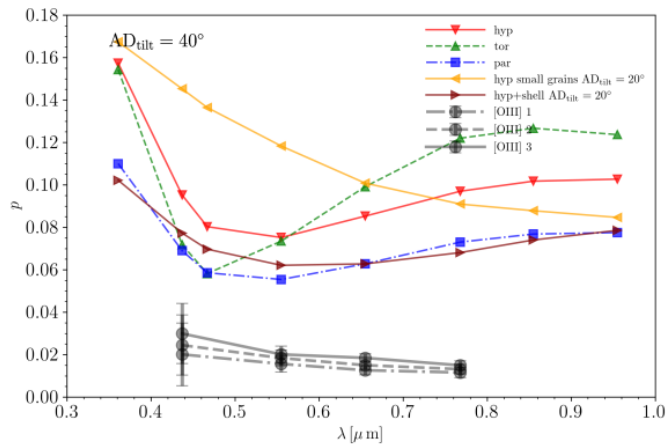
VLT/FORS2 confirms disk+hyp w/ tilted AD



<http://www.skirt.ugent.be>



Aligned accretion disk



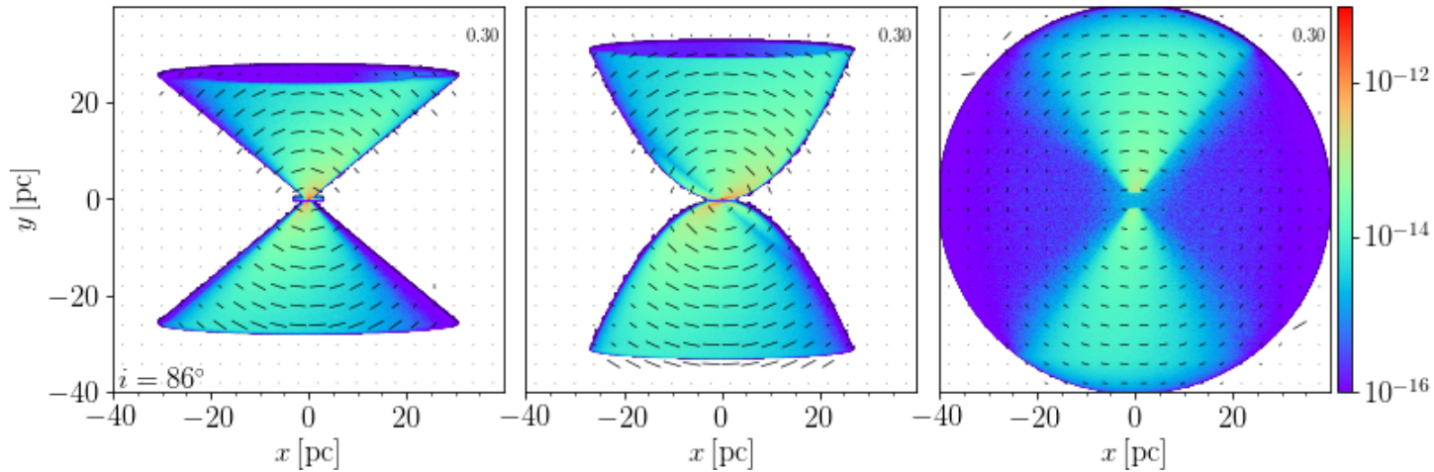
Tilted accretion disk

Pol. degree

Pol. Angle

Stalevski et al. (2023)

VLT/FORS2 confirms disk+hyp w/ tilted AD



MCRT with
SHIFT
<http://www.skirt.ugent.be>

Optical polarimetry confirms:

- dusty cone in the polar/NLR region
- illuminated by a tilted primary source
- MRN graphite grains

Circinus with 10500 km VLBI

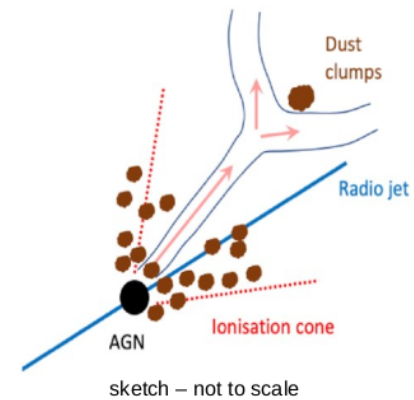
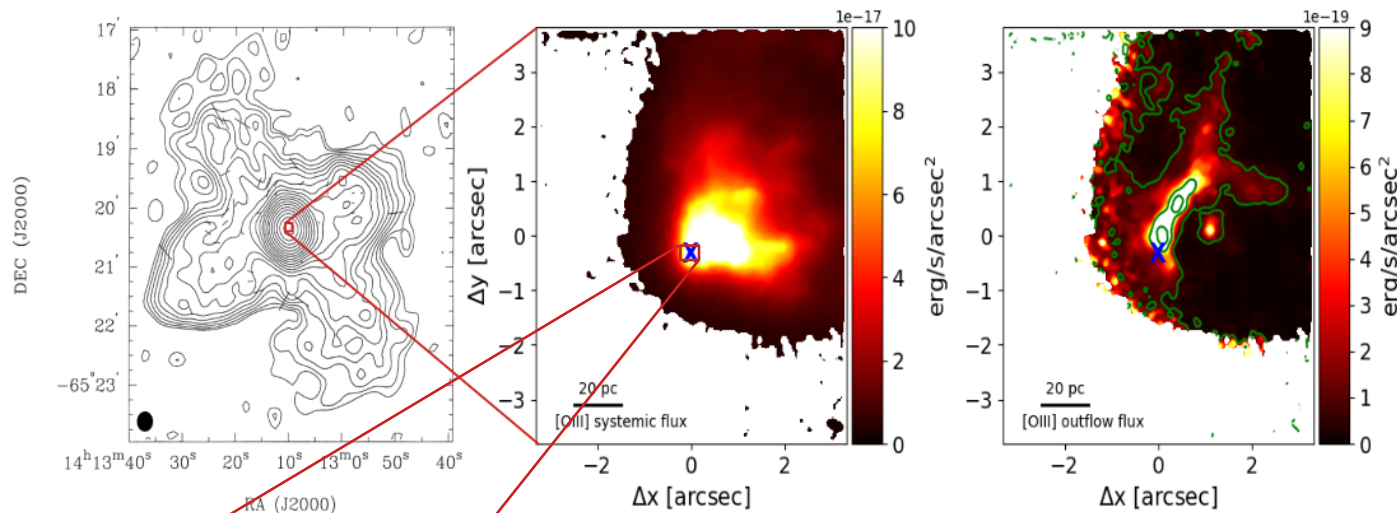
Australian Long Baseline Array

2.3 & 8.4 GHz / 13 & 3 cm

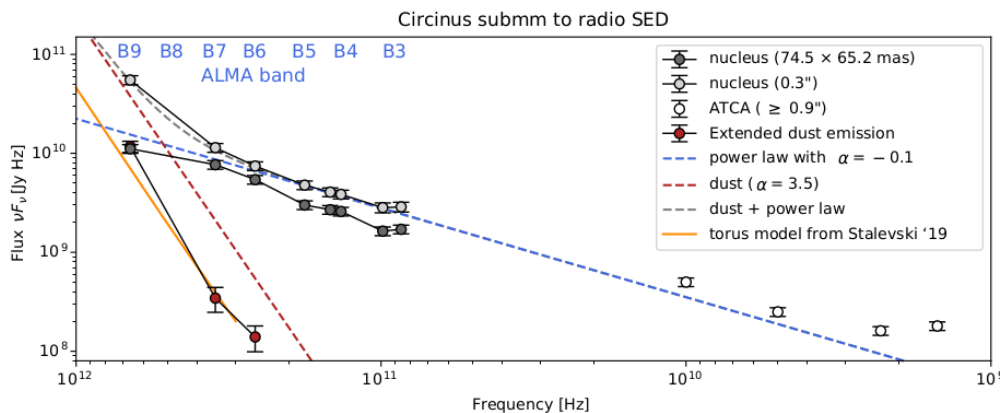
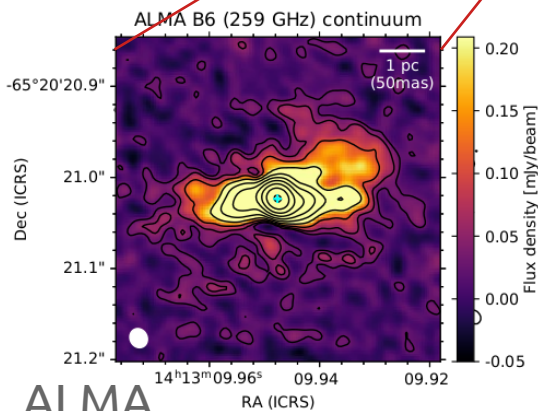
PI: MS



VLT/MUSE-NFM



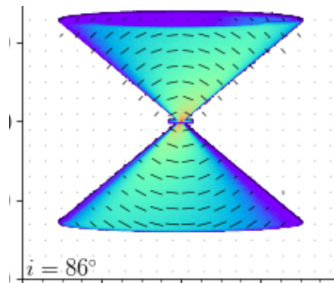
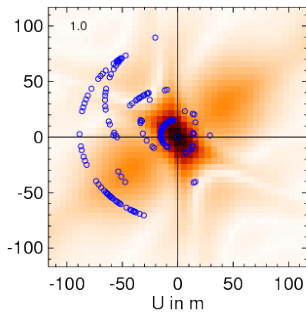
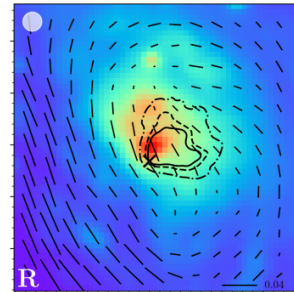
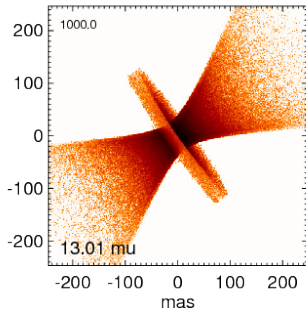
Kakkad, Stalevski+ (2023)



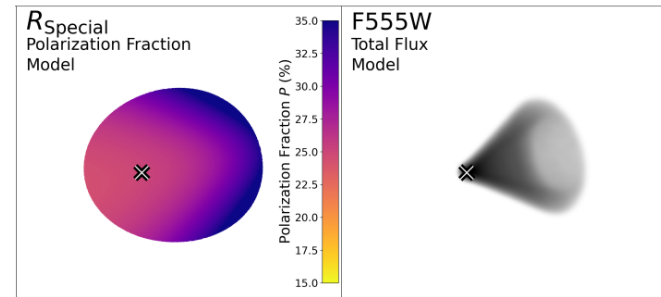
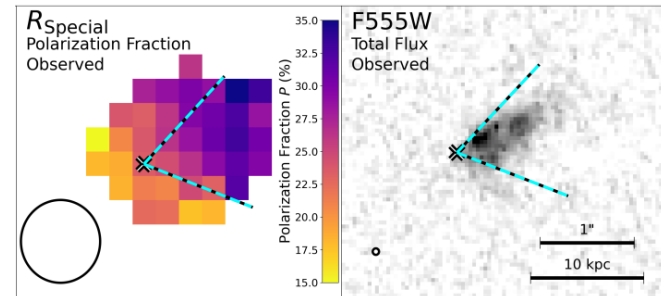
Goesaert+ (2025)

Take home points

1) Blue excess in Hot DOGs is scattered QSO emission



Nearest Sy2
Low luminous
 $z = 0.0015$

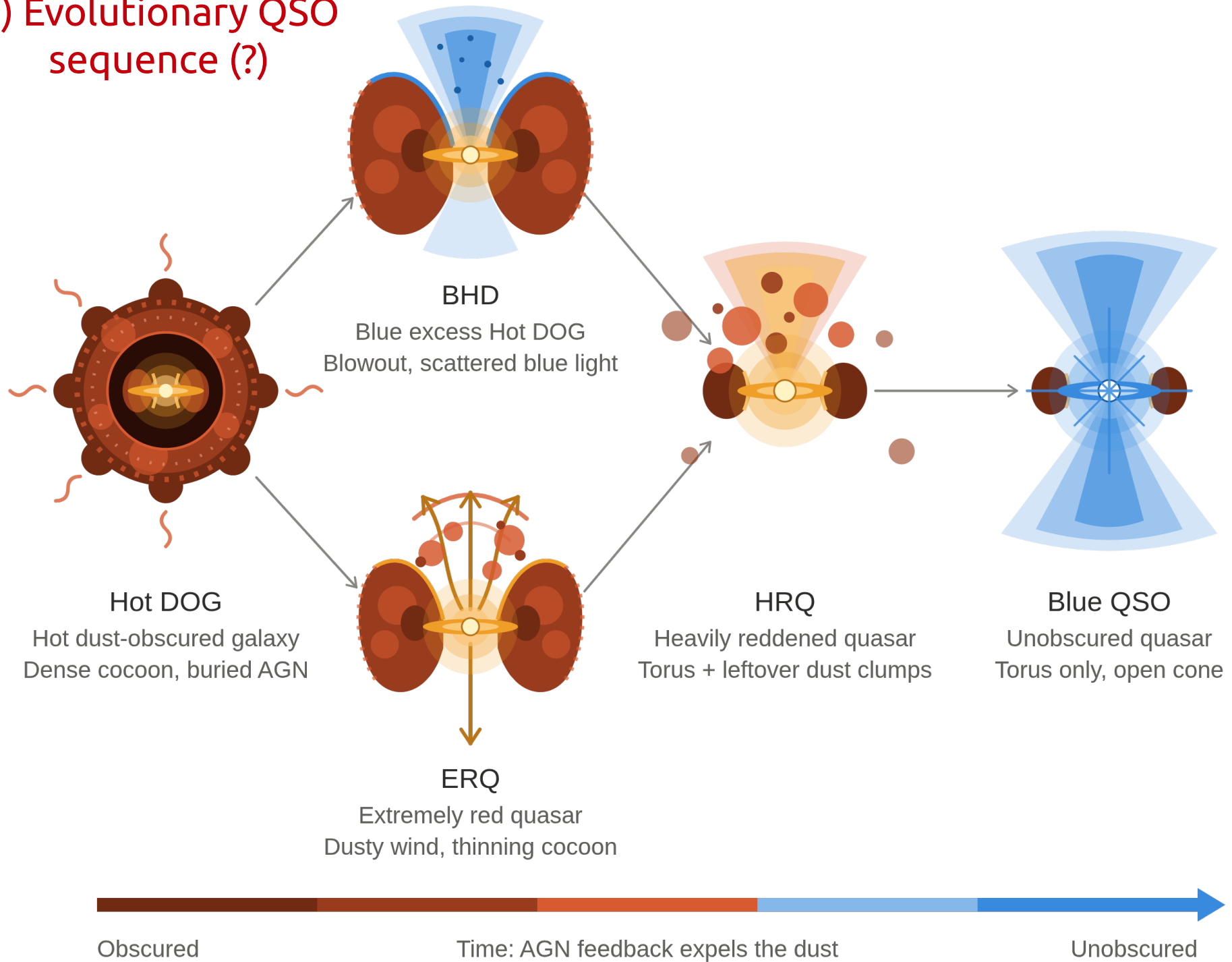


High redshift
hyper-luminous
 $z \sim 2 - 4$

2) Dusty outflows w/ MRN graphite grains

Take home points

3) Evolutionary QSO sequence (?)



Thank you for your attention

...and to all my collaborators below

A&A, 702, A124 (2025)
<https://doi.org/10.1051/0004-6361/202555245>
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**Astronomy
&
Astrophysics**

A massive gas outflow outside the line of sight: Imaging polarimetry of the blue excess Hot Dust-Obscured Galaxy W0204–0506

R. J. Assef^{1,★}, M. Stalevski^{2,3}, L. Armus⁴, F. E. Bauer⁵, A. Blain⁶, M. Brightman⁷, T. Díaz-Santos^{8,9},
P. R. M. Eisenhardt¹⁰, R. Fernández-Aranda^{8,11}, H. D. Jun¹², M. Liao¹, G. Li^{13,14,1}, L. R. Martin⁶,
E. Shablovinskaia¹, D. Shobhana¹, D. Stern¹⁰, C.-W. Tsai^{13,16,15}, A. Vayner⁴, D. J. Walton¹⁷,
J. Wu^{14,13}, and D. Zewdie¹⁸

Astronomy & Astrophysics manuscript no. ms
August 11, 2026

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Scattering from Dusty Outflows in Hot Dust-Obscured Galaxies with Blue Excess Emission

R. J. Assef¹, M. Stalevski^{2,3}, F. E. Bauer⁴, A. Blain⁵, T. Díaz-Santos^{6,7}, P. R. M. Eisenhardt⁸, R. Fernández-Aranda⁹,
H. D. Jun^{10,11}, M. Liao¹, E. Shablovinskaia¹², A. Sarath¹, M. Stepney¹³, D. Stern⁸, C.-W. Tsai^{14,15,16}, A. Vayner¹⁷,
D. J. Walton¹⁸, D. Wylezalek¹⁹, and D. Zewdie²⁰

Monthly Notices

of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS **472**, 3854–3870 (2017)
Advance Access publication 2017 August 30

doi:10.1093/mnras/stx2227

Dissecting the active galactic nucleus in Circinus – I. Peculiar mid-IR morphology explained by a dusty hollow cone

Marko Stalevski^{1,2,3★}, Daniel Asmus⁴ and Konrad R. W. Tristram⁴

Monthly Notices

of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS **484**, 3334–3355 (2019)
Advance Access publication 2019 January 23

doi:10.1093/mnras/stz220

Dissecting the active galactic nucleus in Circinus – II. A thin dusty disc and a polar outflow on parsec scales

Marko Stalevski^{1,2★}, Konrad R. W. Tristram³ and Daniel Asmus⁴

Monthly Notices

of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS **519**, 3237–3256 (2023)
Advance Access publication 2022 December 21

<https://doi.org/10.1093/mnras/stac3753>

Dissecting the active galactic nucleus in Circinus – III. VLT/FORS2 polarimetry confirms dusty cone illuminated by a tilted accretion disc

Marko Stalevski^{1,2★}, Santiago González-Gaitán³, Đorđe Savić^{3,4}, Makoto Kishimoto⁵,
Ana Mourão³, Enrique Lopez-Rodriguez⁶ and Daniel Asmus^{7,8}

Monthly Notices

of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS **519**, 5324–5332 (2023)
Advance Access publication 2023 January 5

<https://doi.org/10.1093/mnras/stac3827>

Dissecting the active galactic nucleus in Circinus – IV. MUSE-NFM observations unveil a tuning-fork ionized outflow morphology

D. Kakkad^{1★}, M. Stalevski^{2,3}, M. Kishimoto⁴, S. Knežević², D. Asmus^{5,6} and F. P. A. Vogt⁷