On the importance of polar dust in AGN

Daniel Asmus
University of Southampton

with
Sebastian Hönig & Marko Stalevski
Out of ~150 nearby AGN without strong nuclear star formation, 21 show extended nuclear mid-infrared emission.
The resolved emission is coming from the polar axis of the AGN systems!

Angular difference (System Axis - MIR extension)

Is the mid-infrared emission of AGN dominated by dust in/along the ionisation cone instead of the obscuring torus?

Minimum relative amount of resolved emission

Asmus et al. (2016)

Hönig et al. (2012)
The reasons for the low detection rates

- **Distance**
  - unresolved

- **Inclination**
  - low S/N
  - intrinsic weakness
  - no elongation

Asmus et al. 2016
Is polar dust ubiquitous in AGN?
The resolved emission strongly correlates with the [OIV] emission produced in the ionisation cone

Asmus et al. 2016
The resolved emission strongly correlates with the [OIV] emission produced in the ionisation cone.
20 hours of A-ranked time for 12 & 18µm deep imaging with the upgraded VLT/VISIR of 9 objects with PSF reference
Asmus et al. (in prep.)
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Extended MIR emission has clear preference for polar direction — origin: polar dusty wind (?)
The polar dust is probably dominating the total mid-infrared emission of the AGN.
So what is it: torus+ambient, torus+cone, disk+cone/wind, or all/none of the above?

Stalevski et al. (2017)

Hönig & Kishimoto (2017)

Wada et al. (2016)

Stalevski et al. (subm.)
CAT3D-WIND (Hönig & Kishimoto 2017)
clumpy torus & pol. wind both work

pol. wind + disk works better

41% 59%
Polar dust structure models by Stalevski et al.

Stalevski et al. (2017)

see M. Stalevski’s talk on Tuesday!
**Disk:**
- Half opening angle: 10°
- $\tau_{9.7\mu m}$ in the plane = 6
- Outer radius = 5pc
- Flat & smooth density

**Polar wind:**
- Half opening angle: 20°
- $\tau_v$ along the cone wall = 1
- Outer radius = 50pc
- Flat & smooth density
NGC1386

8.6µm

f(tot)=0.21 Jy
f(tot)/(PSF)=1.89
maj=0.52"
maj=0.29"
minF=0.29"

10µm

f(tot)=0.35 Jy
f(tot)/(PSF)=1.77
maj=0.69"
maj=0.40"
minF=0.40"

12µm

f(tot)=0.38 Jy
f(tot)/(PSF)=1.99
maj=0.73"
maj=0.40"
minF=0.40"

18µm

f(tot)=1.06 Jy
f(tot)/(PSF)=1.93
maj=1.04"
maj=0.56"
minF=0.56"

14.4 Mpc

f(tot)=0.10 Jy
f(tot)/(PSF)=1.53
maj=0.42"
maj=0.27"
minF=0.27"

20.5 Mpc

f(tot)=0.17 Jy
f(tot)/(PSF)=1.44
maj=0.55"
maj=0.38"
minF=0.38"

27.3 Mpc

f(tot)=0.06 Jy
f(tot)/(PSF)=1.33
maj=0.36"
maj=0.26"
minF=0.26"
NGC1386

- Obs. - 12µm

- Obs. - 18µm

- Mod. - 12µm

- Mod. - 18µm

- 27.3 Mpc

- 8.6µm

- 10µm

- 12µm

- 18µm
Conclusions

- Polar dust emission might be ubiquitous in AGN.
- Polar dust emission appears to dominate the total mid-infrared emission of the AGN.
- Disk + polar wind models fit the observed data better than "classical" clumpy torus models AND can reproduce morphology.
- The generation of instruments will allow to test the above.

[See also poster by Marta Venanzi and Dave Williamson’s talk on Thursday!]
Back-up Slides...
Establishing a system axis from ionisation cones [OIII], radio jets, maser disks, and polarized emission.
The resolved emission is not correlated to the host orientation.

Angular difference (System Axis - MIR extension)
The outliers

- **Seyfert 1.2**
  - [OIII] pointlike
  - marginally resolved
  - PA error 27º

- **Seyfert 1.5/2**
  - wide opening ionisation cones
  - edge-on spiral
  - emission traces
  - host dust lane

- **Seyfert 1.2**
  - wide opening ionisation cones
  - weakest AGN in the sample
  - low S/N

See poster by James Leftley
Polar elongation is dominant also on parsec scale as found with MIDI interferometry (Lopez-Gonzaga et al. 2016).
The small and large scale elongation are aligned and seem to trace the edge of the ionisation cone.
The graph shows the major axis FWHM / PSF FWHM for different inclinations. The data points are color-coded by wavelength:

- Blue circles for 8.6 um
- Green triangles for 12 um
- Red squares for 18.7 um

The x-axis represents the inclination in degrees, ranging from 30 to 90 degrees. The y-axis represents the major axis FWHM / PSF FWHM, ranging from 1 to 5 units.
The mid-infrared—X-ray correlation for all types of AGN is driven by dust in the ionisation cones rather than the torus.

Asmus et al. 2015
Difference between type I and II is smaller than expected