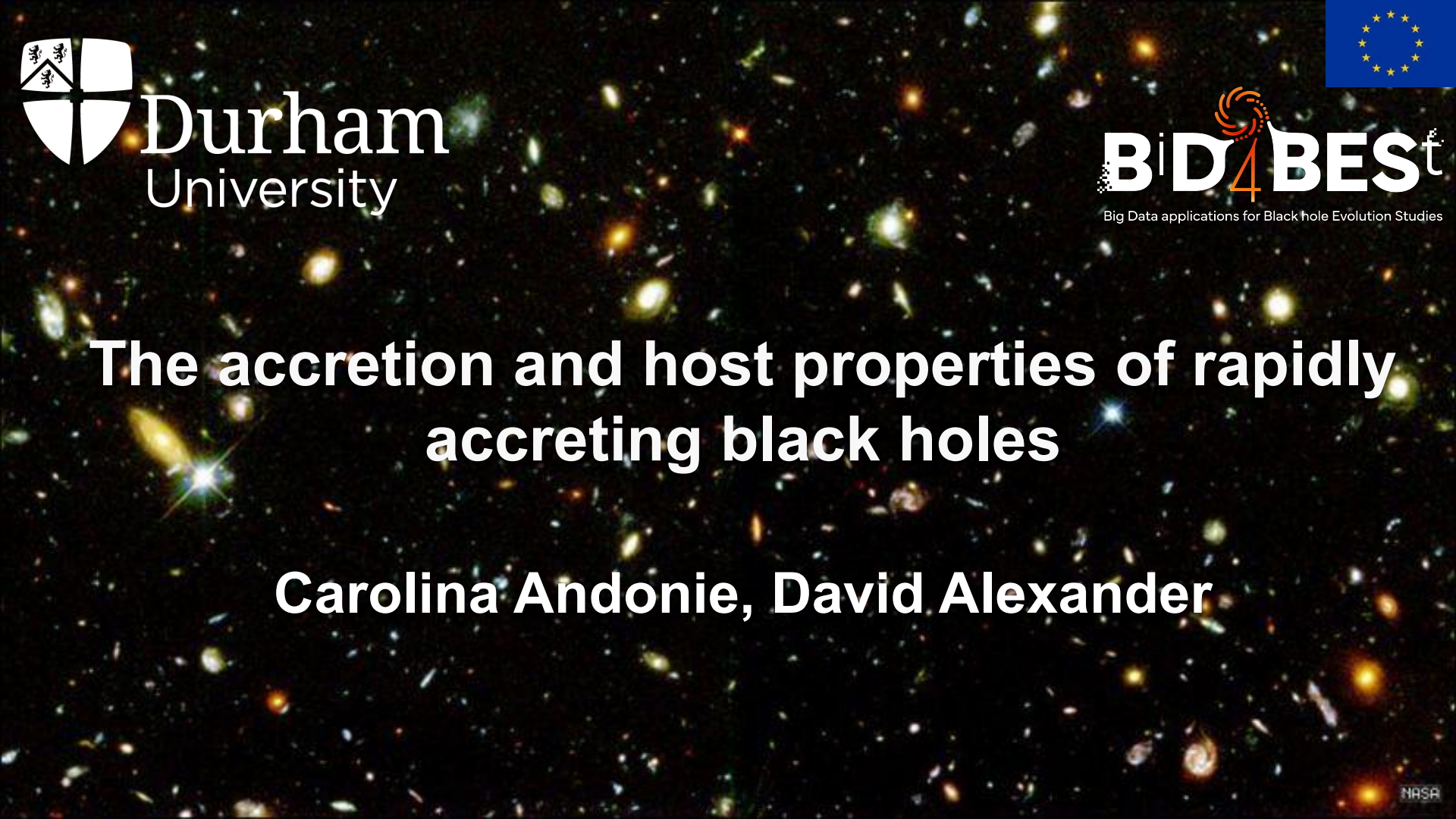
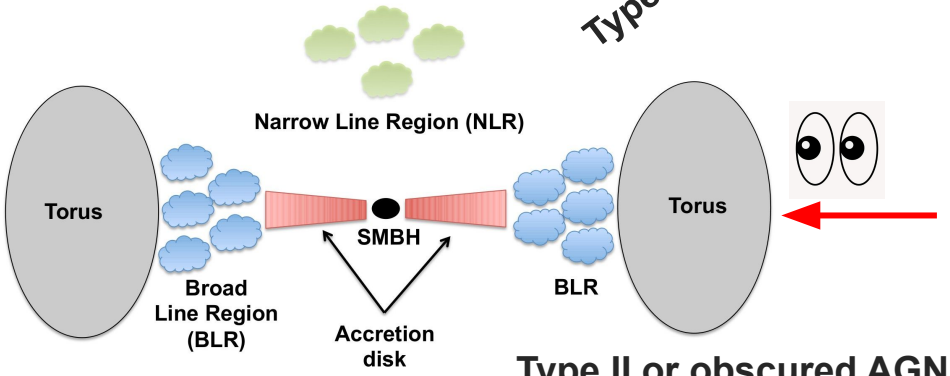
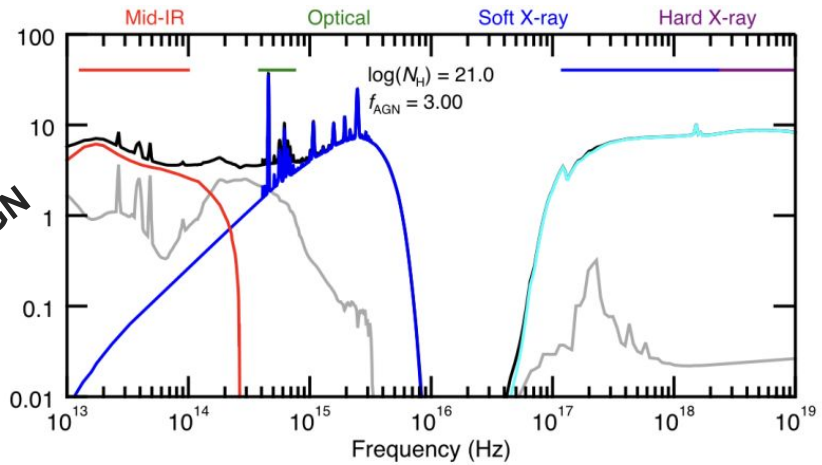

Durham
University
BiD4BESt
Big Data applications for Black hole Evolution Studies
The accretion and host properties of rapidly accreting black holes
Carolina Andonie, David Alexander
NASA

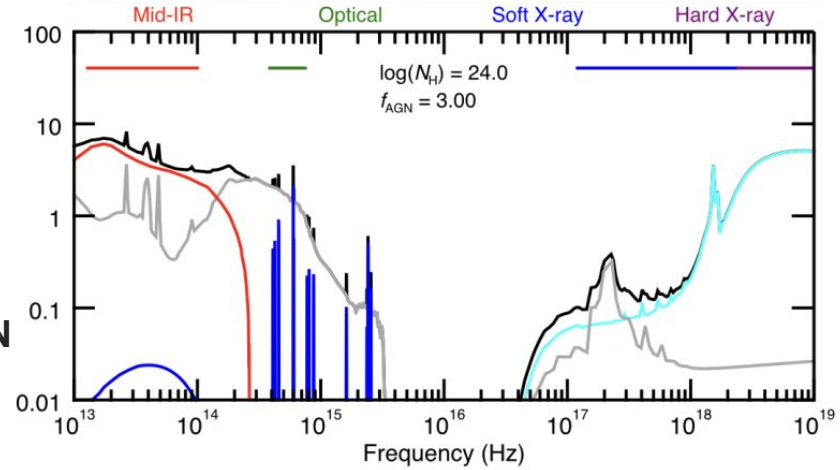
# Standard AGN orientation model




Type I or unobscured AGN

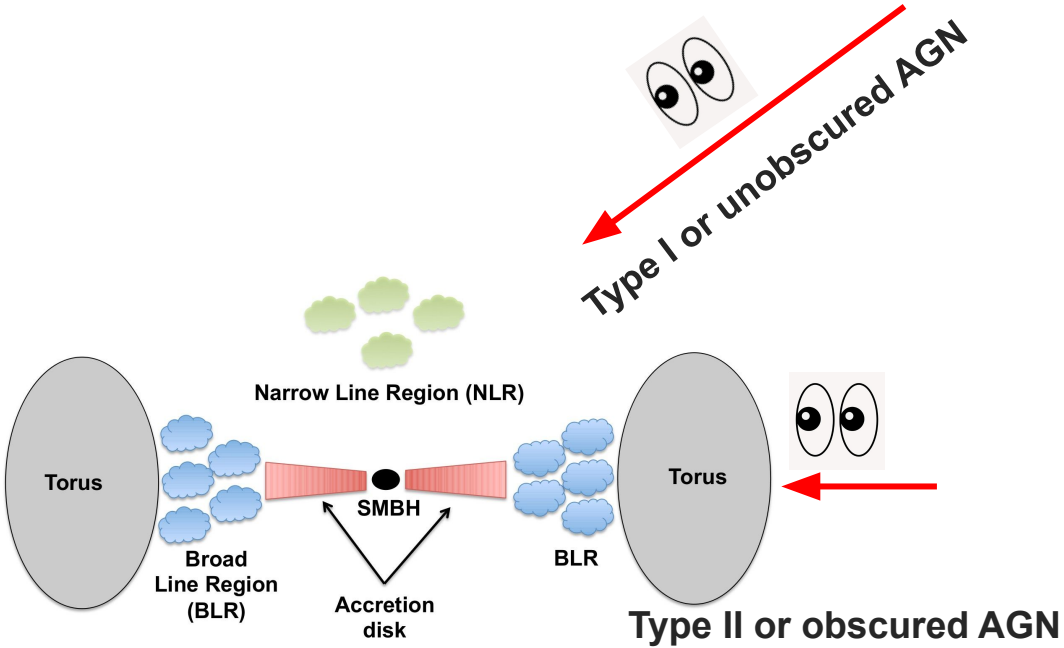
Type II or obscured AGN




Credits: Claudio Ricci

# Standard AGN orientation model



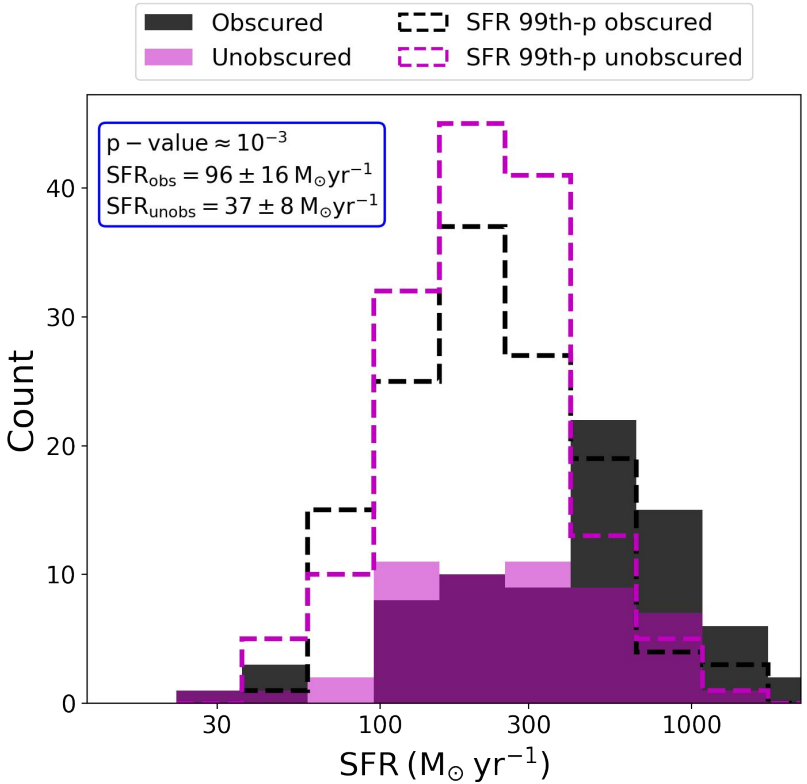

Credits: Claudio Ricci

Obscured and unobscured AGNs should have the **same fundamental properties**

Many works argue against an AGN orientation model!

e.g., Klindt+19, Fawcett+20, Rosario+2020, Fawcett+22, Andonie+22, Petter+22, etc

# Enhanced star-formation rates in obscured quasars

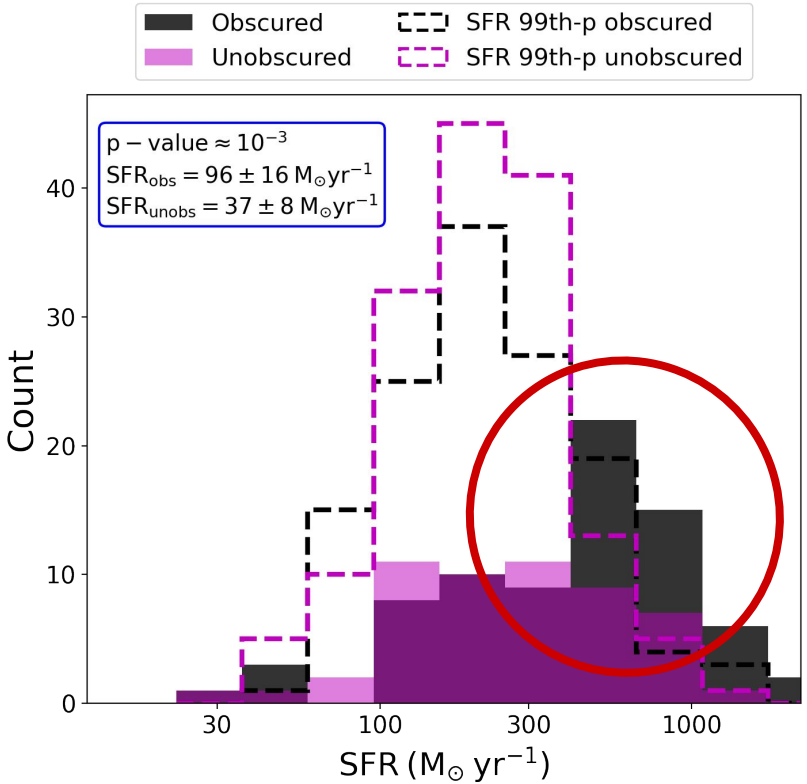



Andonie et al. (2022)

- Using UV-to-far infrared spectral energy distribution (SED) model fitting, we selected a sample of **600 IR quasars** in the COSMOS field at z<3.

Obscured quasars have, on average, **SFR ≈3 times higher** than unobscured quasars.

# Enhanced star-formation rates in obscured quasars



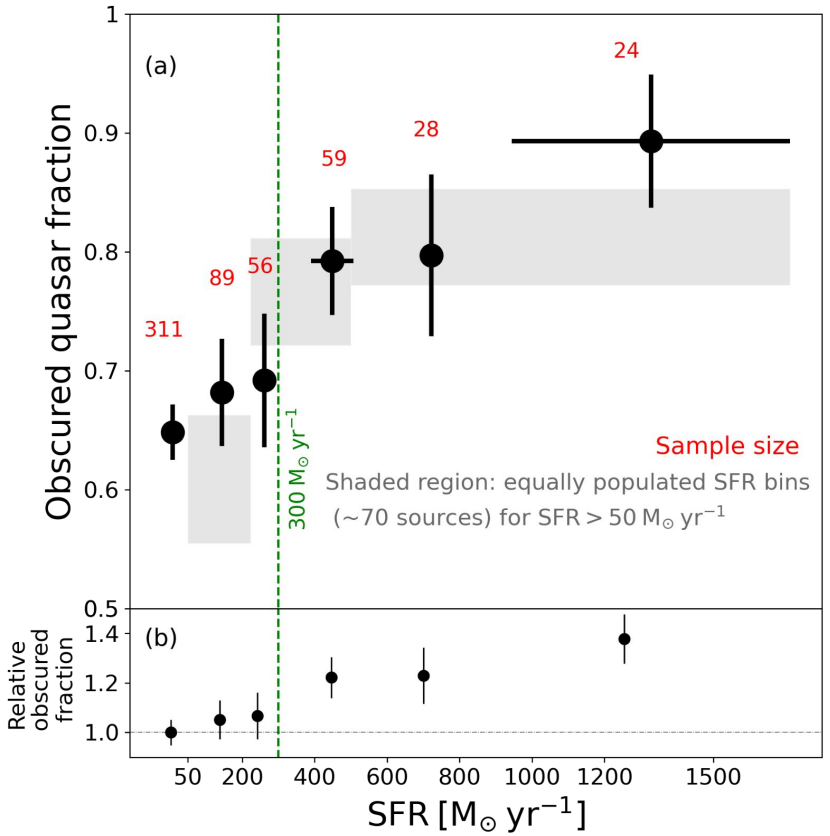

Andonie et al. (2022)

Enhanced star formation coming from SFRs>300 $M_{\odot}yr^{-1}$

Some of the obscuration might be coming from the host galaxy?

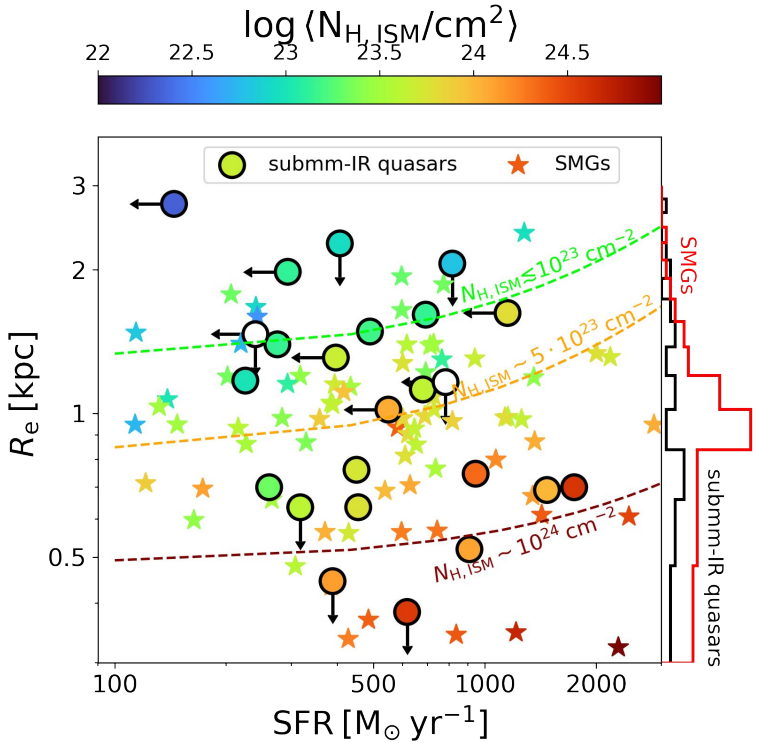
# Clear link between obscuration and SFR

- Obscured fraction is constant for SFR<300 $M_\odot yr^{-1}$
- Obscured fraction increases toward higher SFRs for SFRs>300 $M_\odot yr^{-1}$




Andonie et al. (2024)

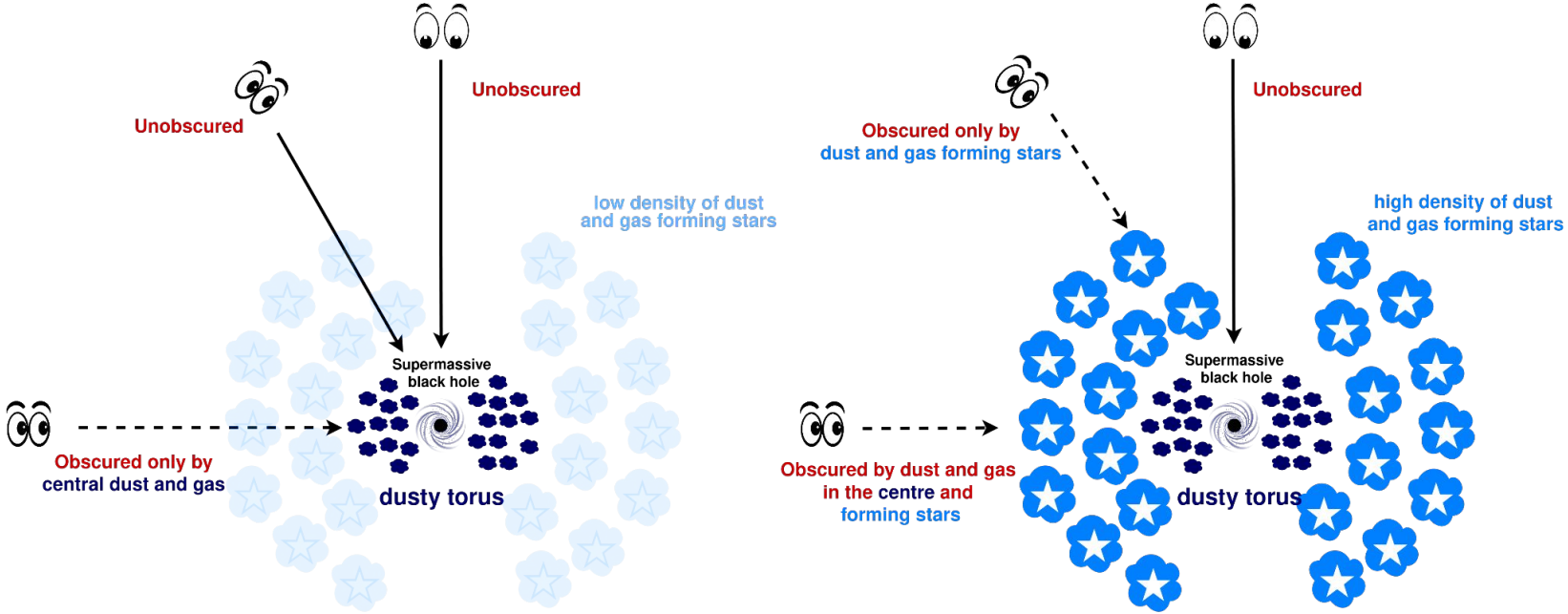
# Is the star-formation causing some of the obscuration? Test with ALMA




Andonie et al. (2024)

- We use ALMA to calculate the interstellar medium obscuration (column density $N_H$ )
- The **ISM** of compact ($R_e$<1kpc) and highly star-forming (SFR>300 $M_\odot yr^{-1}$) quasars **can be Compton-thick ($N_H$ >$10^{24}$ cm$^{-2}$)**

# ALMA data shows that host galaxy obscuration is important in compact starburst host galaxies

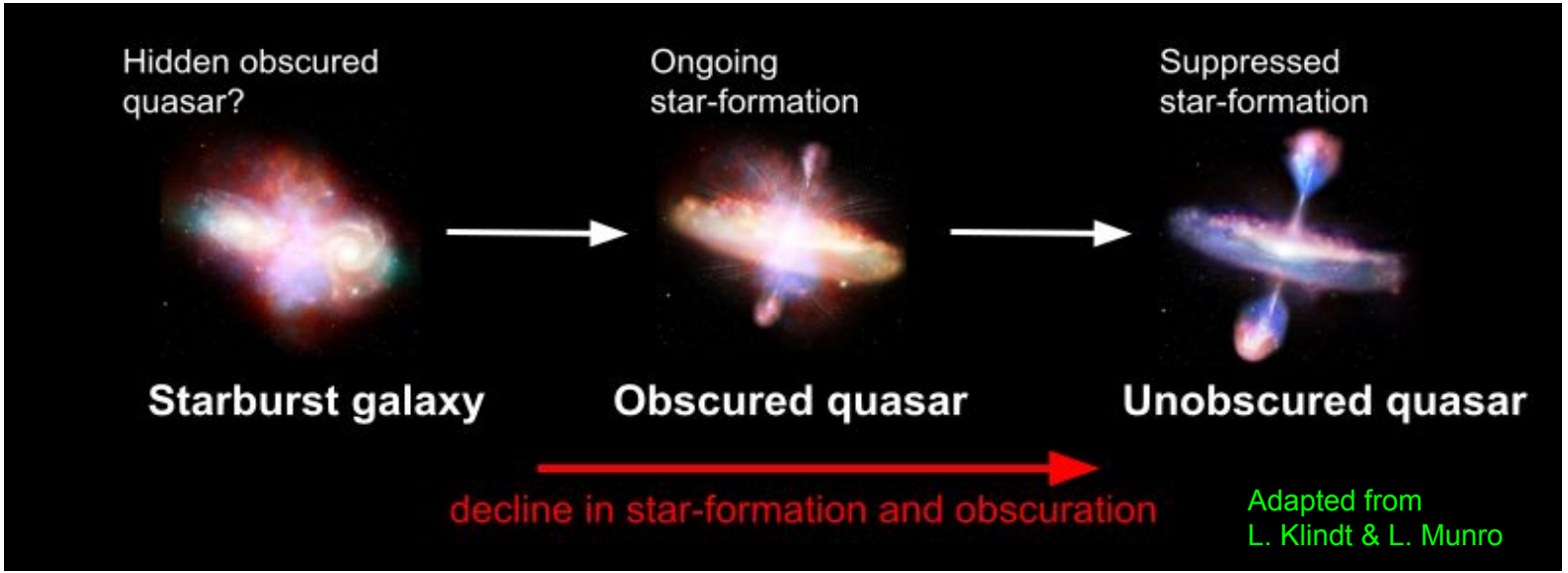



Andonie et al. (2024)

**Press release:** https://phys.org/news/2023-11-quasars-host-galaxies.html

# The obscured-unobscured quasar relationship cannot always be explained by the torus orientation

**Evolutionary connection** characterized by the decrease of dust and gas obscuration?

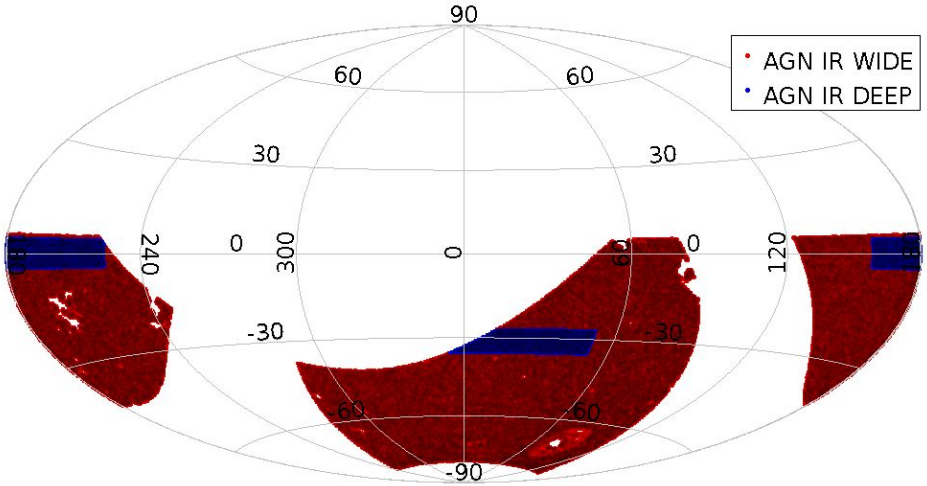


# 4MOST IR AGN survey (Andonie+ in prep)

**4MOST AGN Survey**: optical spectra for >1M AGNs over an area of ~10,000 deg$^{2.}$ The key components:

1. X-ray: ~1M *eROSITA* selected AGNs → unobscured AGNs
2. IR AGN: ~200k obscured, IR AGN selected using WISE colors
   IR Wide: R(AB)<22.1 mag
   IR Deep: R(AB)<22.8 mag

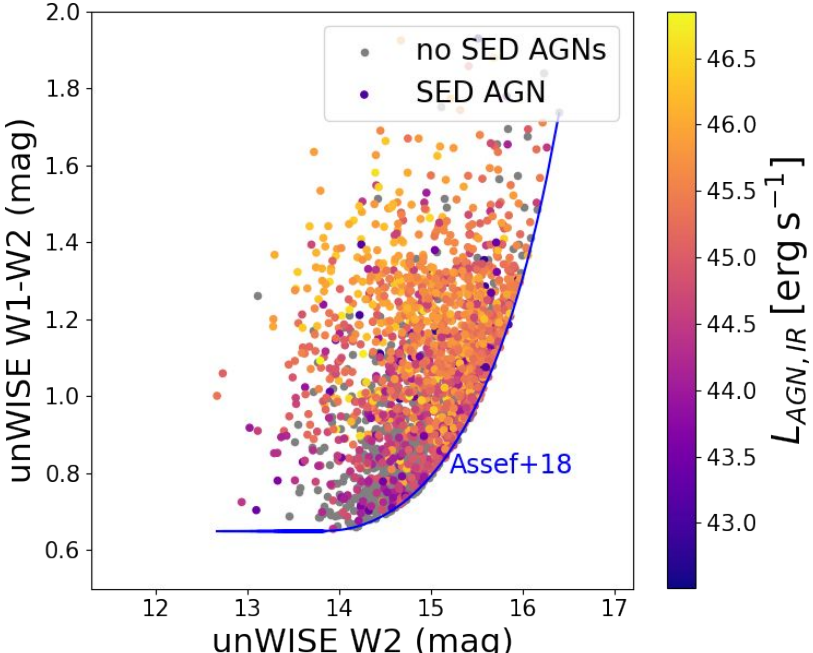
**500k obscured+unobscured IR quasars!**



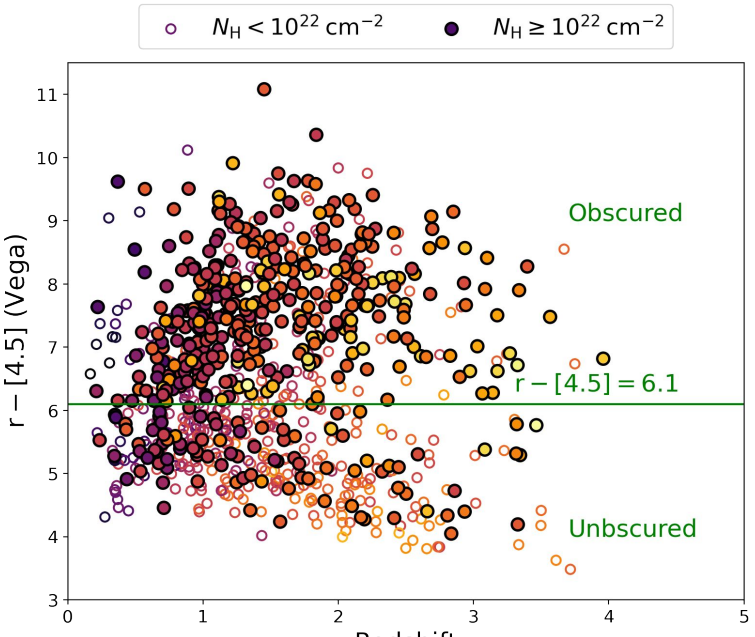

**4MOST**
Large-area multi-object spectrograph
5 year duration – starting in early 2025
Undertaking 18 specific surveys

# 4MOST IR AGN survey (Andonie+ in prep)

- 4MOST is a multi-object optical spectrograph
- We expect to observe **~200000 obscured AGN** at R < 22.8
- Selection approach: Assef+18 selection using unWISE catalogue + r-W2>6.1 [Vega] (Hickox+2008)
- Reliability ~ 80%

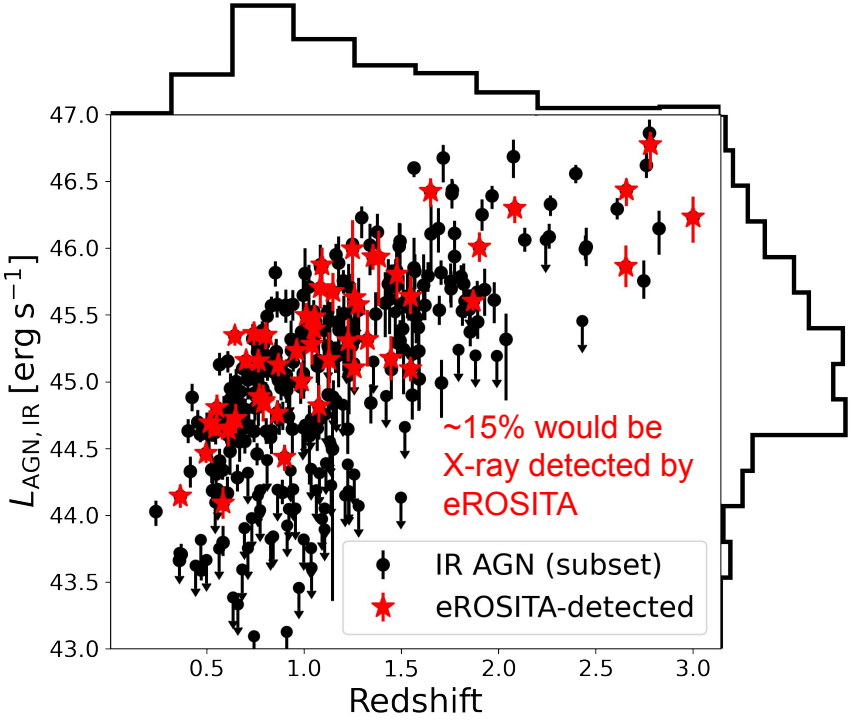


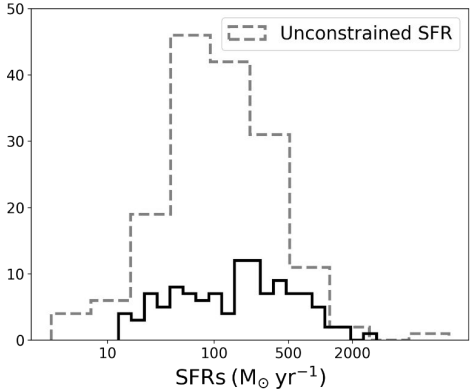

COSMOS fields. X-ray constraints from Laloux+23

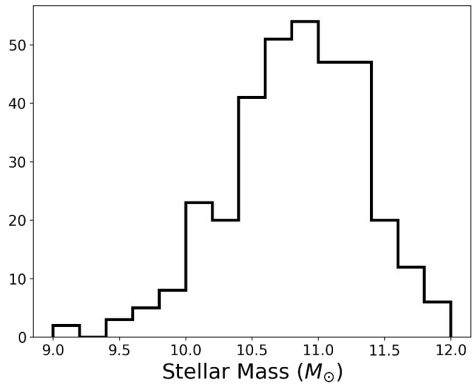


# 4MOST IR AGN survey predictions in deep fields

## Testing our selection in Bootes, ELAIS-S1, and XMM-LSS fields using UV-to-FIR SED fitting




Andonie et. al (in prep)

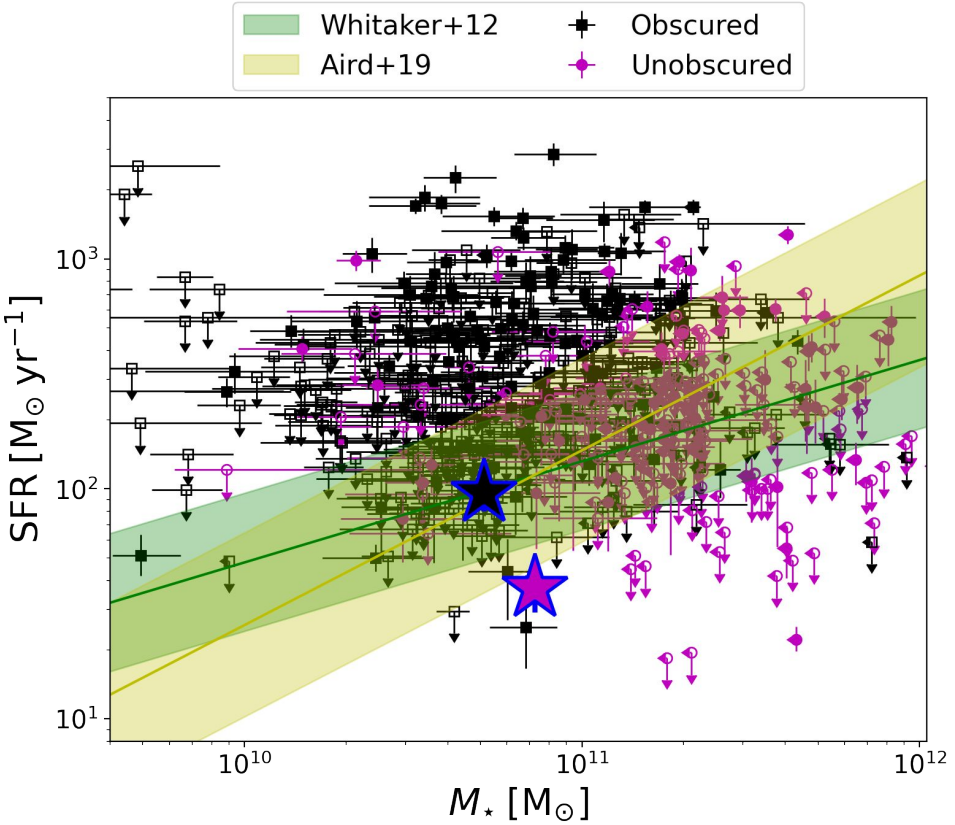
# Key results

- Obscured IR quasars have higher SFRs than unobscured IR quasars
- Host-galaxy obscuration makes a significant contribution to the increase the obscured fraction at high SFR
- Quasar host galaxies with high SFRs and compact sizes can produce Compton-thick $N_{H,ISM}$

# Back-up slides

# IR quasars in the main sequence (MS) of star formation

- Obscured quasars have SFR consistent with the star-forming MS
- Unobscured quasars lie below the star-forming MS→suppressed star formation?



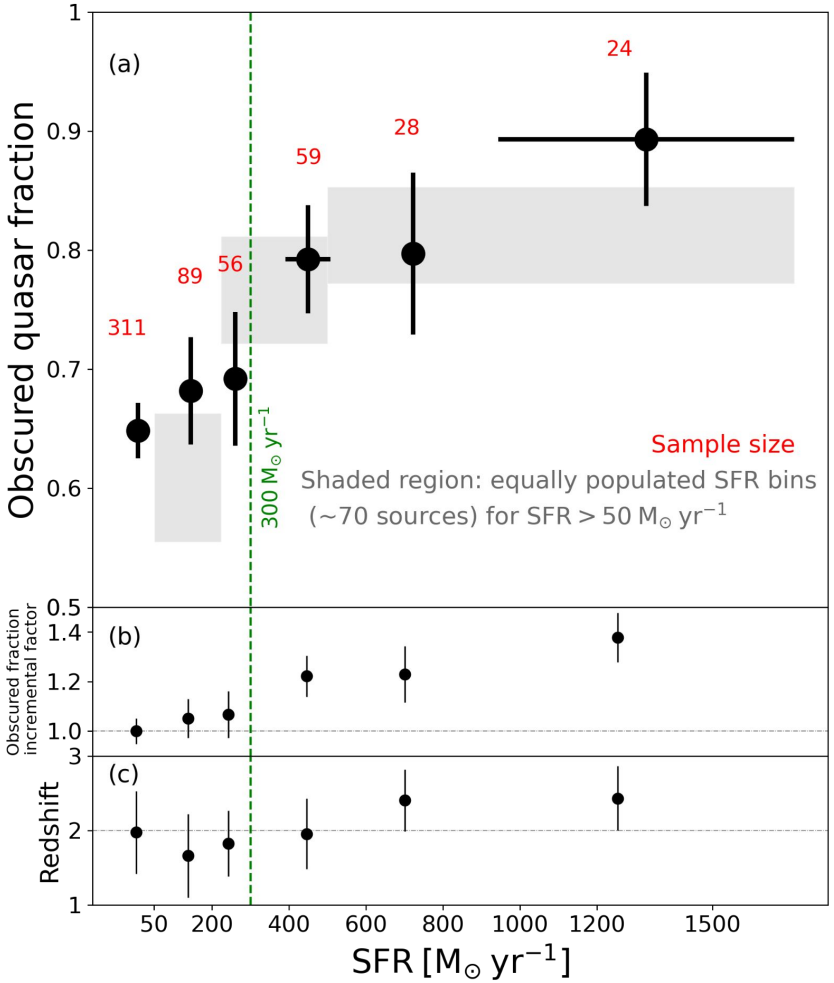

Andonie et al. (2022)

# Clear link between obscuration and SFR

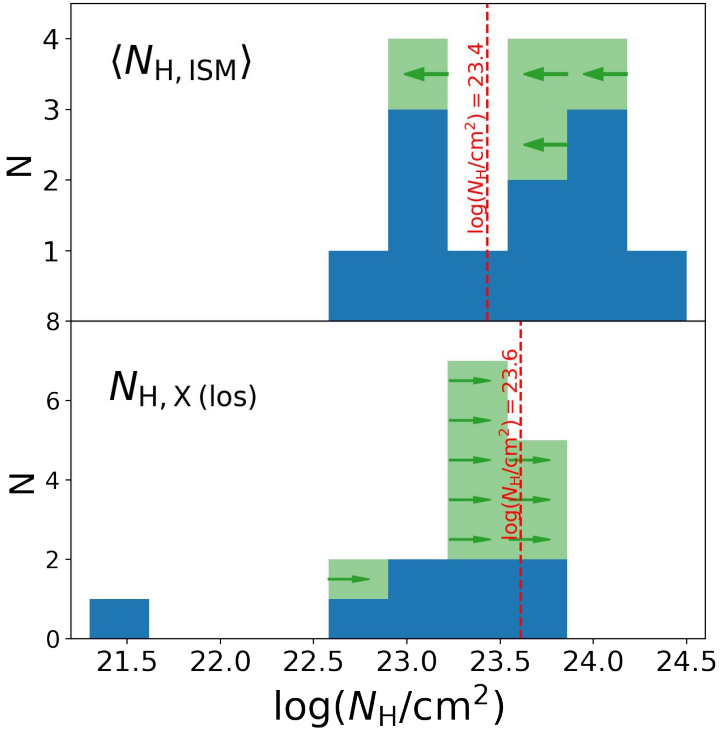
- Obscured fraction is constant for SFR<300 $M_\odot yr^{-1}$
- Obscured fraction increases toward higher SFRs for SFRs>300 $M_\odot yr^{-1}$

Could some of the obscuration come from the host galaxy rather than the AGN torus?

Andonie et al. (submitted)



# Investigating the host galaxy obscuration with ALMA




Andonie et al. (2024)

Line of sight $N_{H,X(los)}$ from X-ray spectral fitting (Laloux+23)

$<N_{H,ISM}>$ is comparable to $N_{H,X(los)}$

The host galaxy can have an important contribution to the total obscuration of the systems

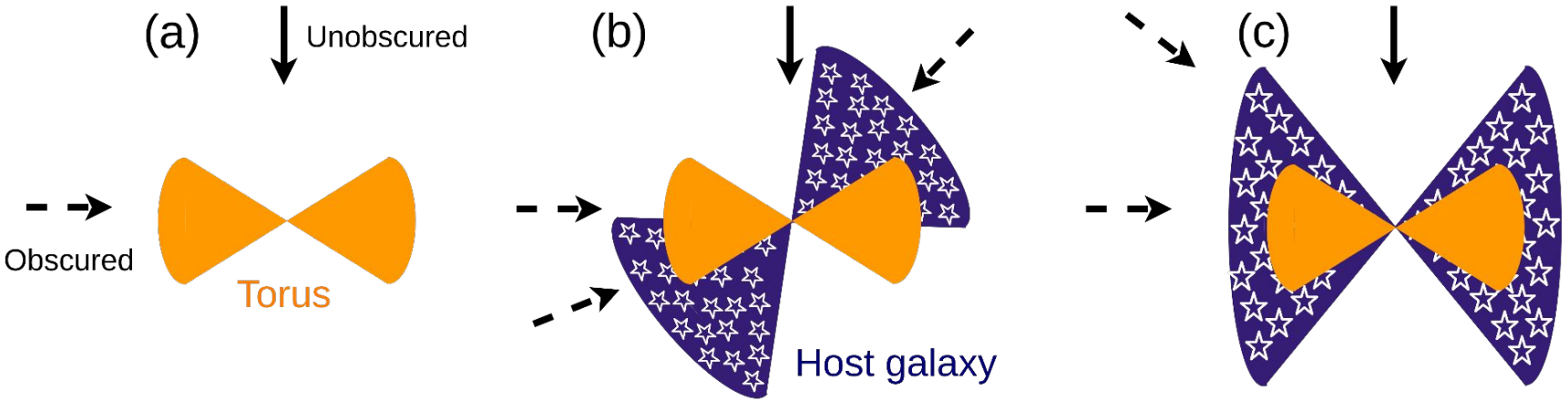
# Quasars subpopulations beyond the standard AGN model

**1) Standard AGN model (torus)**

**Our revised model: Torus + host galaxy**

**2) unaligned**

**3) co-aligned**




Andonie et al. (2024)

* the figures are just illustrative and not drawn to scale