Dust and the far-UV break observed in the energy distributions of Quasars

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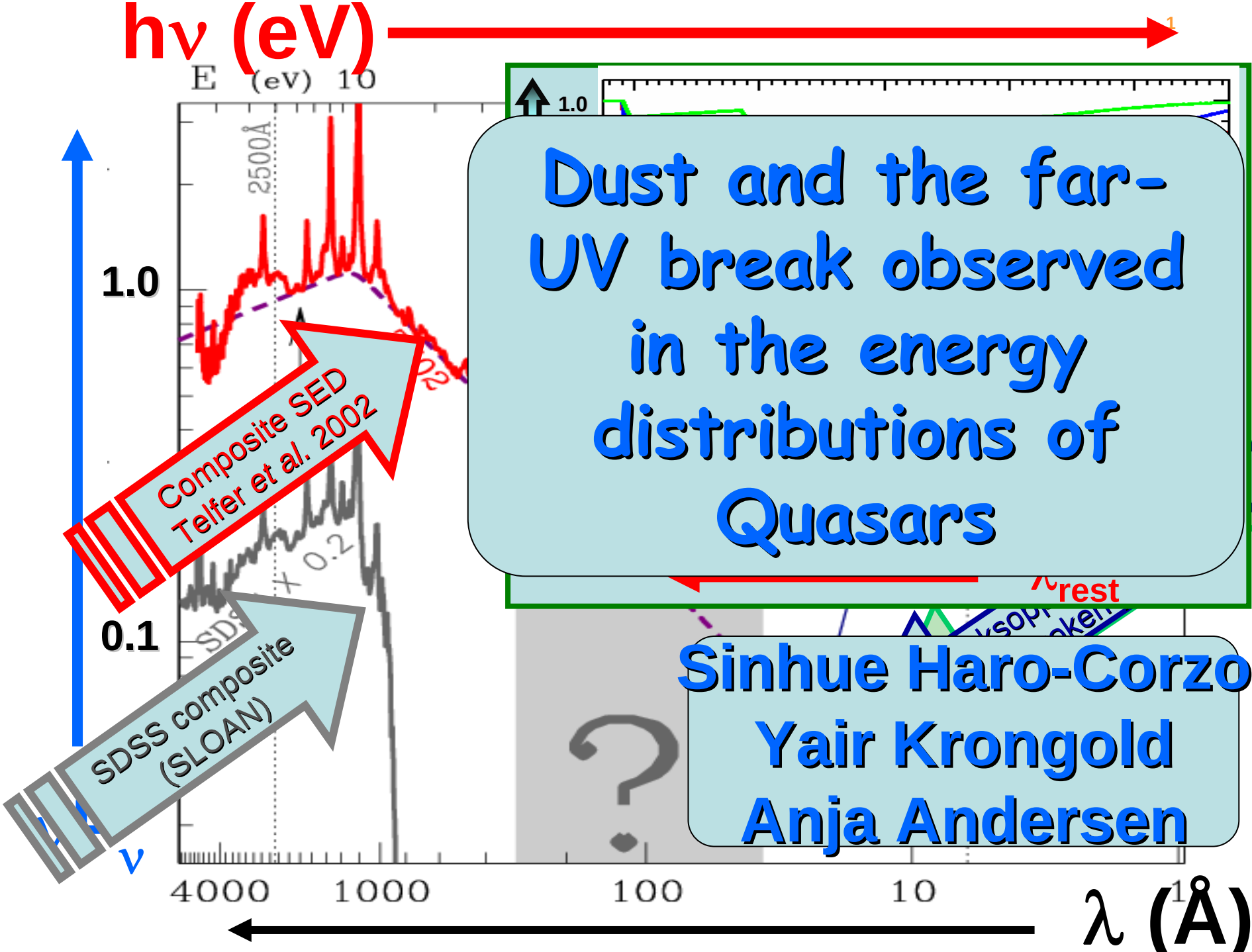
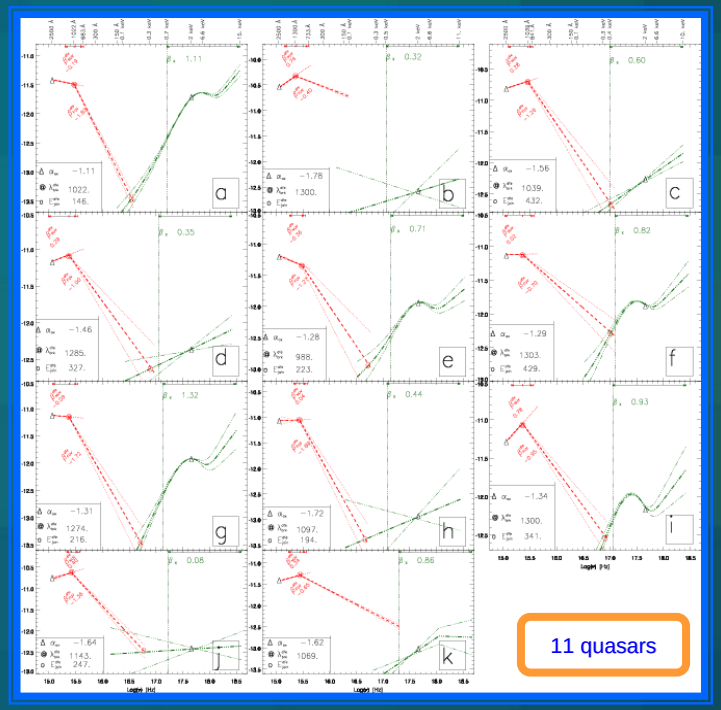
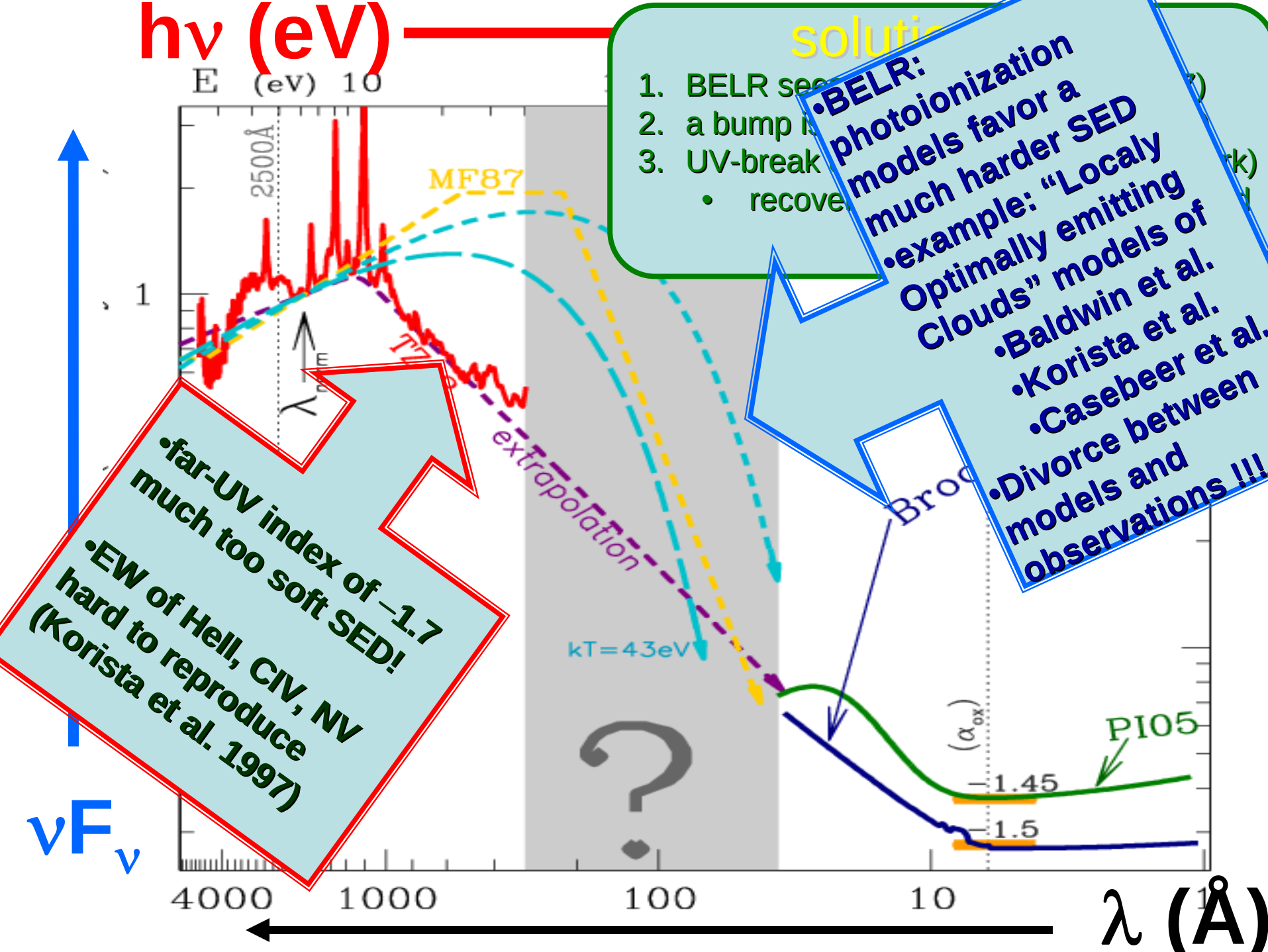


connection between far-UV and X-rays?

- Are soft-X rays a simple extrapolation of the far-UV powerlaw?
  - Haro-Corzo et al. (2007)
  - this afternoon
- "*Composite*" spectra are not always an ideal tool what about individual spectra?
  - in the X-rays?
  - in the far-UV



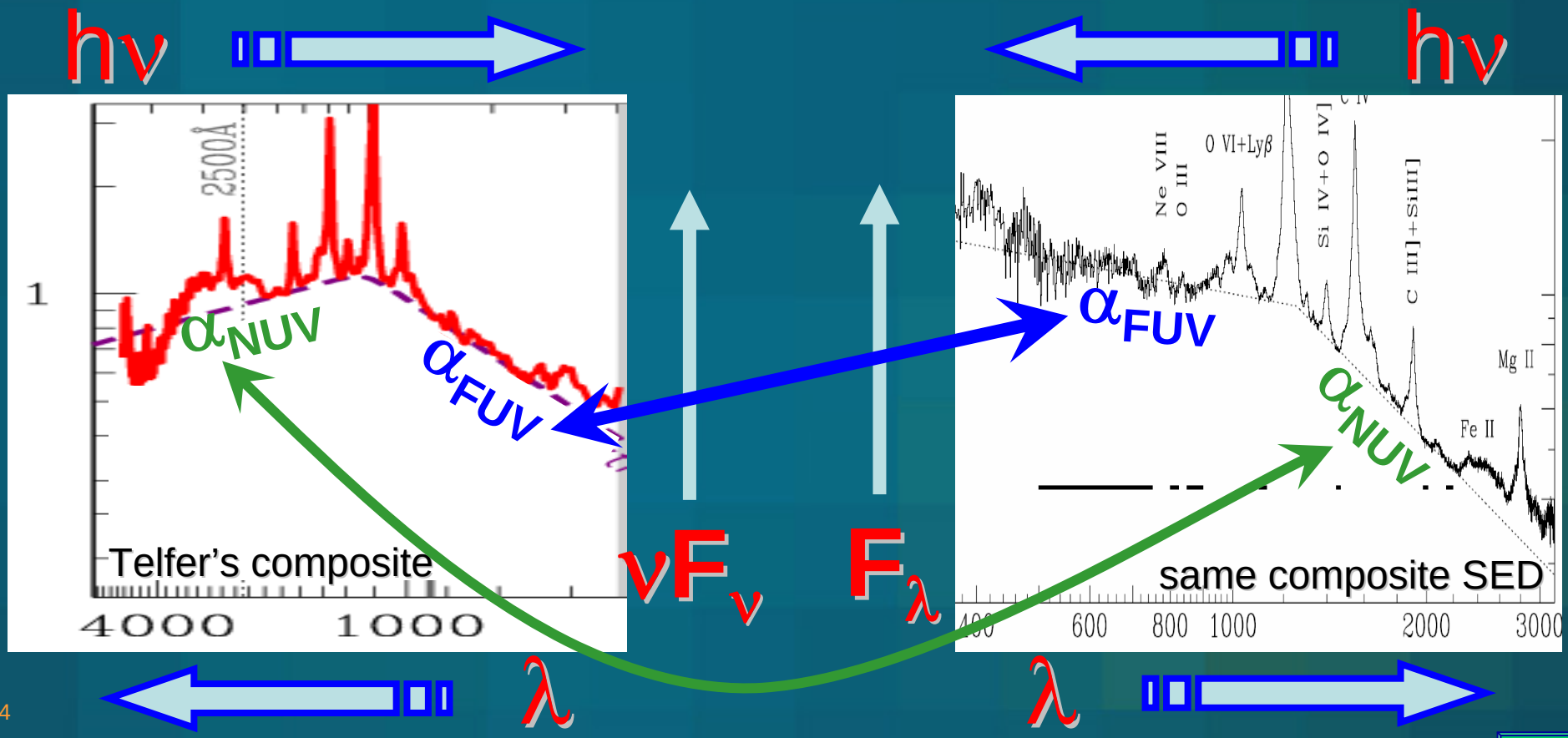

hν (eV)
E (eV) 10
solutio
1. BELR see
2. a bump i
3. UV-break
• recove
•BELR:
photoionization
models favor a
much harder SED
•example: "Localy
Optimally emitting
Clouds" models of
•Baldwin et al.
•Korista et al.
•Casebeer et al.
•Divorce between
models and
observations !!!
•far-UV index of –1.7
much too soft SED!
•EW of HeII, CIV, NV
hard to reproduce
(Korista et al. 1997)
2500Å
MF87
extrapolation
kT=43eV
Broc
PI05
(α_ox)
–1.45
–1.5
1
4000
1000
100
10
νF_ν
λ (Å)

spectral index α

$$F_\nu \propto \nu^{+\alpha} \Rightarrow F_\lambda \propto \lambda^{-(\alpha+2)}$$

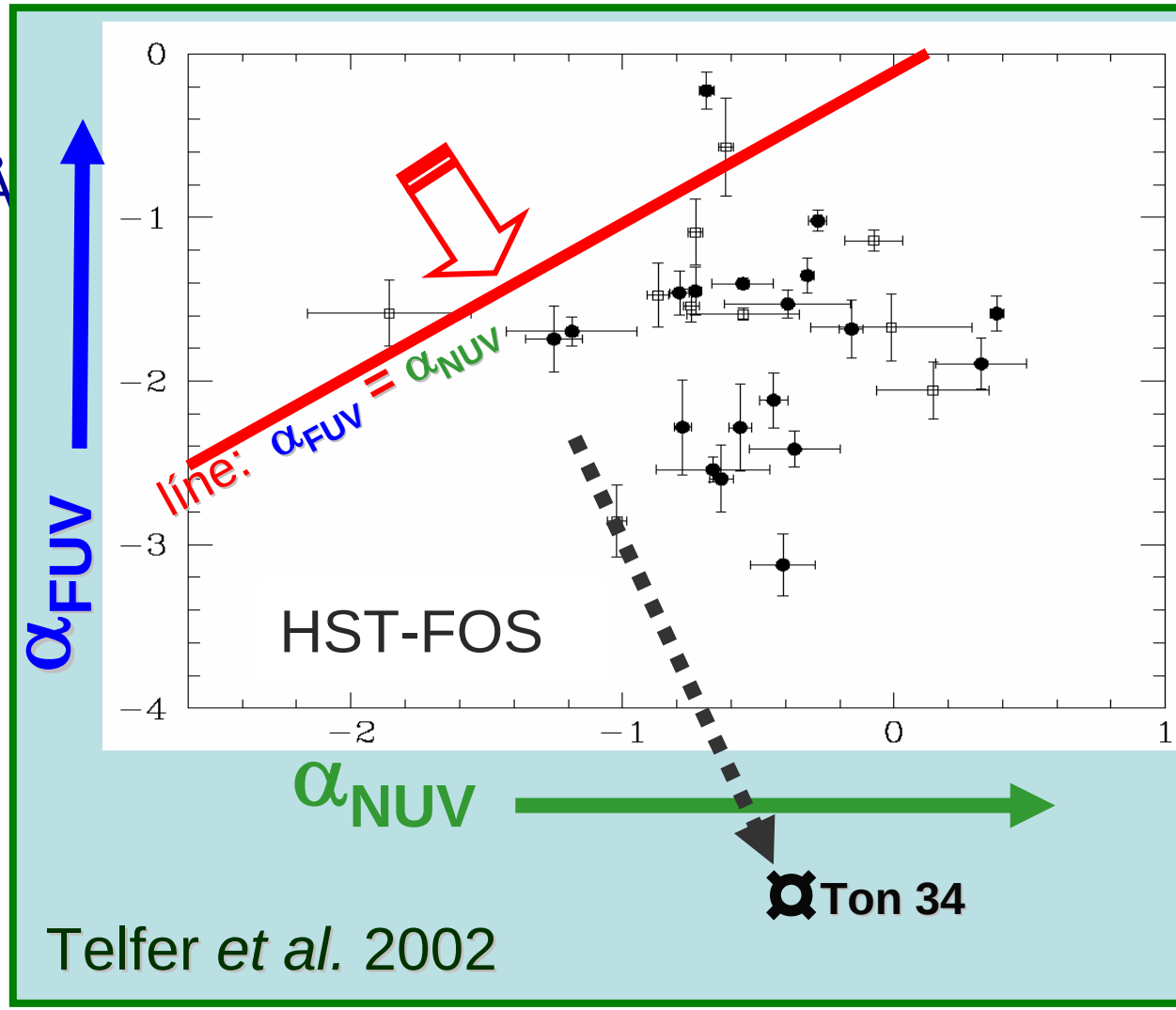
$$\Downarrow$$

$$\nu F_\nu \propto \nu^{\alpha+1} = \lambda F_\lambda \propto \lambda^{-(\alpha+1)}$$



spectral indices from individual quasars

- Telfer's sample,
  - UV break ~1100Å
  - mean indices:
    - $\alpha_{NUV} \approx -0.7$
    - $\alpha_{FUV} \approx -1.7$
- Ton 34
  - extremely UV deficient
    - $\alpha_{NUV} = -0.3$
    - $\alpha_{FUV} = -5.3$!



Telfer *et al.* 2002

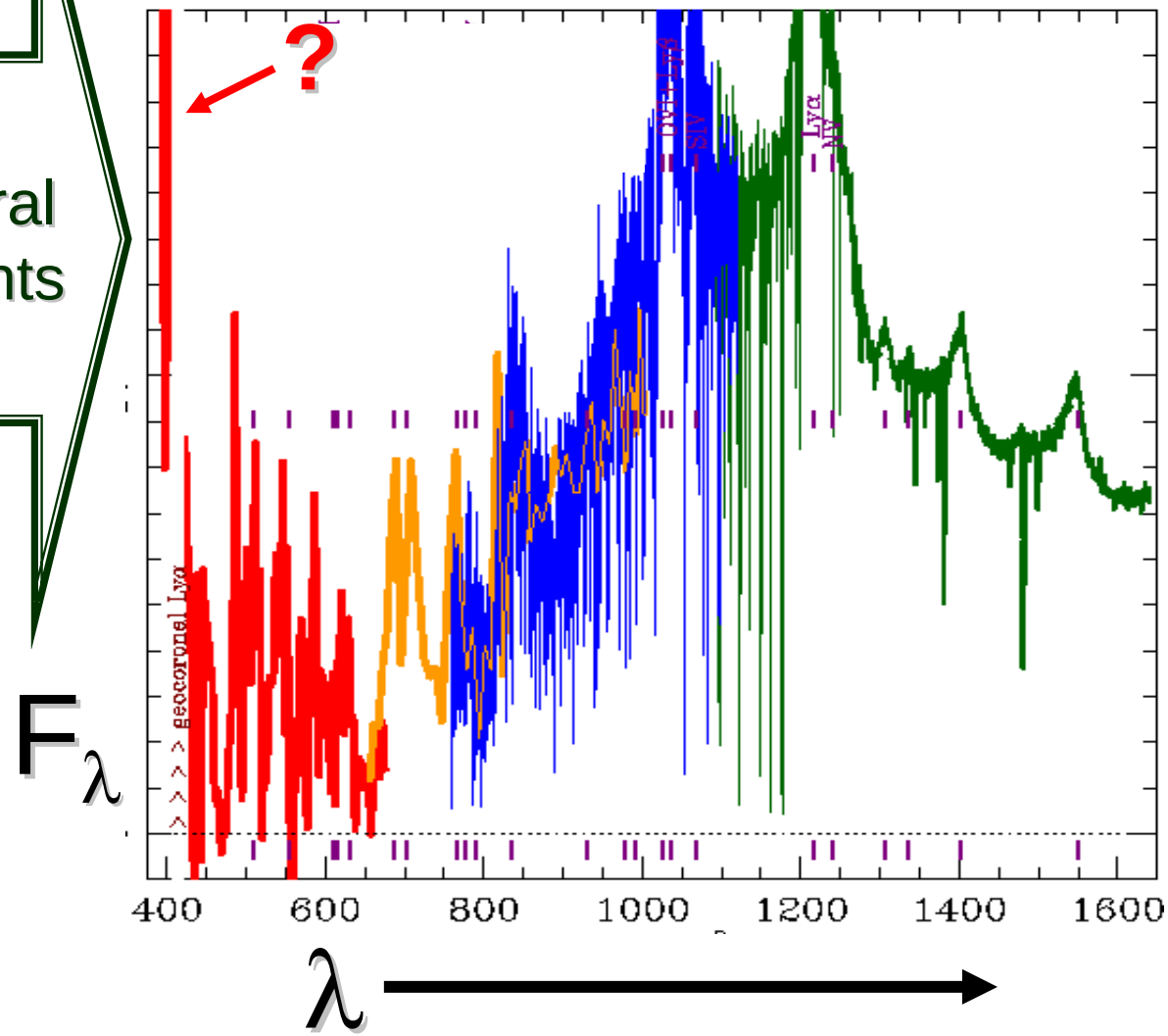
extreme UV deficiency of Ton 34

1. **IUE SWP**
2. **IUE LWP**
3. **HST-FOS**
4. **Palomar**

(Sargent et al.)

- normal near-UV line spectrum
- very unusual in the extreme UV
- better data needed

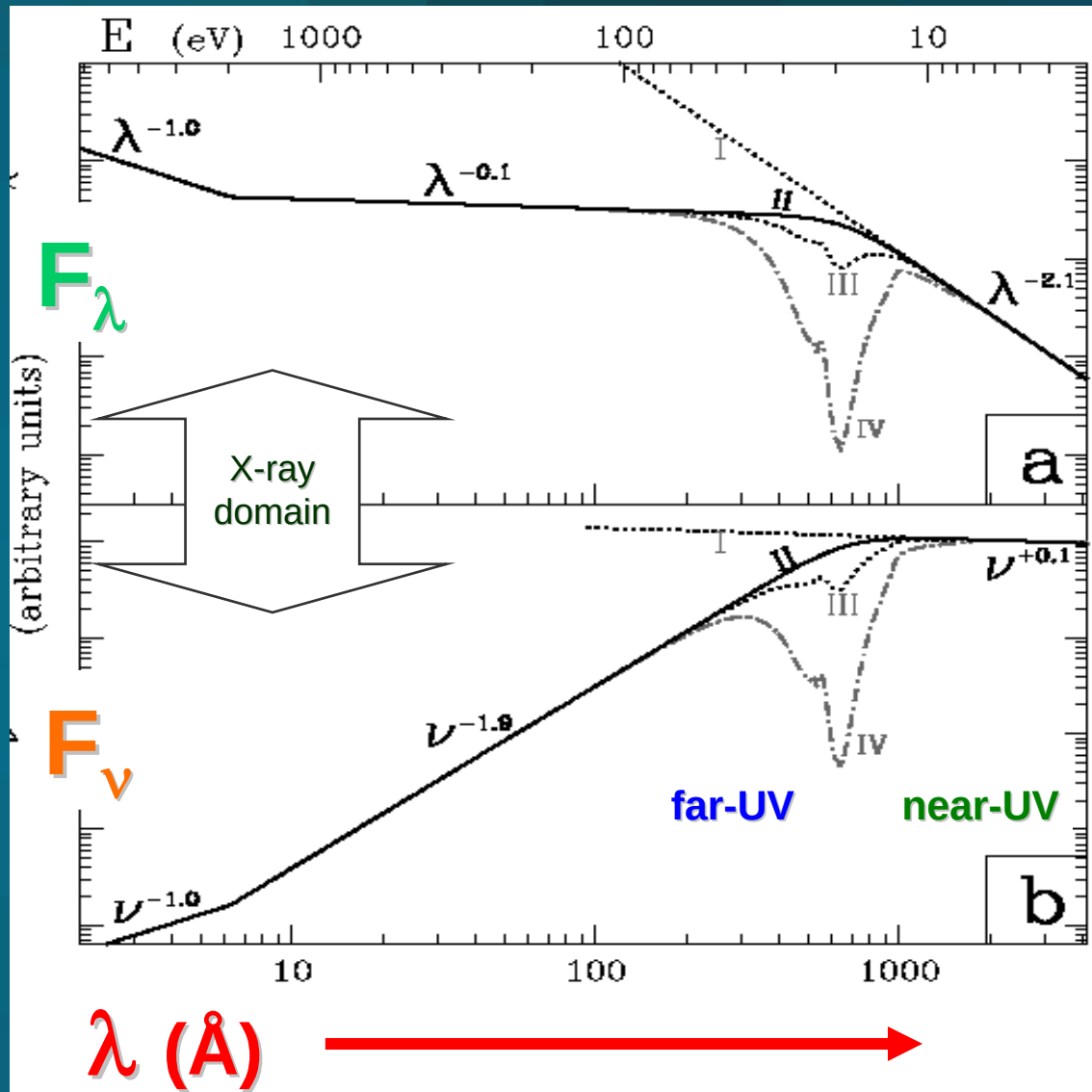
4 spectral segments



(paper with Y. Krongold submitted)

solution: existence of a flux rise or recovery in the extreme-UV?

- maybe continuum picks up un the extreme-UV?
- could the UV break be a localized feature?
- which mechanisms may cause such a localized UV trough?



intergalactic absorption

intrinsic screen

disk photosphere

accelerated ouflow

HI : Lyα ...+ Lyman continuum

dust absorption

1 •jump not seen	2 •too sharp edge	3 •fit so-so •too soft	4 Eastman, MacAlpine, Richstone
A •too much dust	B •IR emission?	C •dust destroyed?	D •not needed •not useful

conclusions

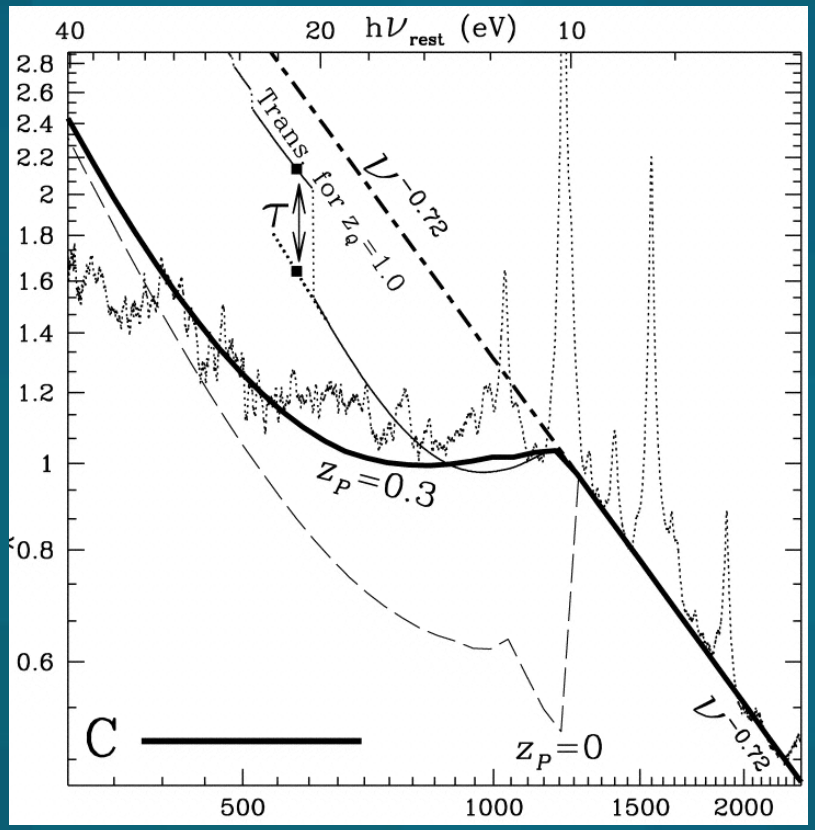
1. intrinsic crystalline C dust, promising:
   - infrared re-emission
     - rules out meteoritic flavor
     - compute bulk impurities of
       - in progress: Anja Anderser
   - polarization *vs* lambda
     - model scattering using pr
2. accretion disk photosphe
   - cooler emission from line driven wind
3. accelerated outflow?
   - speculative but tantalizing

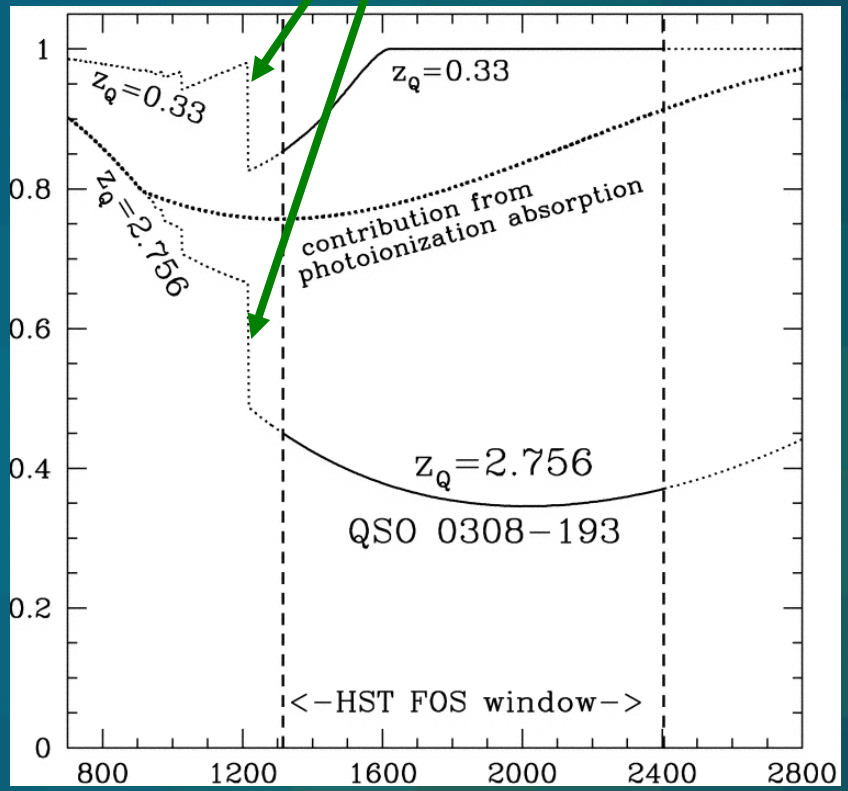
GOAL: reconcile line emission spectrum with observed SED

1- extragalactic HI absorption (WHIM)

ApJ (2003) 590, 58

predicted jump is NOT observed





F_λ

λ (Å) rest-frame

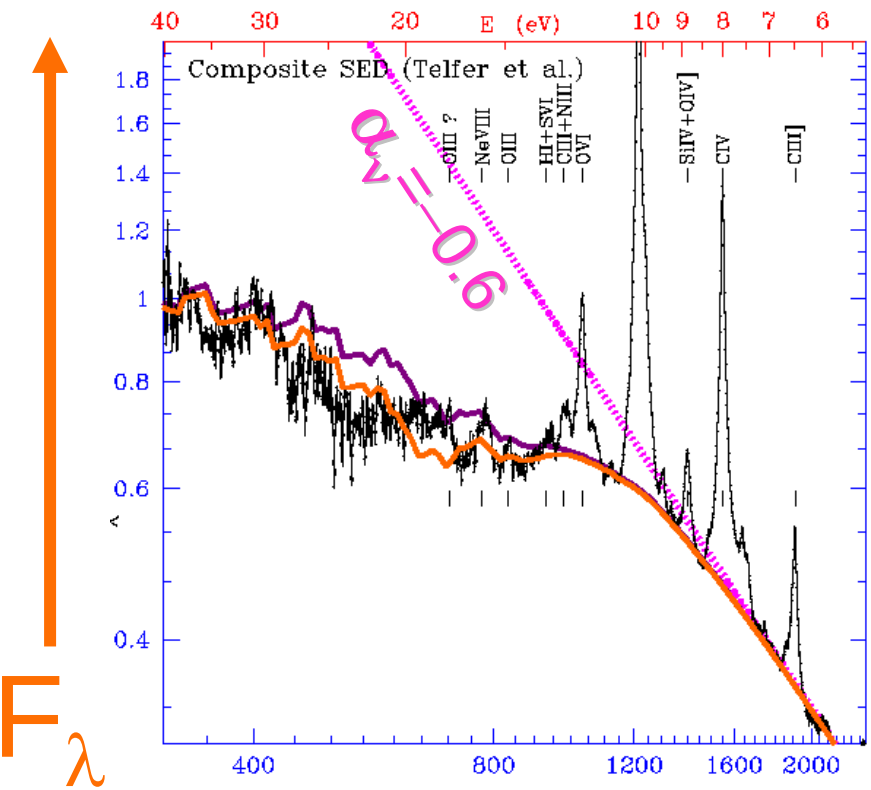
λ (Å) observer-frame

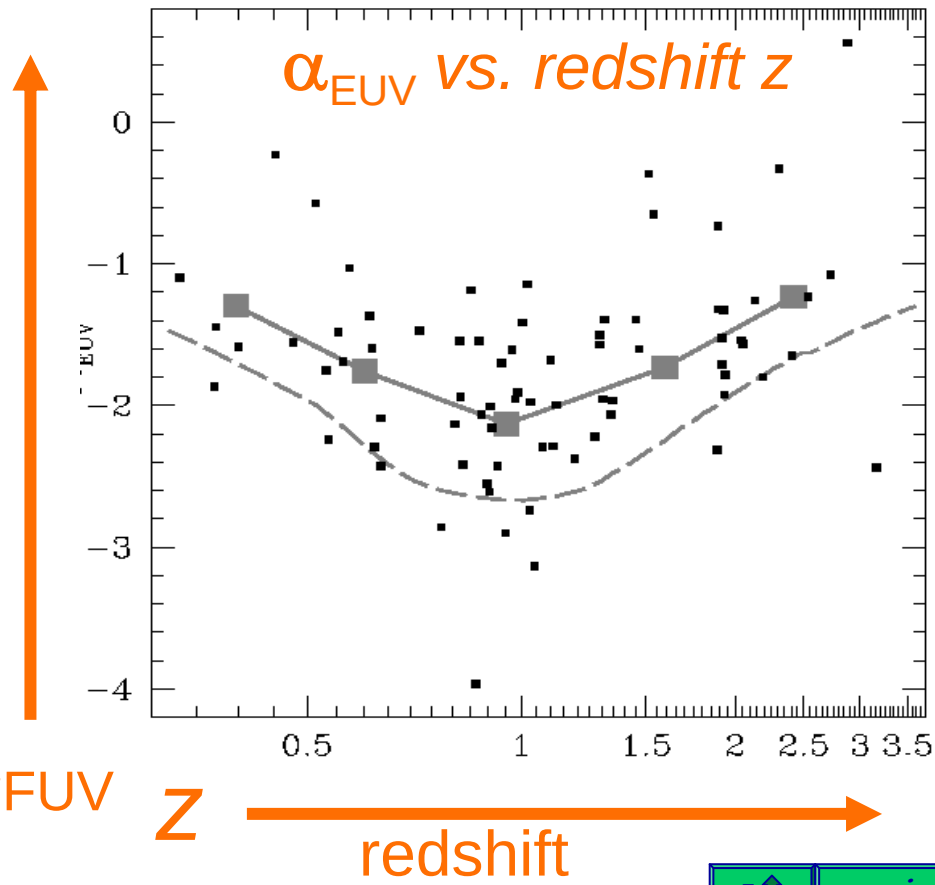
main

A-intergalactic dust

ApJ (2005) 631, 661

- **requires too much dust**
- **carbon crystallites only**

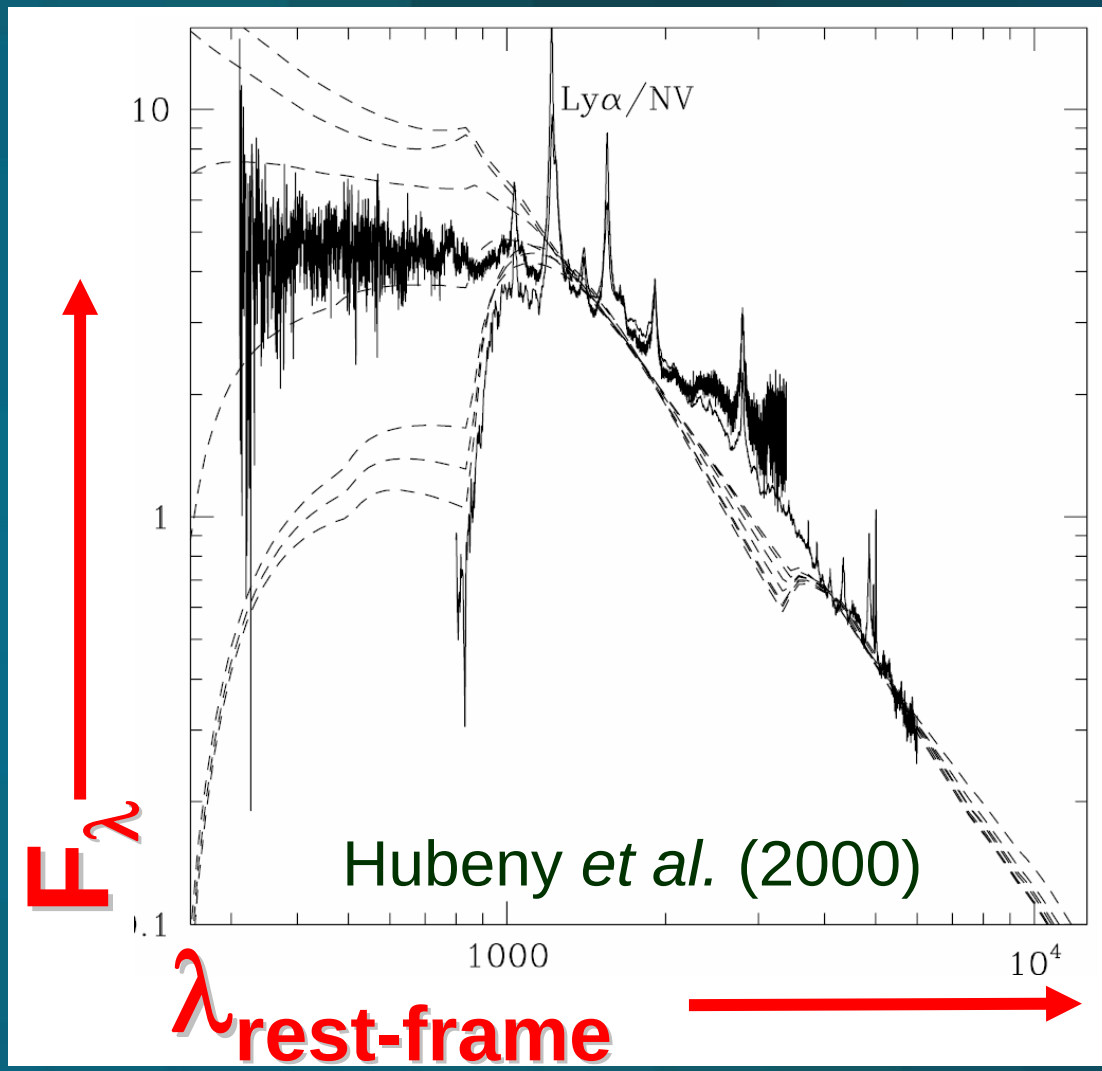




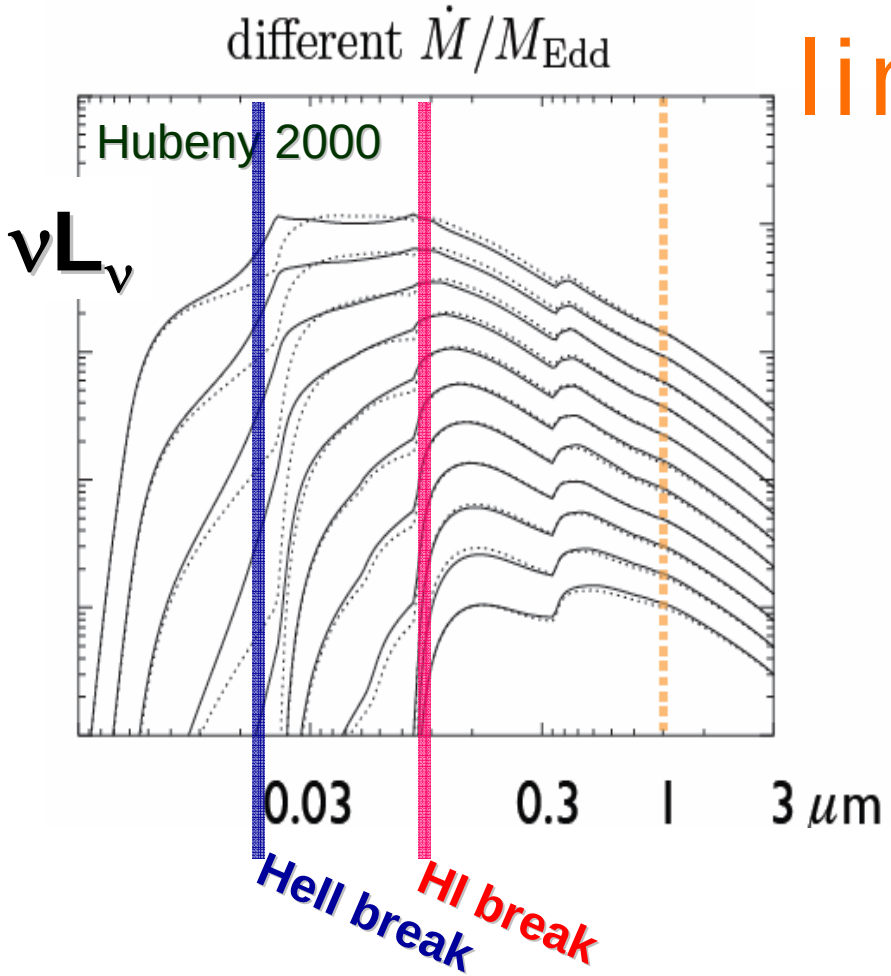
main

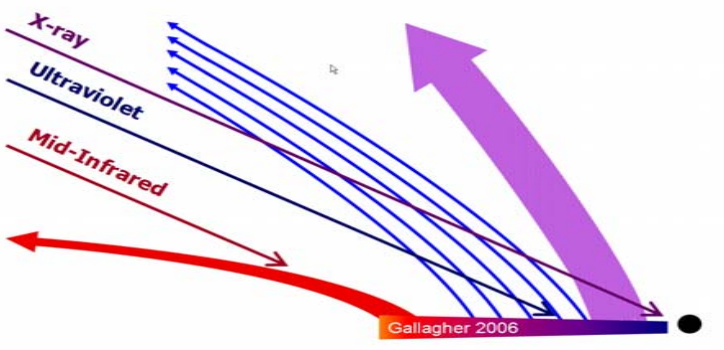
3- problem of SEDs from current accretion disk models

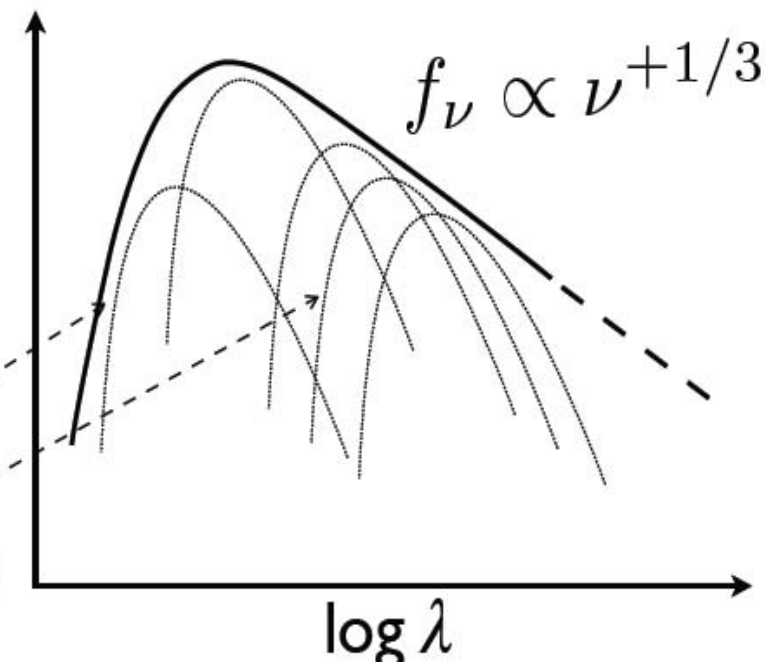
- photospheric models
  - Hubeny et al.
- accretion disks do predict break near Lyman limit
  - does <u>not</u> fit too well observed break
  - <u>too soft</u> an SED to account for high ionization emission lines



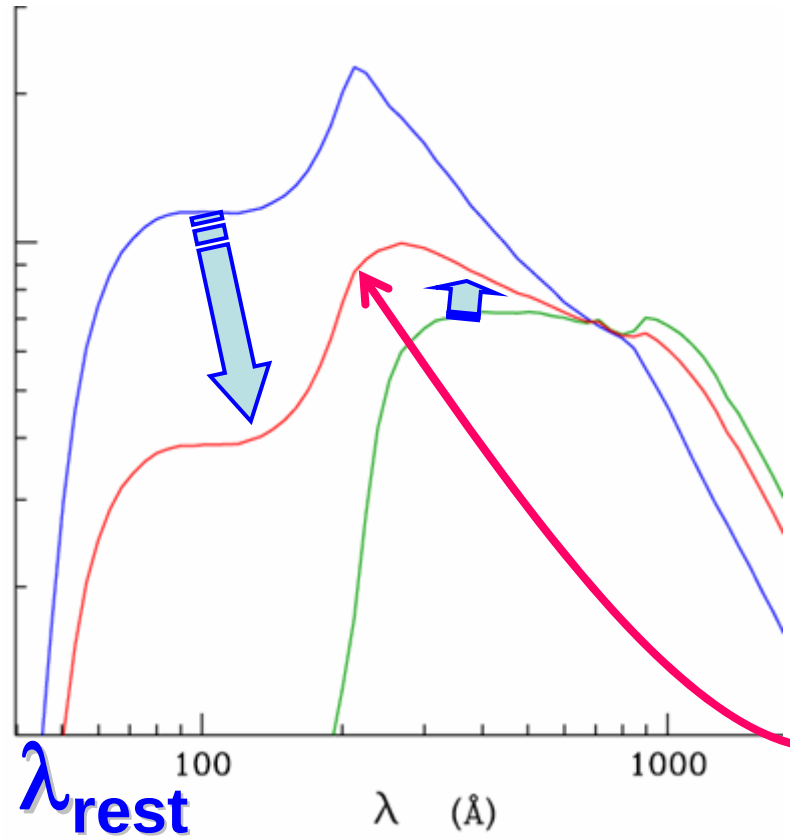
line driven wind

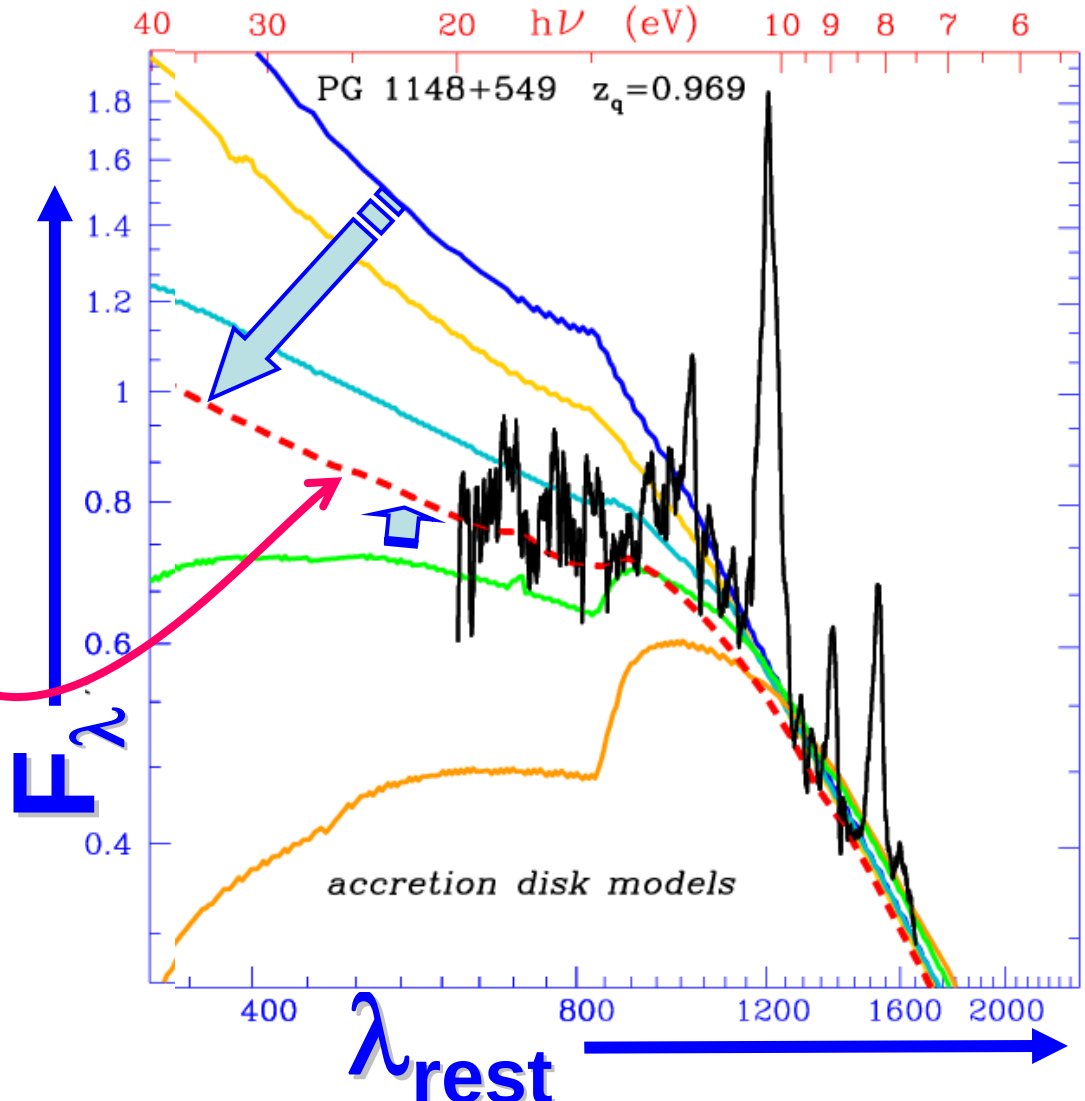






launched wind may induce a cooler emission gas component



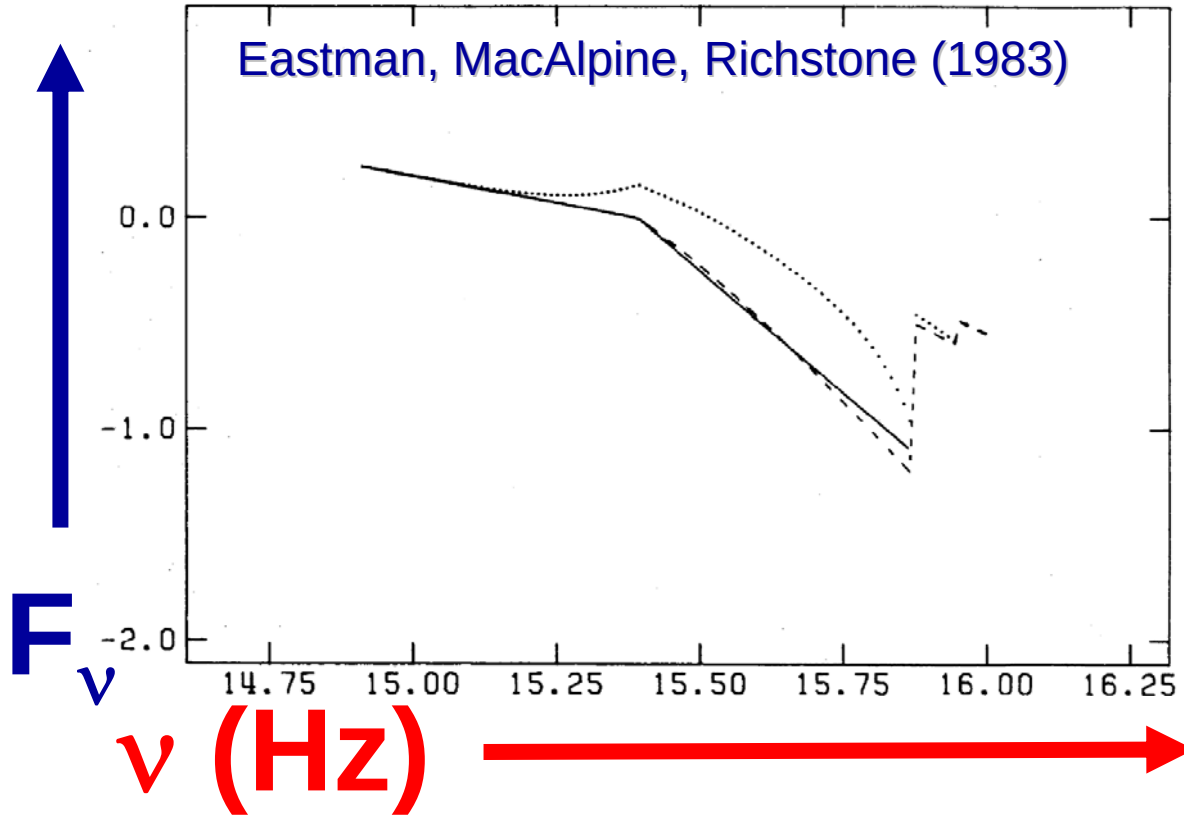


possible scenario ONLY

main

4-accelerated outflow

- gas condensations accelerated up to 0.8 *c*
- model could be modified so that
  - break could be blueshifted by 0.1*c*
  - determine where the flux recovery occurs in the extreme-UV



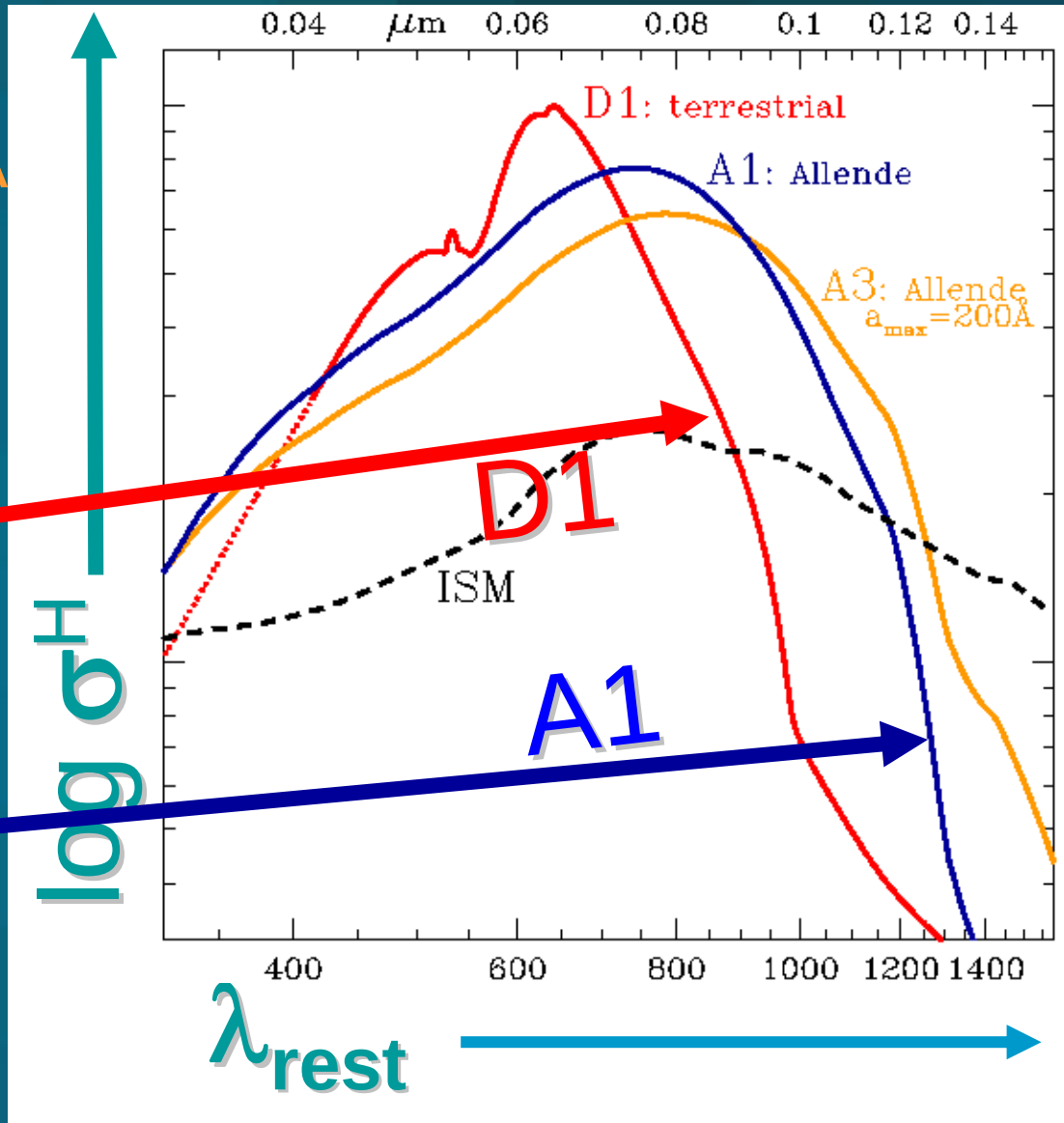
main

B-crystalline carbon extinction

- Shang et al. (2005) explored SMC-like and ISM dust
  - such dust does NOT fit UV break
- crystalline carbon grains
  - extinction very “peaky” in the far-UV
  - can fit UV break (see later)
  - was found in 3 stellar disks around emission line stars
  - formation processes:
    - nucleation of organic ice mixtures by UV photolysis (Kouchi et al. 2005)
    - UV conversion of PAH clusters (Duley & Grishko 2001).

dust model based on carbon crystallites

- small size regime
  - grain radii 2.5–25 Å
- 2 types of crystallite diamonds
  - terrestrial cubic diamond
  - nanodiamonds from meteorite Allende

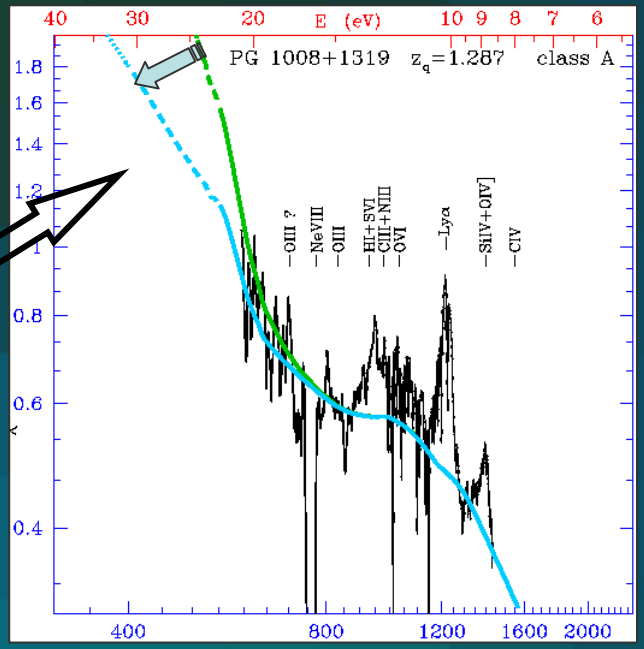


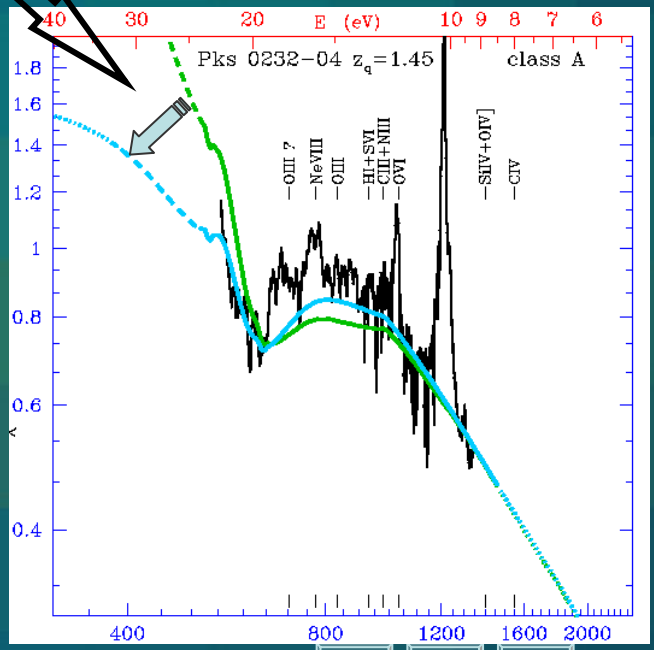
examples of quasars with evidence of far-UV recovery at 18.5eV (670Å)

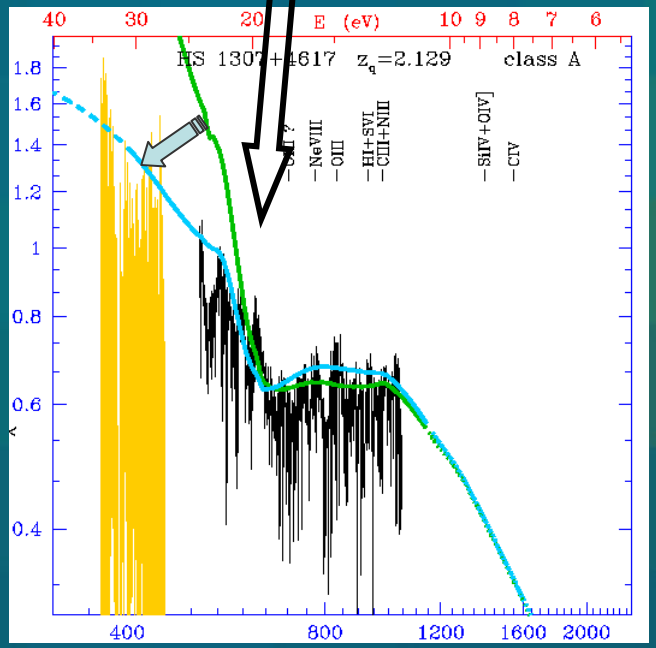
- **PG 1008+1319**
  z_q=1.287
- **Pks 0232-04**
  z_q=1.45
- **HS 1307+4617**
  z_q=2.129

ApJ (2005) 631, 661

•extinction predicts a flux recovery in the extreme UV



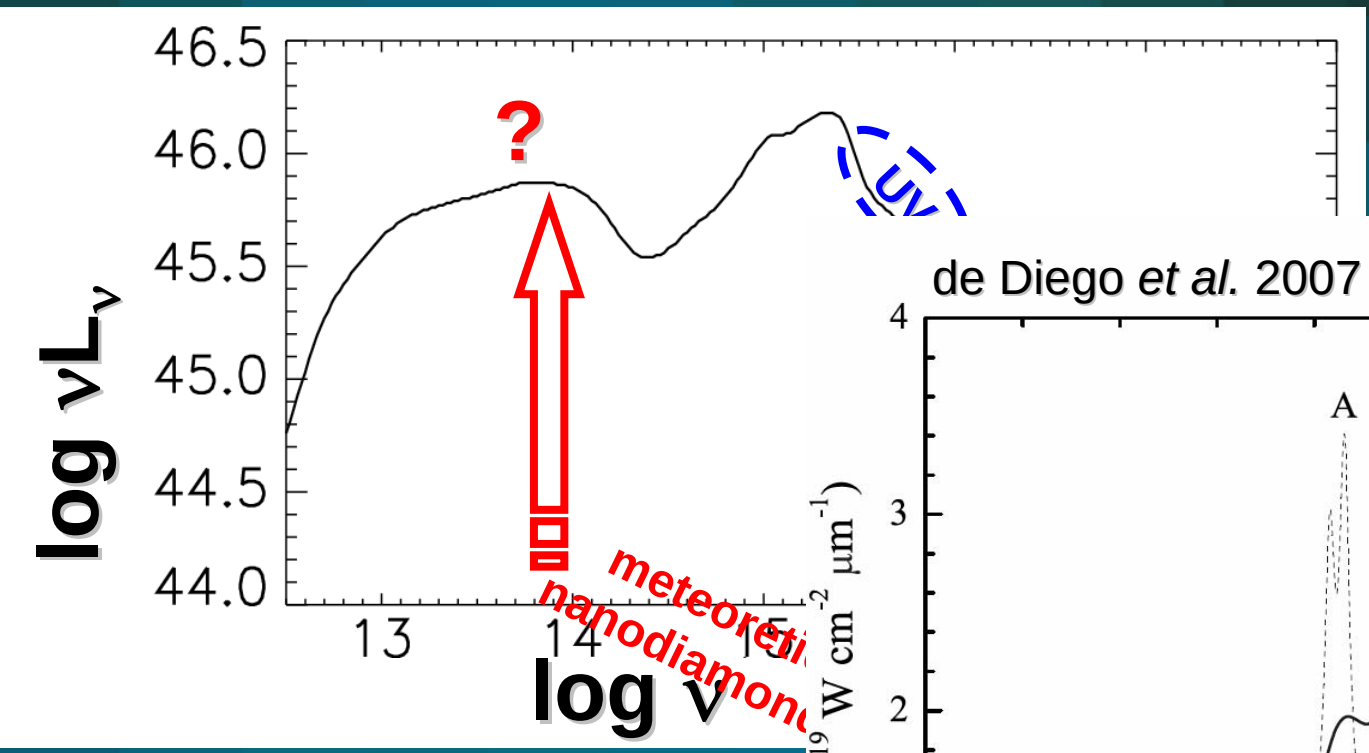


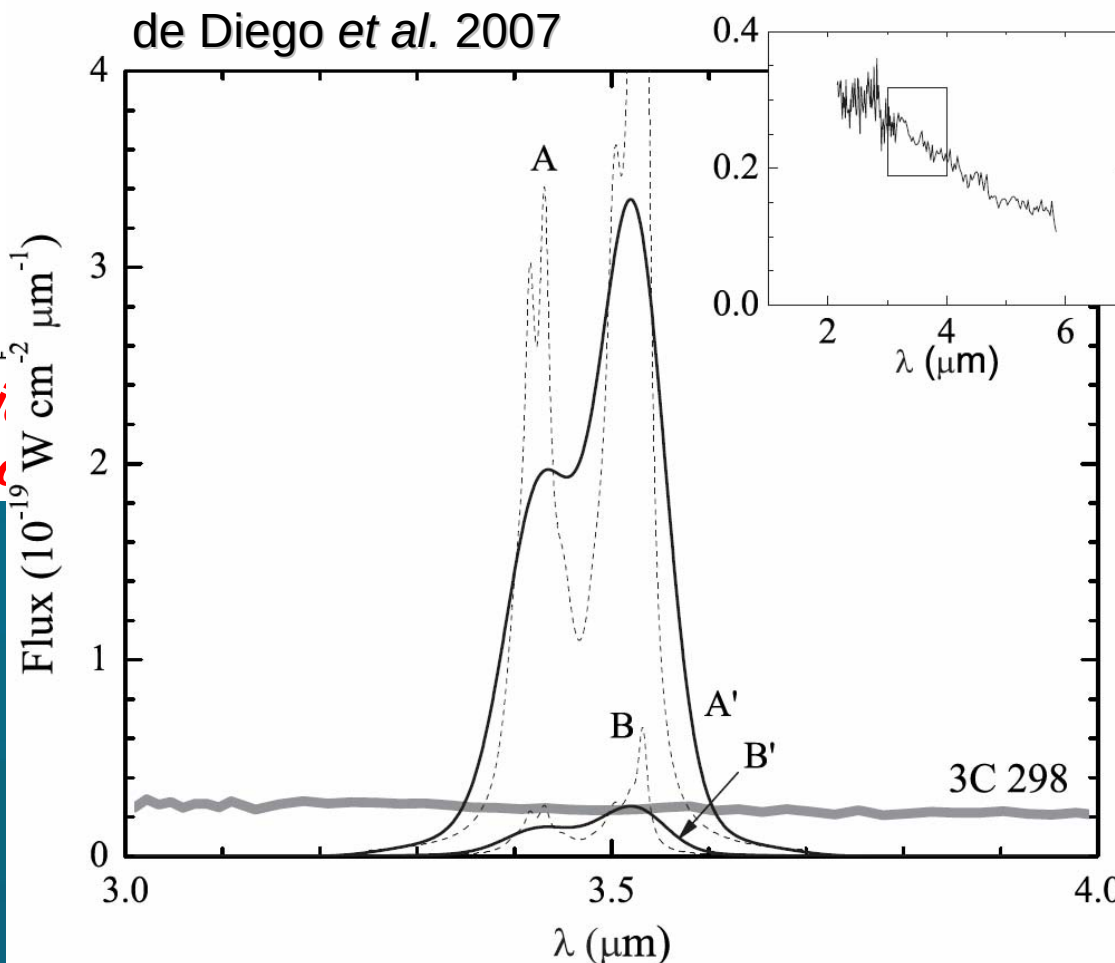


1008 0232 1307

main

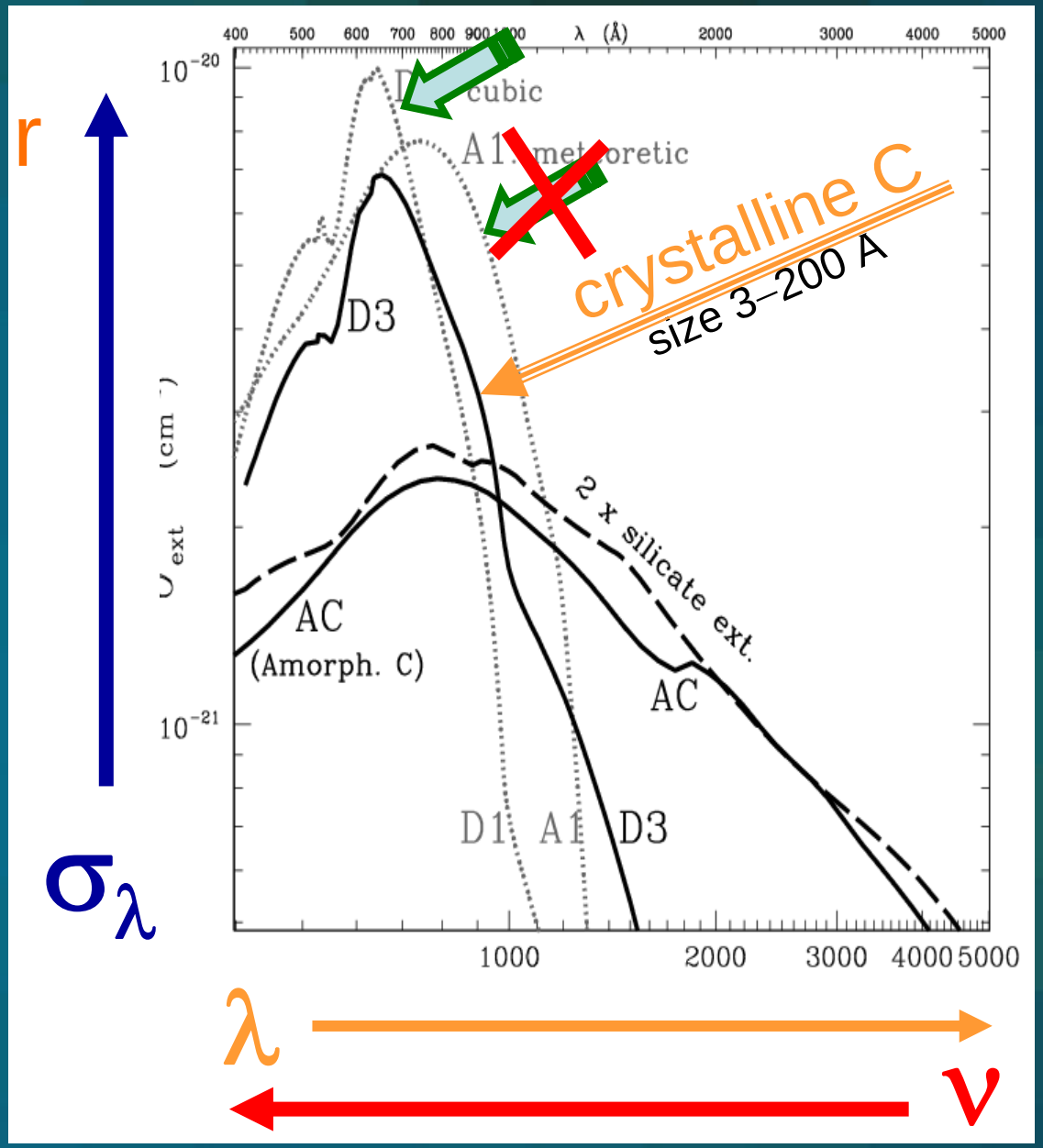
where is energy re-emitted?





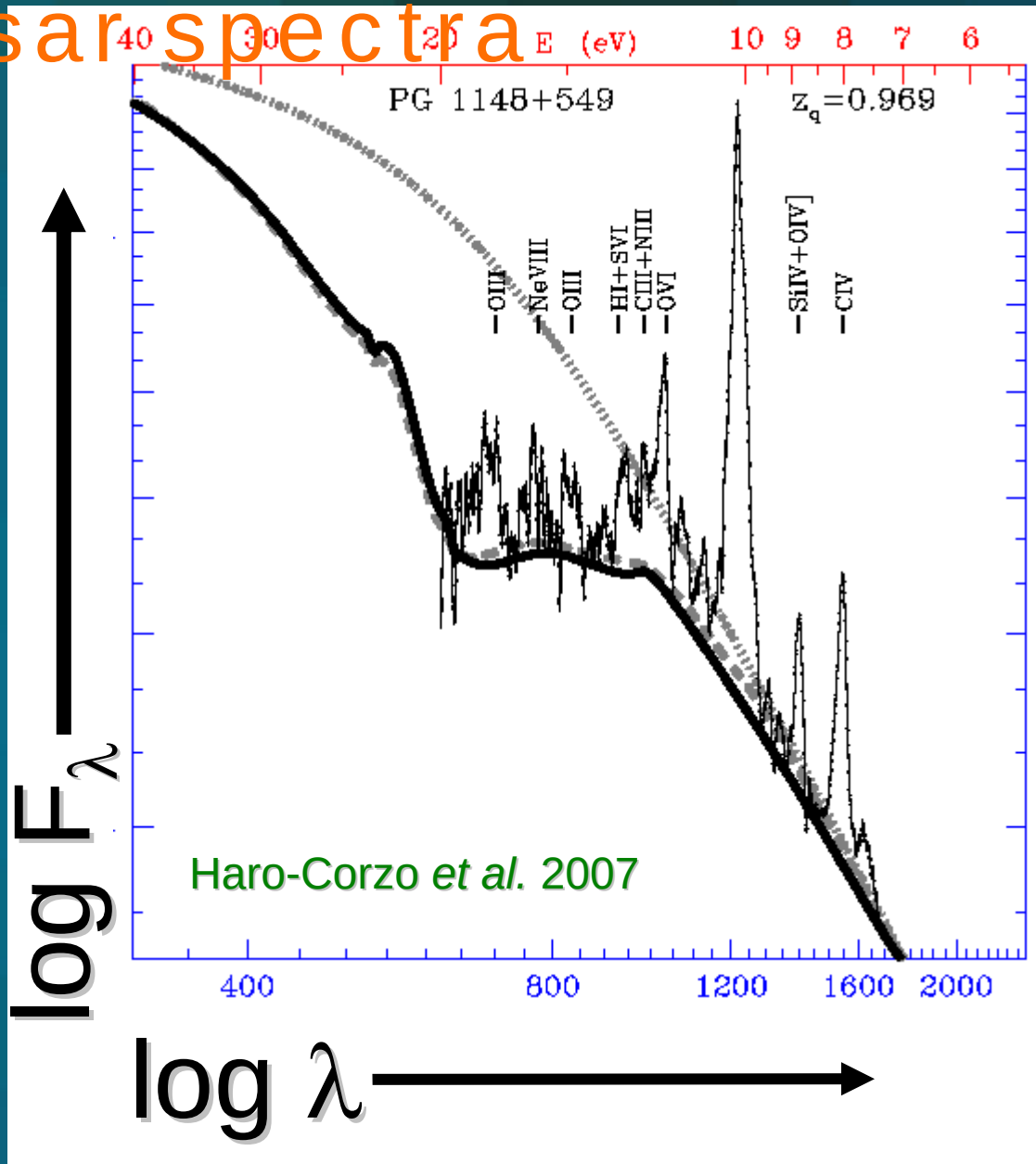
Must use then cubic type only, but wider range of grain sizes

- curve D3
  - grain size range must extend from 3 to 200 Å to fit the UV break



dust abs. fits UV break in *individual* quasar spectra

- example: PG1148+459
- assuming curve D3
  - cubic nanodiamond grains only
  - *size distr.* ($a^{-3.5}$)
    - range 3–200 Å
  - Haro-Corzo et al. (2007)



main