MIR emission of X-ray/EUV irradiated proto-planetary disks

Ralf Siebenmorgen & Endrik Krűgel

-> PAH destruction by hard photons

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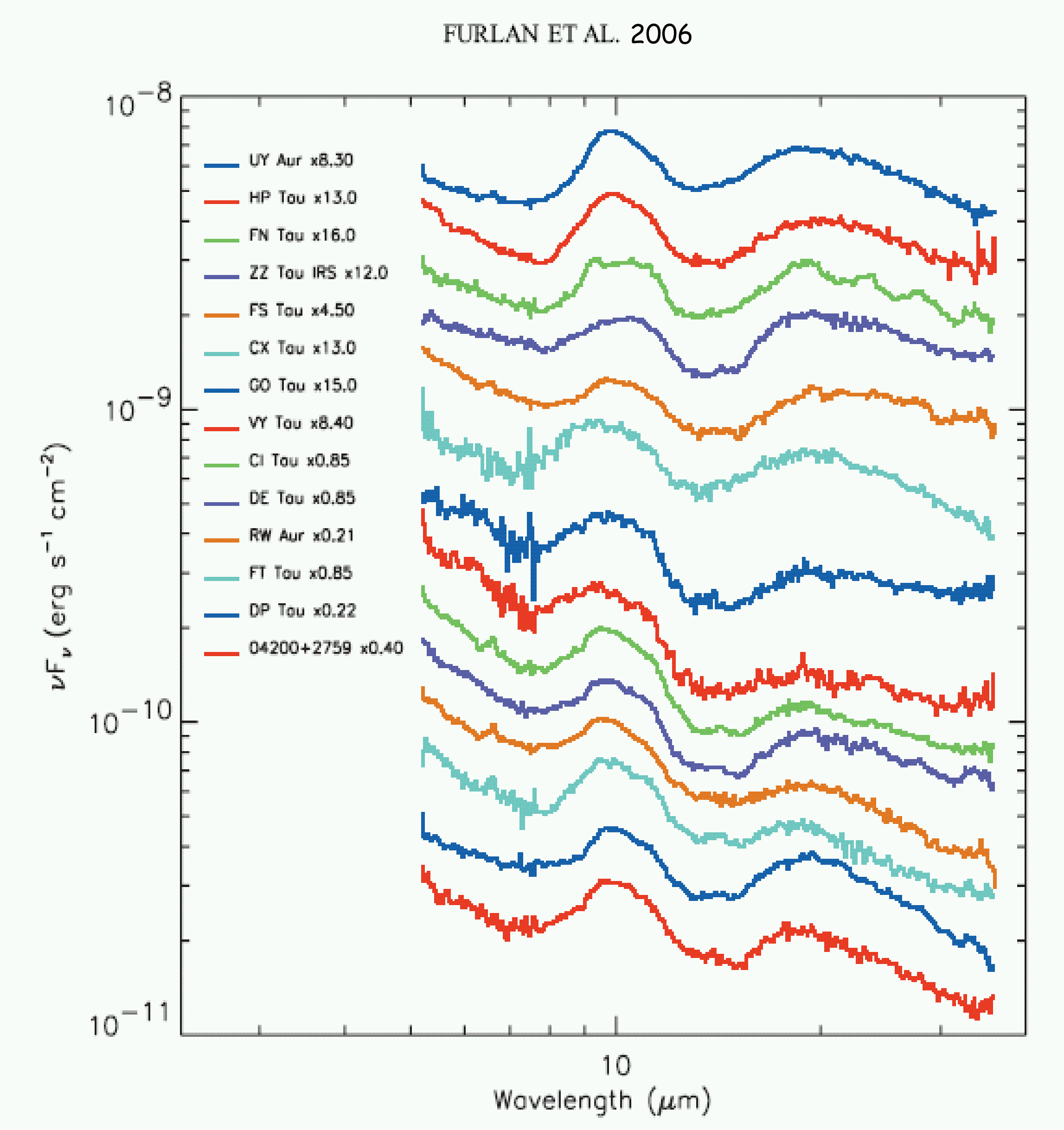


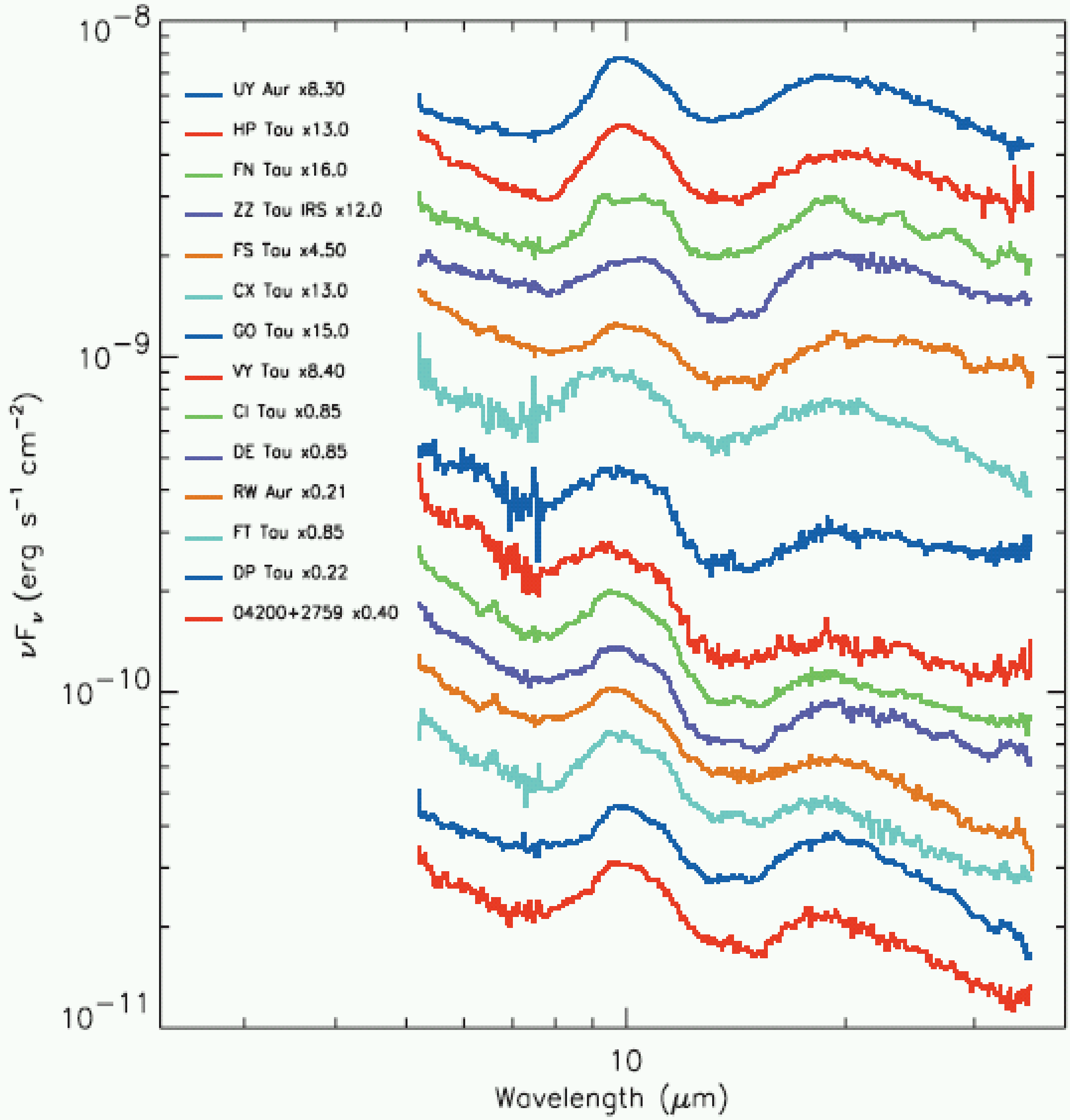
PAH detection rate:

Herbig AeBe 60%

TTS 10%

MIR emission of X-ray/EUV irradiated proto-planetary disks

FURLAN ET AL. 2006



PAH detection rate:
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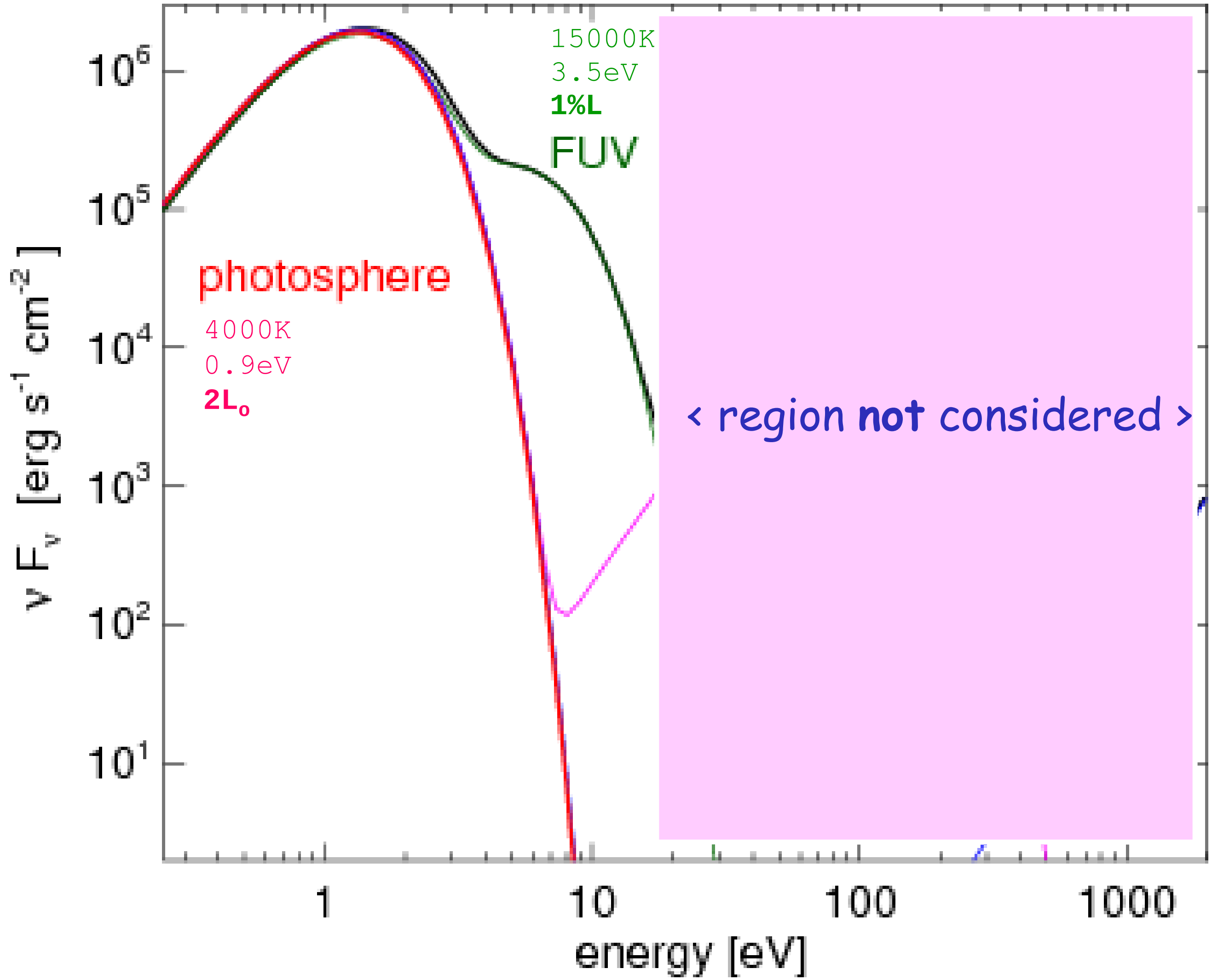
Arguments:

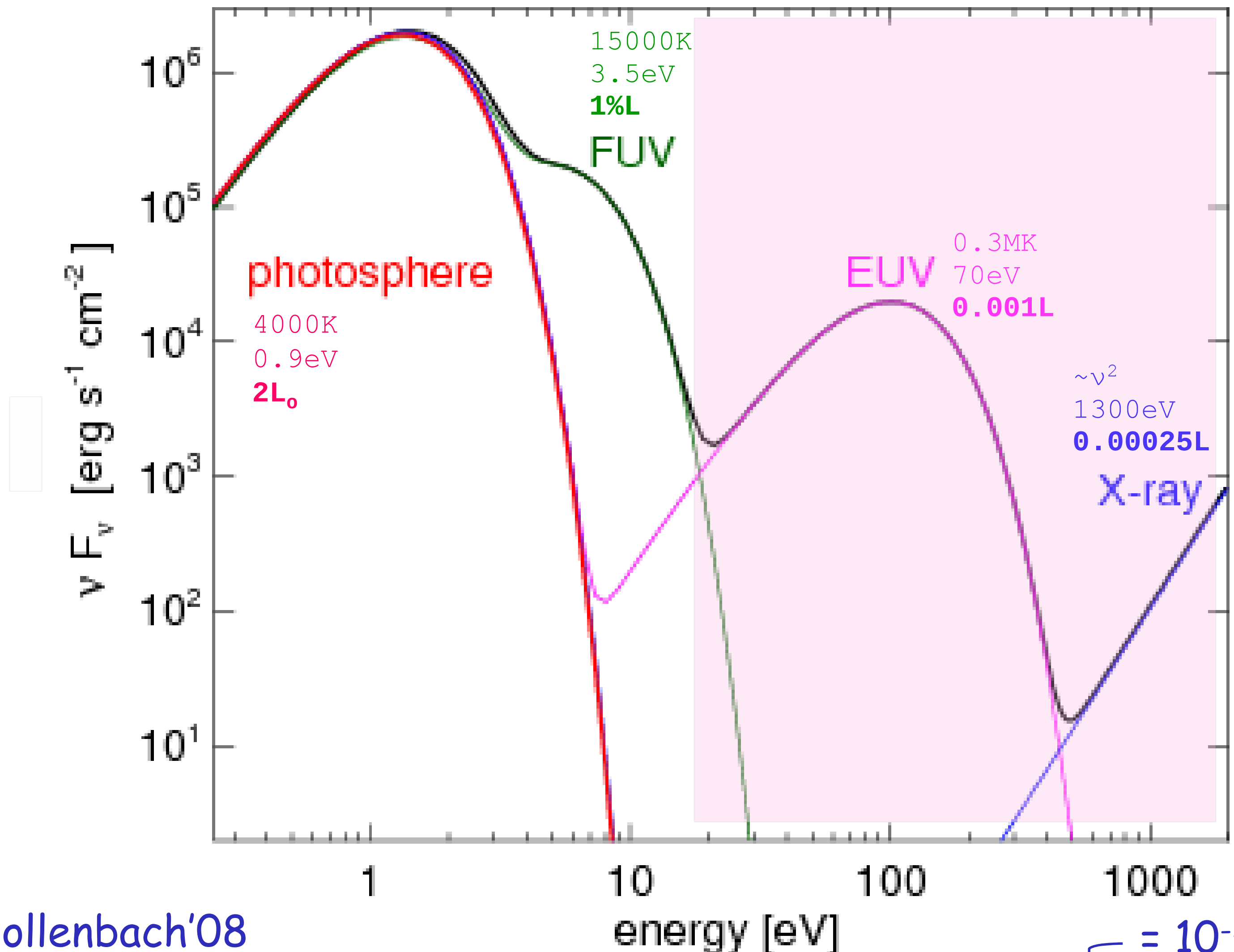
Furlan et al. :
T~4000K=>no PAH excitation

Geers et al.:
PAH under abundance

Passive heated TTauri disks



Passive heated TTauri disks



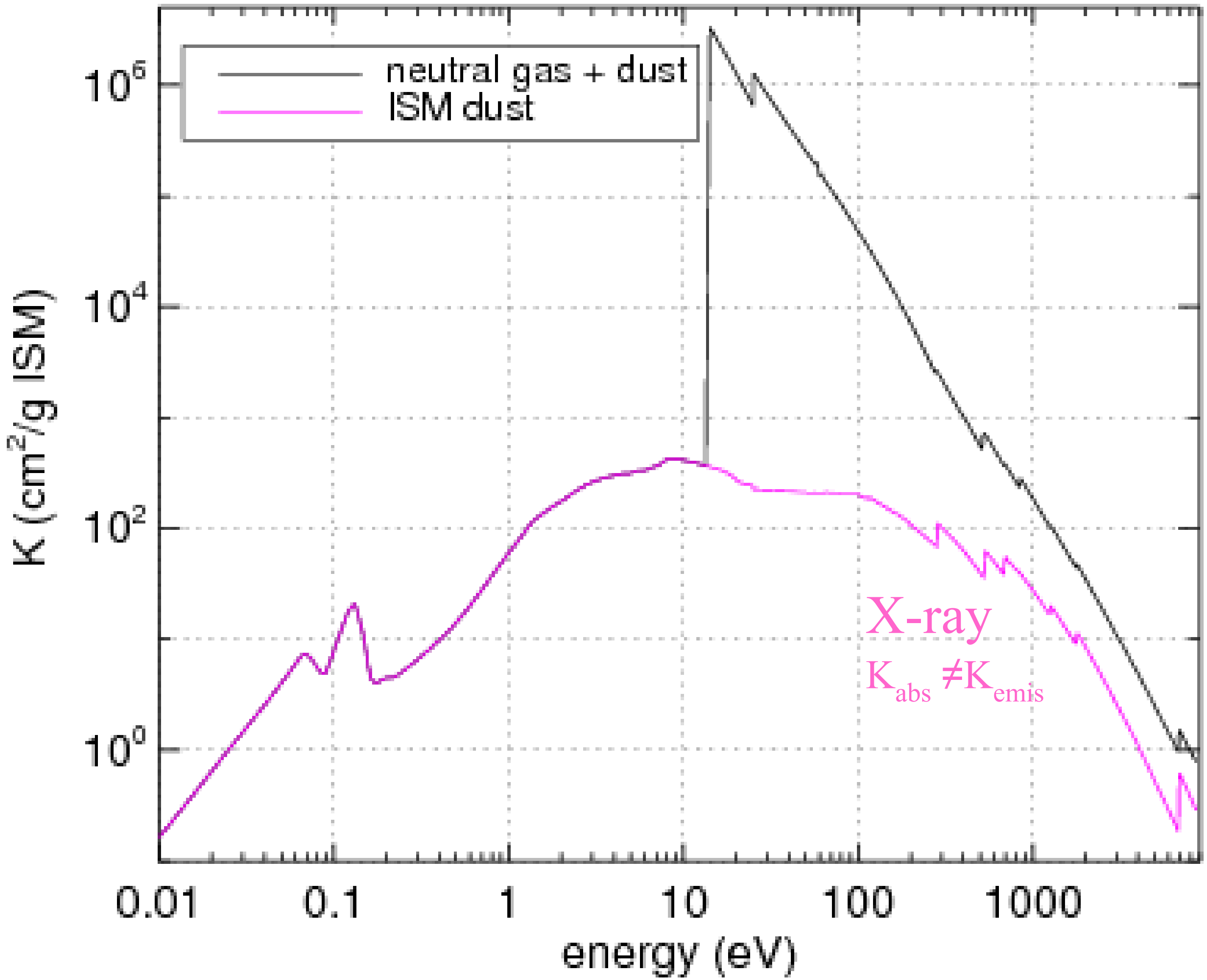
Gorti & Hollenbach'08

EUV, FUV ~ Calvet & Gullbring

X-ray ~ 1 flare per week, Preibisch et al., Güdel'07

Lx/L { $= 10^{-3.6}$ TTS ; $=10^{-7}$ Herbig Ae/Be }

Dust and *gas* extinction



PAH destrcution

Voit 1992, Leach et al. 1989

0- Columb explosion:

X-ray (284eV) -> Auger e^-

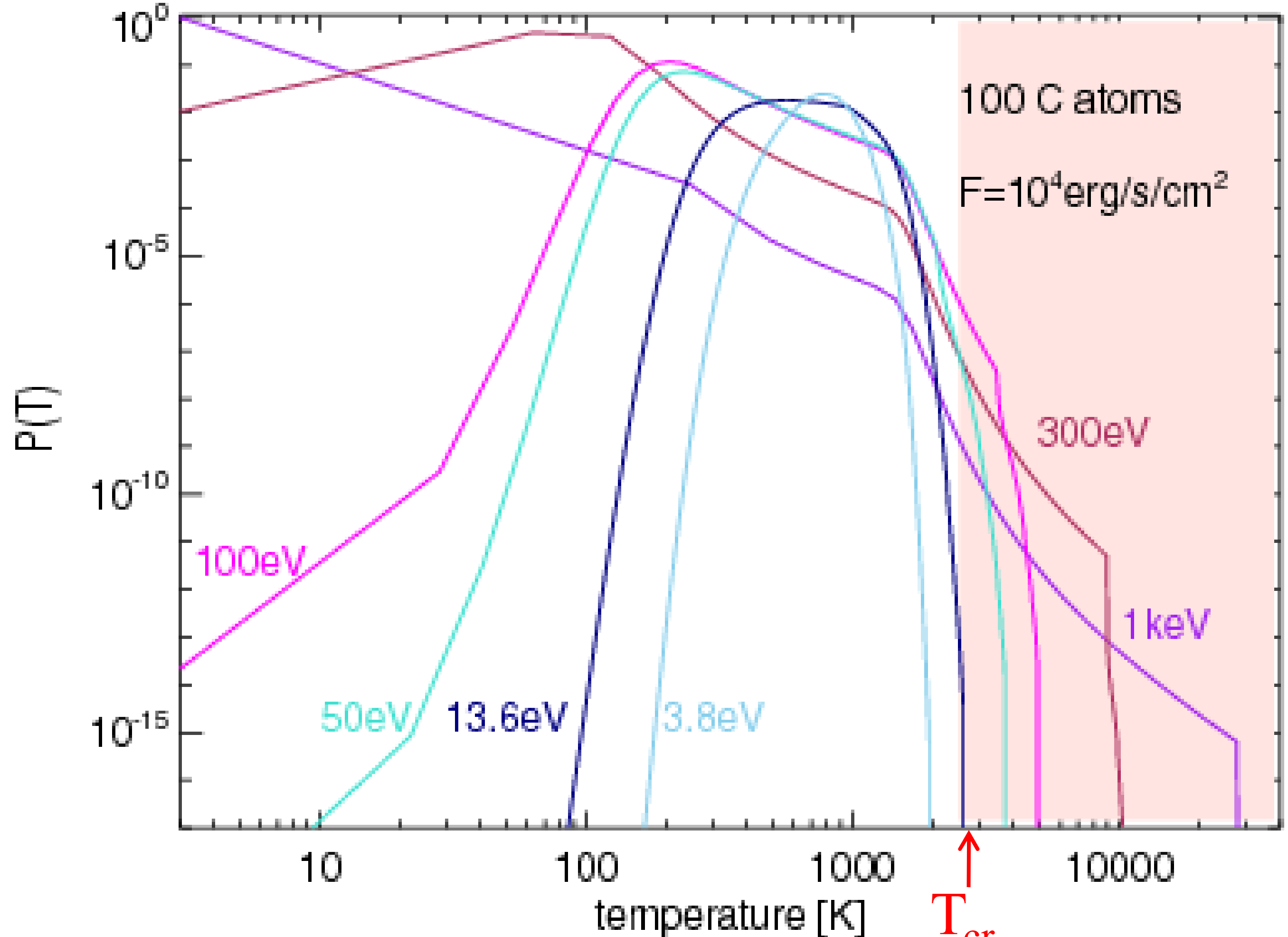
important for small PAH

1- Evaporation by super-heating

2- Dissociation / Expulsion of "atoms"

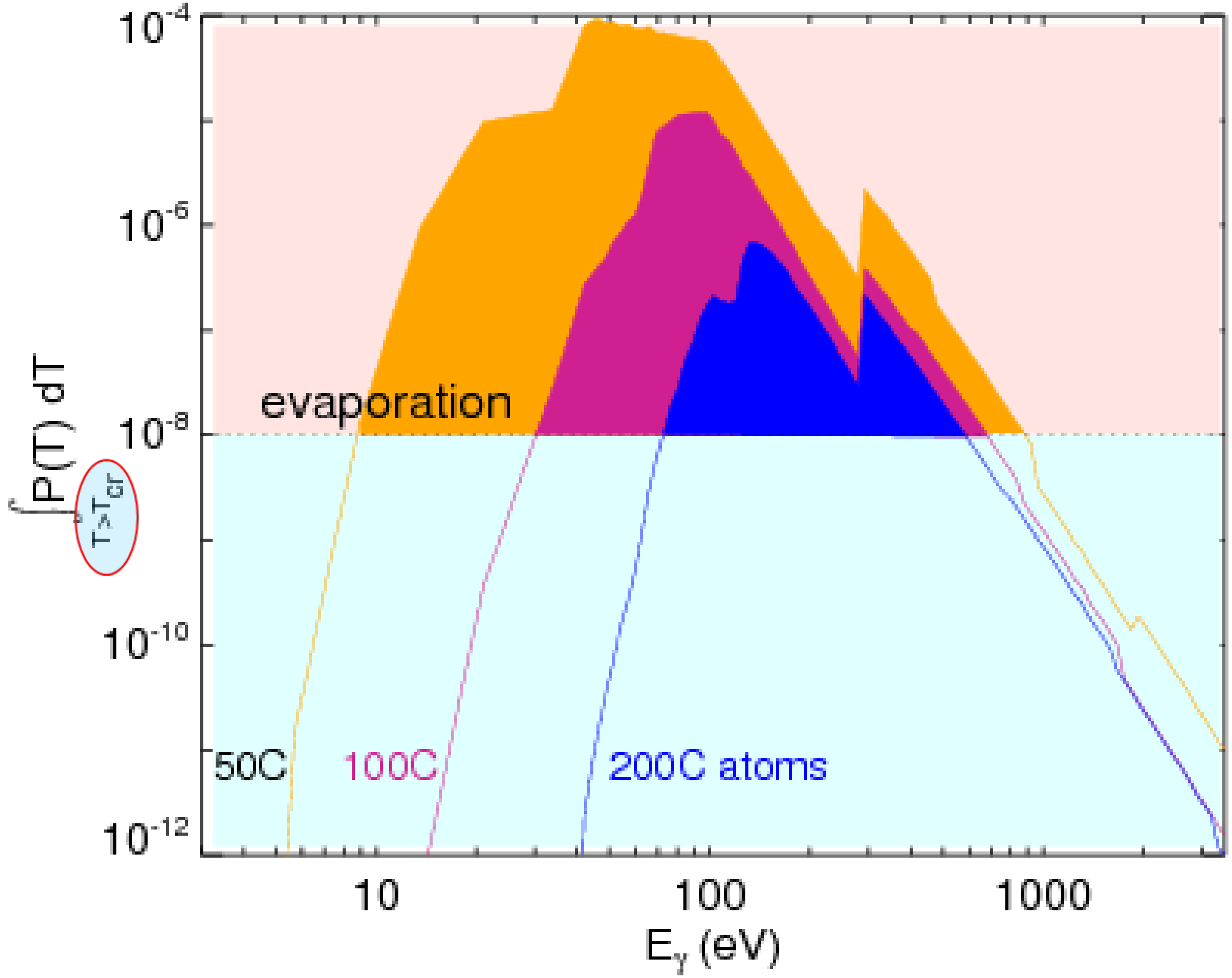
Destruction by ***super-heating***

PAH temperature distribution function in mono-energetic heating bath



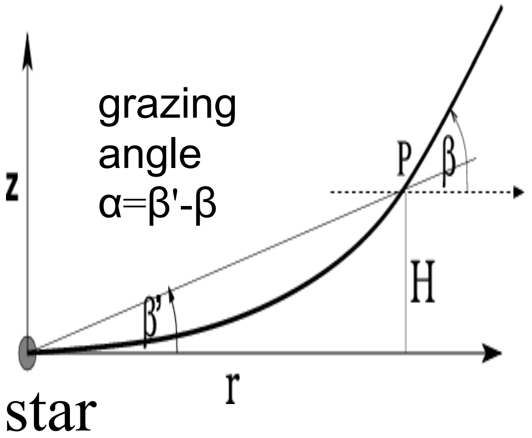
$| U_f - U_i - h\nu | < \frac{1}{2} \Delta U_f$: $A_{fi} = \kappa F / h\nu$

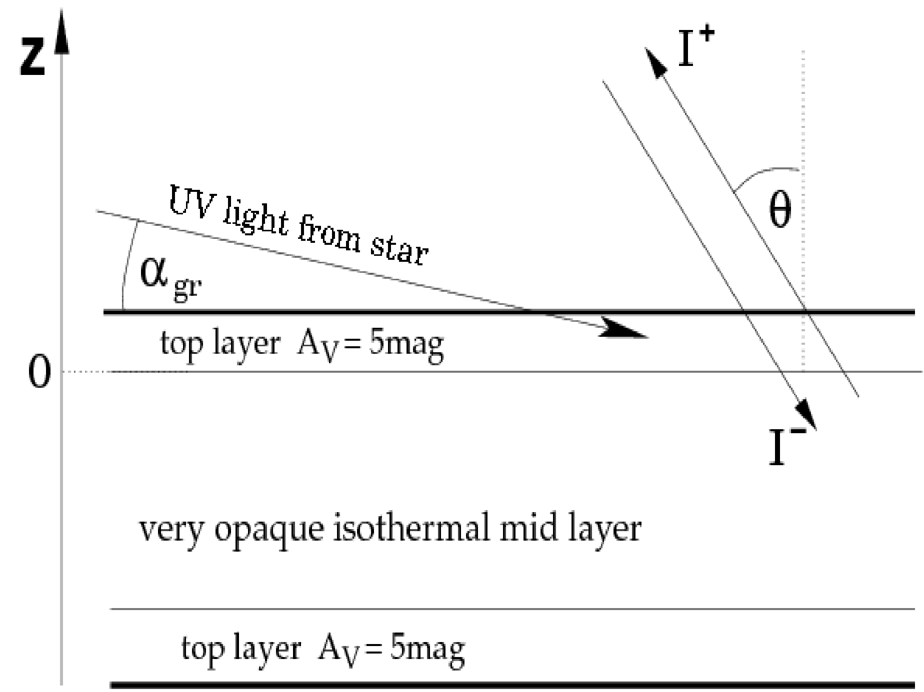
PAH destruction by ***super-heating***



RT in inflated passive disks

- Monte Carlo
- 1+1d





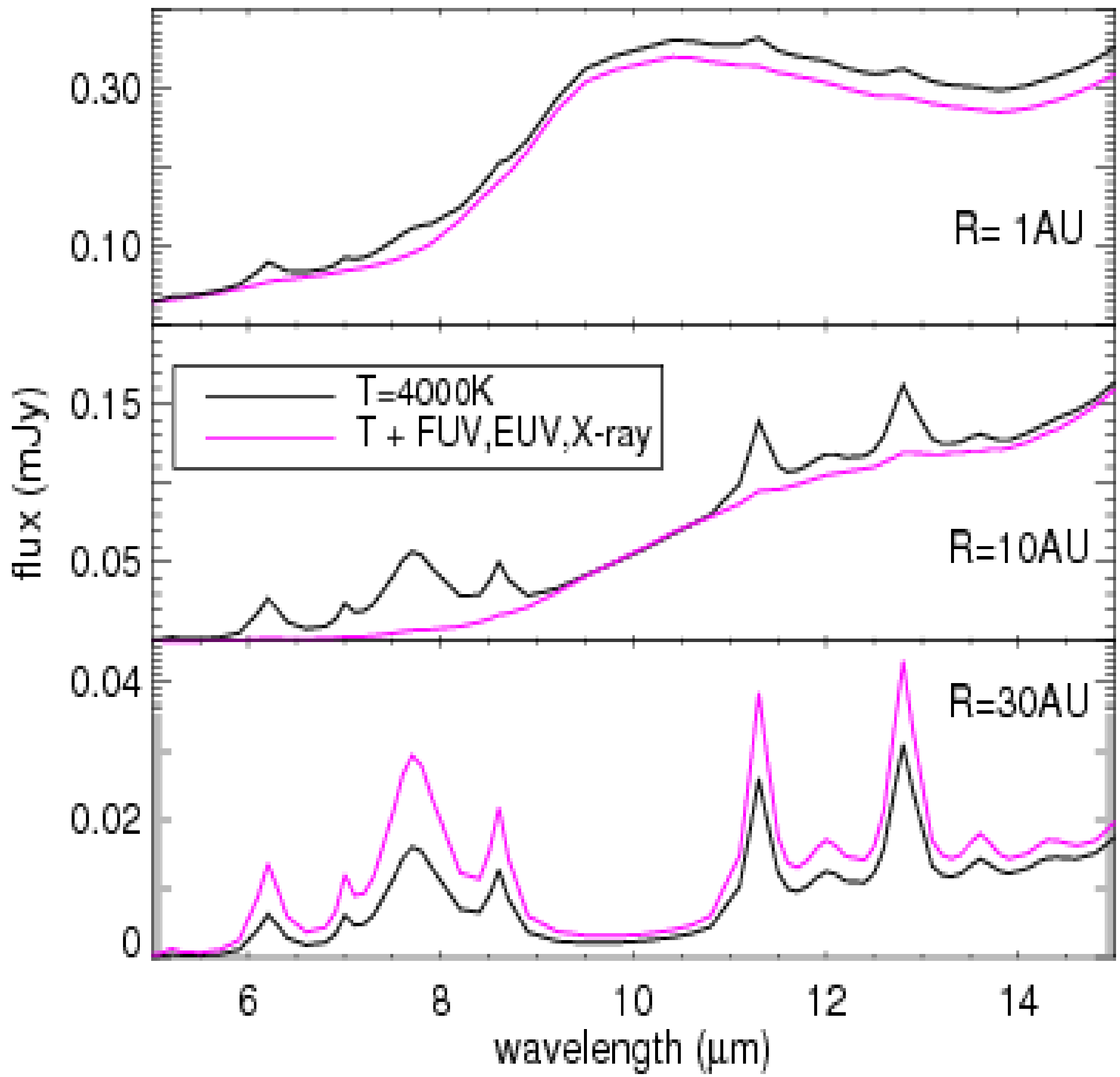
PAH: 100 C

Emission segments of a TTau disk

silicate emission

evaporation

excitation

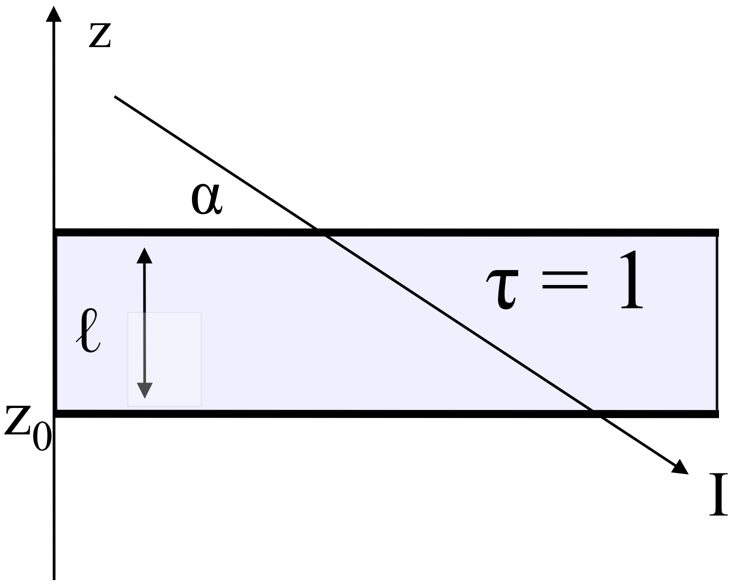


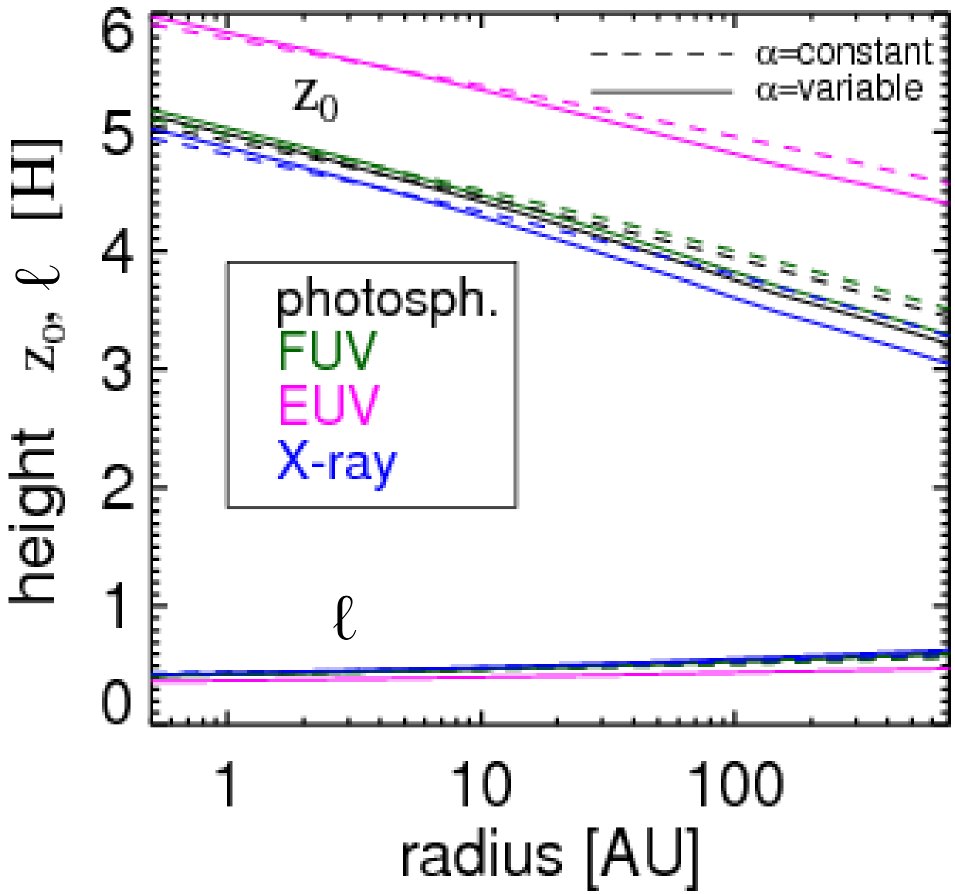
-> super-heating not sufficient

Photosphere of a hydrostat. Keplerian disk

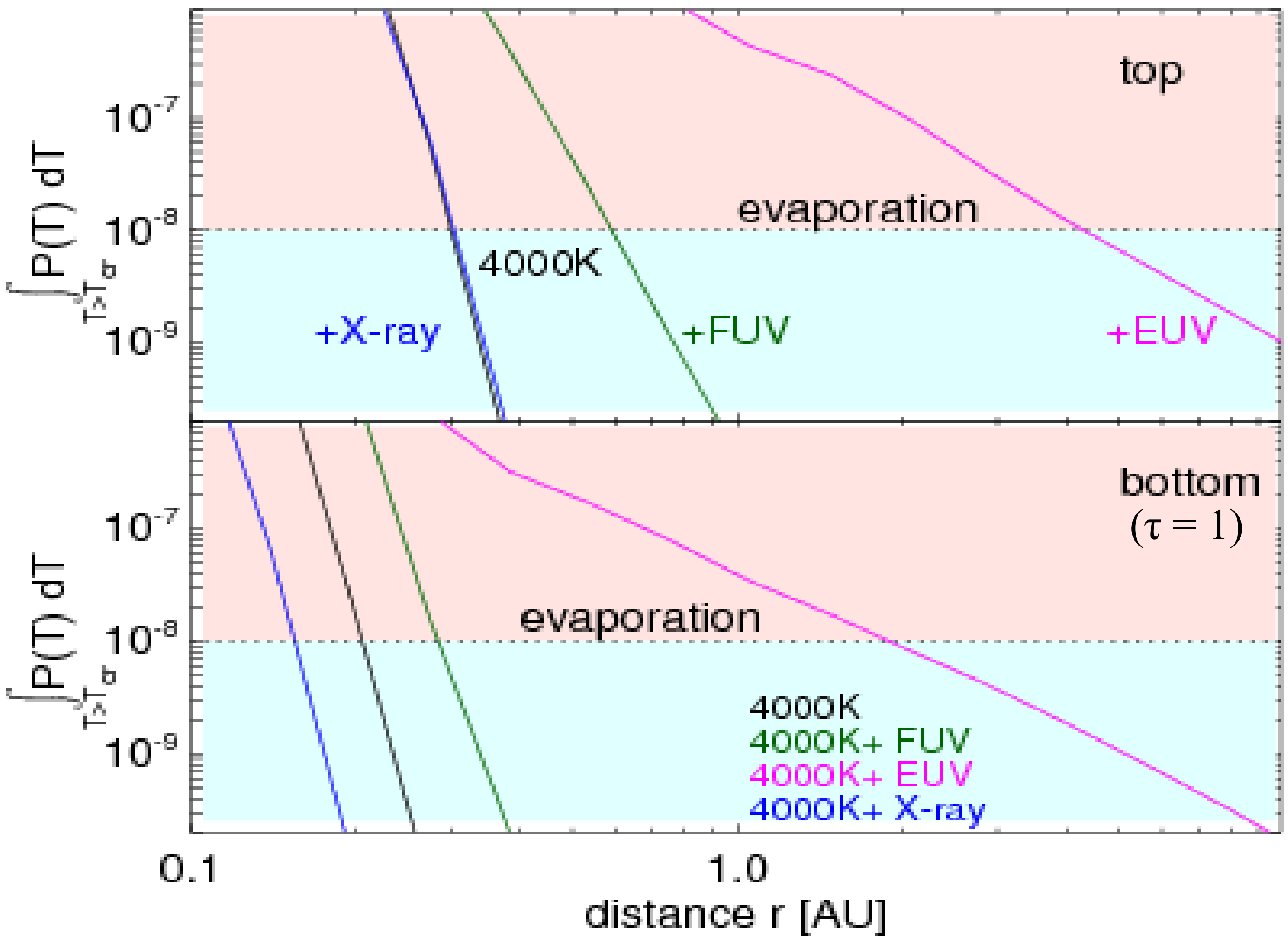
$\rho(z) \sim \exp\{-z^2/2H^2\}$

$H = \sqrt{kTr^3 / GMm}$



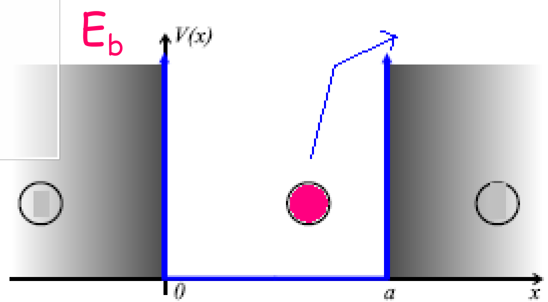


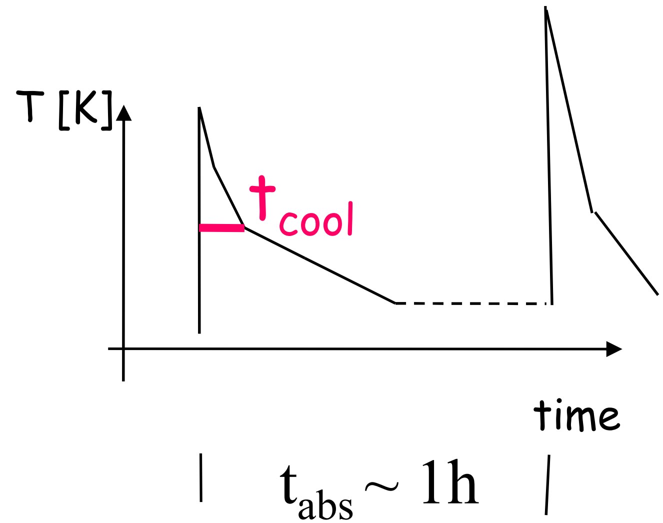
PAH evaporation in disk photopshere



-> super-heating not sufficient

PAH dissociation: 'Expulsion of atoms'





Dissociation time (Omont '86)

$t_{dis} = \exp(E_b/kT) / \nu_0 \quad \ll t_{cool}/f \sim 1s$

$T_{cr} = E_b/k \ln(\nu_0) \sim 2000K; \quad E_b \sim 5eV$

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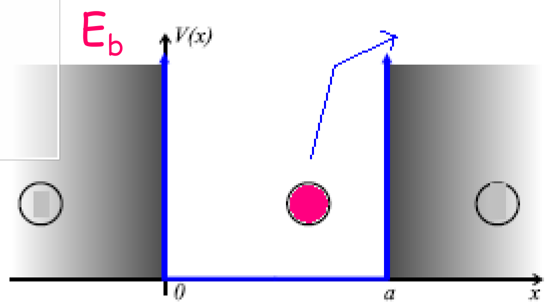

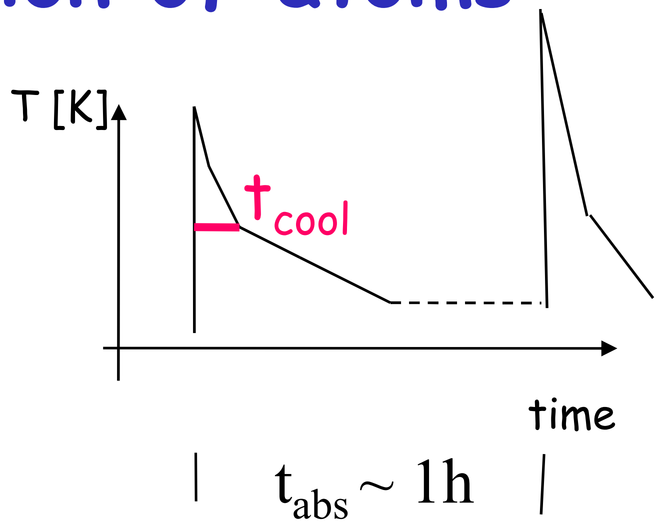

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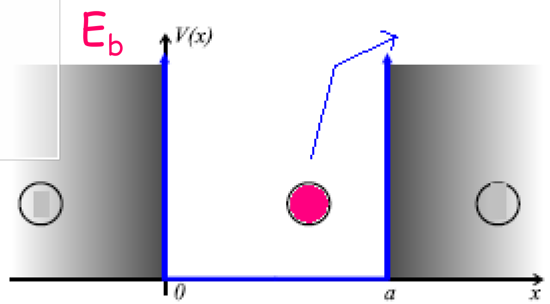
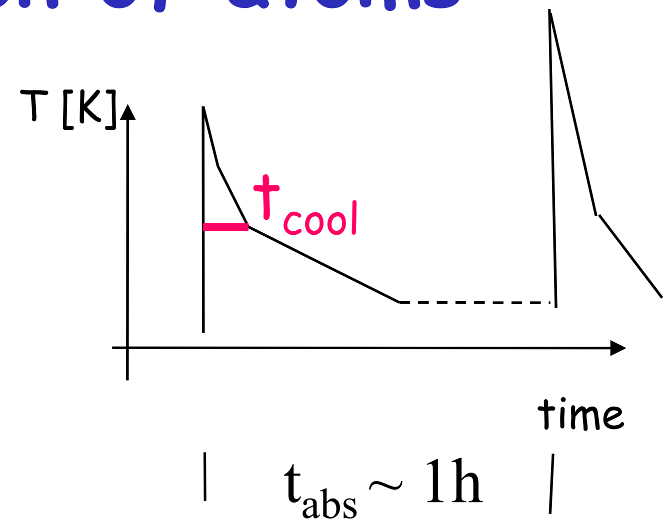
$\Delta E = 3N_c\, kT_{cr} \quad \sim 0.1\, N_c \cdot E_b \quad => \quad N_c < 2\, \Delta E / [eV]$

=> PAH unstable independent of distance

PAH dissociation: 'Expulsion of atoms'





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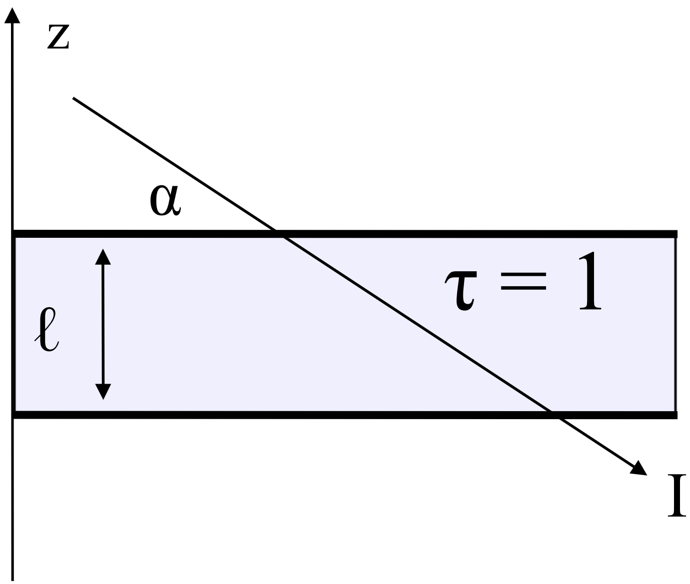
(PAH unstable)

Sufficient X-ray photons?
Vertical mixing in disk?

Sufficient X-ray photons?

Stationary disk



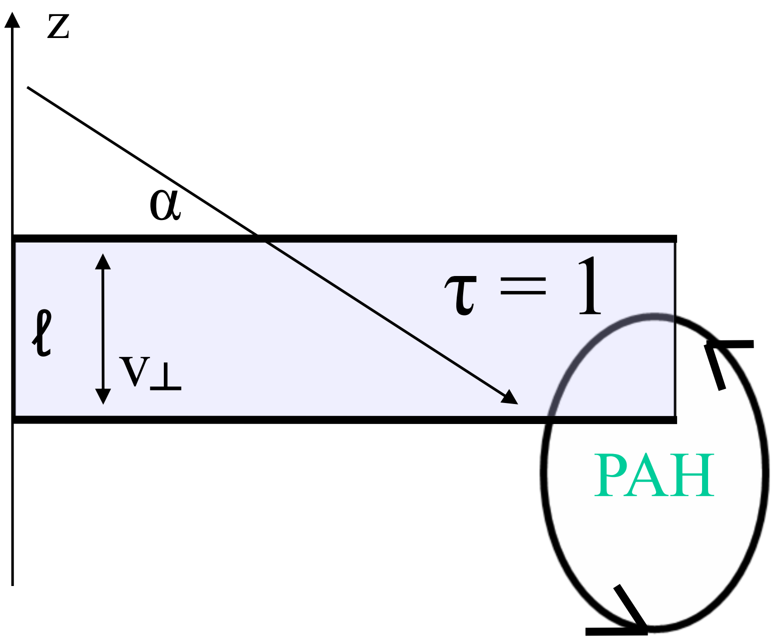
} disk photosphere $\Sigma_\ell = \alpha/\kappa$

$$\frac{\#\ \text{C in PAH}}{\#\ \text{hard } \gamma \text{ absorption/sec}} = h\nu \cdot 4\pi r^2/L\kappa$$

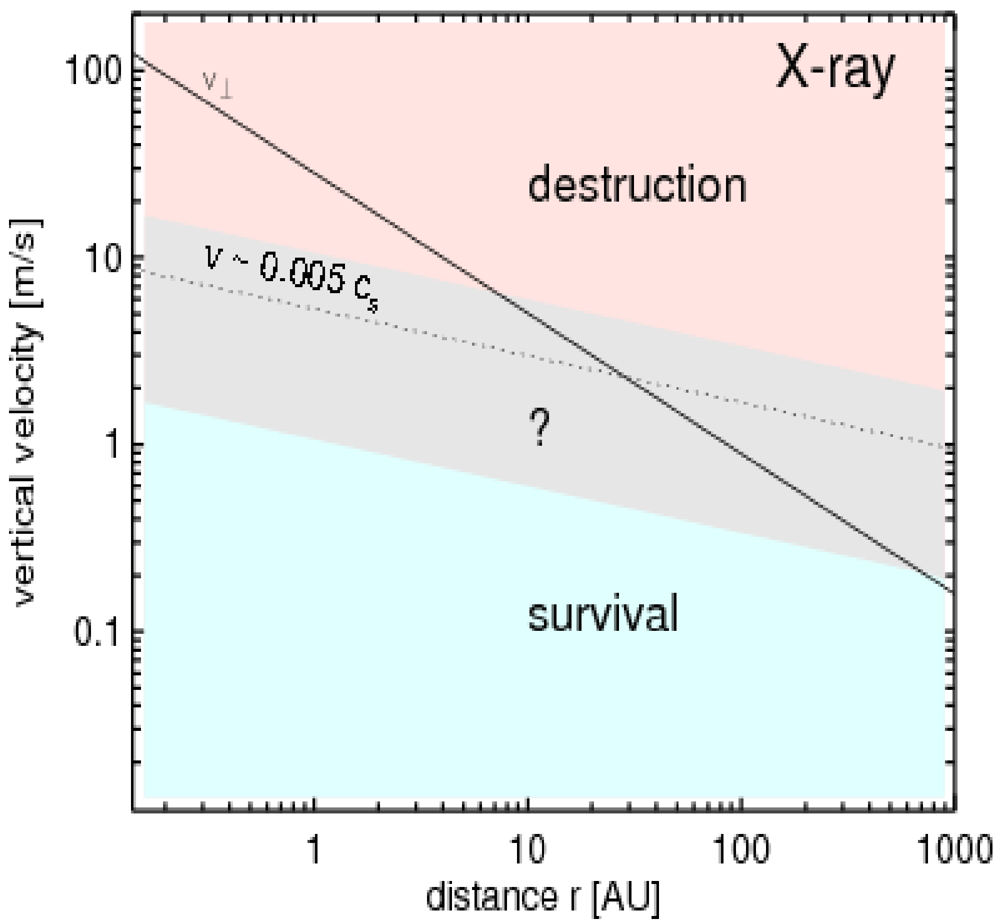
↓

'PAH removal time' << TT phase

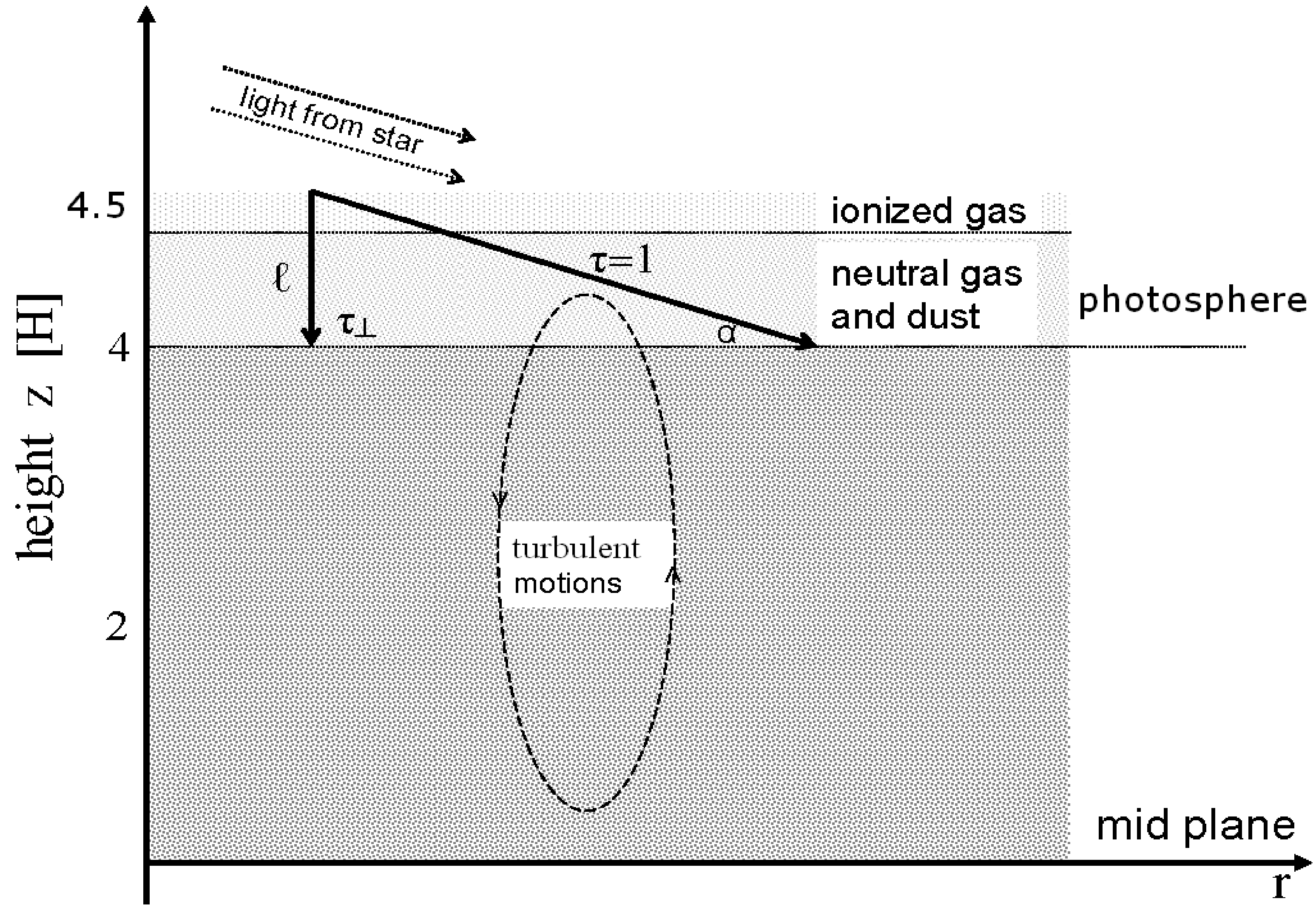
PAH replenishment: Vertical disk mixing?



$$\ell / v_{\perp} = t_{exp} > N_C \, t_{abs}$$



PAH replenishment: Vertical disk mixing?



Conclusion

- Luminosity of hard radiation (EUV/X-ray) small but important for PAH destruction

- Extinction: dust ***+ gas***

- PAH replenishment by vertical motions

- PAH detection ⟷ young TTS ?