How applicable is the “unified model” of AGN, and what is the physical nature of the obscuring torus?

Urry & Padovani, 1995
Evidence for a (toroidal) distribution of dust

- broad IR bump in the nuclear SEDs & cutoff

![Graph showing evidence for a (toroidal) distribution of dust](Elvis et al. 1994)
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Bock et al. 2000
Macchetto et al. 1994
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- MIDI directly resolves dust tori for the first time

Evidence for a (toroidal) distribution of dust

Tristram+2014
Evidence for a (toroidal) distribution of dust

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  e.g. true type 2, changing look AGN
  do all studies come to the same answer?
  collimation on which scale?
  geometrically thick or outflow?
Models of AGN tori

Geometrical torus models

- smooth and clumpy, puffed-up structures, disc winds, warped discs

Stalevski+ 2016

large degeneracies, dynamically unstable

Netzer+ 2015
Models of AGN tori

Physical torus models

- warped discs

difficult to explain the obscured fraction

Sanders+, 1989

Jud+, 2016/17
Models of AGN tori

Physical torus models

- magnetised clouds
- magneto-centrifugal winds

(Too) strong magnetic fields necessary
Unclear whether dust clumps can be lifted

Emmering+, 1992
Models of AGN tori

Physical torus models

- nuclear starbursts

problems at small scales, partly require extreme conditions

Schartmann+, 2009

Wada+, 2009

Hueyotl-Zahuantitla, 2013
Models of AGN tori

Physical torus models

- UV and/or IR radiation pressure

  promising, various mechanisms proposed, converged to same results (?)

Wada, 2012

Chan & Krolik, 2016

Dorodnitsyn+, 2015
Models of AGN tori

Physical torus models

- warped discs
- magnetised clouds
- magneto-centrifugal winds
- nuclear starbursts
- UV and/or IR radiation pressure

• difficult to explain the obscured fraction
• (too) strong magnetic fields necessary
• unclear whether dust clumps can be lifted
• problems at small scales
• promising, various mechanisms proposed, converged to same results (?)
What is the physical nature of the central obscuring structure (i.e. the "torus")?

- Gas/dust Outflow <10pc: 31.6%
- Gas/dust Inflow <10pc: 36.7%
- There is No Torus: 3.8%
- Circumnuclear Star Formation: 3.8%
- Other: 24.1%

thanks to Mackenzie!
What is the physical nature of the central obscuring structure (i.e. the "torus")?

- Obscuration from the Broad Line Region
- Gas/Dust Clumpy Structure - Not a Torus
- Varies Among AGN Types
- Depends on the Luminosity
- Inflow and Circumnuclear SF
- Inflow, Outflow, and Circumnuclear SF
- Inflow and Outflow
- Not Enough Evidence...Yet

Percent
outflow
torus
gas
inflow
Polar emission & outflows & obscuration

- What are the conclusions to draw from the detection of polar emission?
  - Is it an indication that the torus should be replaced by an outflow?
  - Or is this just a second component in addition to a toroidal structure (e.g. the inner part of the dusty NLR)?
- Where is the mass located?
- How can we observationally distinguish?
- How to sustain the obscuring structure over a duty cycle?

Tristram+ 2014

Wada+ 2012

“mass”

“light”
Obscuration: near or far?

- Where is the bulk of the obscuration happening? On BLR scale, pc-scale as seen by MIDI, on a few 10–100 pc scales (as in SB models or due to gas/dust lanes) or even on galactic scales?
- Can this explain the luminosity and redshift dependence of the covering factors?

Prieto+ 2015 filaments, ~100 pc
NGC 1386 clumpy torus, ~1 pc
Stalevski+, 2016

BLR, < r_{sub}

Risaliti+ 2011
Nature of the torus – clues from simulations

• large no. of clumpy torus models
• hydro models: quite large progress in the last years; radiation pressure on dust: IR / UV, various mechanisms have been proposed; significant contribution on large scales due to SB in some sources
• In hydrodynamics models of outflows: is it the outflowing gas that provides most of the obscuration? Or back flowing gas stirring random motions?
• What have we learned from the models? Do we converge?
Wish lists / TODO lists

- Modellers: Proposals for observations to distinguish between models?
- Observers: Specific process / physics that should be modelled / diagnostic plots?

Any other questions / points for discussion?
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Do you think *obscuration* is done by...

- inflow
- outflow
- inflow and outflow
- puffed-up dusty structure
- circum-nuclear star formation
- all of the above
- none of the above
If polar emission is seen, where does the dust come from?

- in-situ formation in an outflow
- acceleration from equatorial region
- entrainment from a puffed-up structure
- it was always there