High Resolution Mid-Infrared Imaging of Dusty Narrow Line Regions (NLR) in Seyferts

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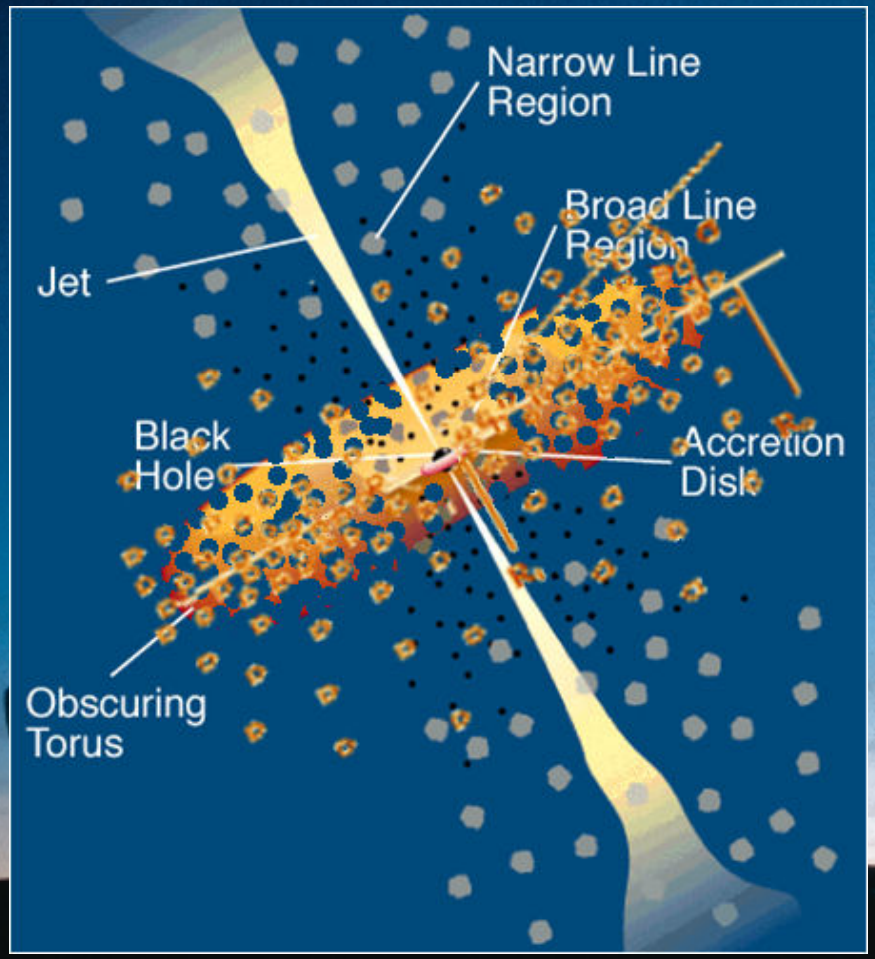
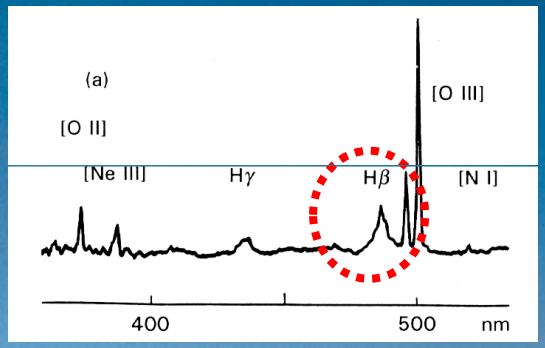
AGN (Unified Model -Modified)

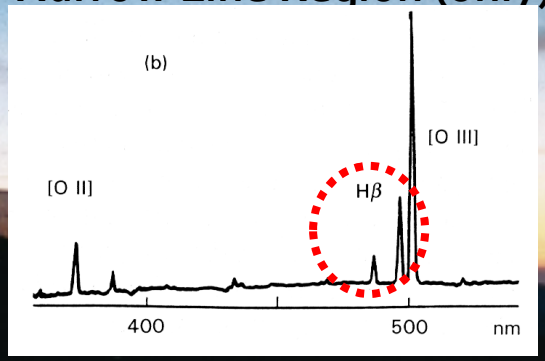


Original: Urry & Padovani (Modified)

- Type 1 AGN (Viewed Face on)
  - –Broad Line Region
  - –Narrow Line Region

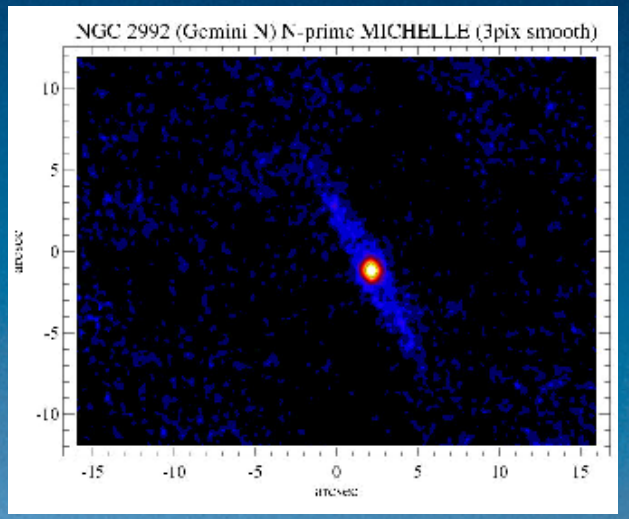


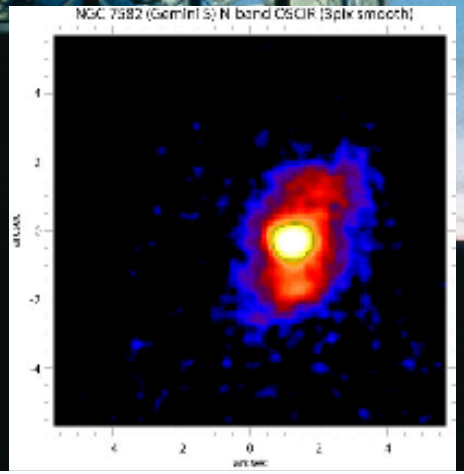
- Type 2 AGN (Viewed Edge-on)
  - Narrow Line Region (only)

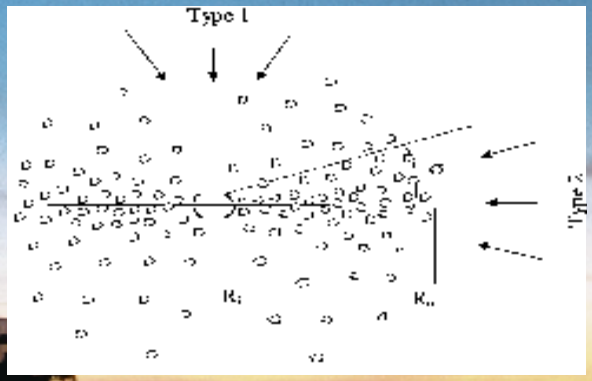


Extended Thermal Emission in AGN

- Galactic Dust Lane (>100-1000pc)
- Stars (>10-100pc)
- Torus (~few pc)
- Narrow Line Region (NLR) (>100pc)





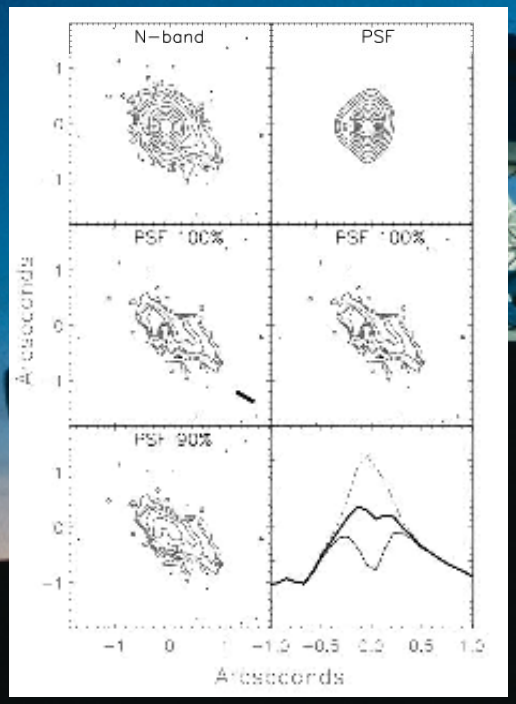


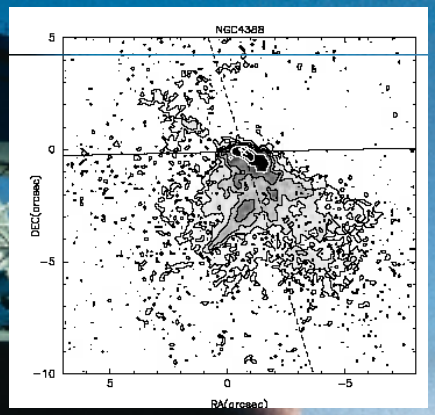
Clumpy Torus Model (Nenkova et al. 2002 ApJ 570)

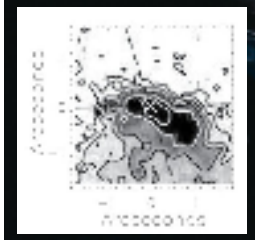
Seyfert+NLR

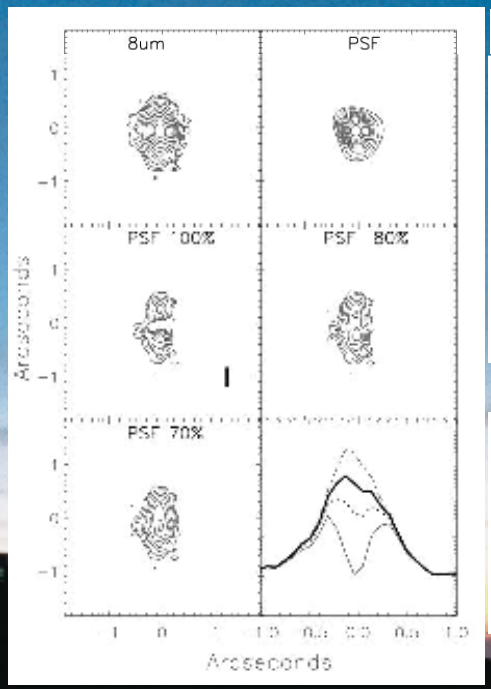
- Thermal dust overlaps [OIII] emission

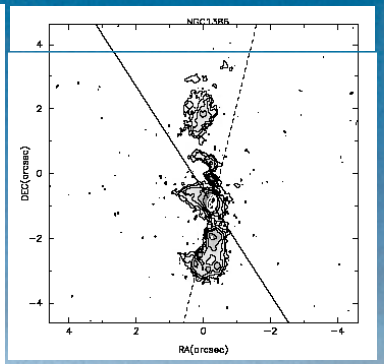
NGC 4388 (MICHELLE) NGC 1386 (T-ReCS)





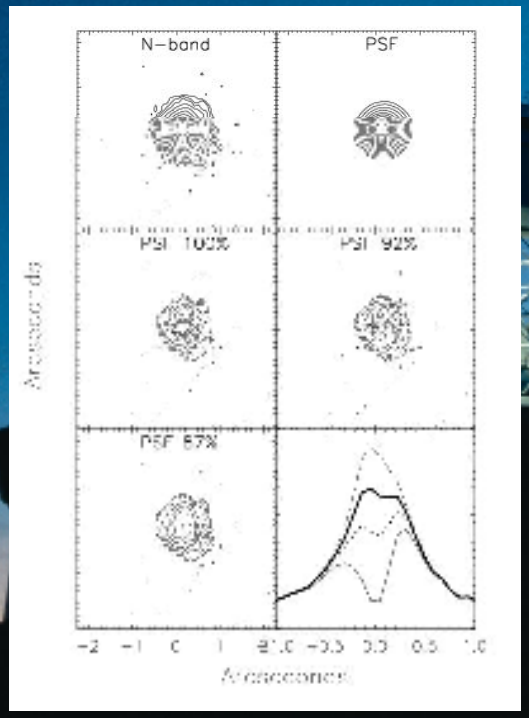


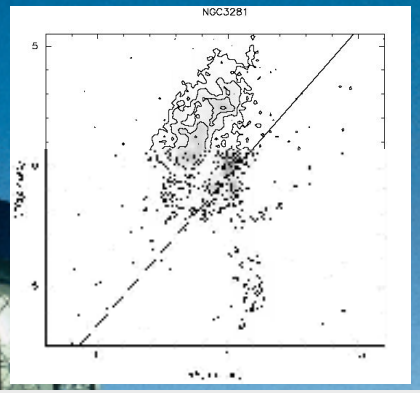


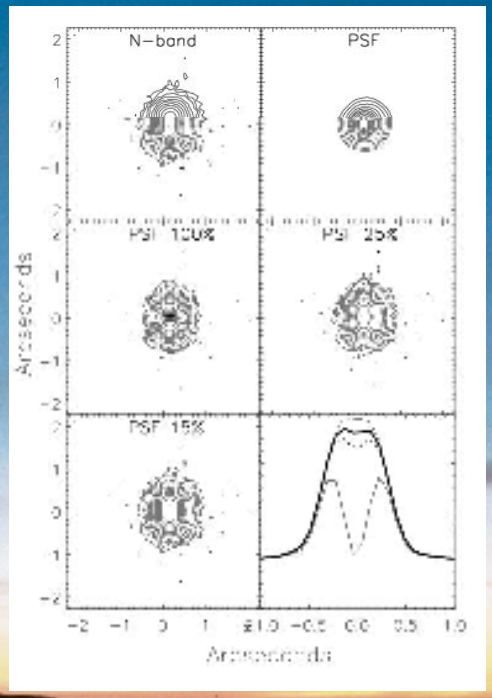


NLR (NGC3281)

- PSF subtraction very good at fitting extended emission (~10%)





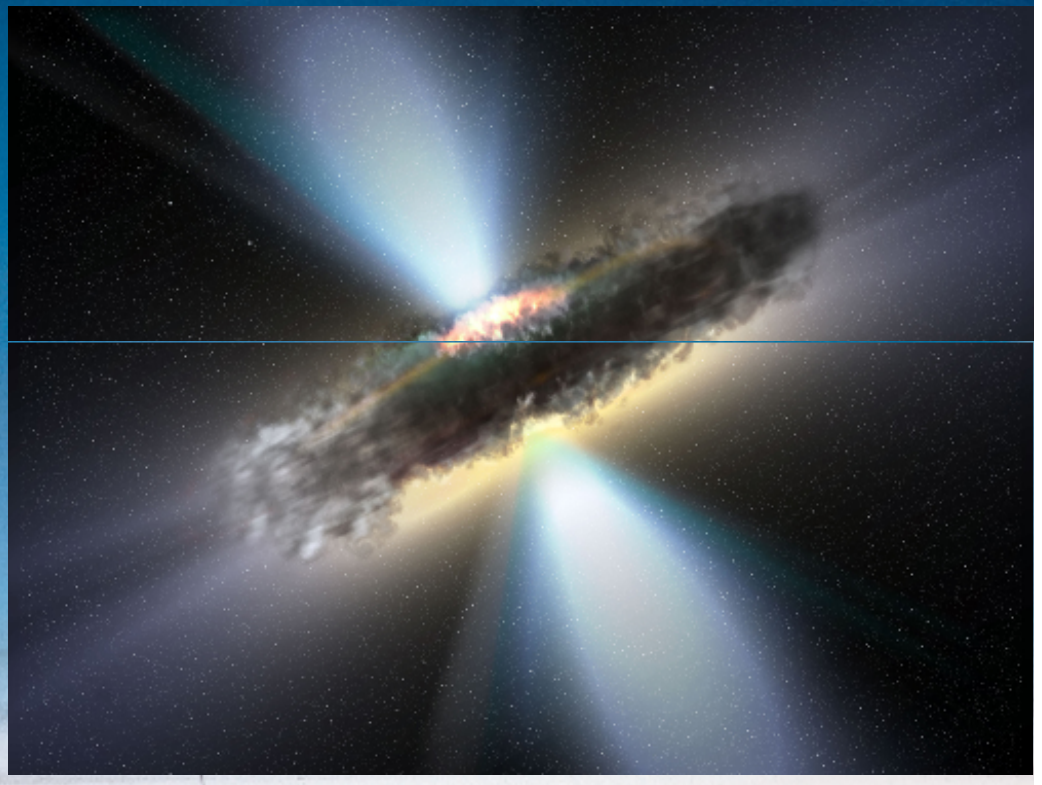


Dust Heated in NLR

- Extended emission follows simple model

(like [OIII] Sanders et al. 1989, Schmitt et al. 2003)

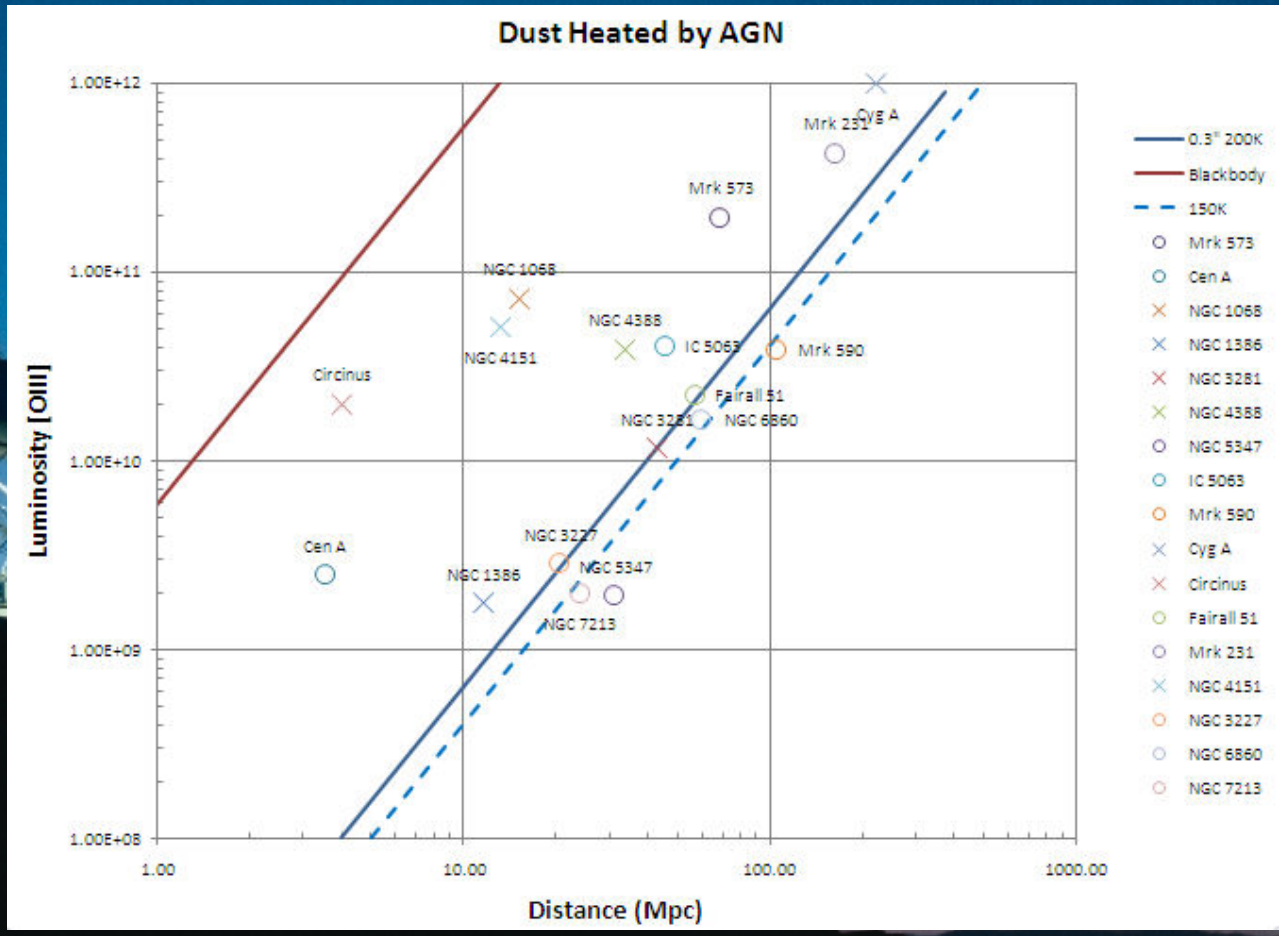
$$r = \left(\frac{L_\nu}{16 \cdot \pi \cdot \sigma \cdot T_d^{\,4}} \cdot \frac{Q_{UV}}{Q_{IR}} \right)^{\frac{1}{2}}$$



Dust Heated in NLR

$$r = \left(\frac{L_\nu}{16 \cdot \pi \cdot \sigma \cdot T_d^{\,4}} \cdot \frac{Q_{UV}}{Q_{IR}} \right)^{\frac{1}{2}}$$

- Red Line (Blackbody 200K 0.3” Resolution)
- Blue Line (Model 200K 0.3” resolution)
- X-Resolved
  O-Unresolved

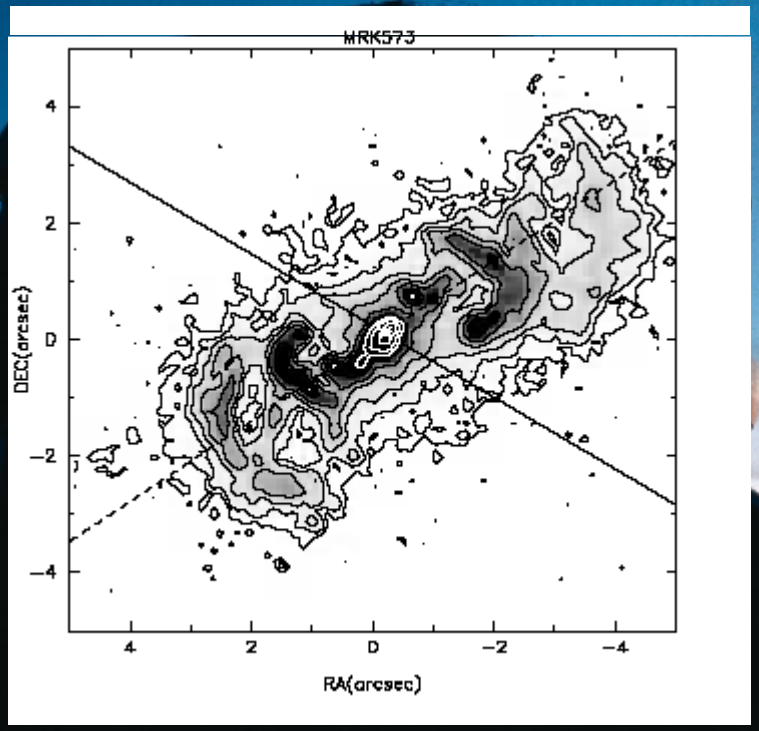


No Significant Dusty NLR

- Large [OIII] NLR, plenty of luminosity, but no thermal dust emission

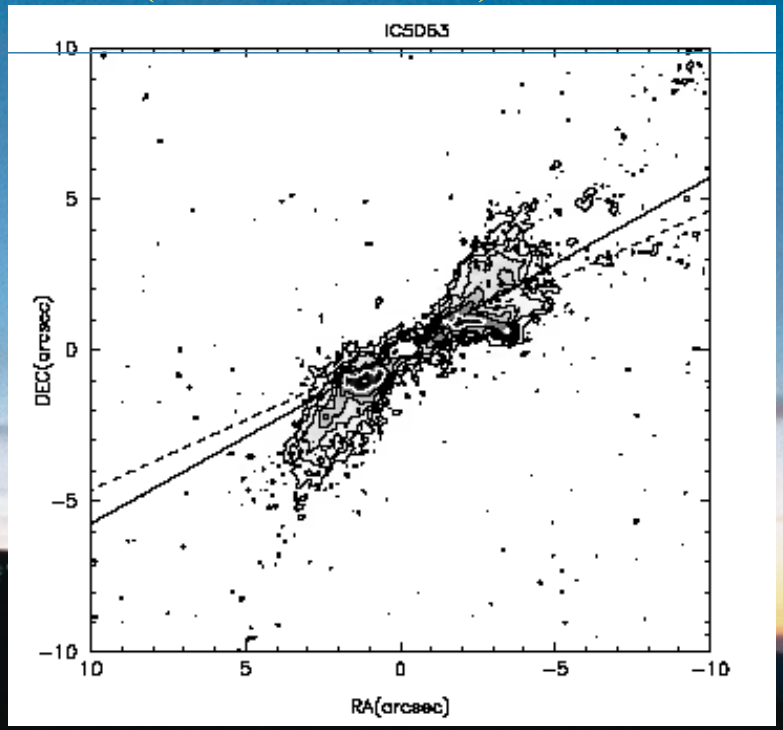
Mrk 573 [OIII]

(Schmitt et al. 2003)

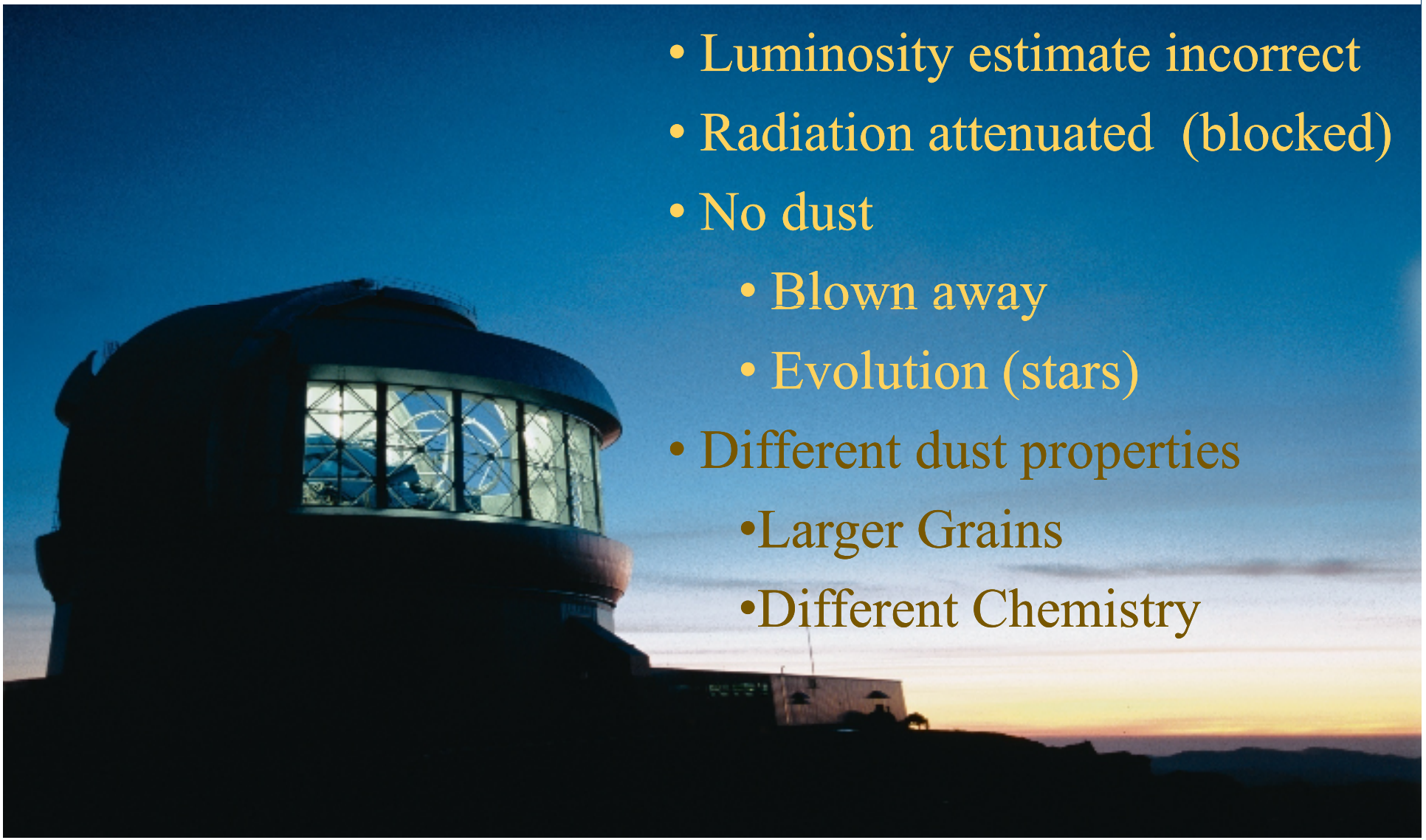


IC 5063 [OIII]

(Schmitt et al. 2003)



Why Not Always Extended



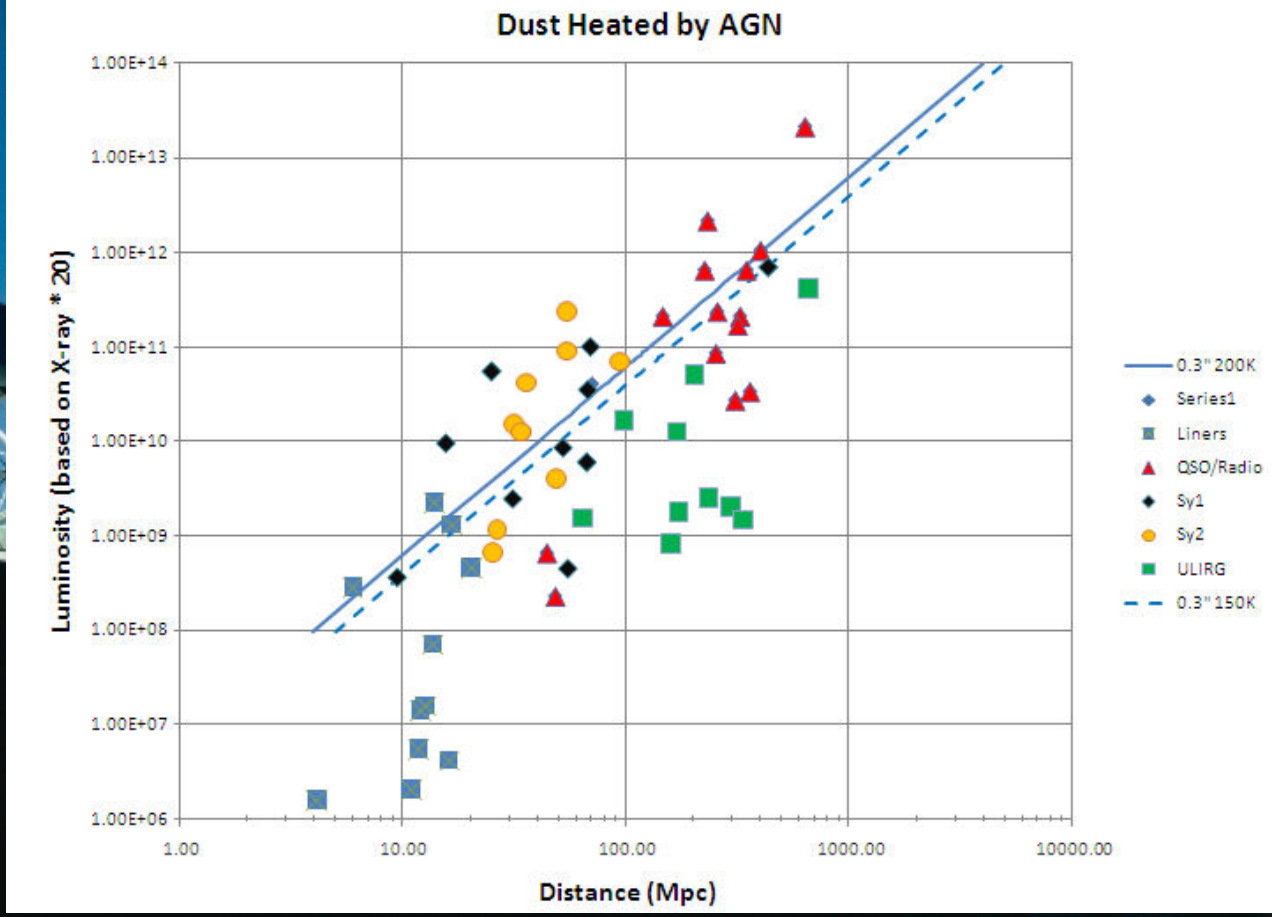
- Luminosity estimate incorrect
- Radiation attenuated (blocked)
- No dust
  - Blown away
  - Evolution (stars)
- Different dust properties
  - Larger Grains
  - Different Chemistry

Dust Heated in NLR (Predicted)

$$r = \left(\frac{L_\nu}{16 \cdot \pi \cdot \sigma \cdot T_d^{\,4}} \cdot \frac{Q_{UV}}{Q_{IR}} \right)^{\frac{1}{2}}$$

CanariCam AGN Survey

- Will be difficult to resolve NLR (with current 8-10m telescopes)



Results

- "Measured" thermal emission from NLR not dominant*10-40%
- "Modeled" emission may have stronger effect (indicate more contamination)

- NLR emission important in modeling torus/starburst (especially at far-IR)

- Using simple model can roughly predict if source is likely to be resolved.