

Background Opacities

Inga Kamp

- What are background opacities
- Why use background opacities
- Two examples: nitrogen and carbon

What are background opacities ?

$$R_{ic} = \int \alpha_{ic}(\lambda) J(\lambda) d\lambda$$

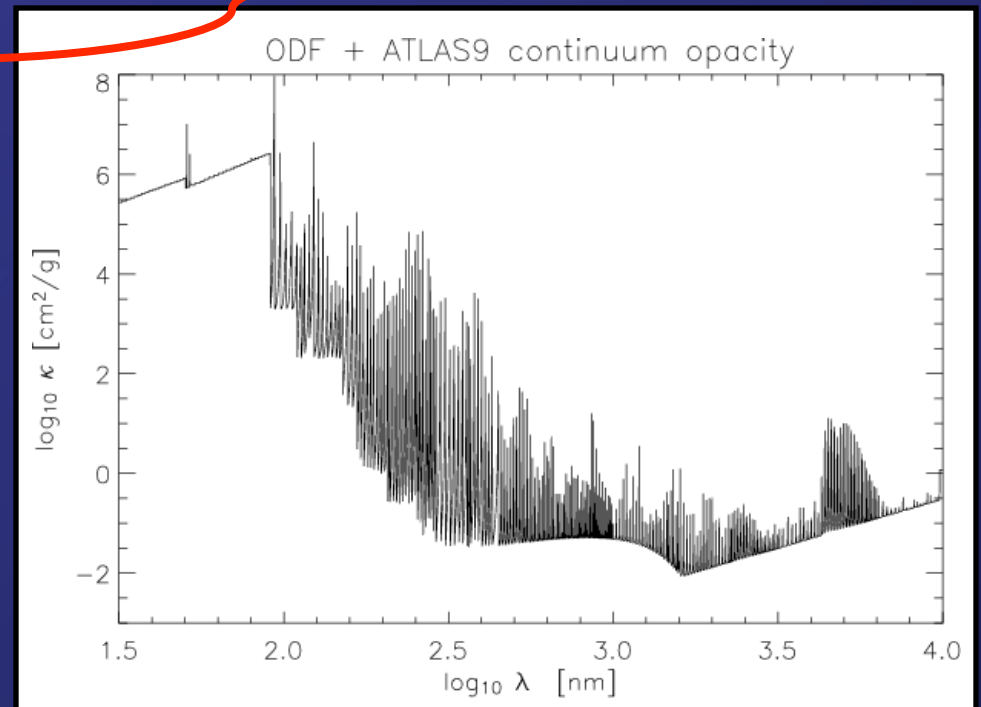
$J(\lambda)$ from radiative transfer equation

$$\mu dI_{\nu}/d\tau = I_{\nu} - \eta_{\nu}/\kappa_{\nu}$$

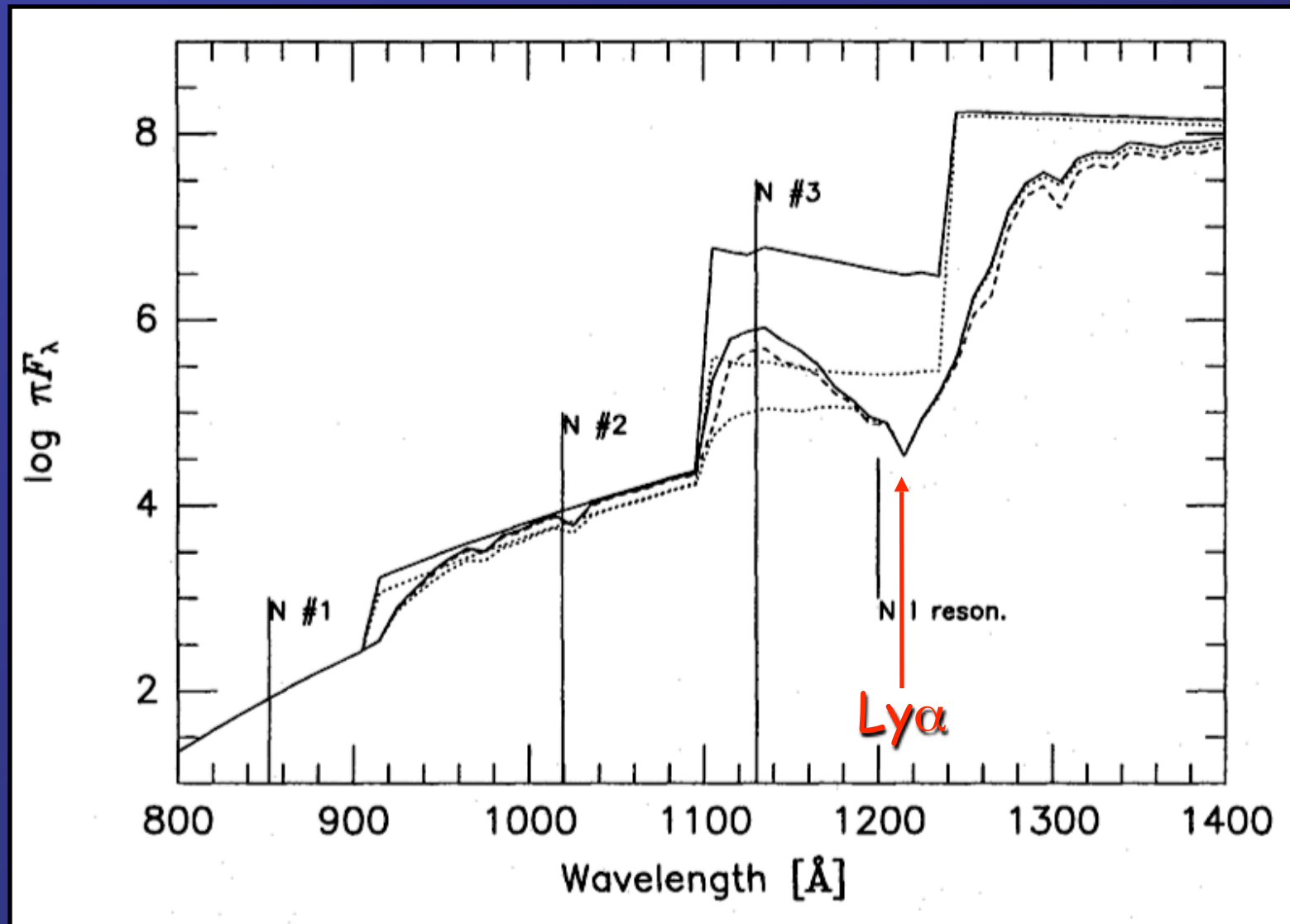
contains line + continuum absorption

background opacity:

all opacity that does not arise from the model atom under consideration



What are background opacities ?



What are background opacities ?

Table 1. Summary of the different codes with their respective algorithm and treatment of the background opacity (added to the continuous opacity) for bound-free and bound-bound transitions: ATLAS and CD 18 (Kurucz 1979, 1992, 1993), ATMOS (Baschek et al. 1966), OPS means opacity sampling, OPMET calculates the b-f opacities using TOPbase and Auer et al. (1972) data.

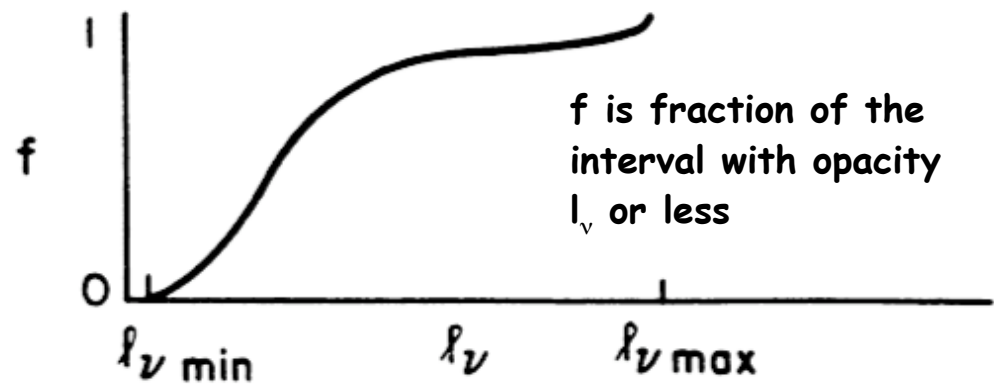
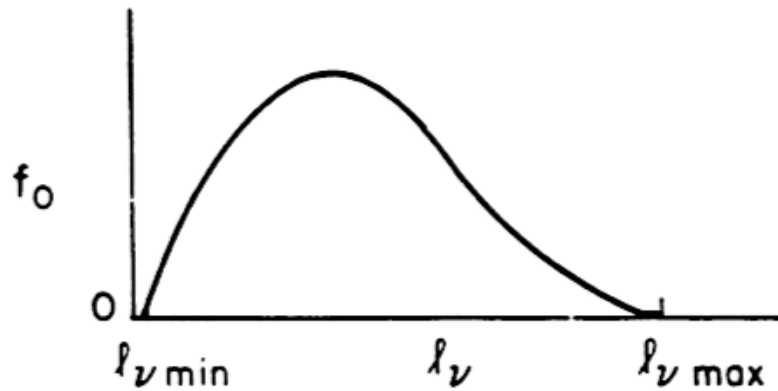
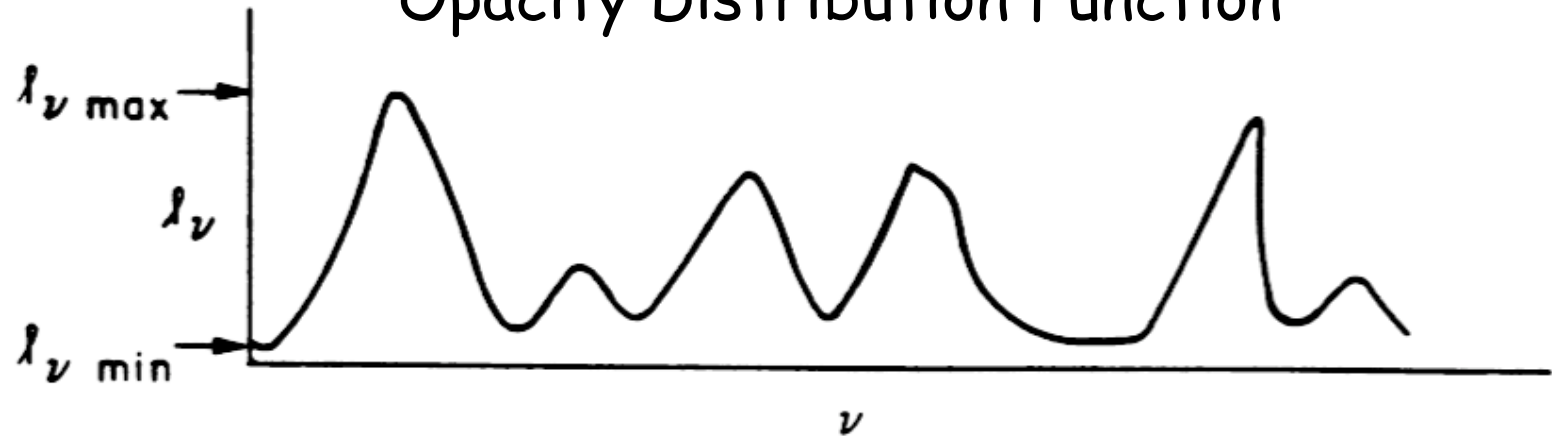
Name	alg.	b-f transitions		b-b transitions	
		b-f opacity	b-b opacity	b-f opacity	b-b opacity
NONLTE3	CL	ATLAS	OPS+CD 18	ATLAS	OPS+CD 18
NONLTE3a	CL	OPMET	OPSa+CD 18	OPMET	OPSa+CD 18
DETAIL	ALI	DETAIL	ATLAS ODF's	DETAIL	ATLAS ODF's
Kiel code	CL	ATMOS	ATLAS ODF's	ATMOS	none
MULTIa	OPT	ATLAS	ATLAS ODF's	ATLAS	none

[Kamp et al. 2003]

have to be specified explicitly

What are background opacities ?

Opacity Distribution Function



What are background opacities ?

- Thomson scattering of free electrons
- Rayleigh scattering of HI, HeI, H₂
- HI, H⁻, He⁻, He, C-Ni free-free opacity
- HI, H⁻, H₂, H₂⁺, HeI/II, C-Fe bound-free opacity

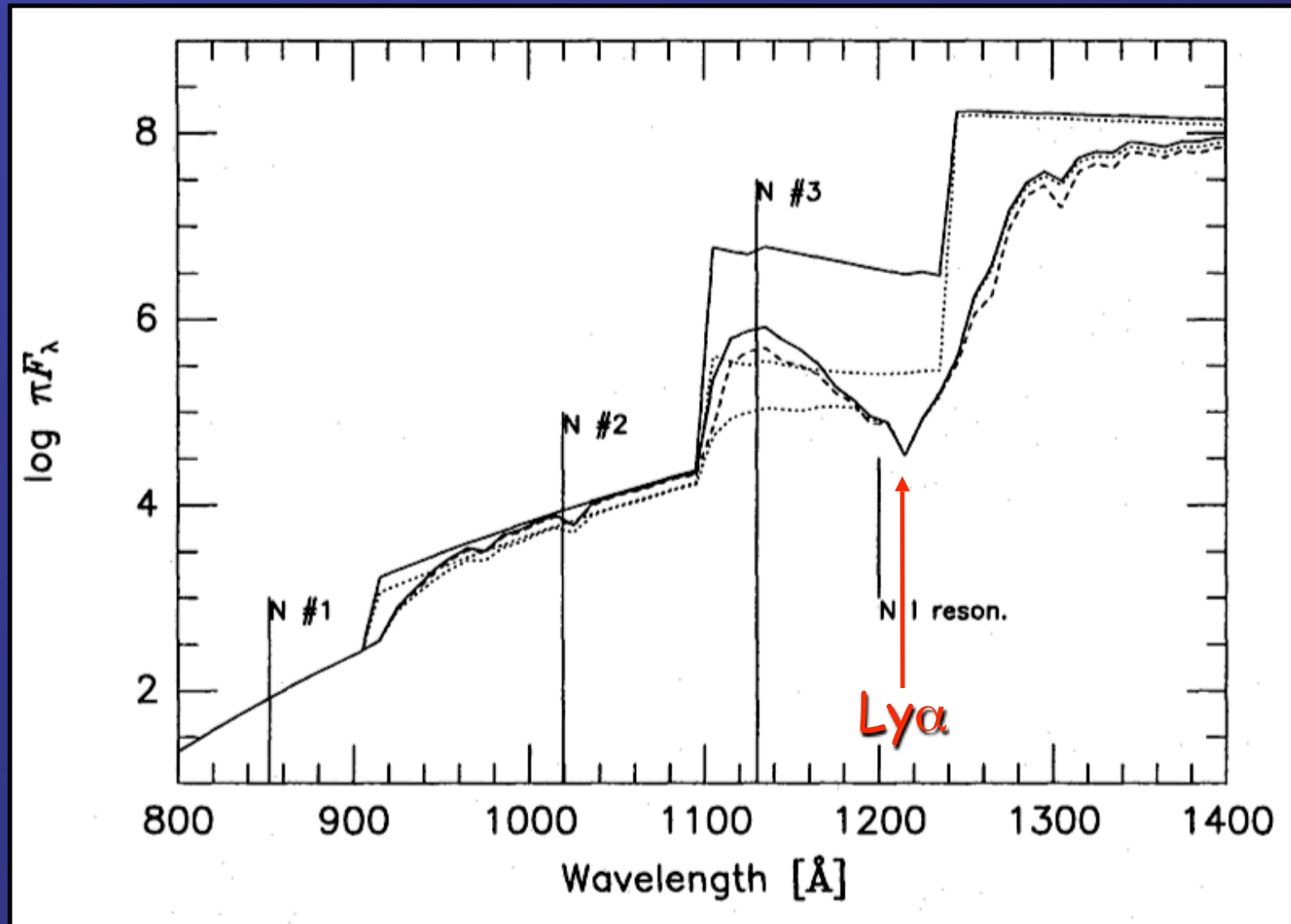
low temperatures (<10000 K) CI, MgI, SiI, AlI

medium temperatures (10000<T<20000)

SiII, MgII, CaII, NI, OI

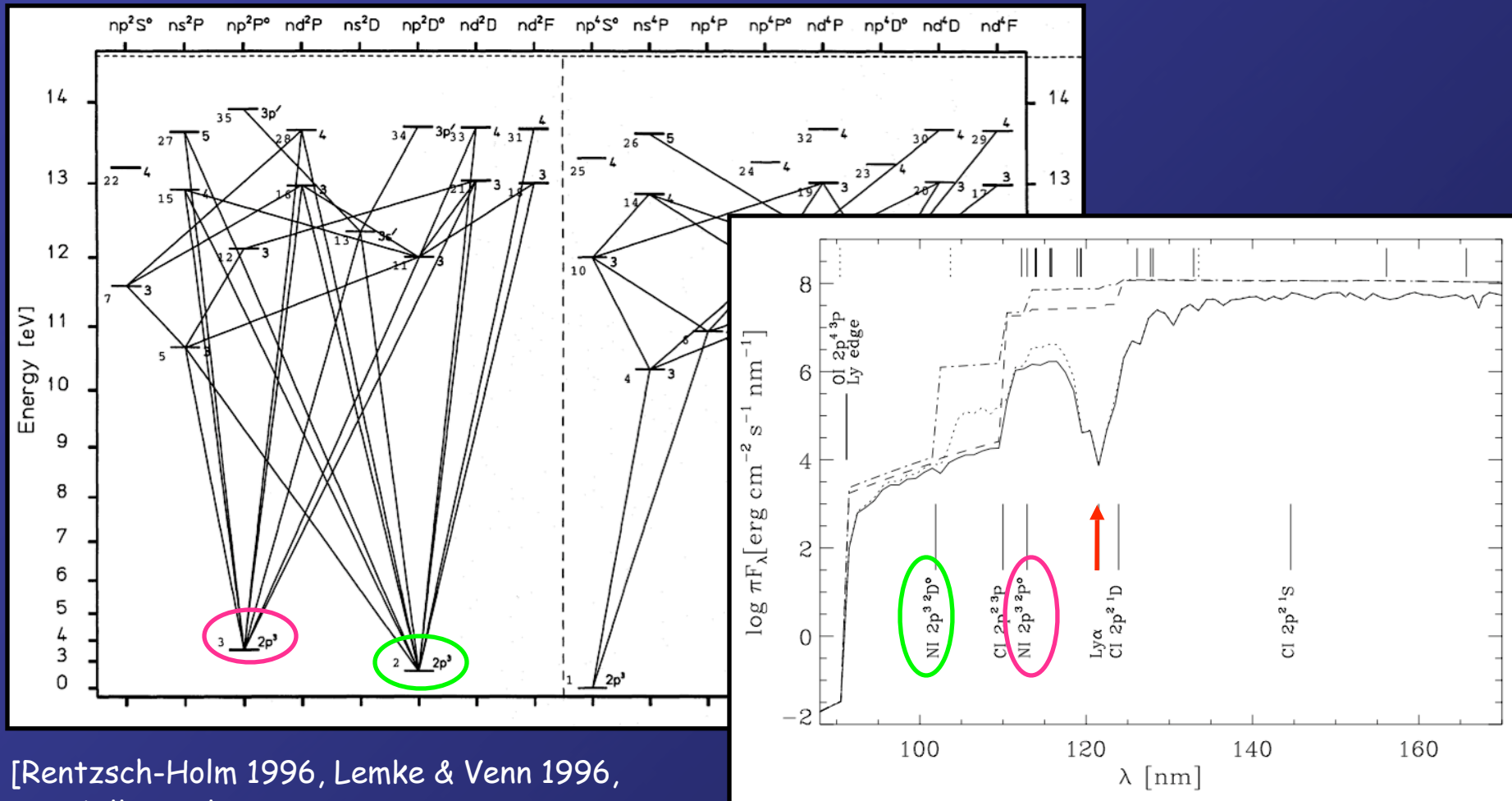
high temperatures CII-IV, NII-IV, OII-VI, NeI-VI

Why use background opacities ?



Nitrogen

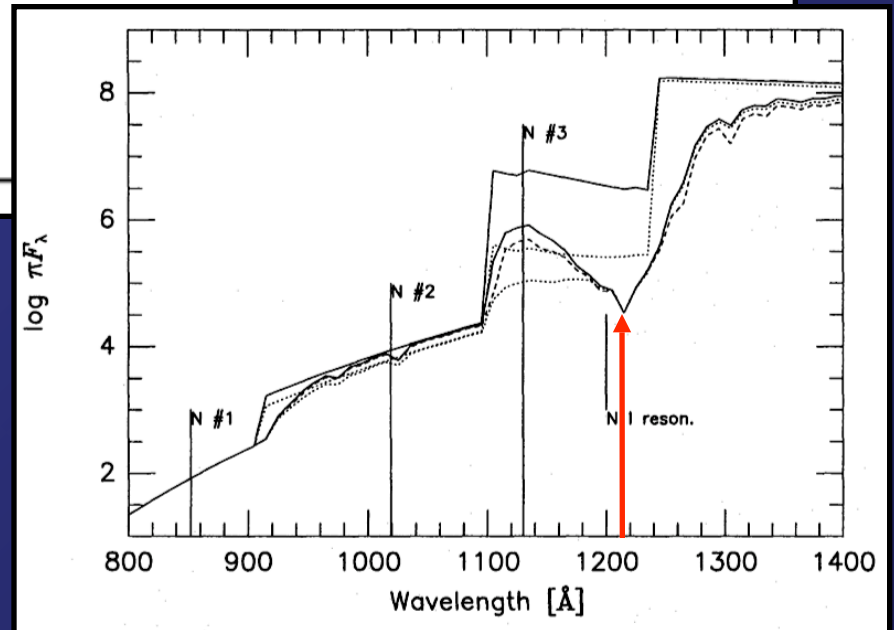
- Strong impact of carbon abundance through UV bf continua



[Rentsch-Holm 1996, Lemke & Venn 1996, Przybilla et al. 2001]

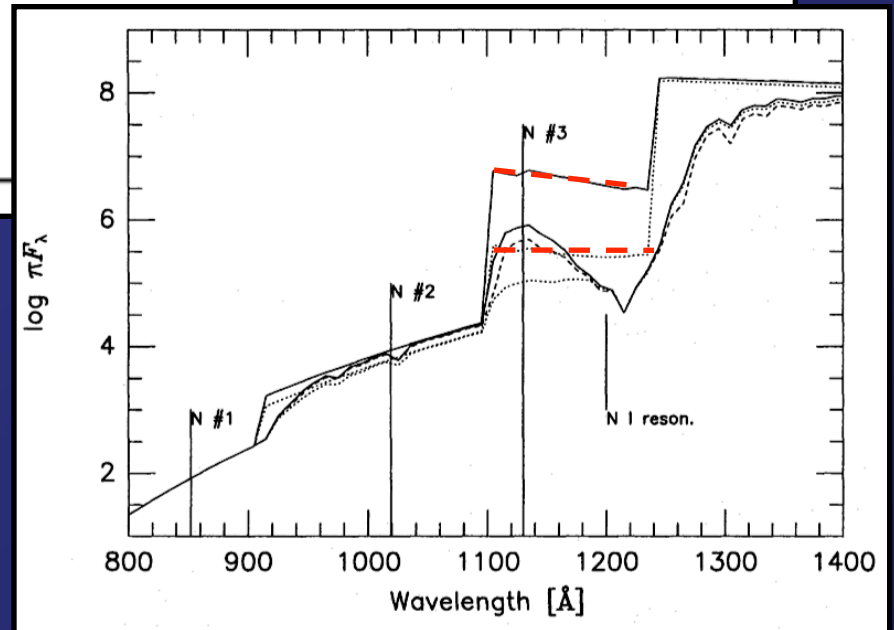
Nitrogen in Vega

		$\log \epsilon(\text{N})$	$\Delta \log \epsilon$	$\log \epsilon(\text{N})$	$\Delta \log \epsilon$	$\log \epsilon(\text{N})$	$\Delta \log \epsilon$
		$\lambda 7468$		$\lambda 9392$		$\lambda 10108$	
no Ly α ,	C = 8.67:	7.67	-0.42	7.30	-0.59	7.56	-0.27
	C = 8.28:	7.52	-0.56	7.26	-0.63	7.44	-0.40
	C = 7.67:	7.18	-0.91	7.18	-0.71	7.15	-0.69
with Ly α ,	C = 8.67:	7.72	-0.37	7.33	-0.56	7.61	-0.23
	C = 8.28:	7.67	-0.42	7.31	-0.58	7.56	-0.28
	C = 7.67:	7.54	-0.55	7.27	-0.62	7.43	-0.40
Equivalent width (mÅ):		46					
Multiplicity:		4					



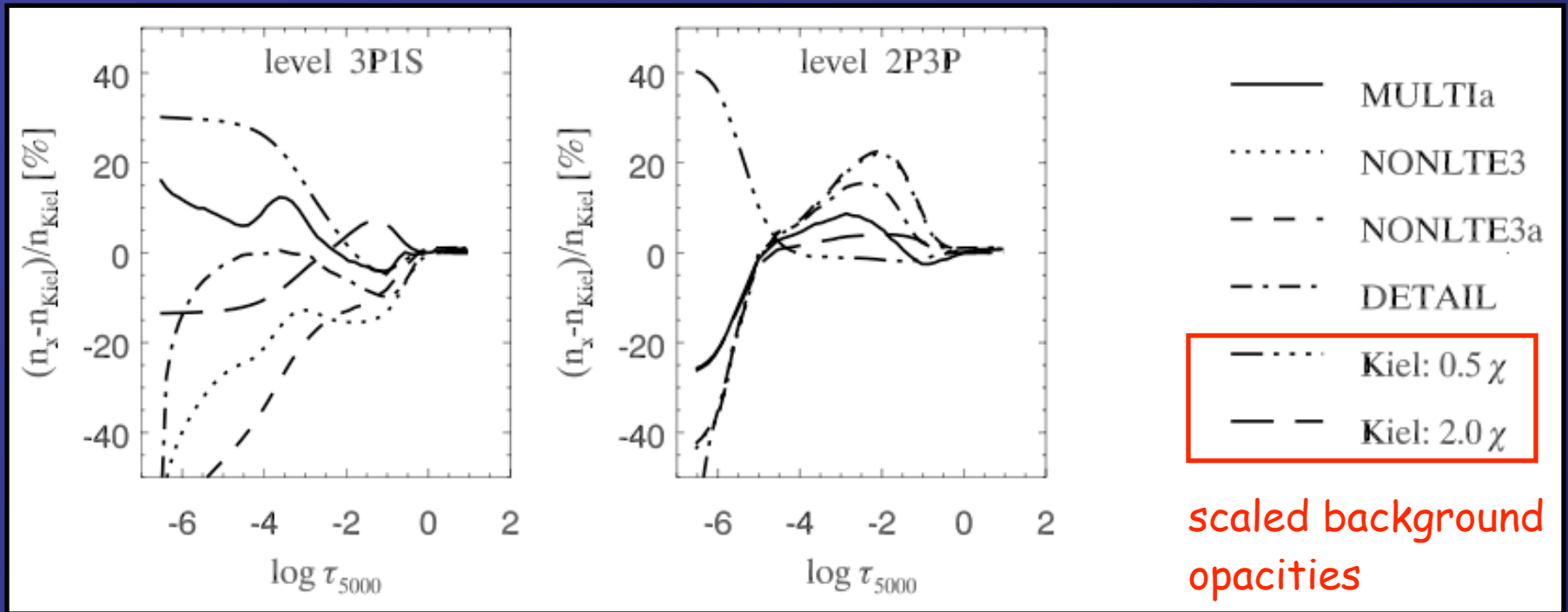
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Different treatment of background opacities

Carbon model atom in the Sun (IAU Symposium 210)



[Kamp, Korotin, Mashonkina, Przybilla, Shimansky 2003]

Summary

- Background opacities are **VERY** important for minor elements (b-f transitions) and major elements (b-b transitions)
- Be careful with chemical peculiar stars !
 - use ODFs wisely or use Opacity Sampling