SED models of galactic nuclei
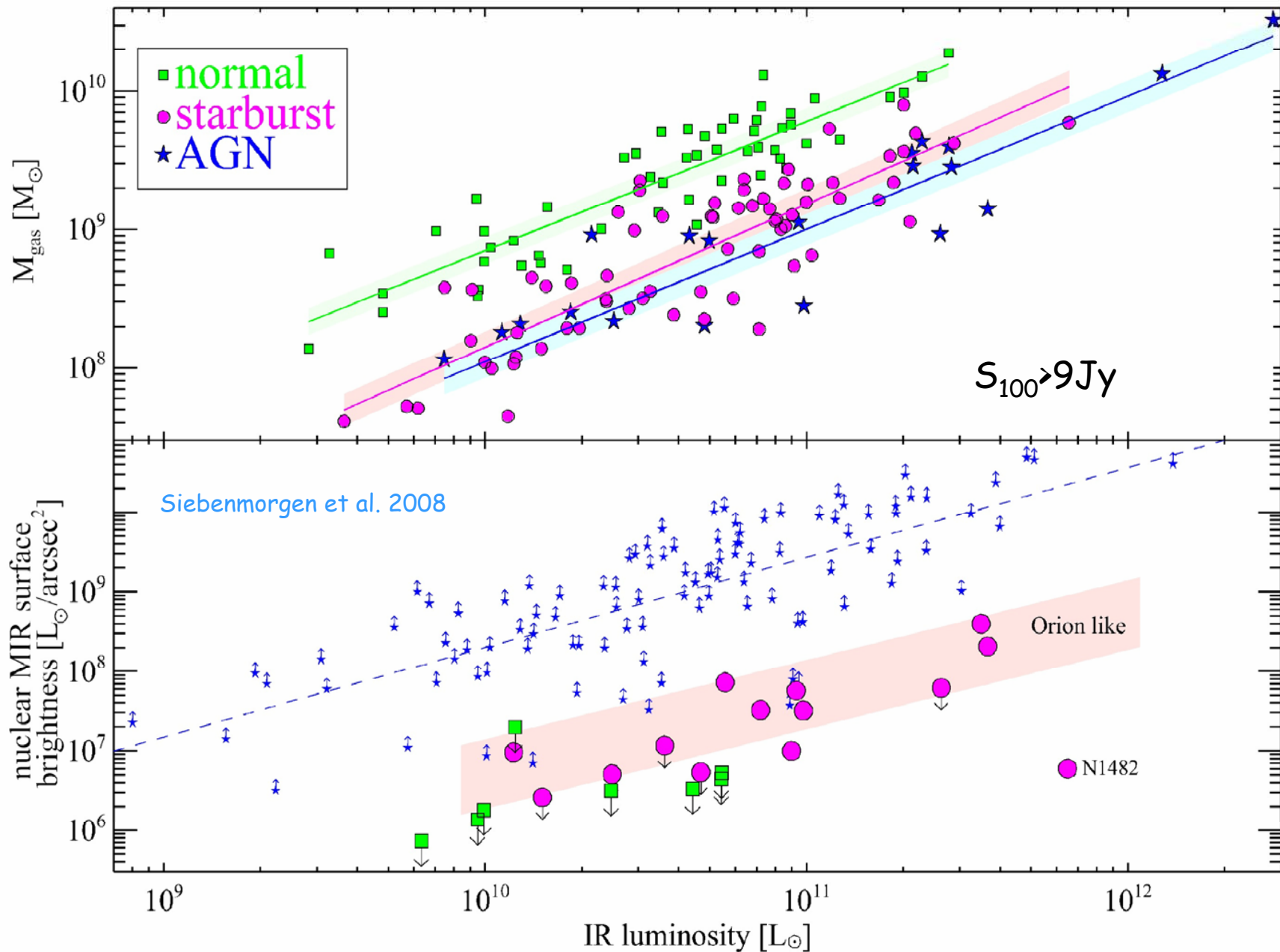
Observation:

IR imaging
spectroscopy
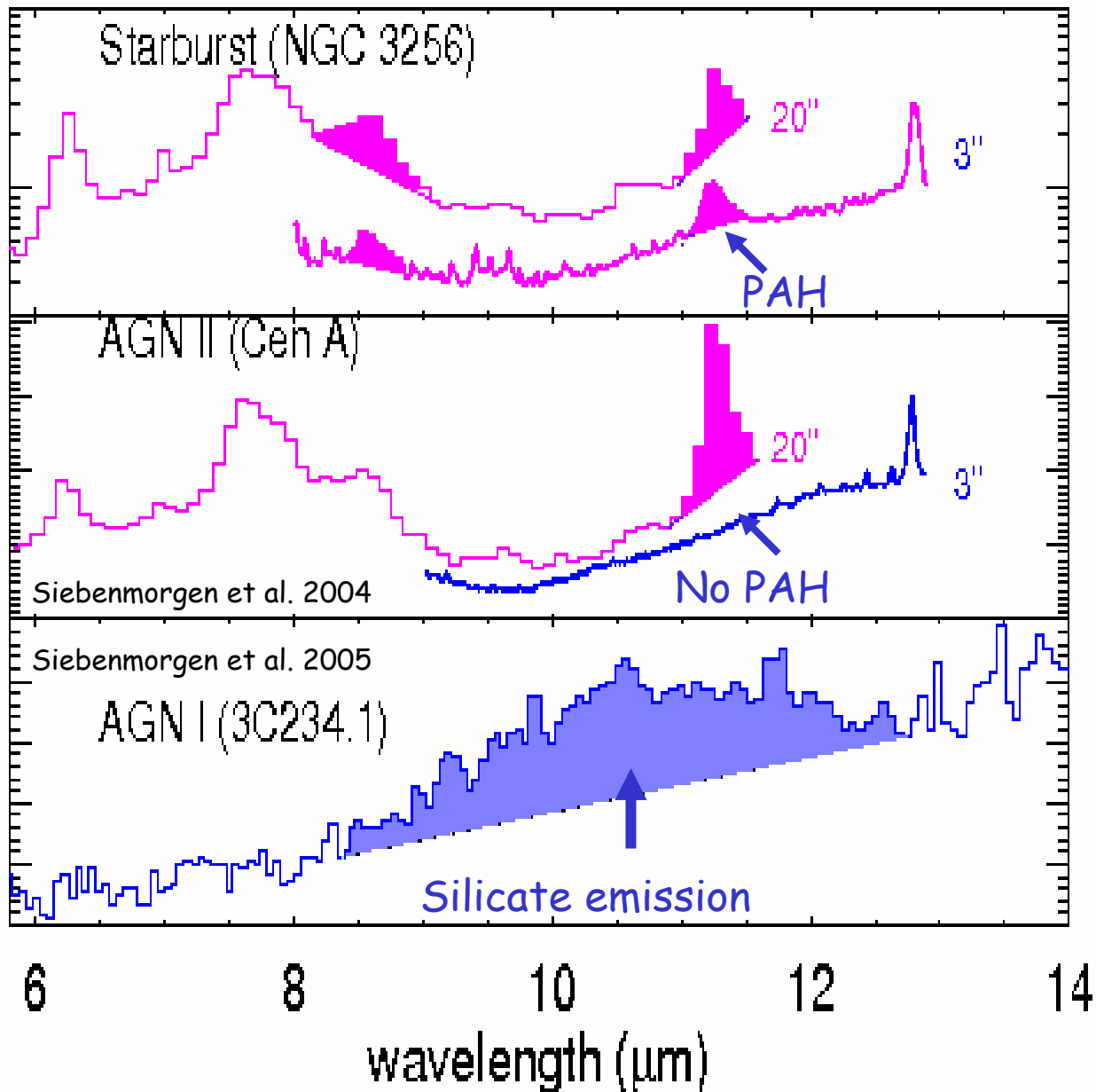
Starburst: SED library

AGN: dust <-> X-ray's: ->   PAH destruction
geometry, clumps -> Monte Carlo

14.12.07   Ralf Siebenmorgen

MIR Imaging

Siebenmorgen et al. 2008

$S_{100} > 9$Jy

Legend: normal, starburst, AGN

Axes: M_{gas} [$M_\odot$], nuclear MIR surface brightness [$L_\odot$/arcsec^2], IR luminosity [$L_\odot$]

Orion like

N1482

MIR spectroscopy

Ralf Siebenmorgen

Dust radiative transfer model

- **Intensity (ray tracing)**

$$I(\tau) = I_0 \cdot e^{-\tau} + \int_0^\tau S(x) \cdot e^{x-\tau} dx$$

- **Source function**

$$S = \frac{1}{\kappa^{ext}} \cdot \left[\kappa^{sca} \cdot J^{ISRF} + \epsilon^{dust} + \epsilon^{bulge} + \epsilon^{HS} \right]$$

- **Dust emission**

$$\epsilon_\nu = \kappa^{ext} \int B_\nu(T) P(T) dT$$

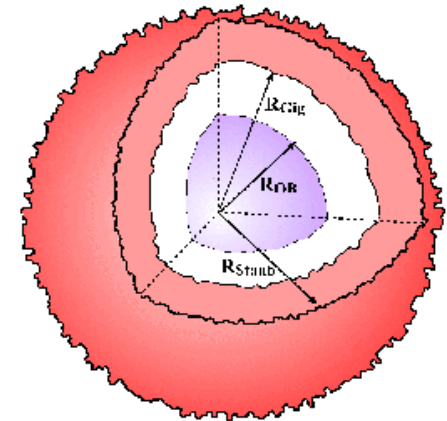- **Stars** distributed in disk

1. $naked$ OB + old $bulge$:
$$\epsilon_\nu^{bulge}(r) = n^{bulge}(r) L_\nu^{bulge}$$

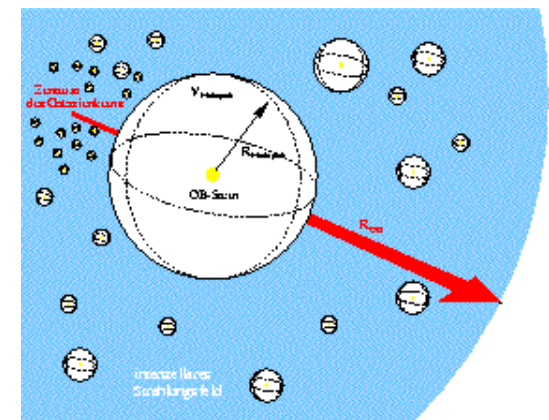2. $OB \ embedded \ in \ MC$ (**hot spots**) :
$\epsilon_\nu^{HS}(r)$: need radiative transfer solution
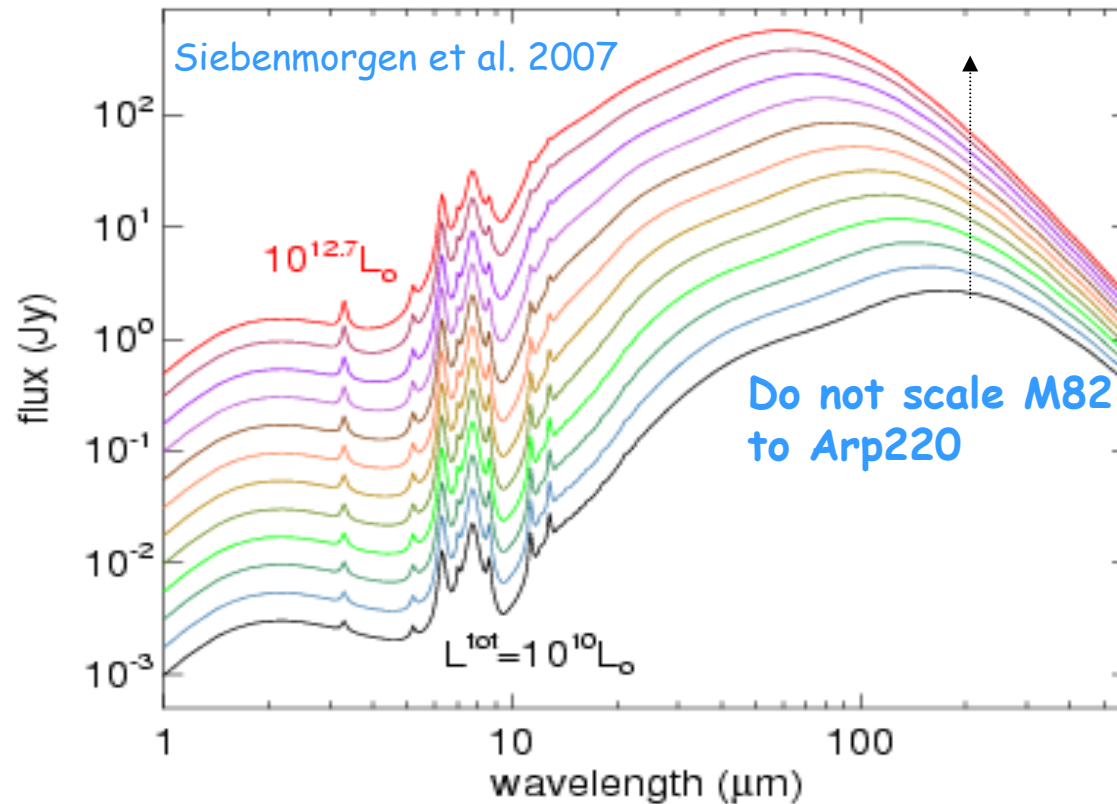with boundary conditions:
r_{in} – evaporation
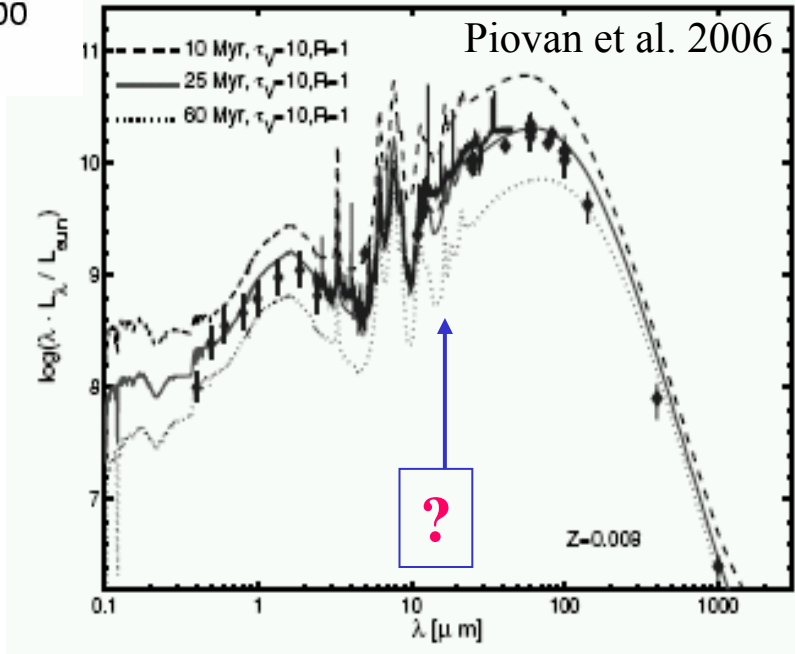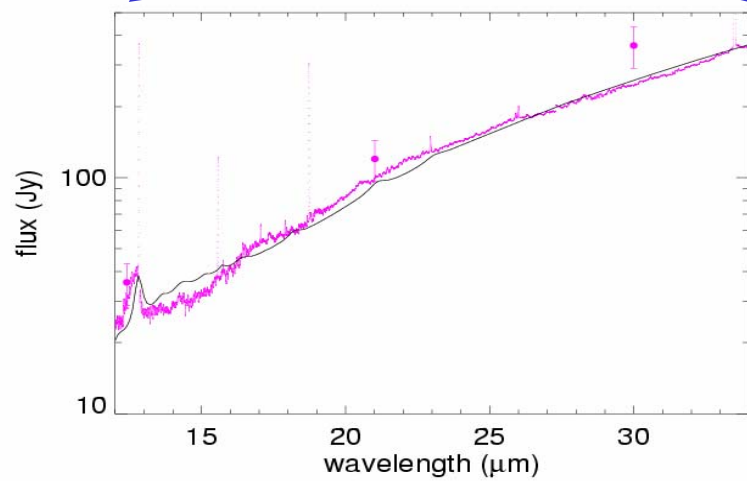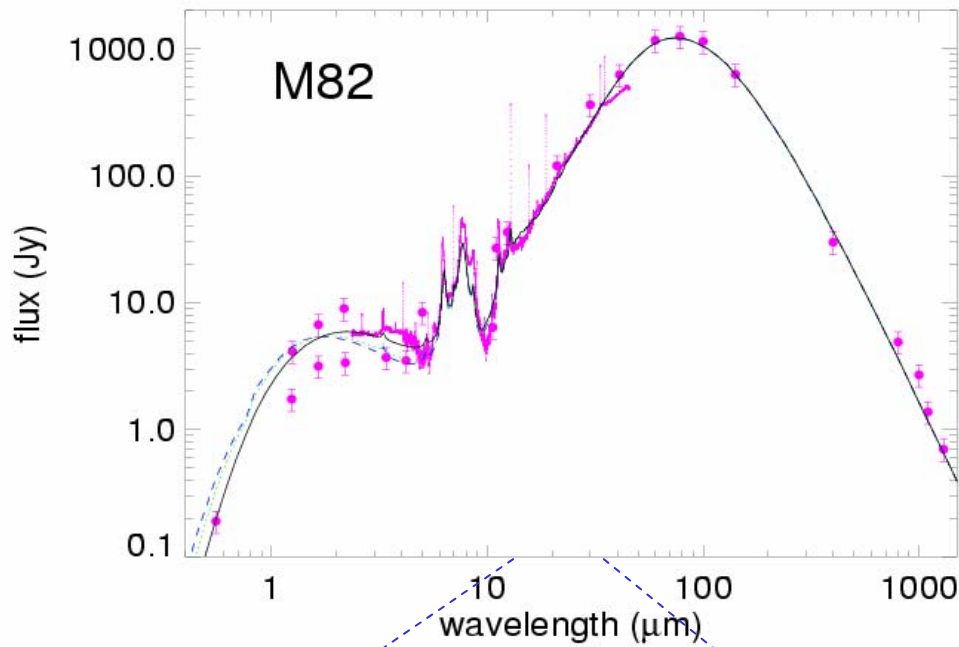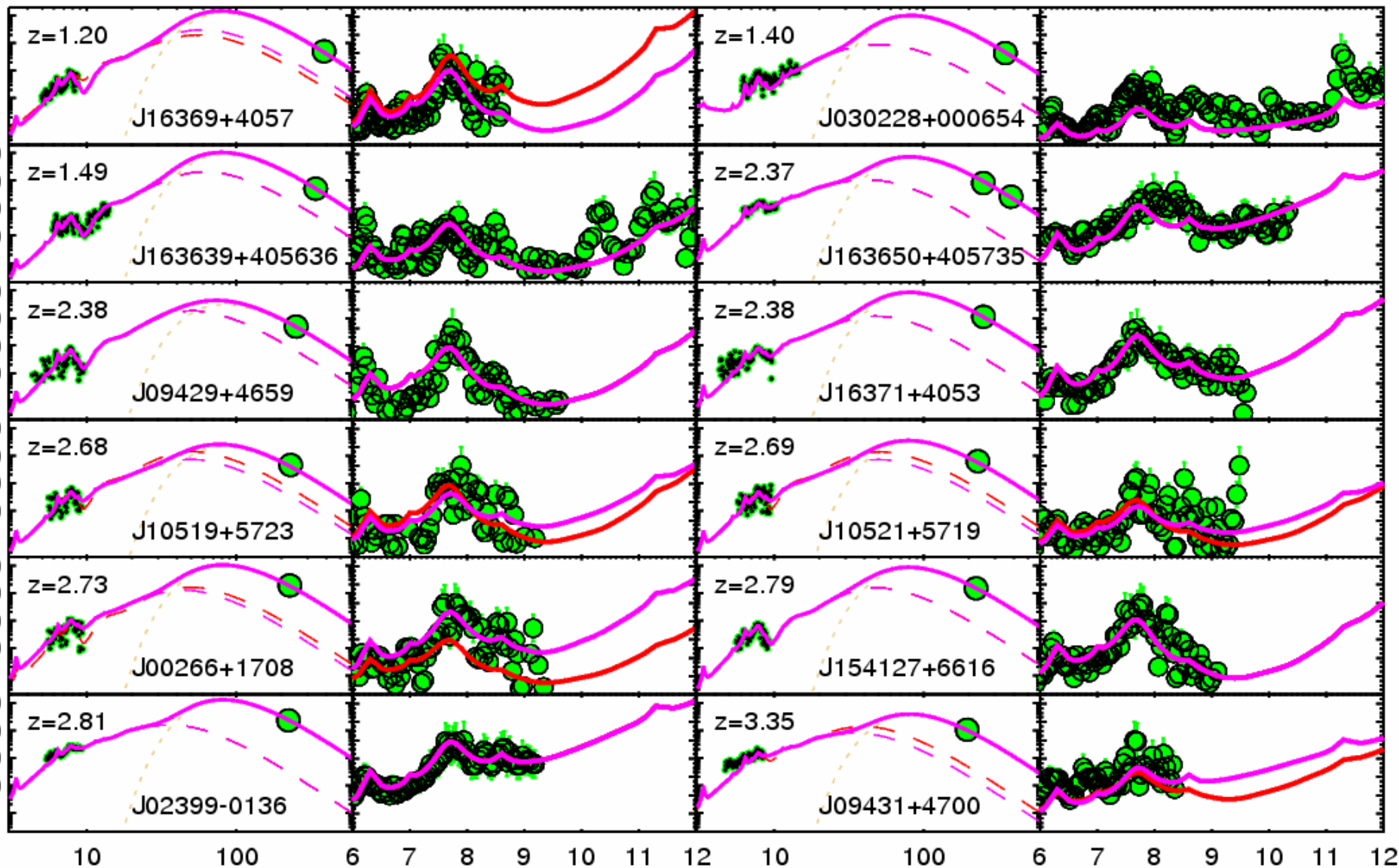r_{out} – heating as ballance of star and galaxy

Krügel & Siebenmorgen (1994)

SED model library
www.eso.org/~rsiebenm

1. Luminosity
2. Radius
3. Mass

Siebenmorgen et al. 2007

$10^{12.7} L_\odot$

$L^{tot} = 10^{10} L_\odot$

flux (Jy)

wavelength (µm)

Do not scale M82 to Arp220

14.12.07   Ralf Siebenmorgen

M82

Piovan et al. 2006

14.12.07 Ralf Siebenmorgen

SED library fit SMG

SED library viz Spitzer

8μm+24μm
-> luminosity
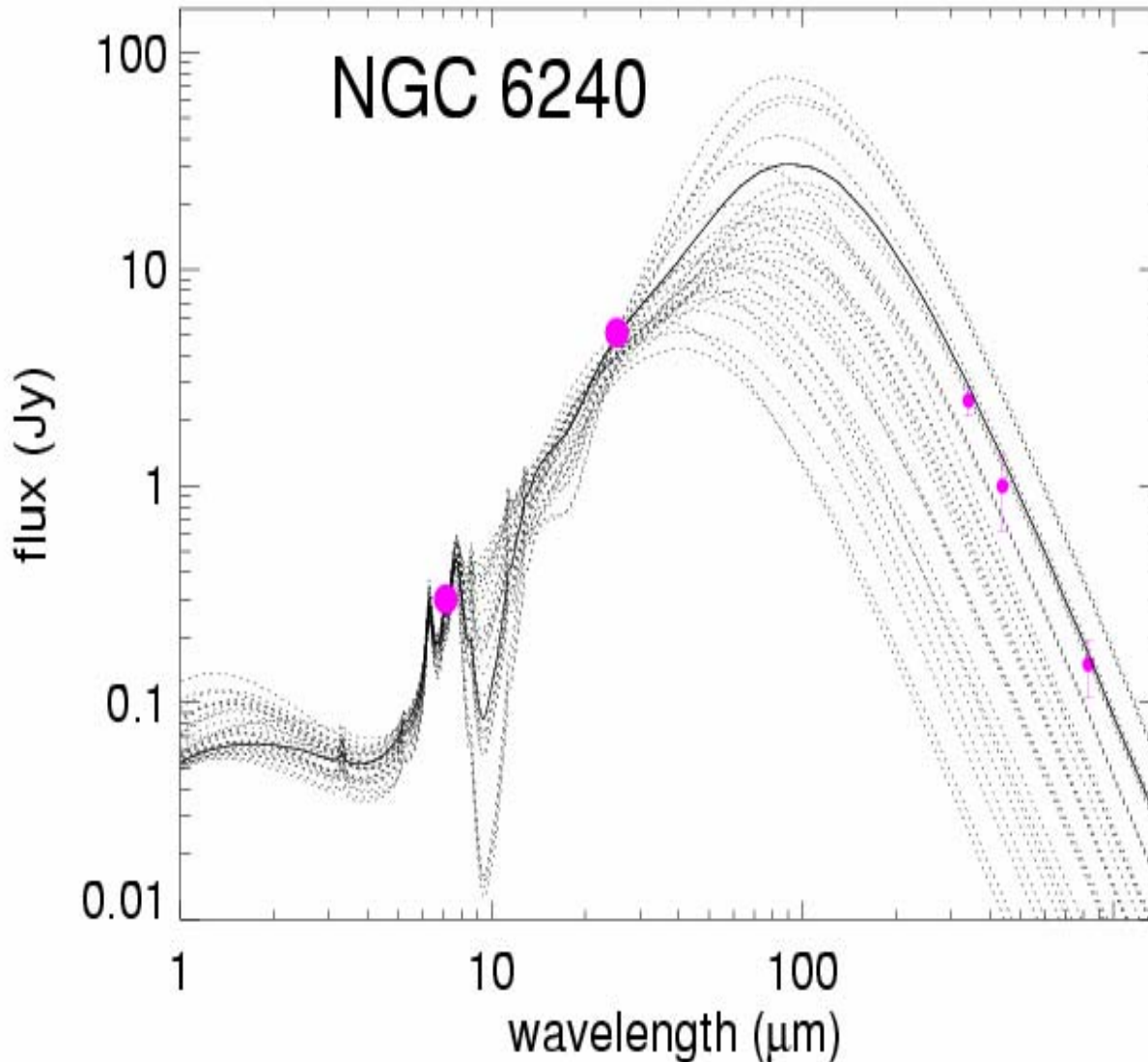
8μm+24μm+submm
-> SED

AGN models: dust + X-rays
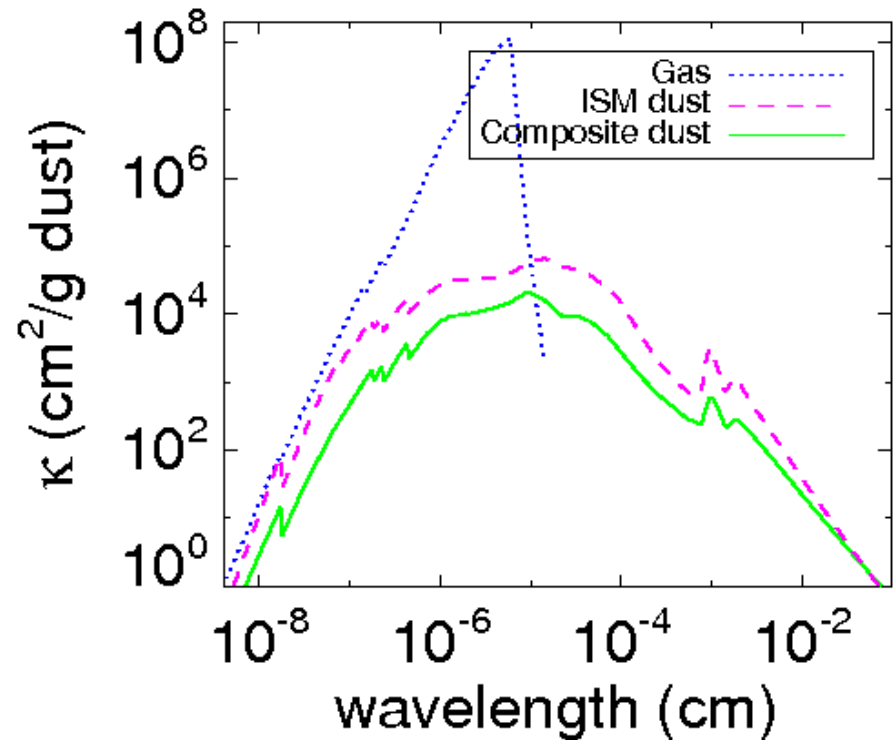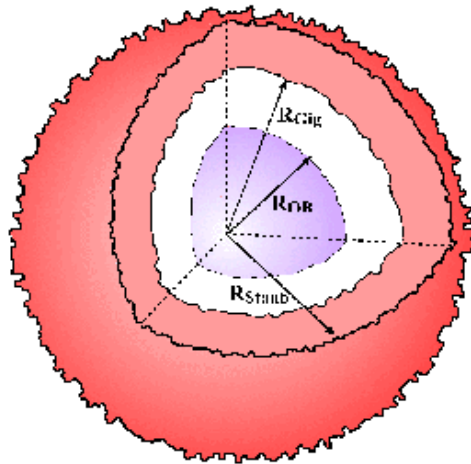
Limits of Mie theory:

hν > 100eV   -> photo e⁻

            -> $\kappa^{abs} > \kappa^{em}$

PAH destruction by X-rays (I)

Ralf Siebenmorgen
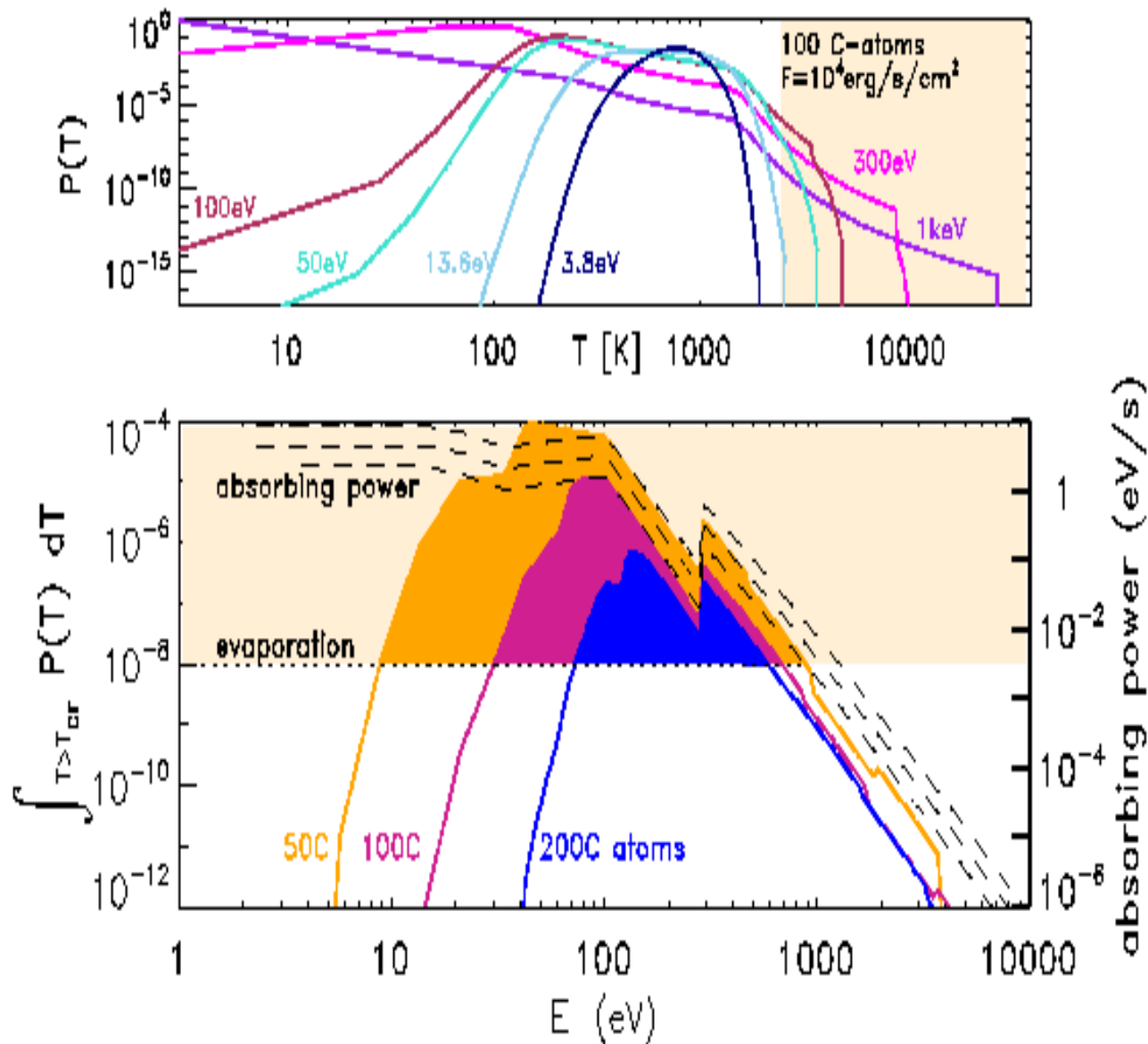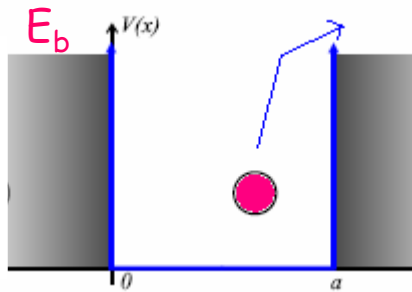
PAH destruction (II)
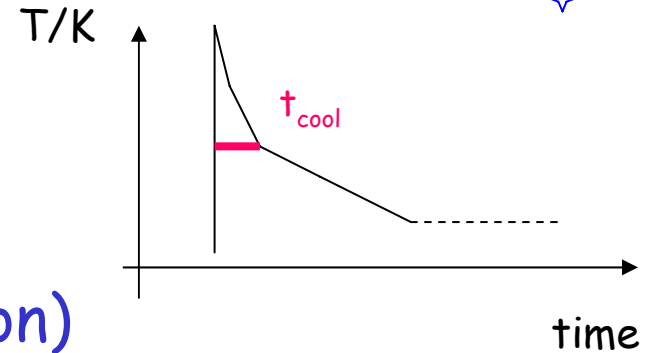
Thermal hopping:

$P_2/P_1 = \exp[-E_b/kT]$ (Boltzman distribution)
$P_2 + P_1 = 1, \; P_2 \ll 1$

Dissociation time:

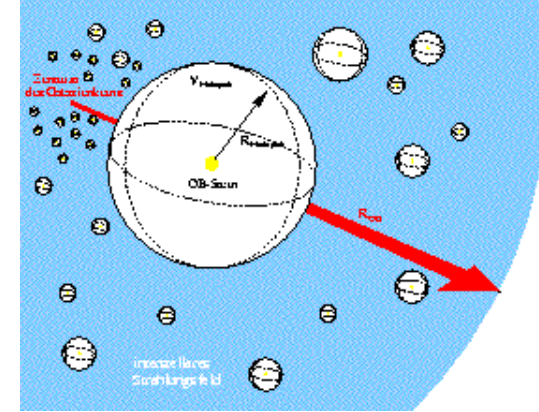$t_d = \exp(E_b/kT) / v_0 \quad < \quad t_{cool}/f \sim 1s$

$T_m = E_b/k \; \ln(v_0) = 2000K$

$\Delta E = 3 N_c \, k T_m \quad \sim 0.1 \, N_c \cdot E_b \quad \Rightarrow \quad N_c < 2 \, \Delta E \, /[eV] \quad$ (PAH unstable)
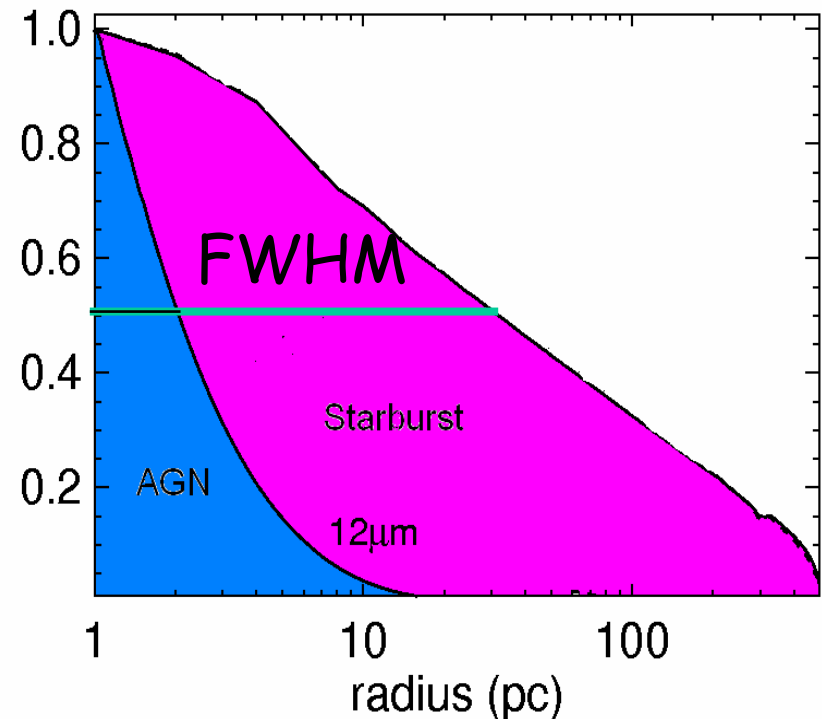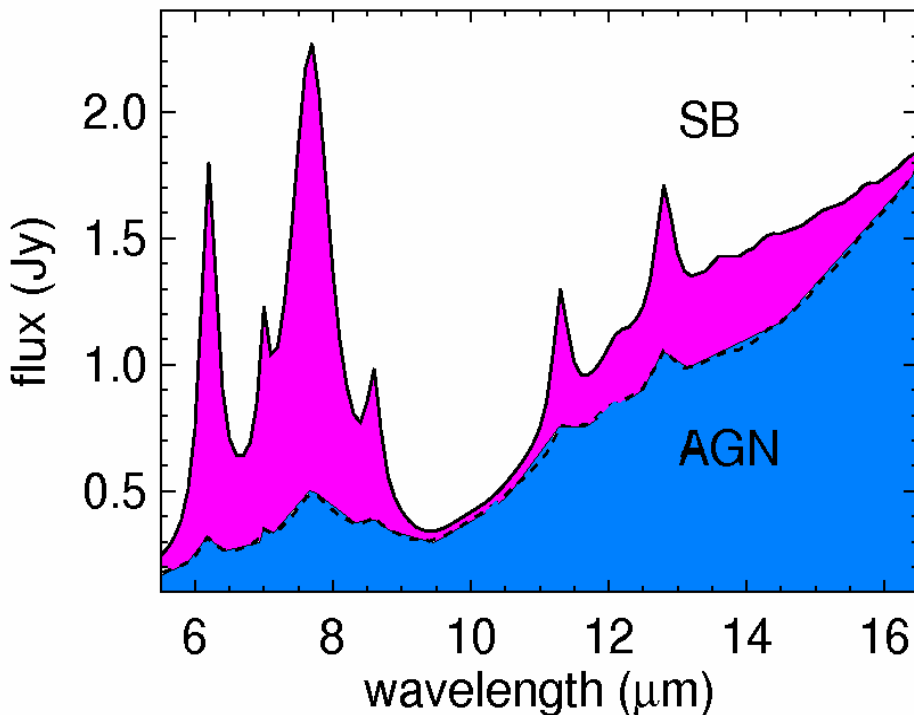
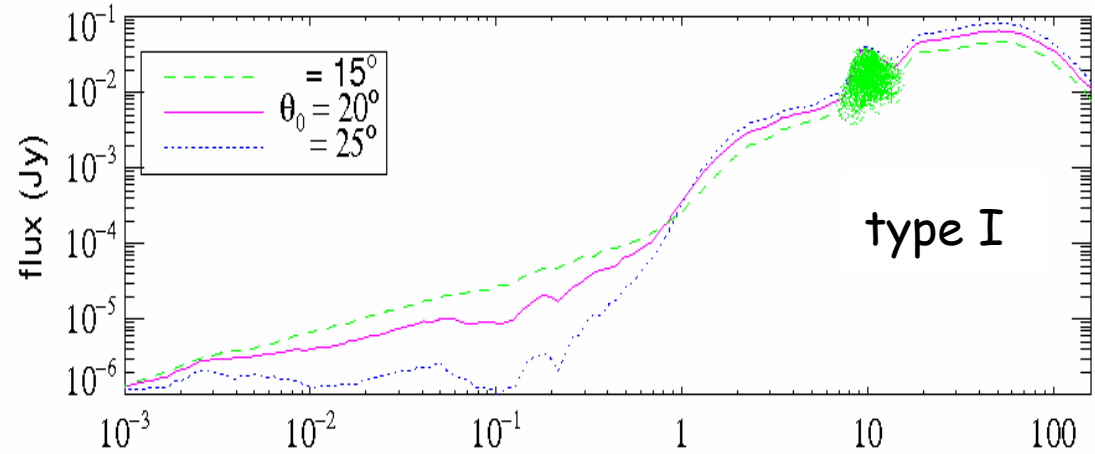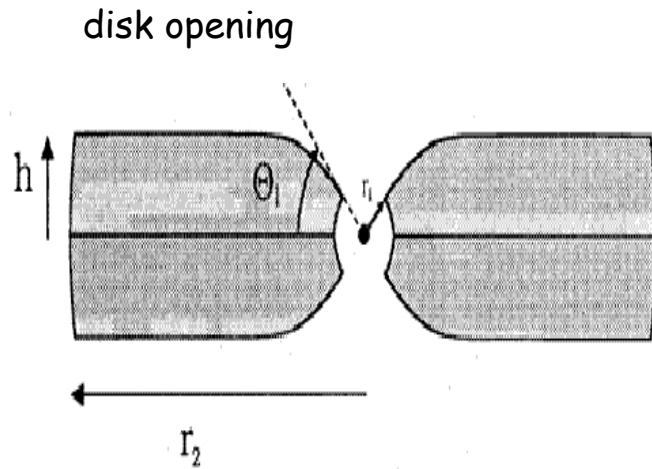But: sufficient X-ray photons
    vertical mixing in torus
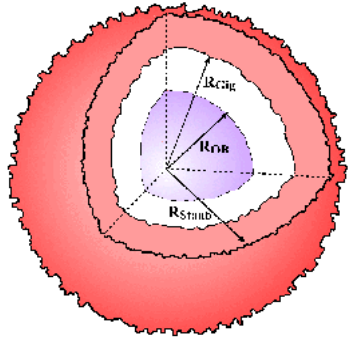
AGN vis SB

AGN: No PAH + unresolved
SB   :   PAH +   resolved

Geometry:
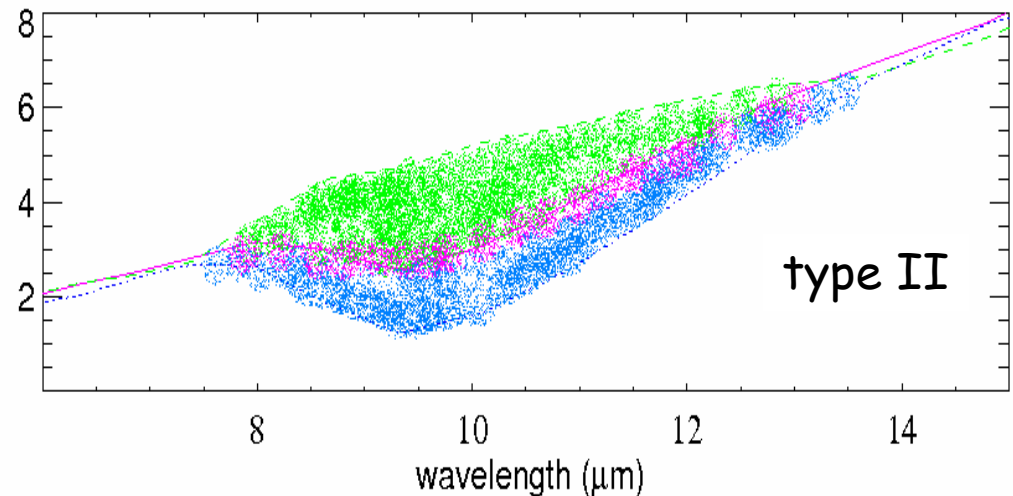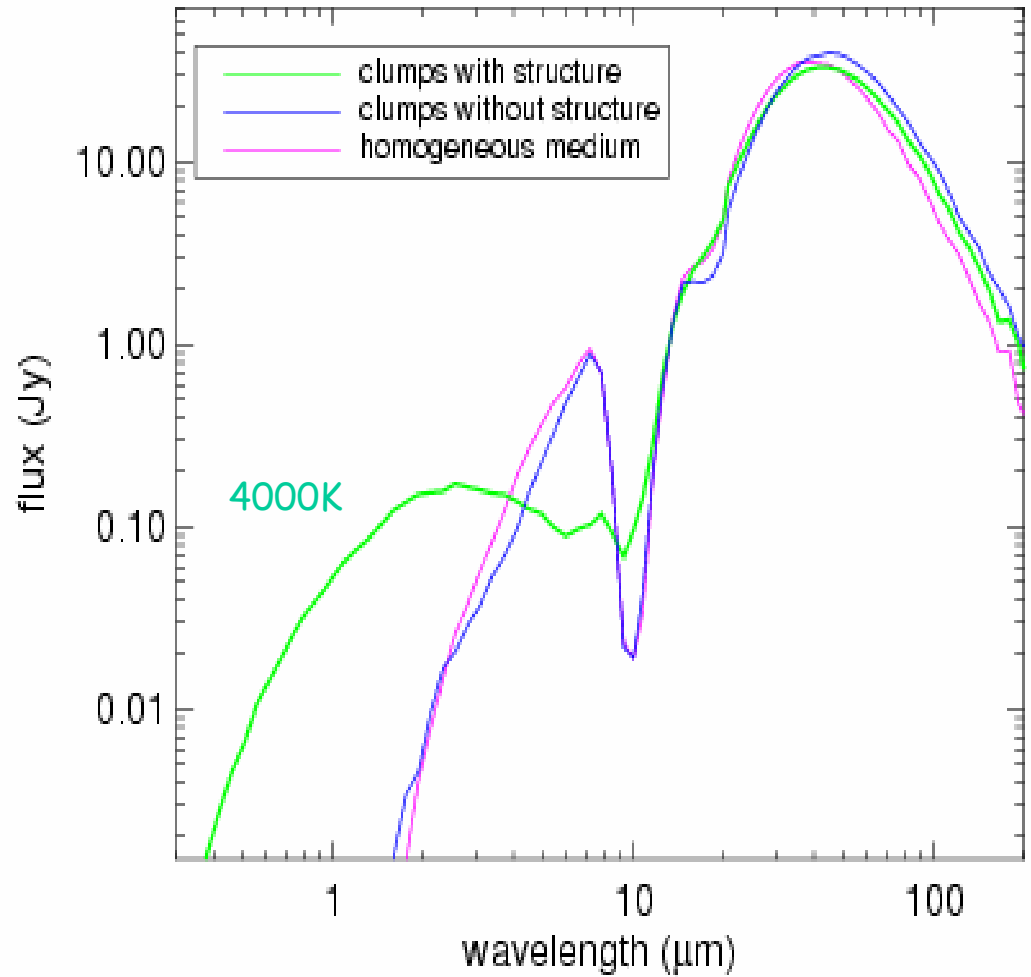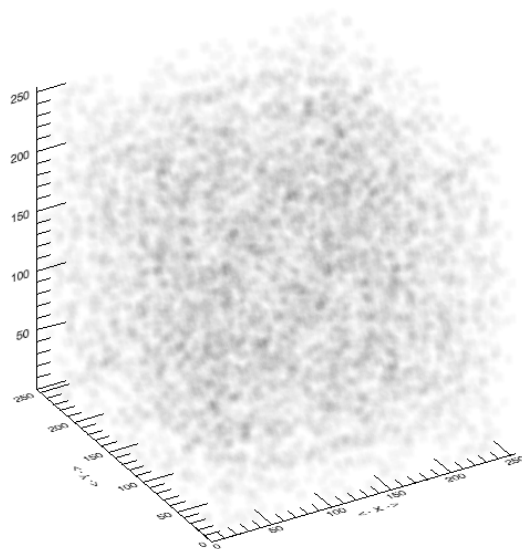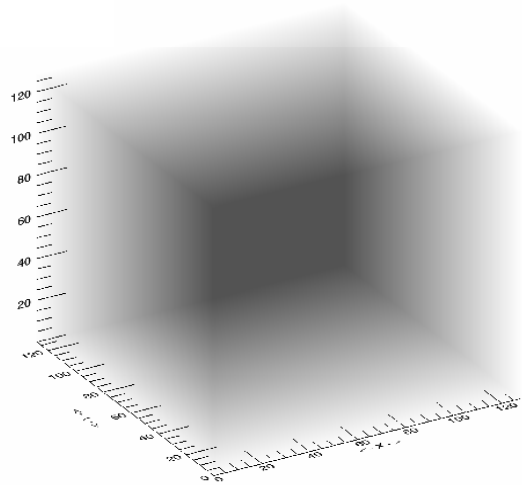## Monte Carlo radiative transfer

disk opening

type I

silicate emission

type II

3D Monte Carlo: clumpiness

SED models of galactic nuclei

Observation:

AGN: No PAH + unresolved
SB :   PAH +   resolved

Starburst: SED library (www.eso.org/~rsiebenm)
Quick estimate of L, R, M
Predict flux
AGN: PAH destruction   <-> X-ray's
geometry, clumps   -> Monte Carlo

SED library viz ULIRGs

Dopita et al.2005