IR emission from the NLR

Constraining the Contribution of AGN

Brent Groves
Leiden Observatory

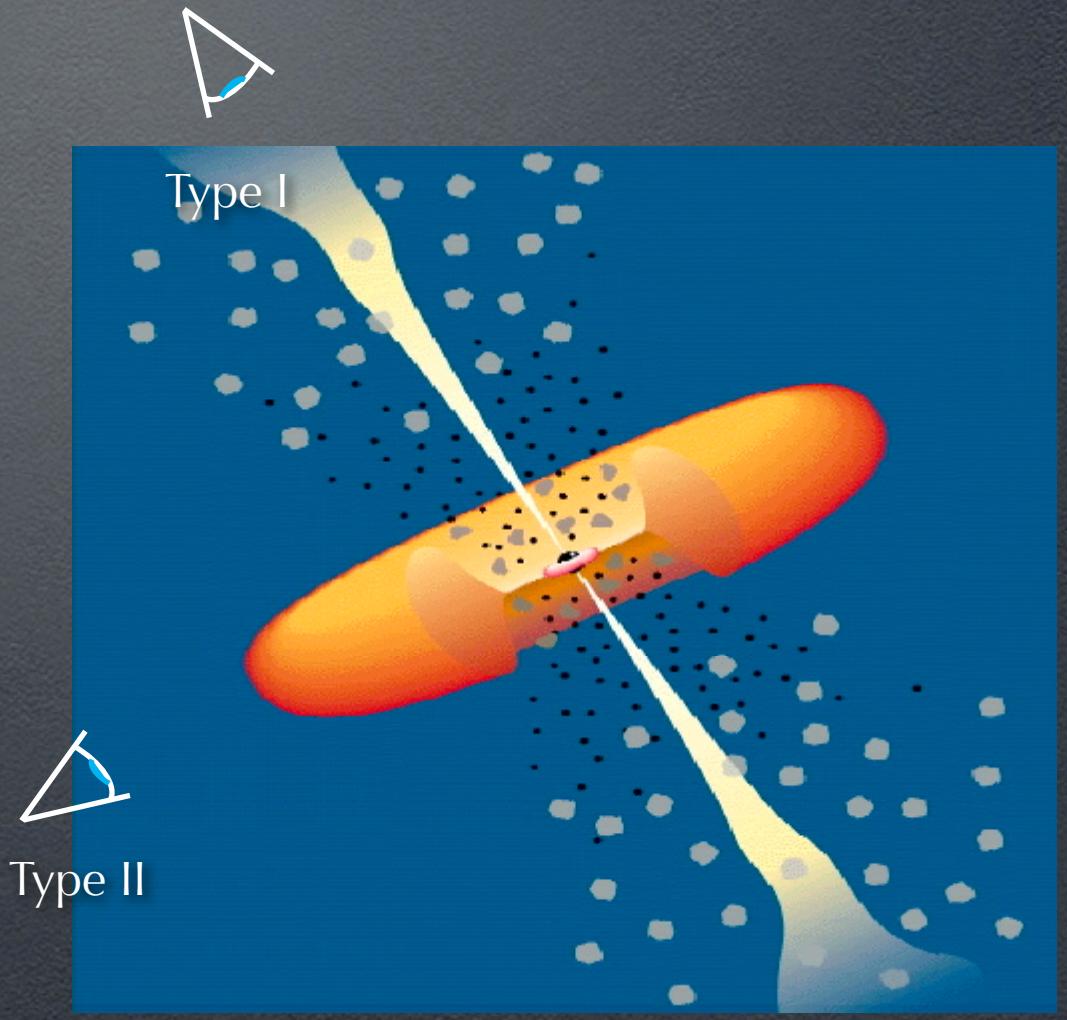
Michael Dopita, Ralph Sutherland
ANU, Australia

Sterrewacht Leiden

Universiteit Leiden

There's Dust There?

- Traditionally, most Dust emission is thought to come from the putative torus
- However models of the NLR suggest dust is extant through the NLR
- Current Observations support this view



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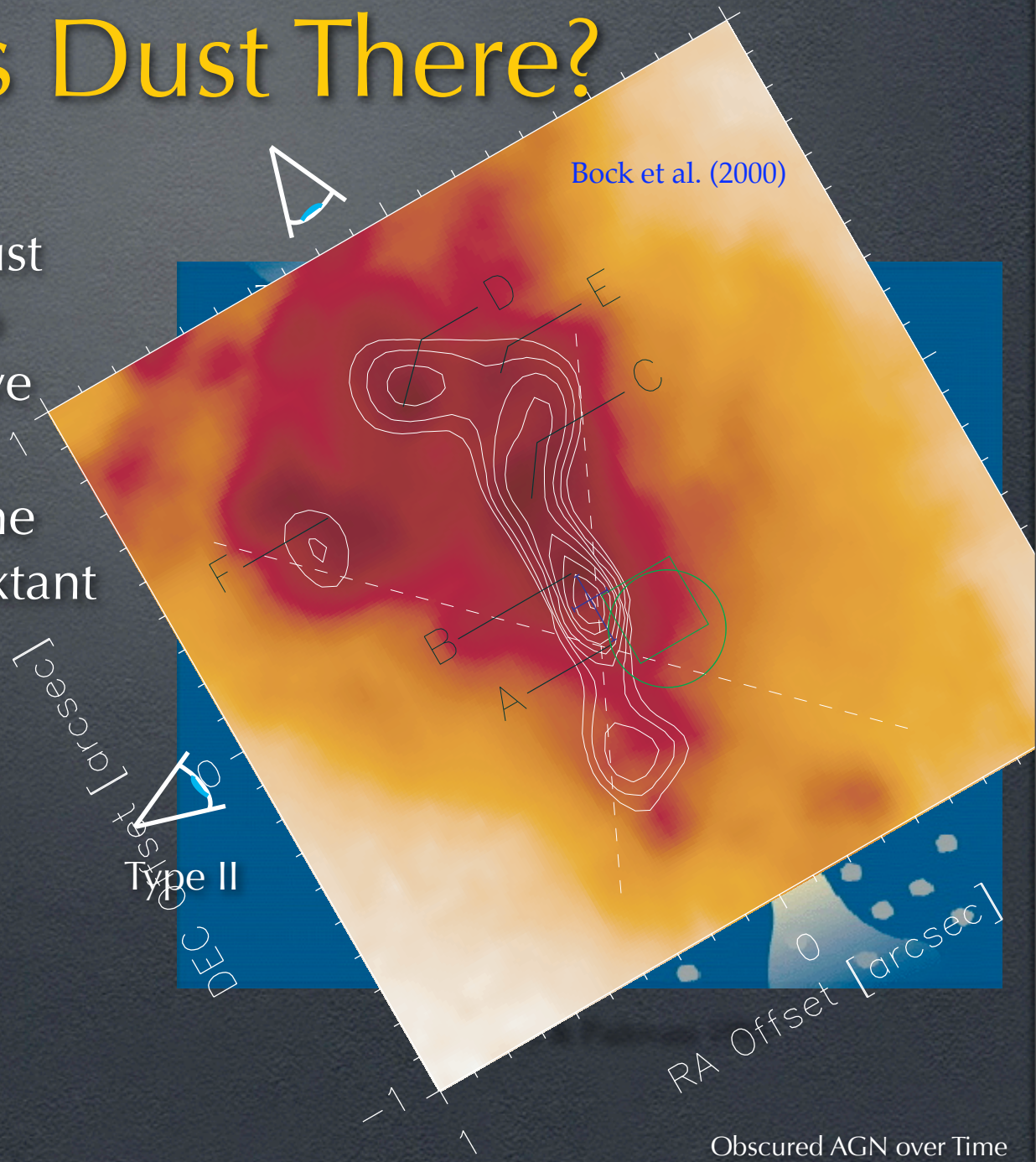
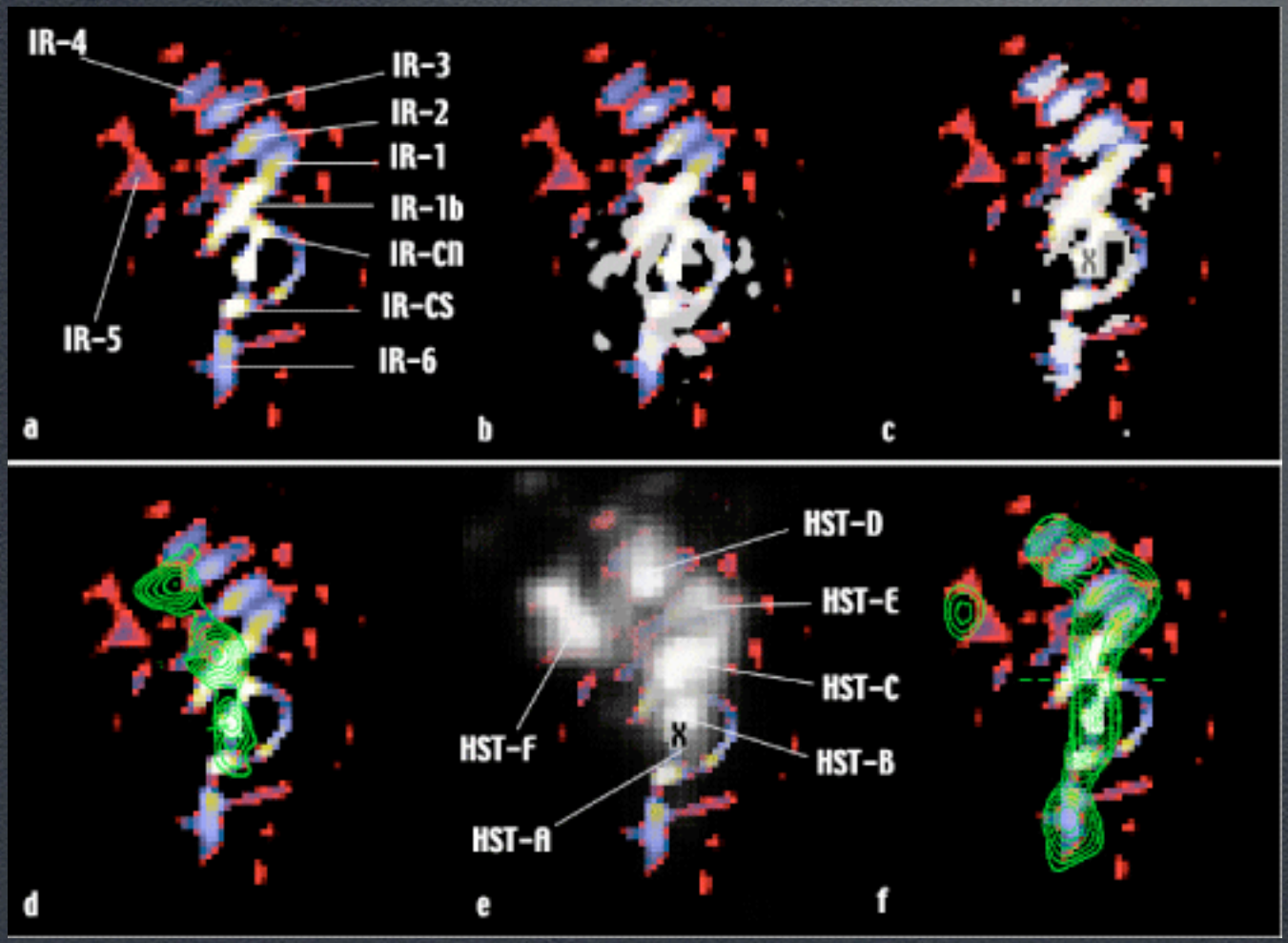


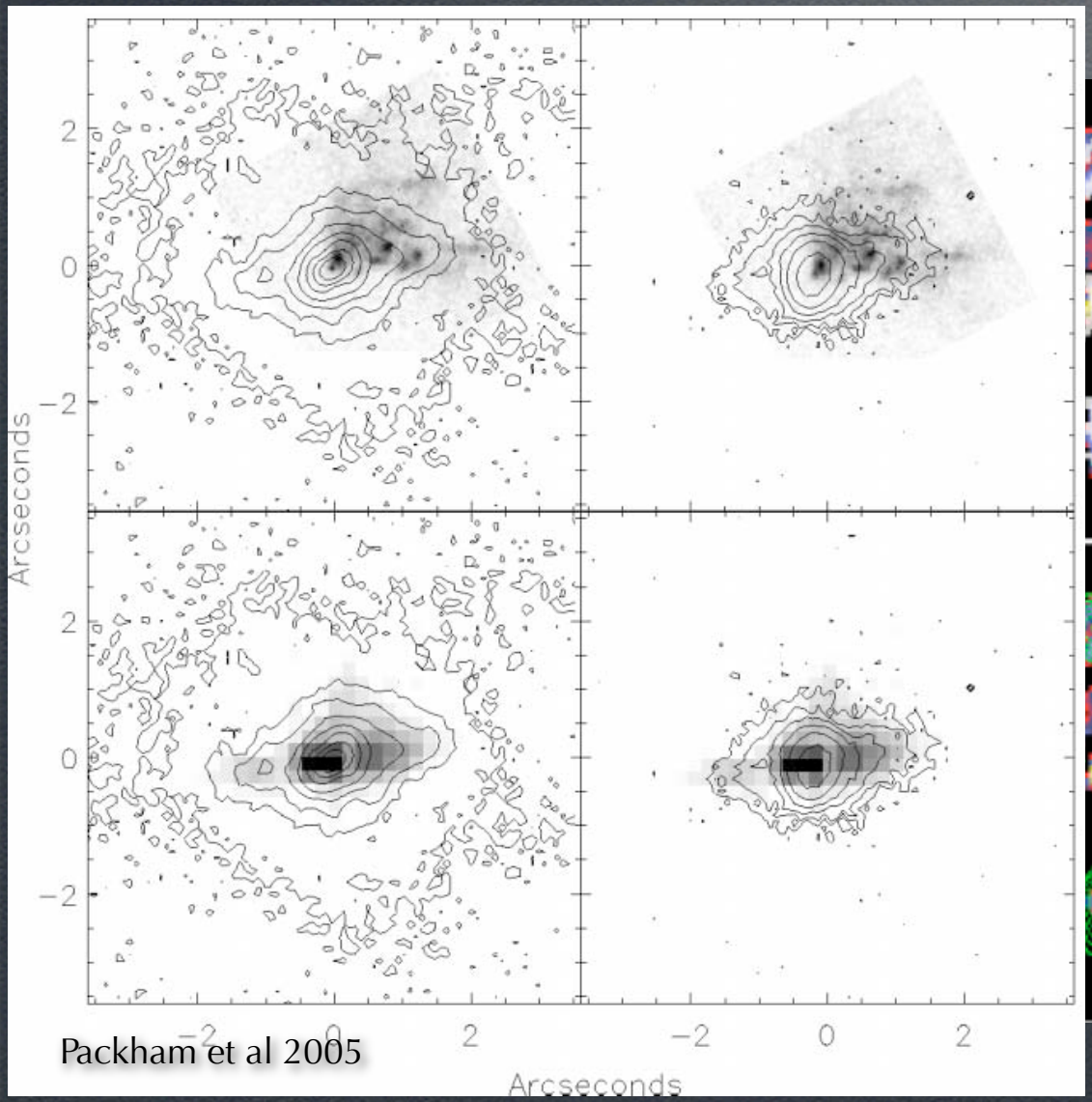
Extended Emission



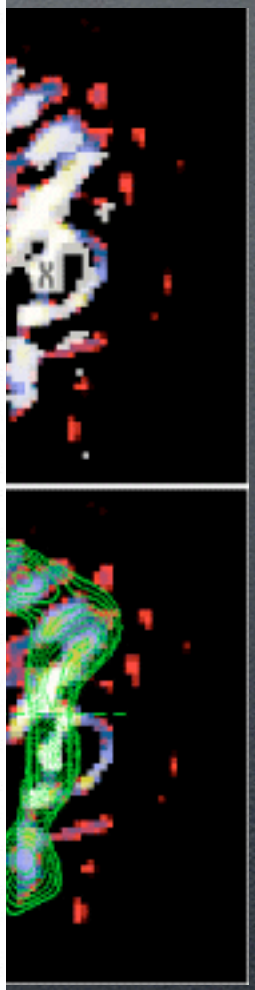
Gratadour et al 2006

- Extended IR emission observed in Nearby AGN
- NGC1068
- Circinus

Extended Emission



Packham et al 2005



- Extended IR emission observed in Nearby AGN
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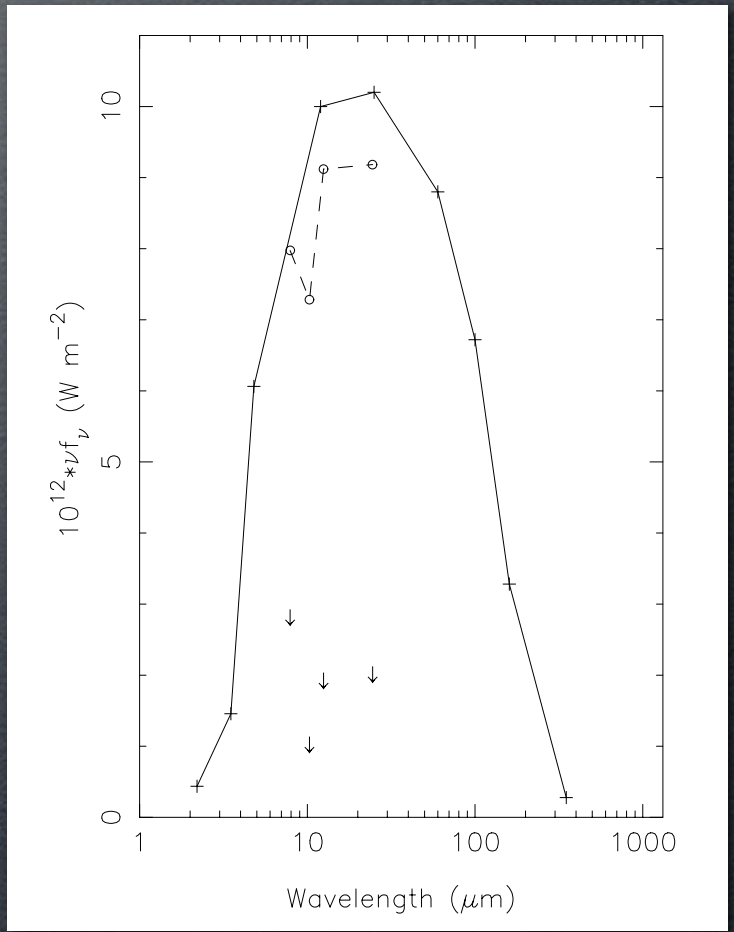
Doughnut Bump or Diffuse IR?

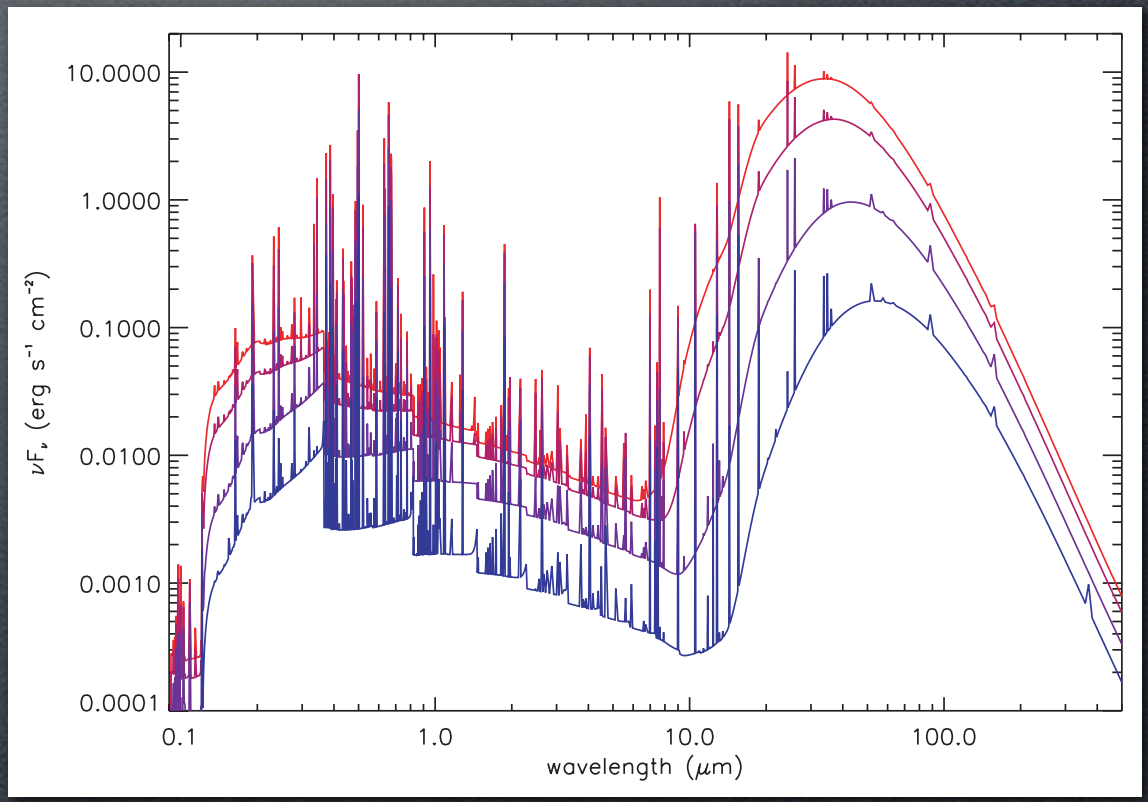
- Torus dominated IR?
- Observations by Bock suggest only ~25% arises from AGN nucleus
- 75% must come from extended source -
  - Star formation
  - ...NLR?



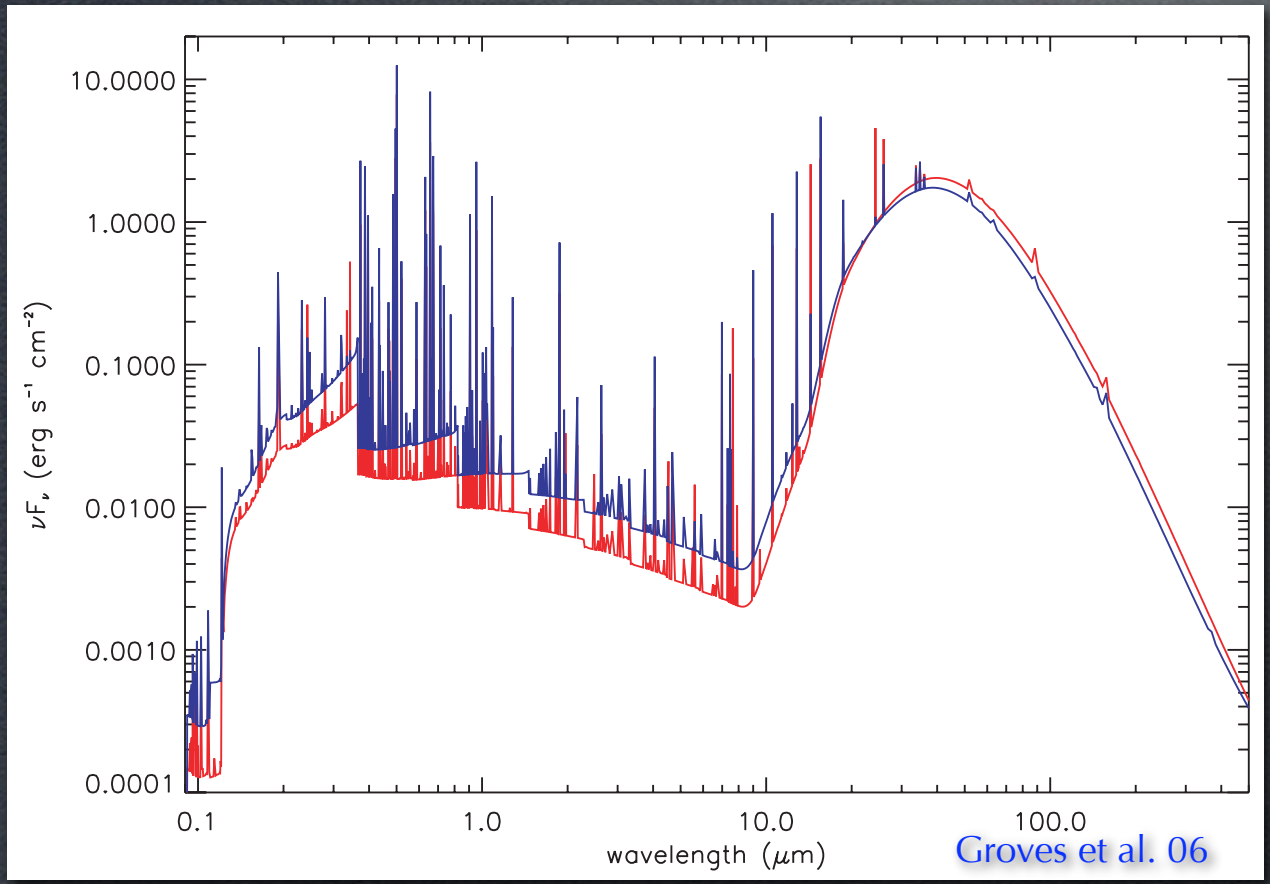
Bock et al 2000

Marvelous Mapping Models

- Based on NLR models of Groves et al (2004)
- Kept Metallicity at $1Z_o$
- Varied Pressure
  - $P/k=10^6,10^7,10^8$ K cm^{-3}
- And incident Flux
  - 4.0,3.0,2.0,1.0,0.5,0.25, & 0.1x I_0
- I_0 Giving Typical NLR ionization parameters

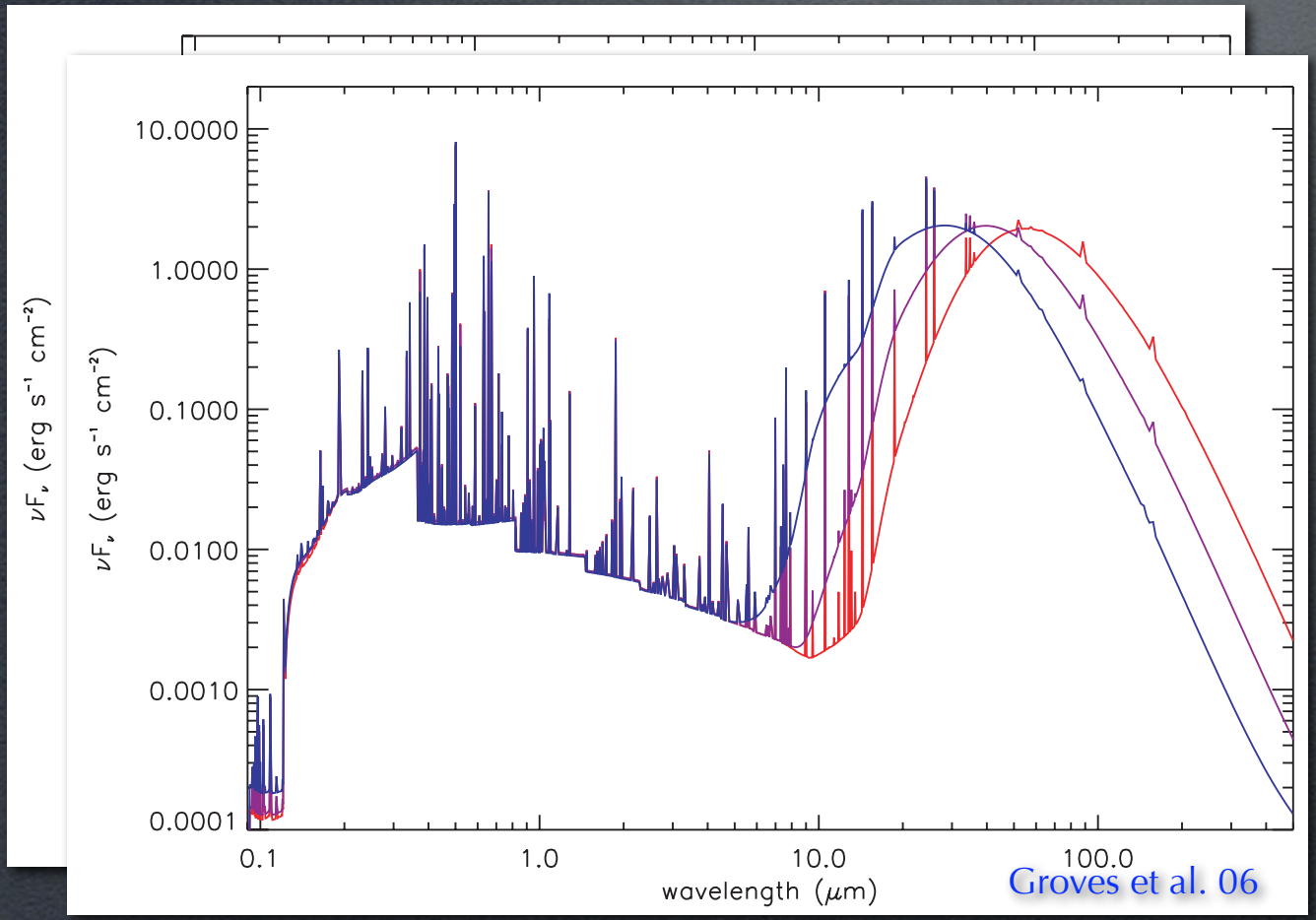


Profiling Parameters



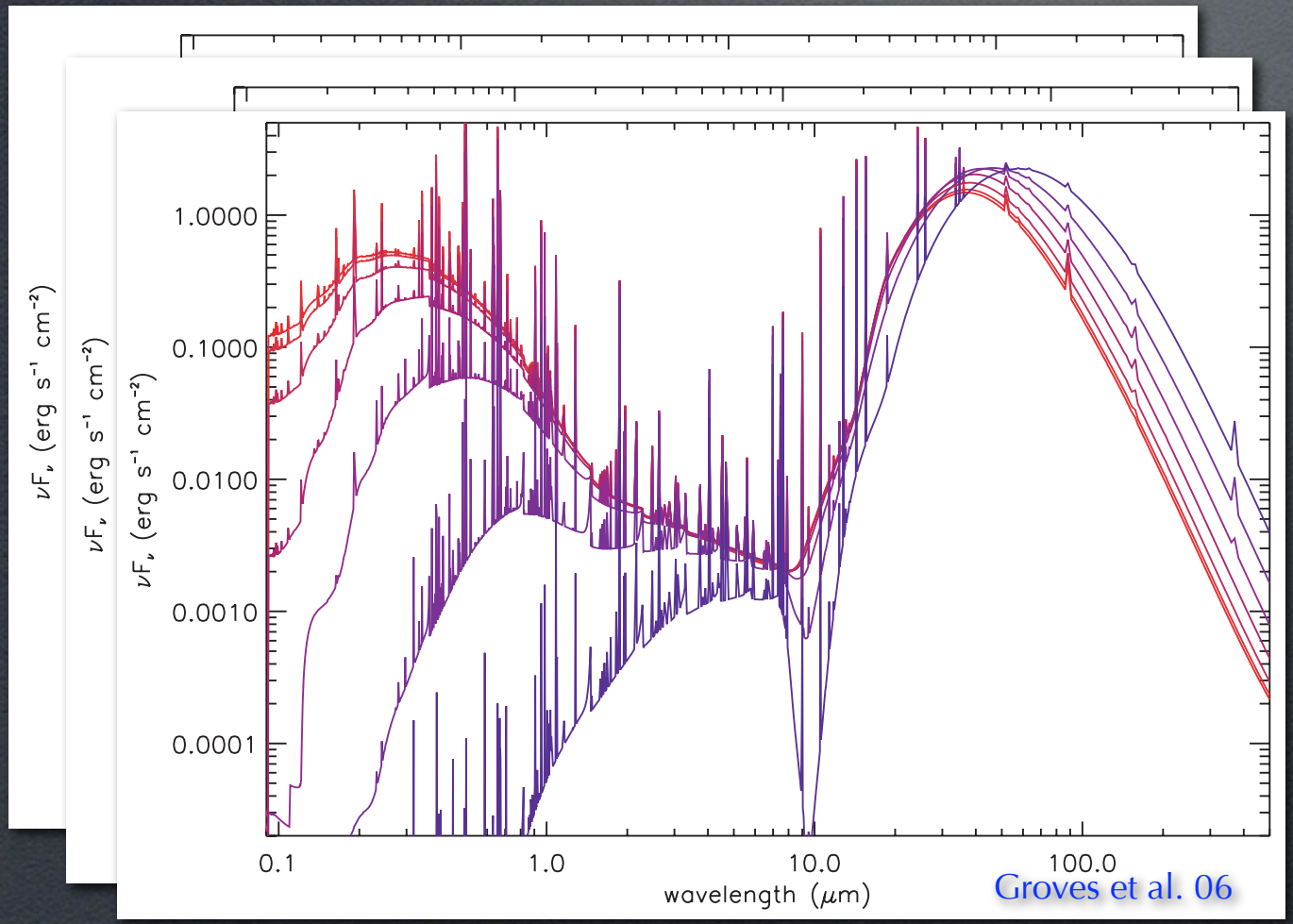
- Same incident flux, different Pressures
- ∴ different Ionization parameters
- IR feature ~ same, but gas emission obviously different
- Some affects due to greater dust absorption ($\propto U$)

Profiling Parameters



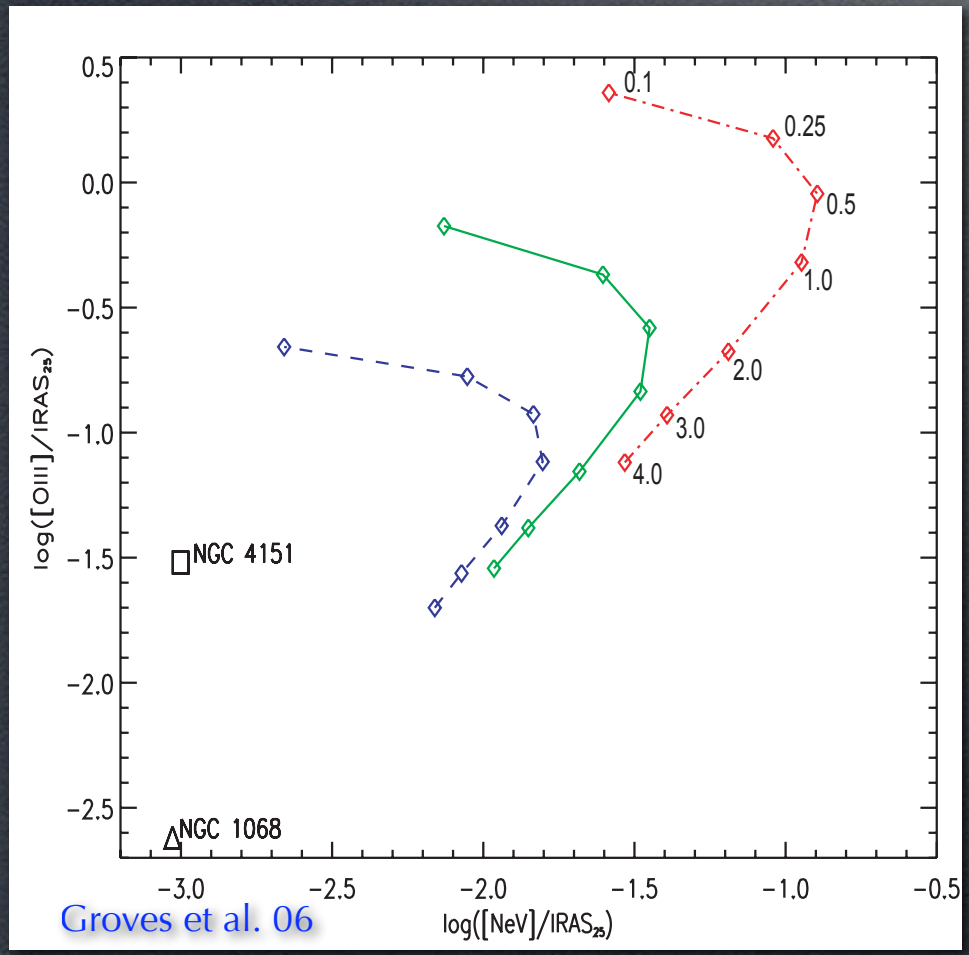
- Same Ionizing parameter, different Incident flux
- Scaled to remove flux effect
- Clearly shows dependance of IR emission on I_0.
- Gas emission depends on *U* *(weakly on P)*

Profiling Parameters



- Increasing optical depth from log N(HI) =20 to 24
- IR feature ~ constant at short wavelength
- just increases overall IR flux

The NLR contribution?



Groves et al. 06

- Lines [OIII]500.7nm & [NeV]14.3 μm with respect to IRAS 25 μm flux
- Observations about 1 dex off - NLR contributes 10%?
- NGC 4151 relatively stronger [OIII] to NGC 1068 - Obscuration?

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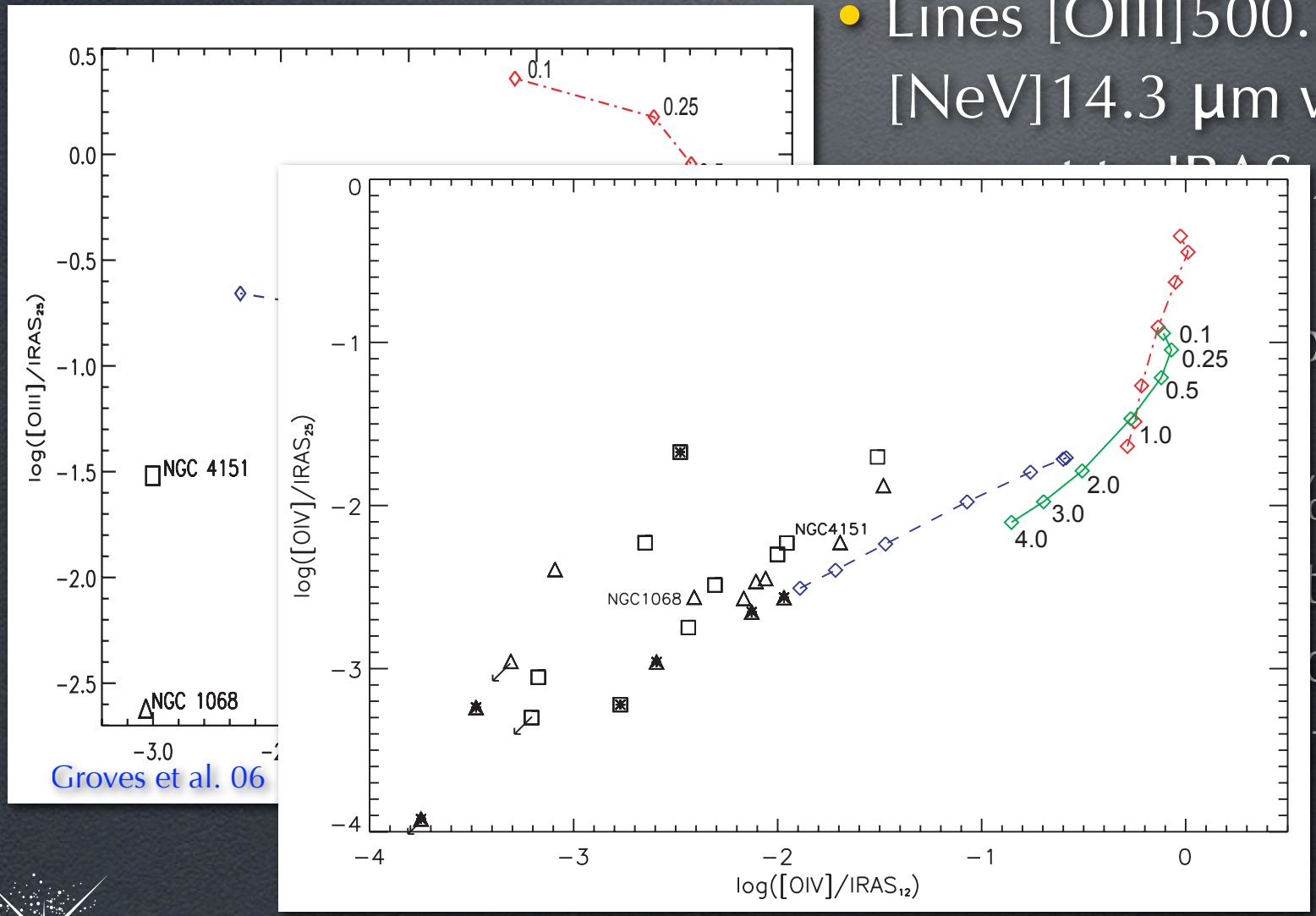
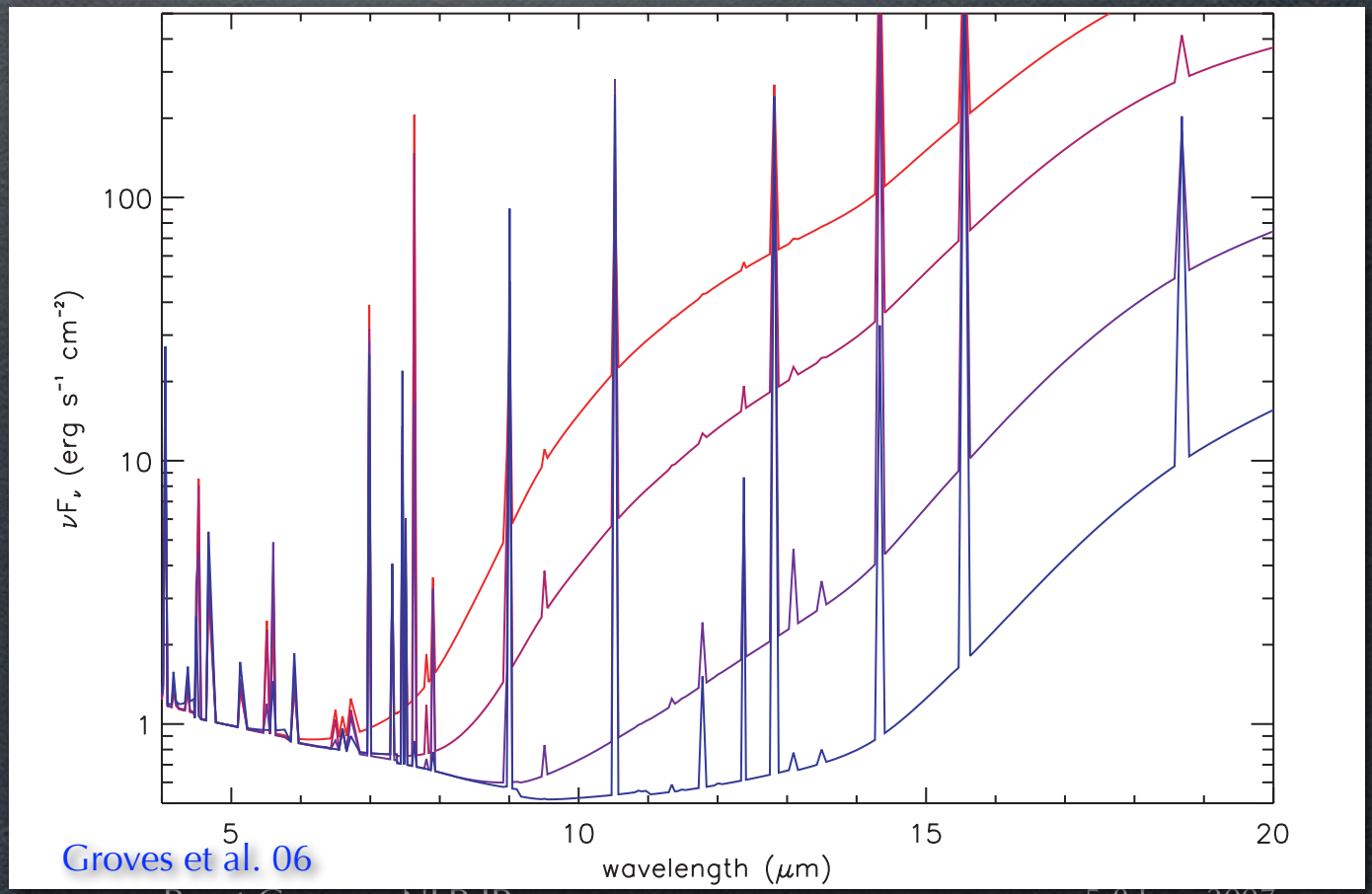


Groves et al. 06

Today's Feature: Silicate!

- The NLR dust can even reach temperatures where the silicate emission features begin to appear

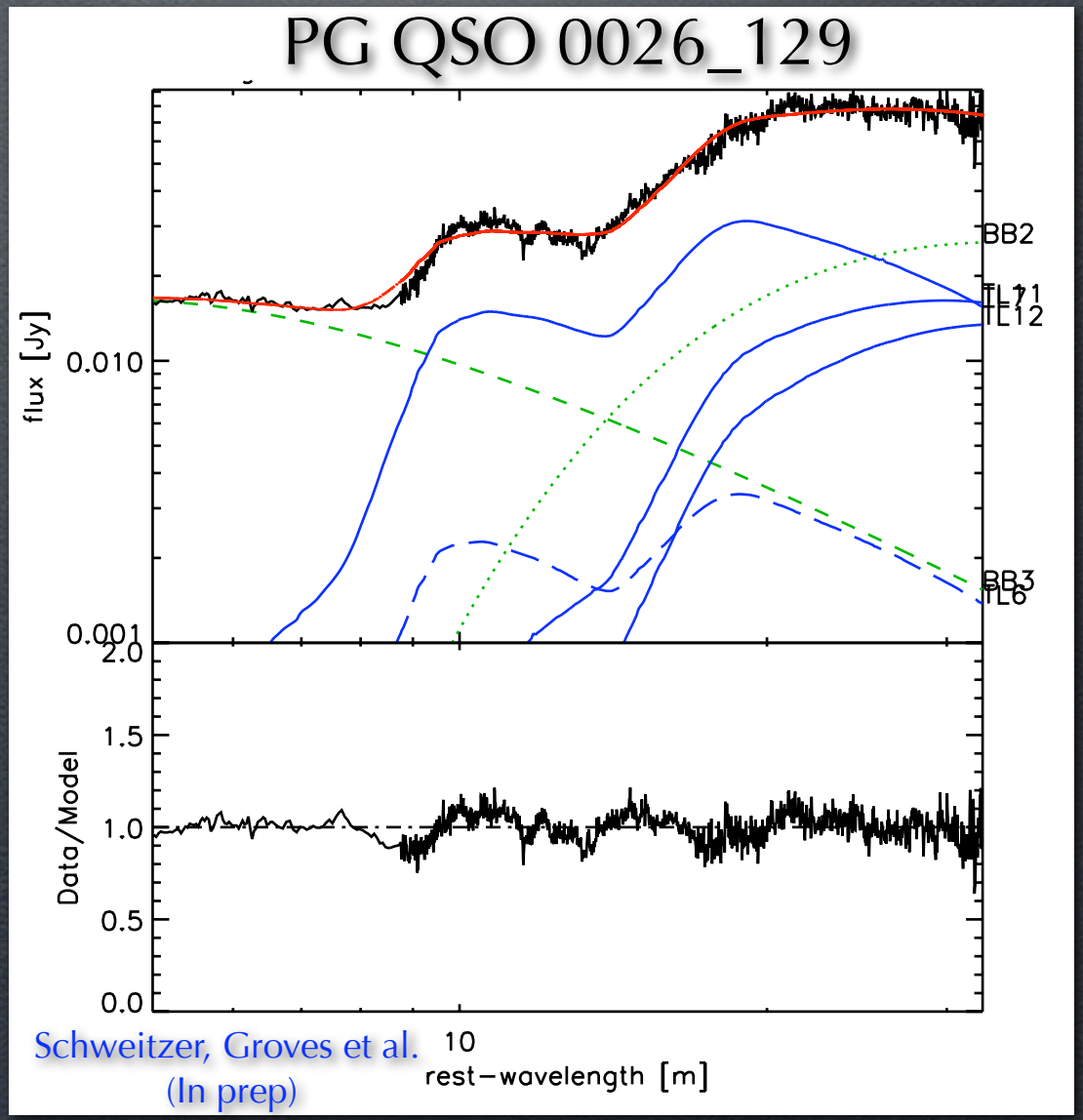
- Features appear at highest I_0
- Not limited to the Torus!



Groves et al. 06

NLR dominated QSO?

- Quest Survey QSOs
- Fit the IRS spectra with:
  - NLR models
  - Hot BB (Torus)
  - warm/cool BB (Star formation?)



Schweitzer, Groves et al. (In prep)

NLR dominated QSO?

- Quest Survey QSOs
- Fit the IRS spectra with:
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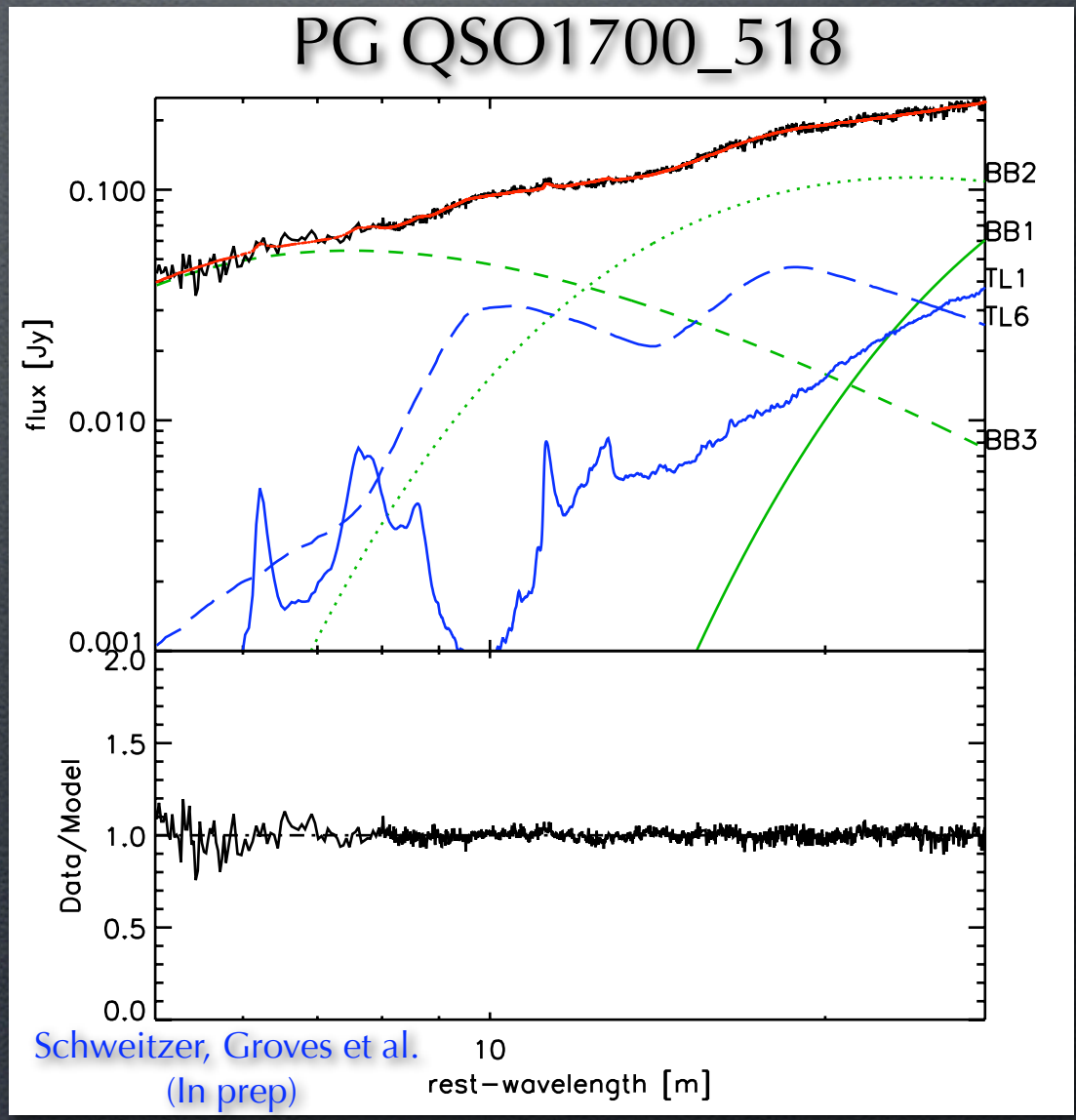
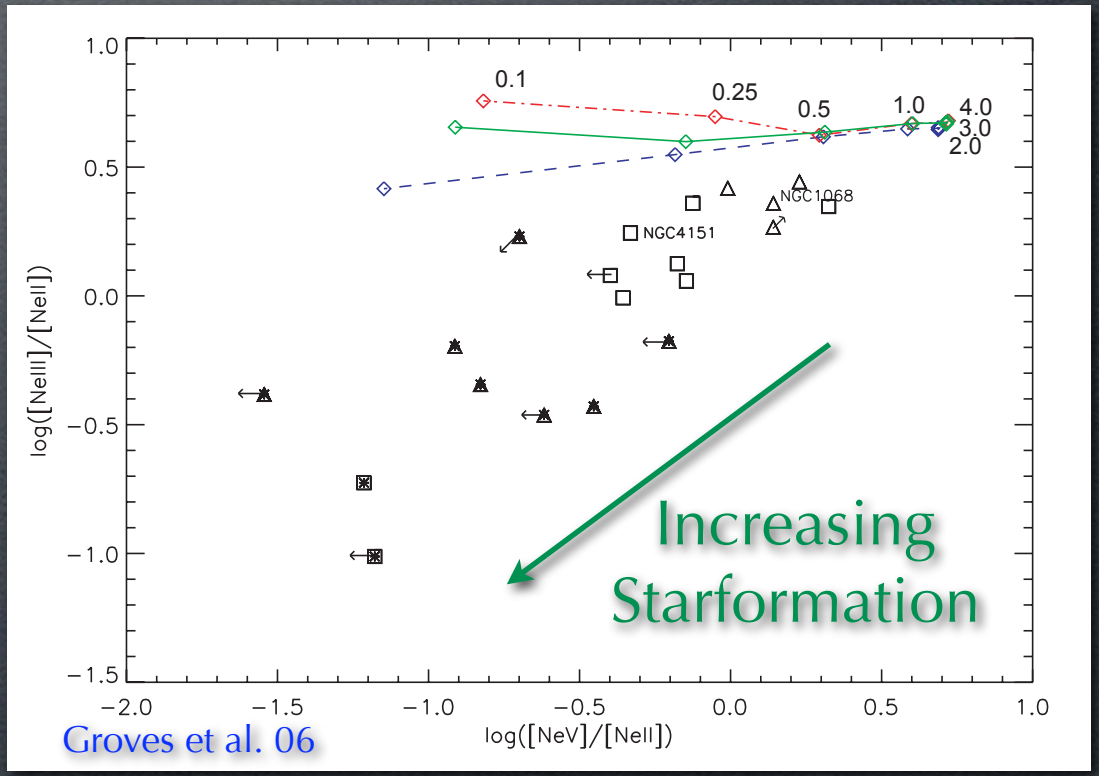
  - warm/cool BB (Star formation?)
  - M82 for PAHs



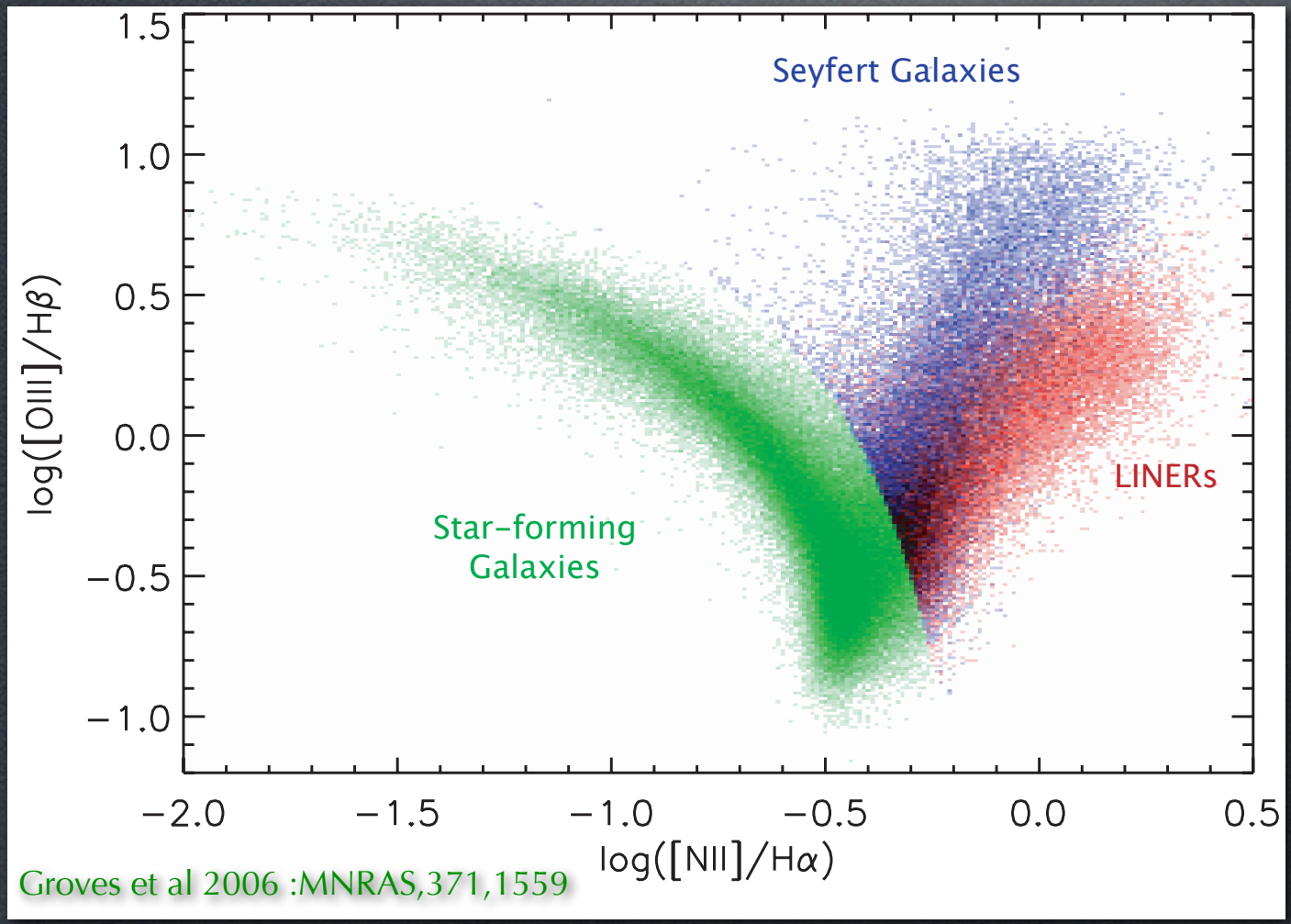
Knowing Neon

- Neon ratios very sensitive to Ionization mechanism
- NeV is from AGN, while NeIII & NeII from both AGN & SB
- However Average ionization state of AGN higher - Higher [NeIII] 15.5/[NeII] 12.8
- AGN- Star formation Diagnostics?



Groves et al. 06

Distinguished Diagnostic Diagrams?



Groves et al 2006 :MNRAS,371,1559

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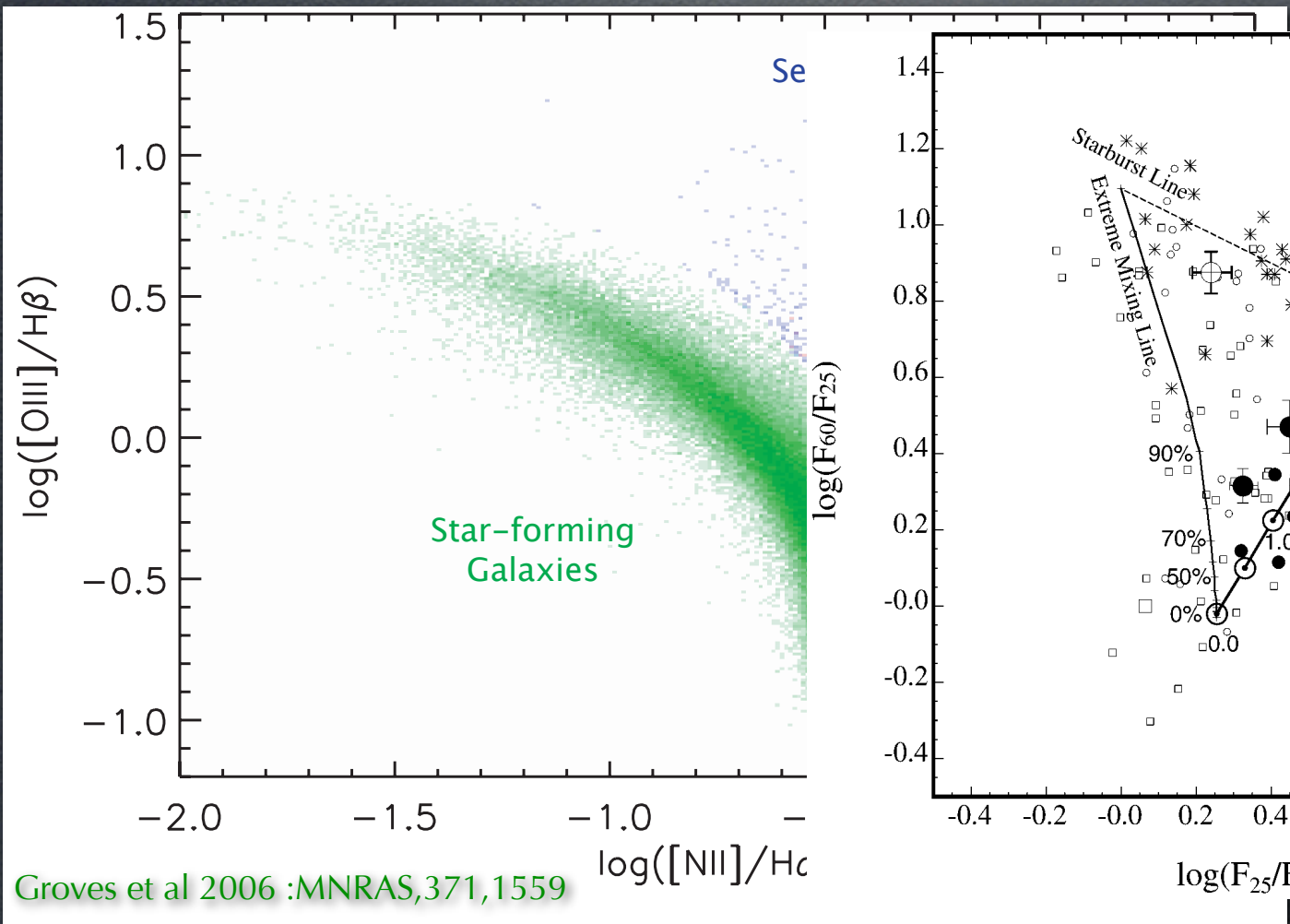

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Dopita et al. 98

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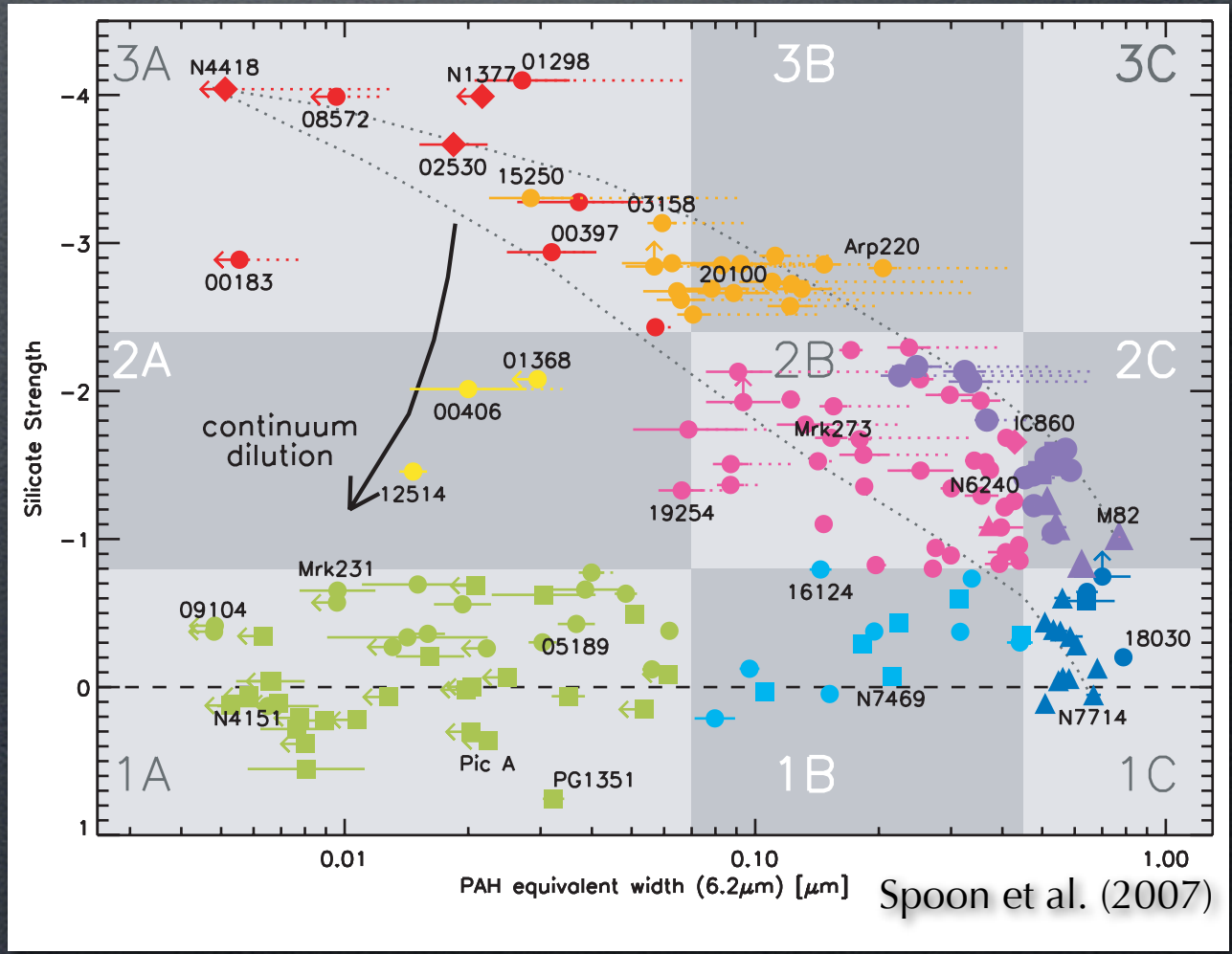

Spoon et al. (2007)

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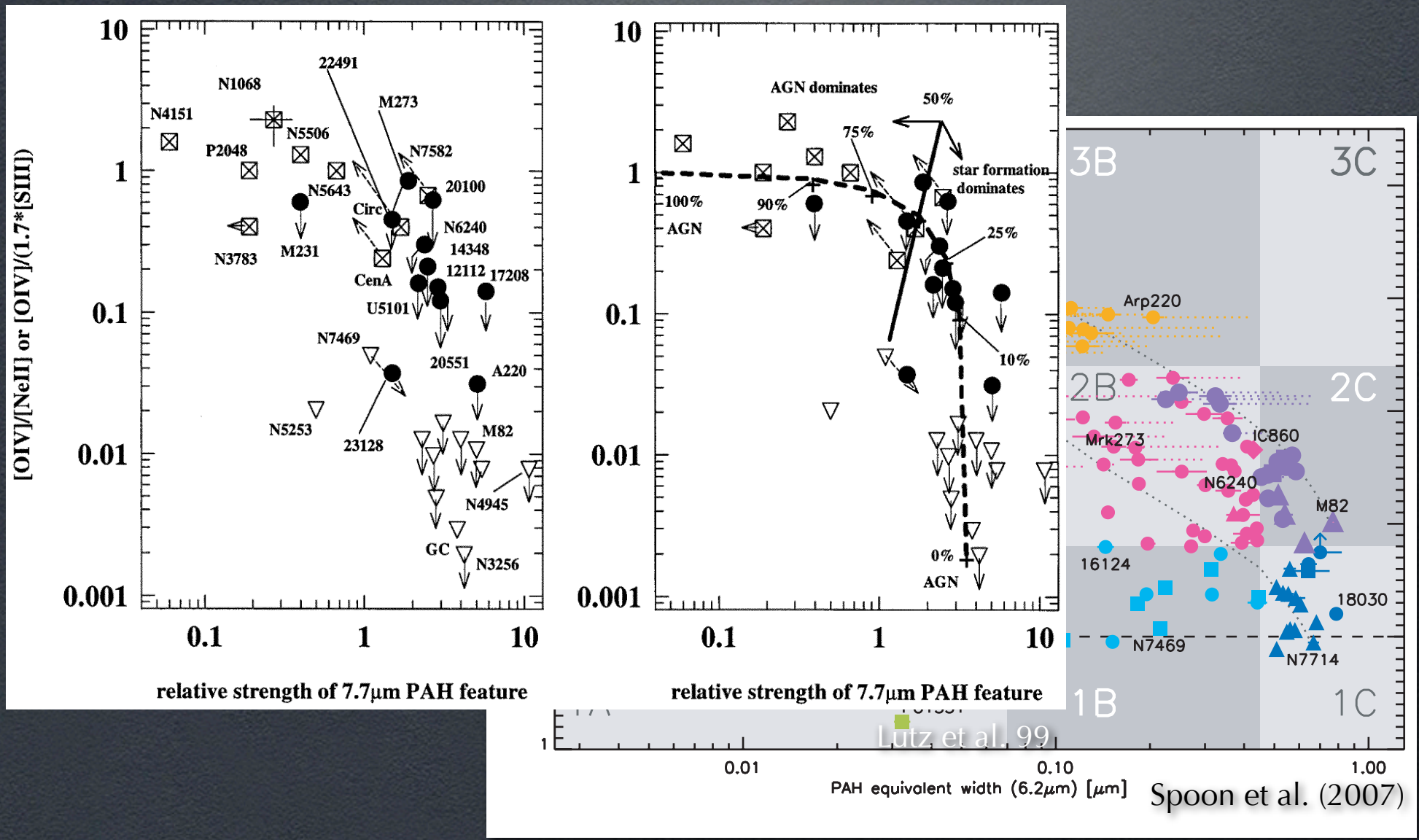
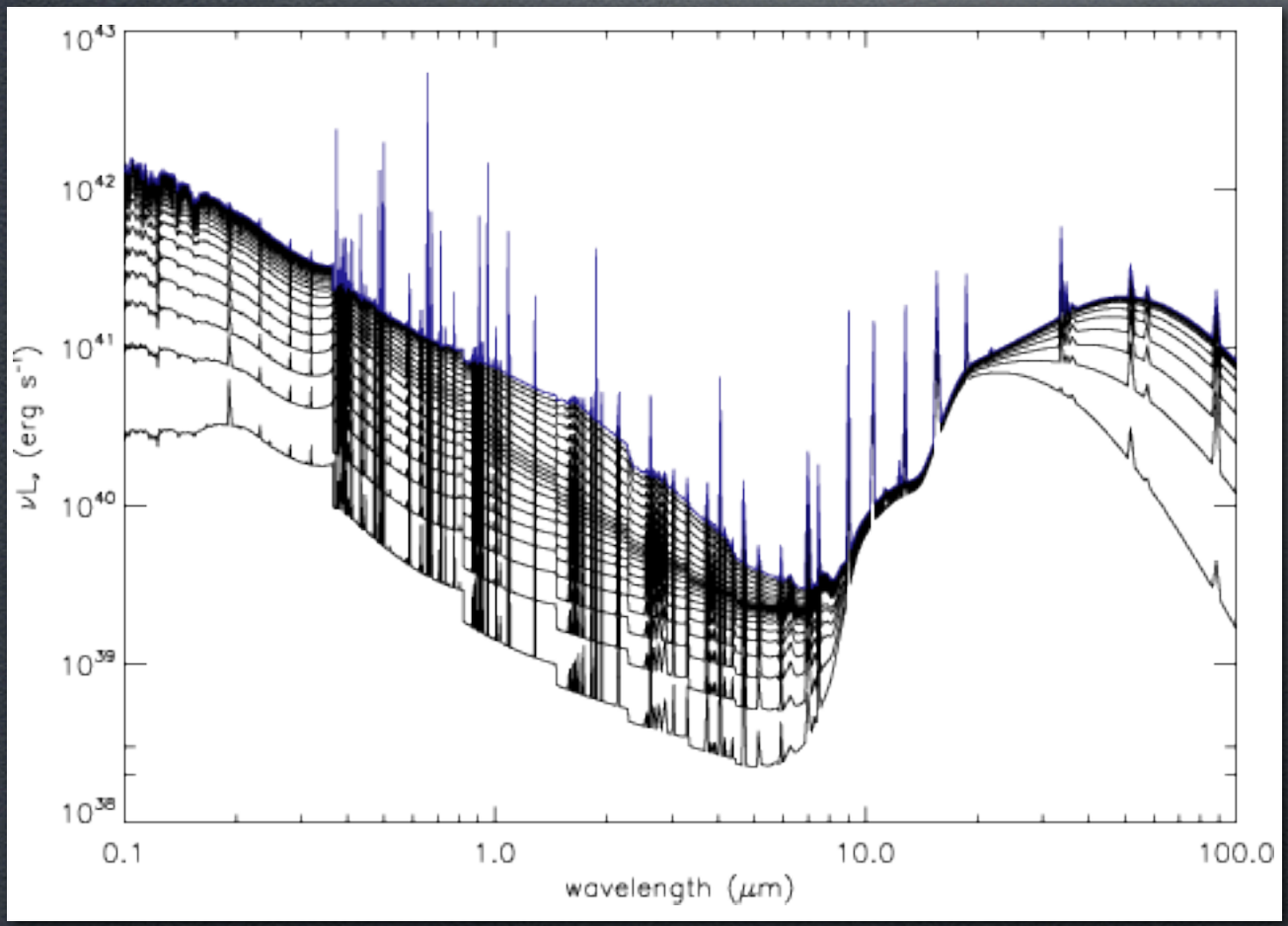


Summing a Starburst?



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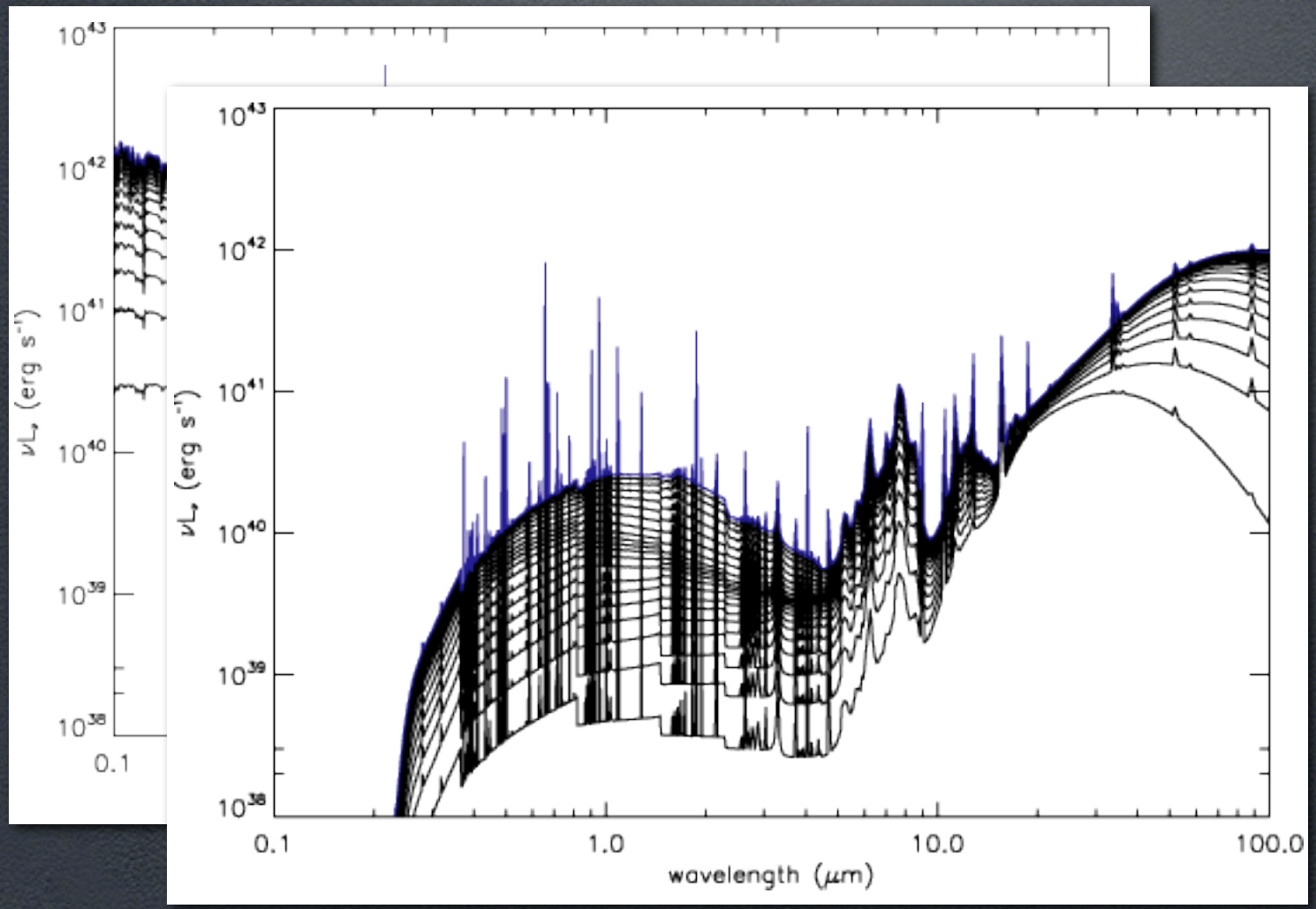

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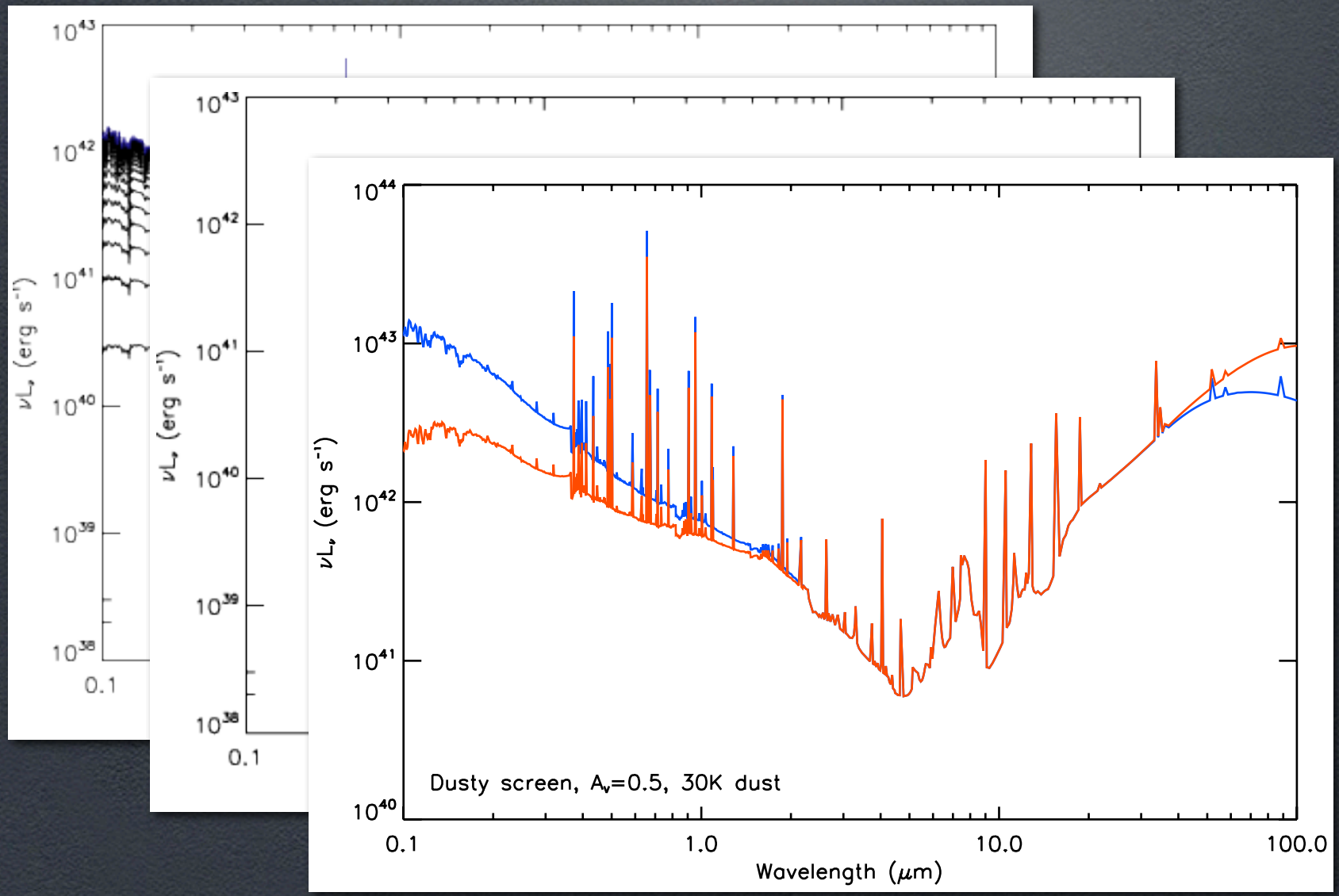

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Sterrewacht Leiden

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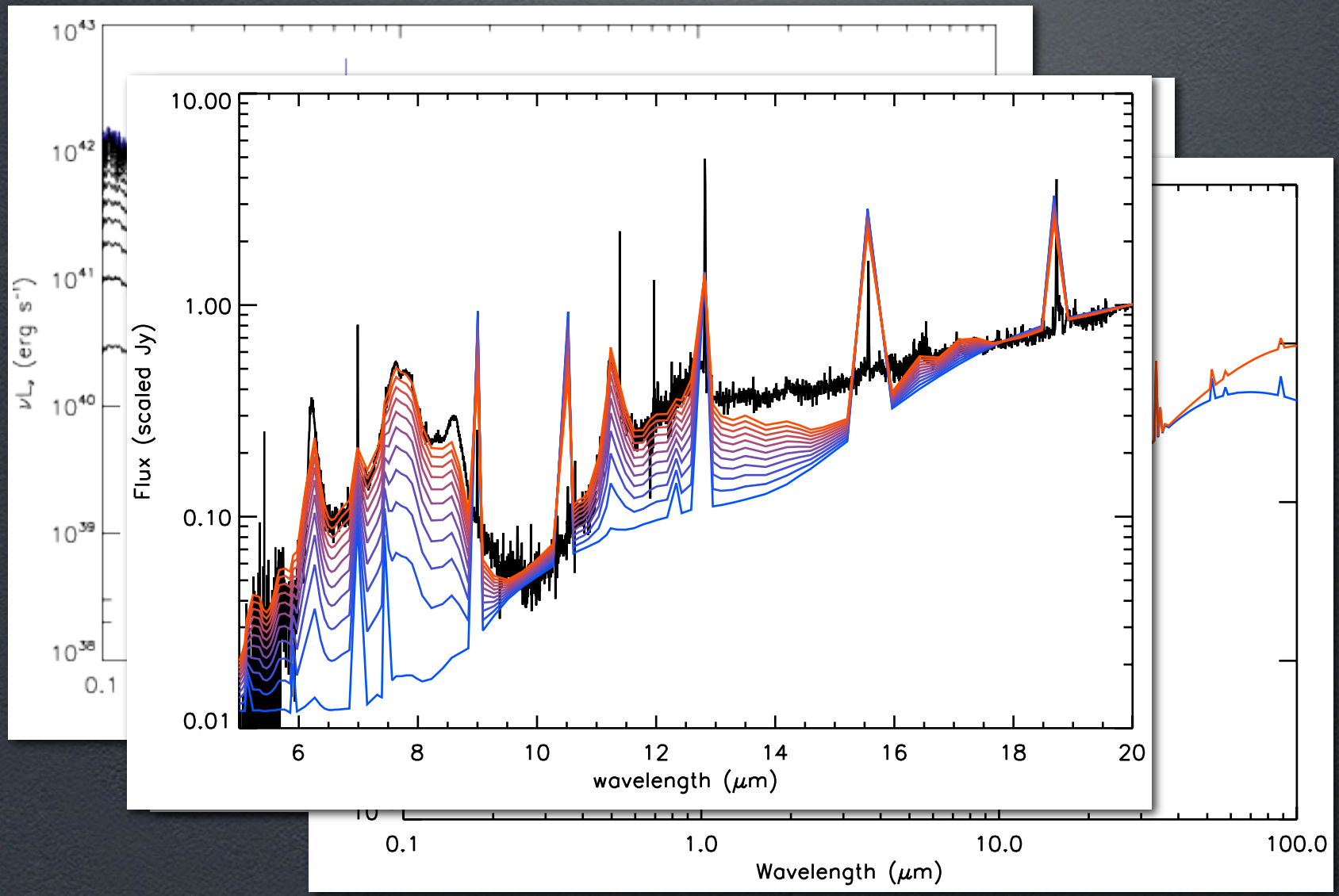

Groves, Dopita et al. 07 (in prep.)

The NLR: Important or Not?

- Both Observations and Modelling support the idea that dust is extant through the NLR
- Observations suggest that this may be a large contributor to the total AGN IR emission

The NLR: Important or Not?

- We ran a series of NLR models to compare the line emission with IR continuum
- Models suggest only ~10% of the total IR arises from the NLR
- Warning! : models are limited in Geometry
- Also Shocks may be a contributor to the NLR emission (e.g. Contini et al 2004)

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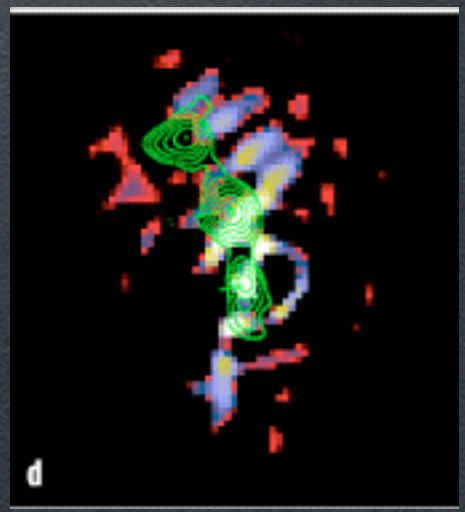

The NLR: Important or Not?

- These models have also suggested another possible Star formation/ AGN diagnostic with the IR Neon ratios
- And, with upcoming Starburst models, mean we are one step closer to being able to provide fully theoretical SEDs for active galaxies