Combined line-continuum modeling
PDR clumps

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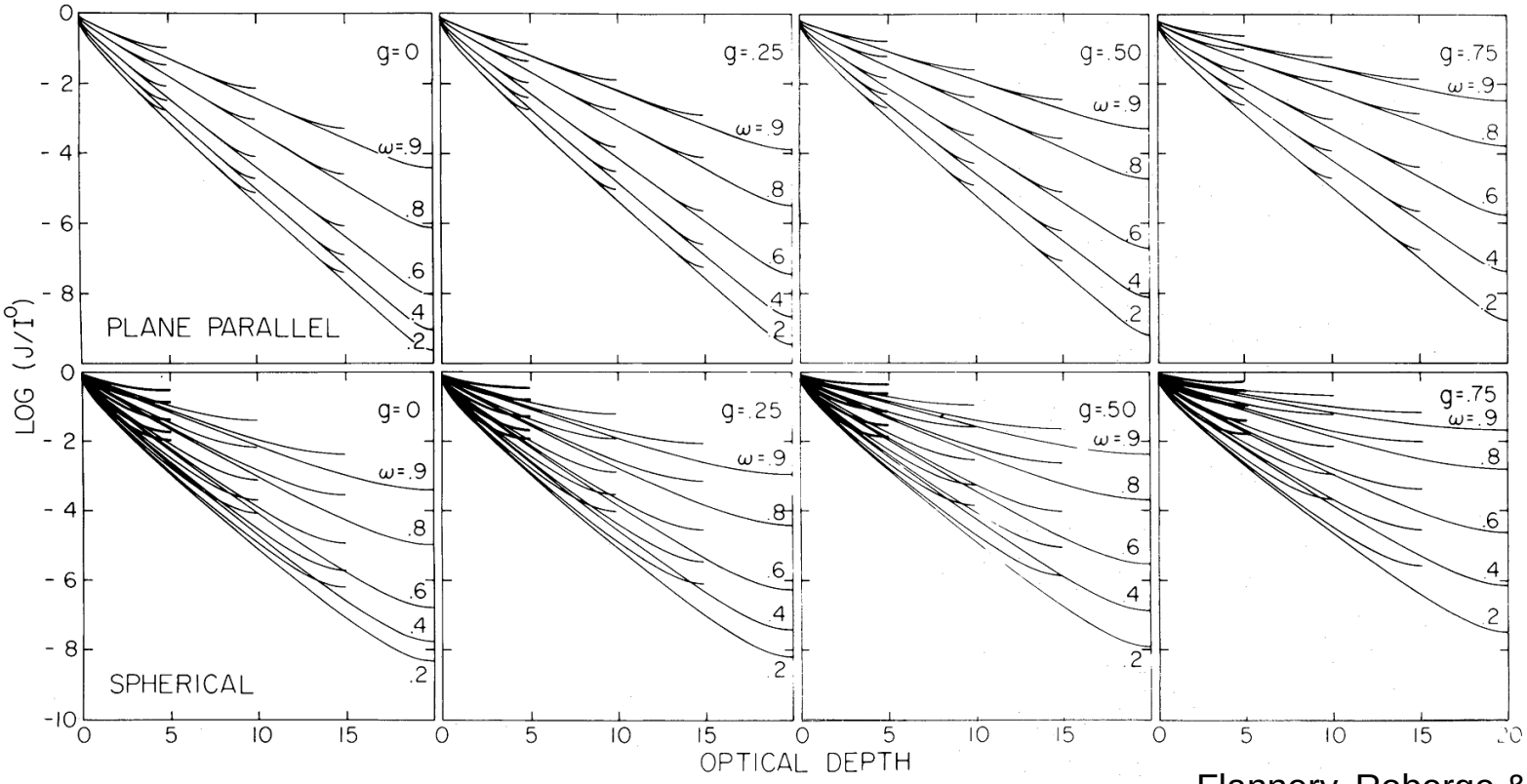
Combined line-continuum modeling – PDR clumps

The dust properties are one of the most influential properties of PDR model calculations.

- radiative transfer (shielding, gas cooling capabilities,…)



Flannery, Roberge & Rybicky 1980

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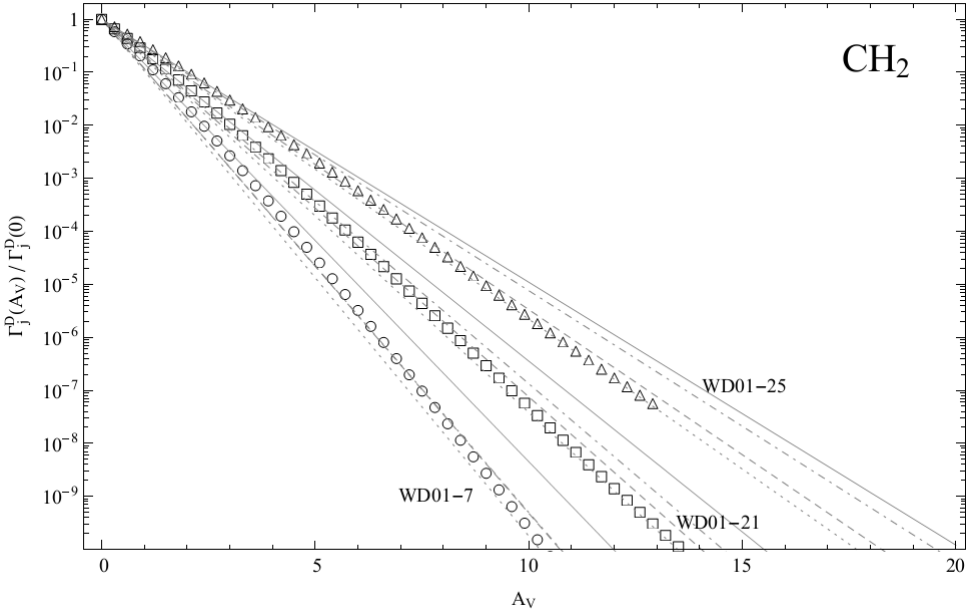
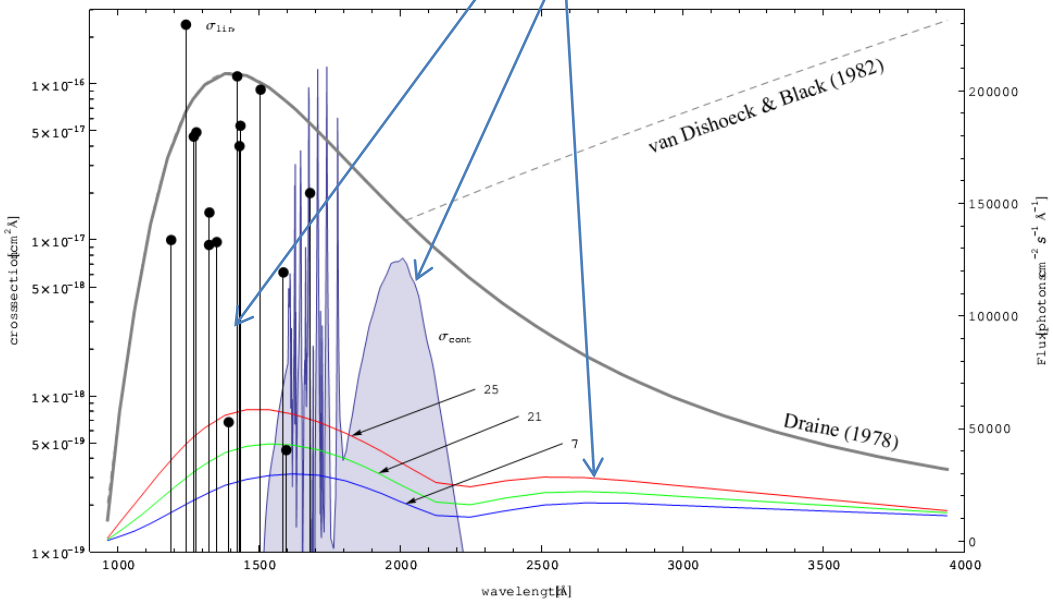
$$\Gamma_j(r) = 4\pi \int_{\lambda_H}^{\lambda_j} J_\lambda(r)\sigma_j(\lambda)d\lambda.$$

CH_2 photodissociation rate for R_V=3.1, 4.0, 5.5





Flannery, Roberge & Rybicky 1980

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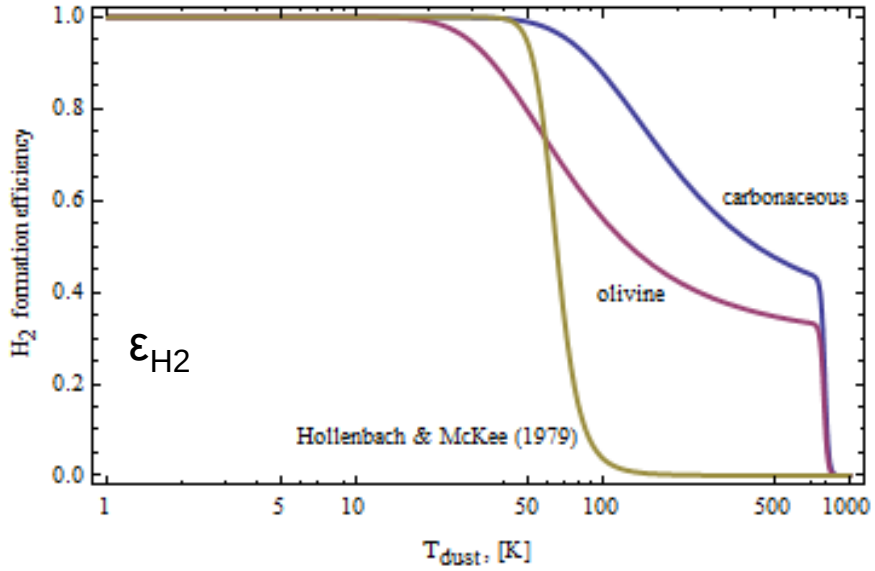
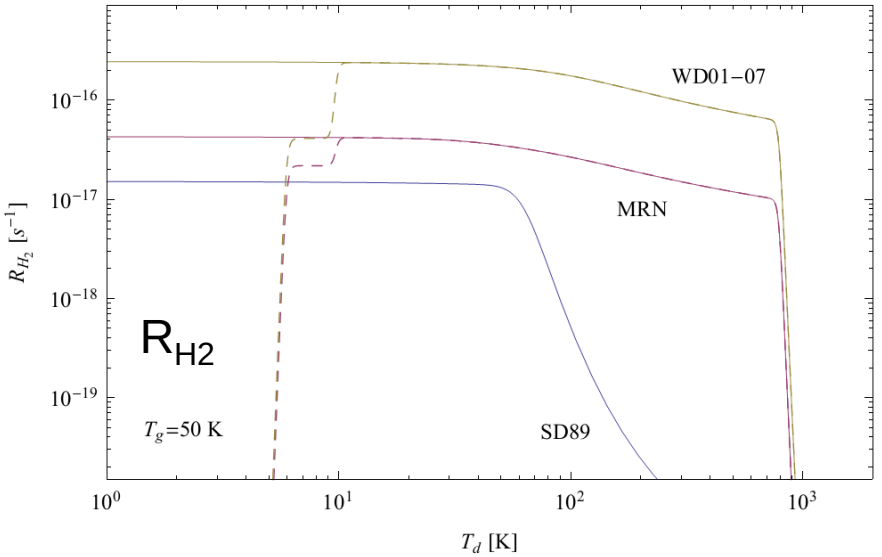
- Chemistry (surface reactions, H_2 formation, …)

Dust sort	Surface/H [cm^2]
MRN	1.2×10^{-21}
WD-7, R_V=3.1	6.7×10^{-21}
WD-21, R_V=4.0	4.3×10^{-21}
WD-25, R_V=5.5	3.0×10^{-21}





Cazaux & Tielens 2004, ApJ 604

Röllig et al. 2012

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more H_2 formation
→more formation heating

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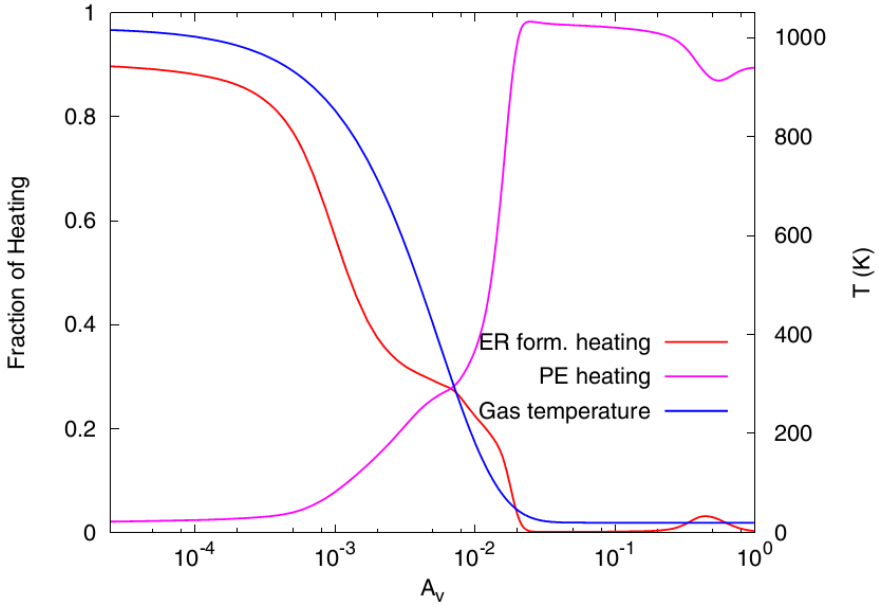
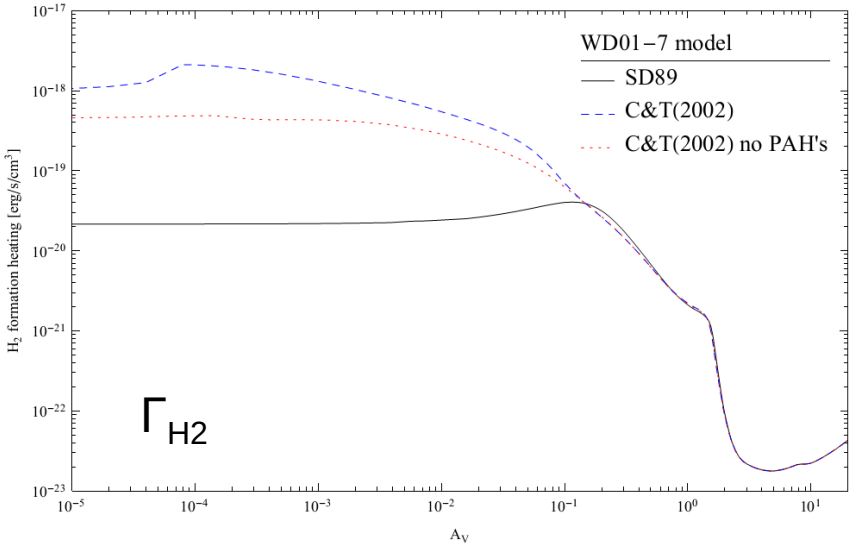


Le Bourlot et al. 2012



Röllig et al. 2012

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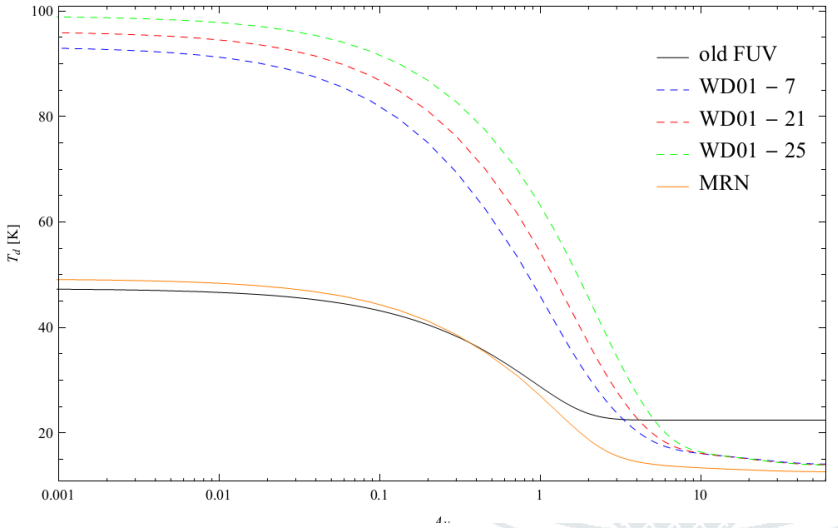
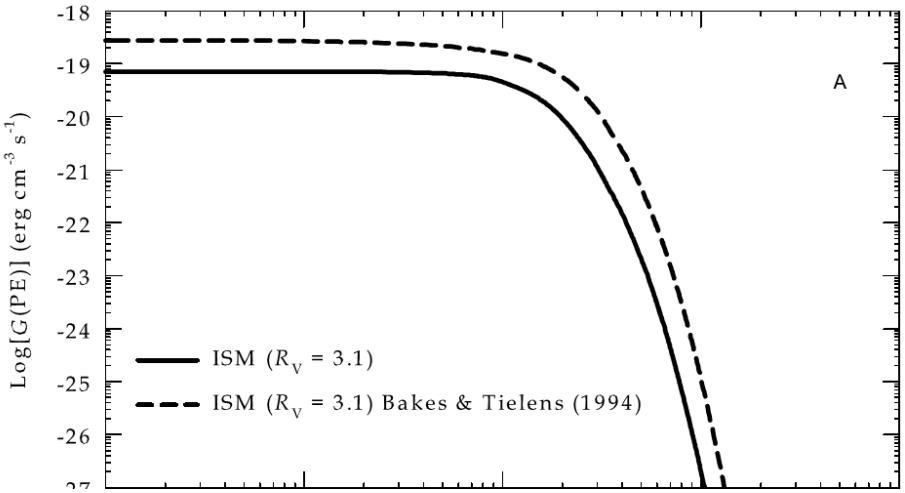
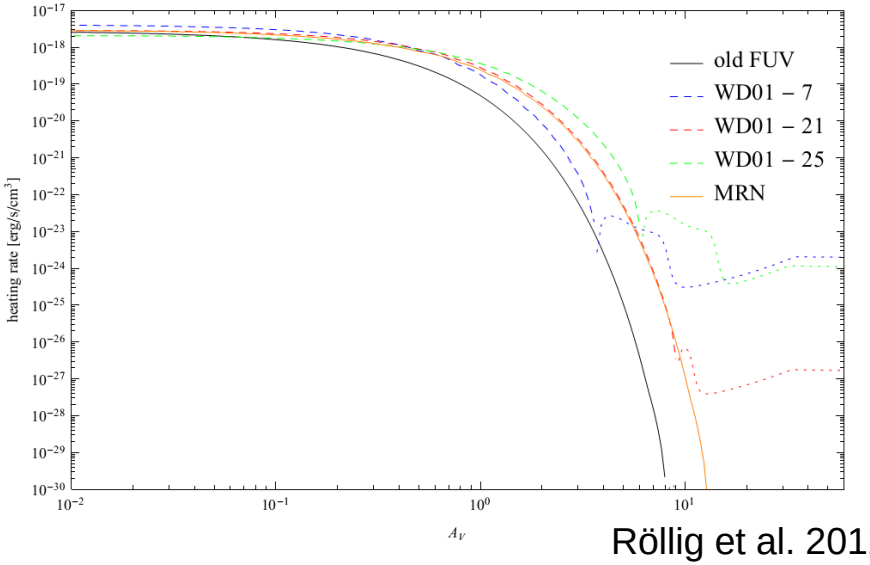
The dust properties are one of the most influential properties of PDR model calculations.

- Energy balance (gas/dust temperature, photo-electric heating, recombination cooling,…)





Abel et al. 2008

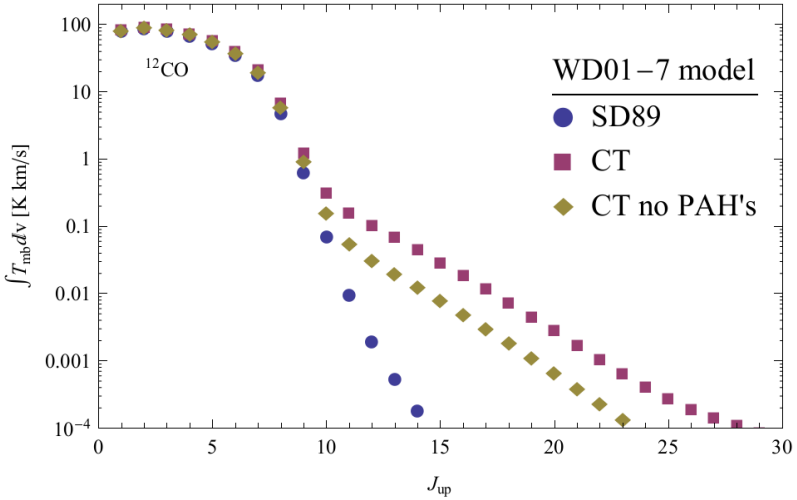


Röllig et al. 2012

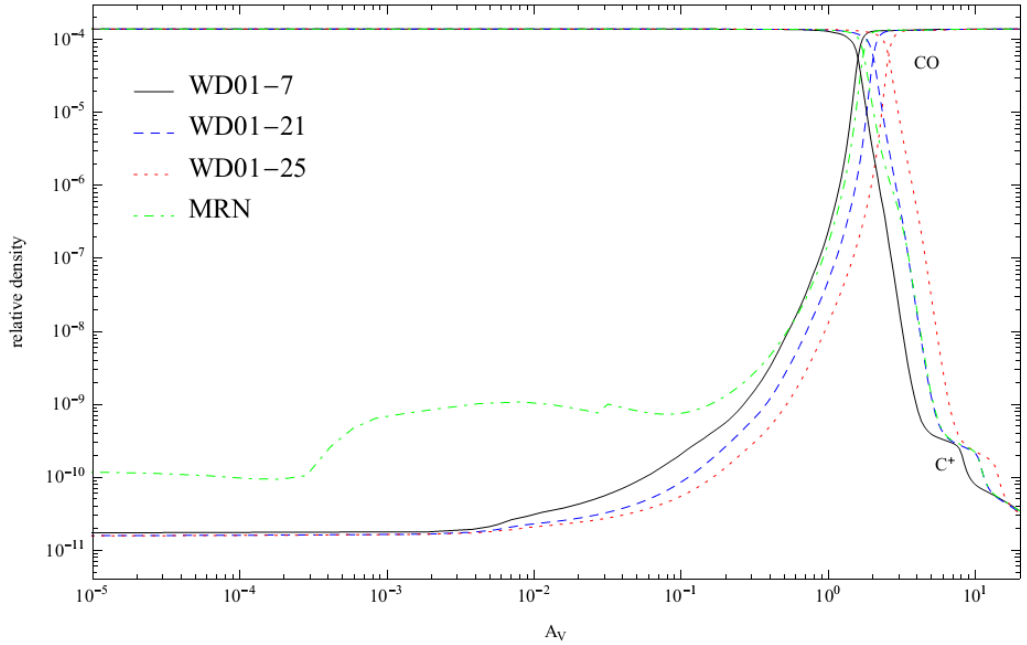
Combined line-continuum modeling – PDR clumps

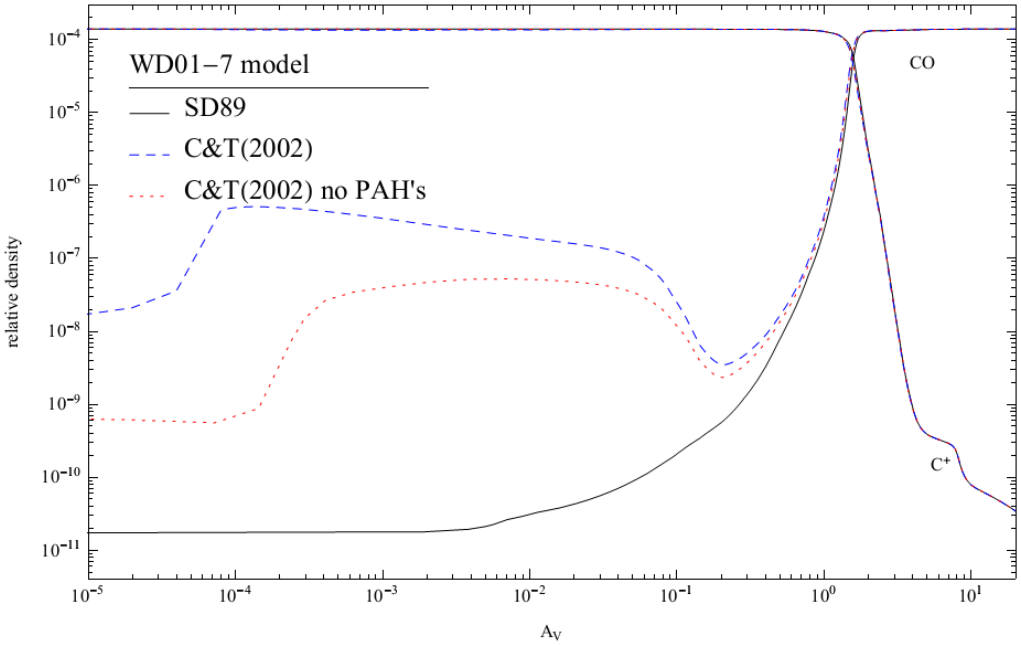
The dust properties are one of the most influential properties of PDR model calculations.

- The combined effects on the PDR structure can be profound



C$^+$ - CO transition





Röllig et al. 2012

Combined line-continuum modeling – PDR clumps

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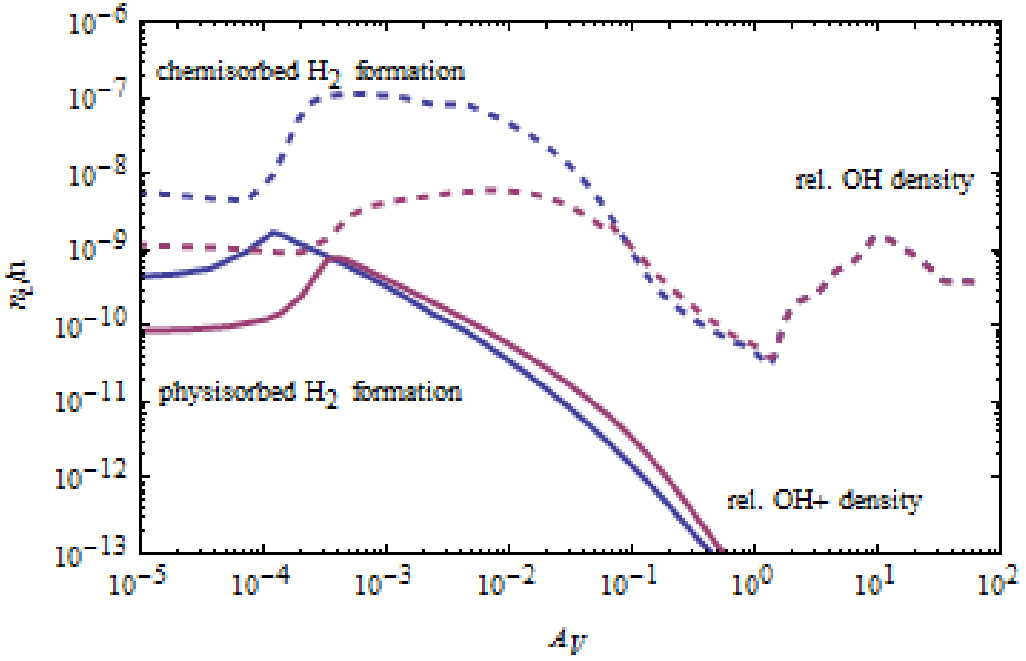
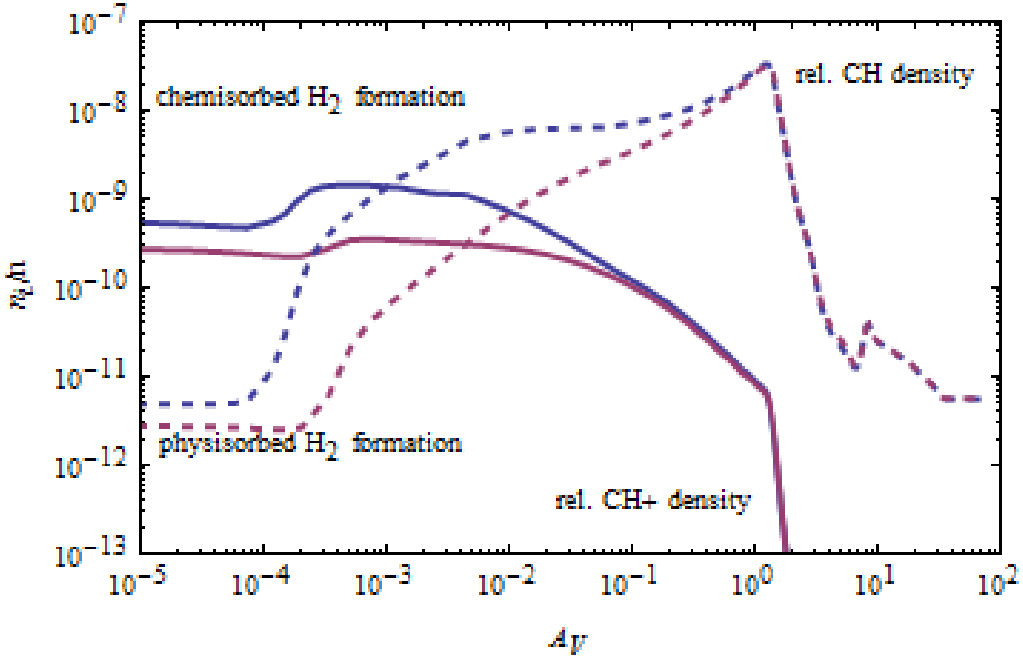
- The combined effects on the PDR structure can be profound

light hydrides strongly affected





Röllig et al. 2012

Combined line-continuum modeling – PDR clumps

The dust properties are one of the most influential properties of PDR model calculations.

- We updated KOSMA-τ to self-consistently account for different dust content (dust composition & size distributions) and adapt all related properties.
  - FUV radiative transfer
  - Dust temperature for all sizes at all depths
  - Photodissociation/ionization rates
  - Surface reactions (H_2 via chemi- and physisorption)
  - Dust continuum emission
- No non-equilibrium heating so far

- Output: Line & Continuum Emission

Combined line-continuum modeling – PDR clumps

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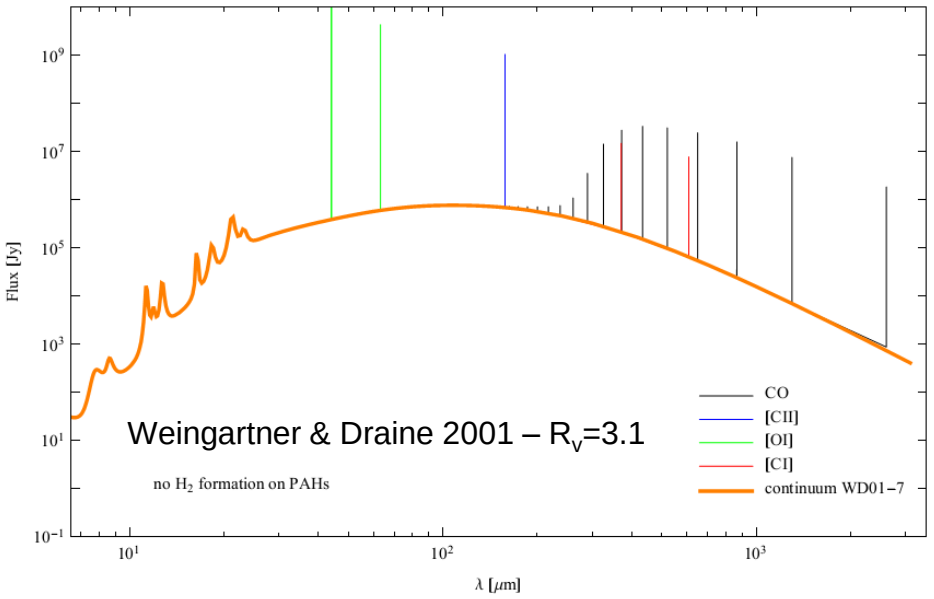
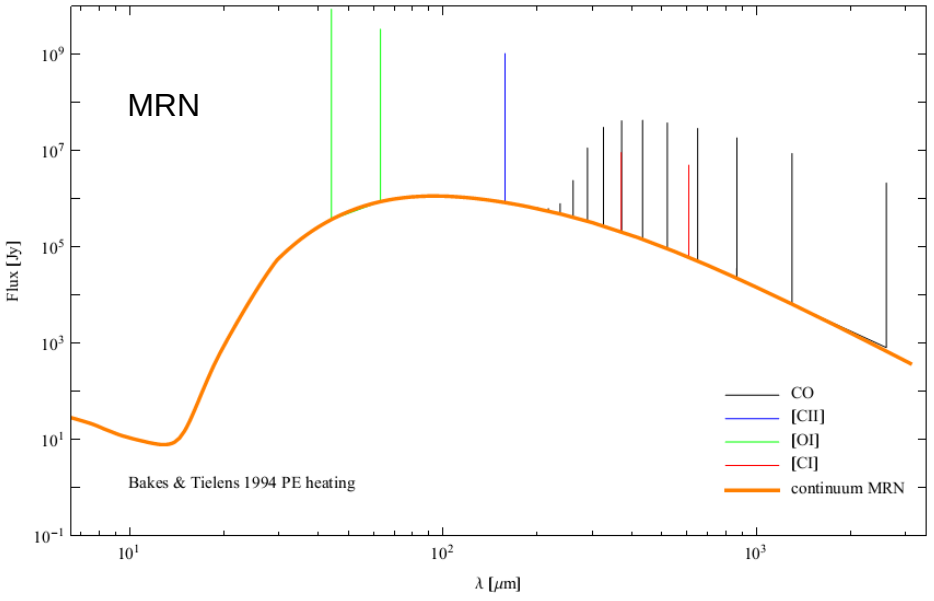
- Output: Line & Continuum Emission



Idea:

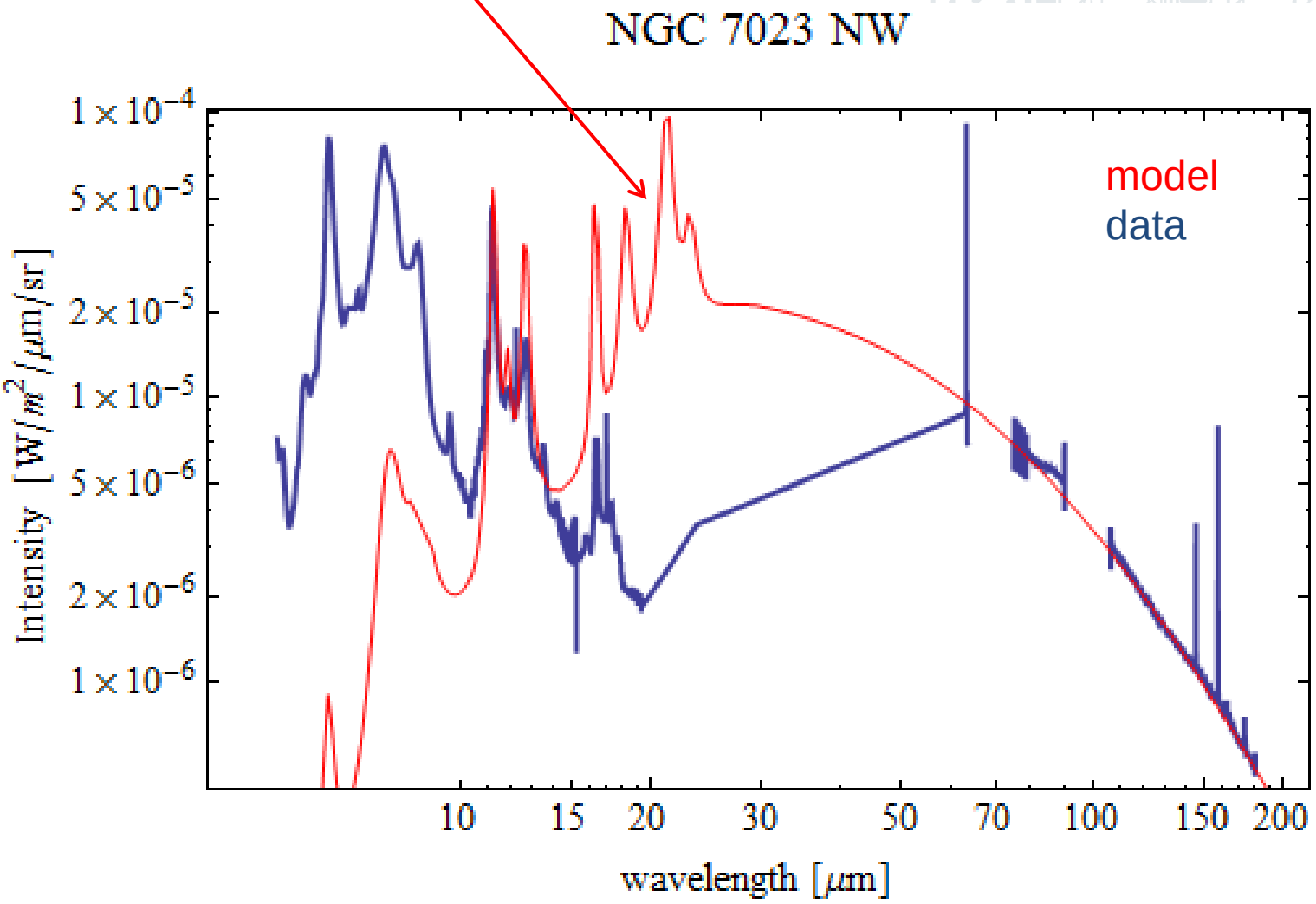
Use continuum emission to better constrain the parameter range while fitting the line emission.



Combined line-continuum modeling – PDR clumps

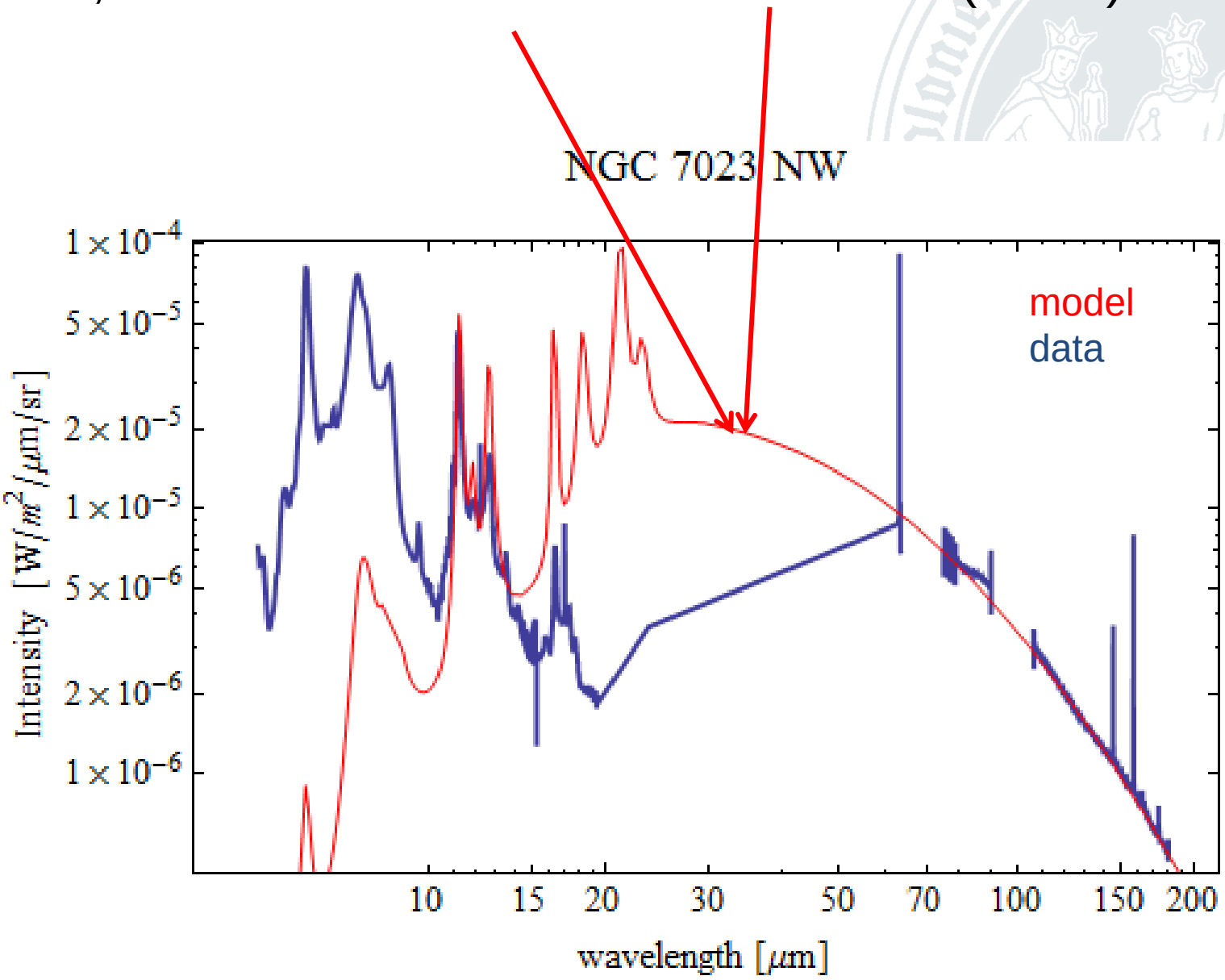
For NGC 7023 NW we find the following parameters:

log(n) = 4.5, log(M) = 0.6, log(χ) = 3.7



Combined line-continuum modeling – PDR clumps

So far, we use a fixed PAH^0 and PAH^+ ratio (50:50).



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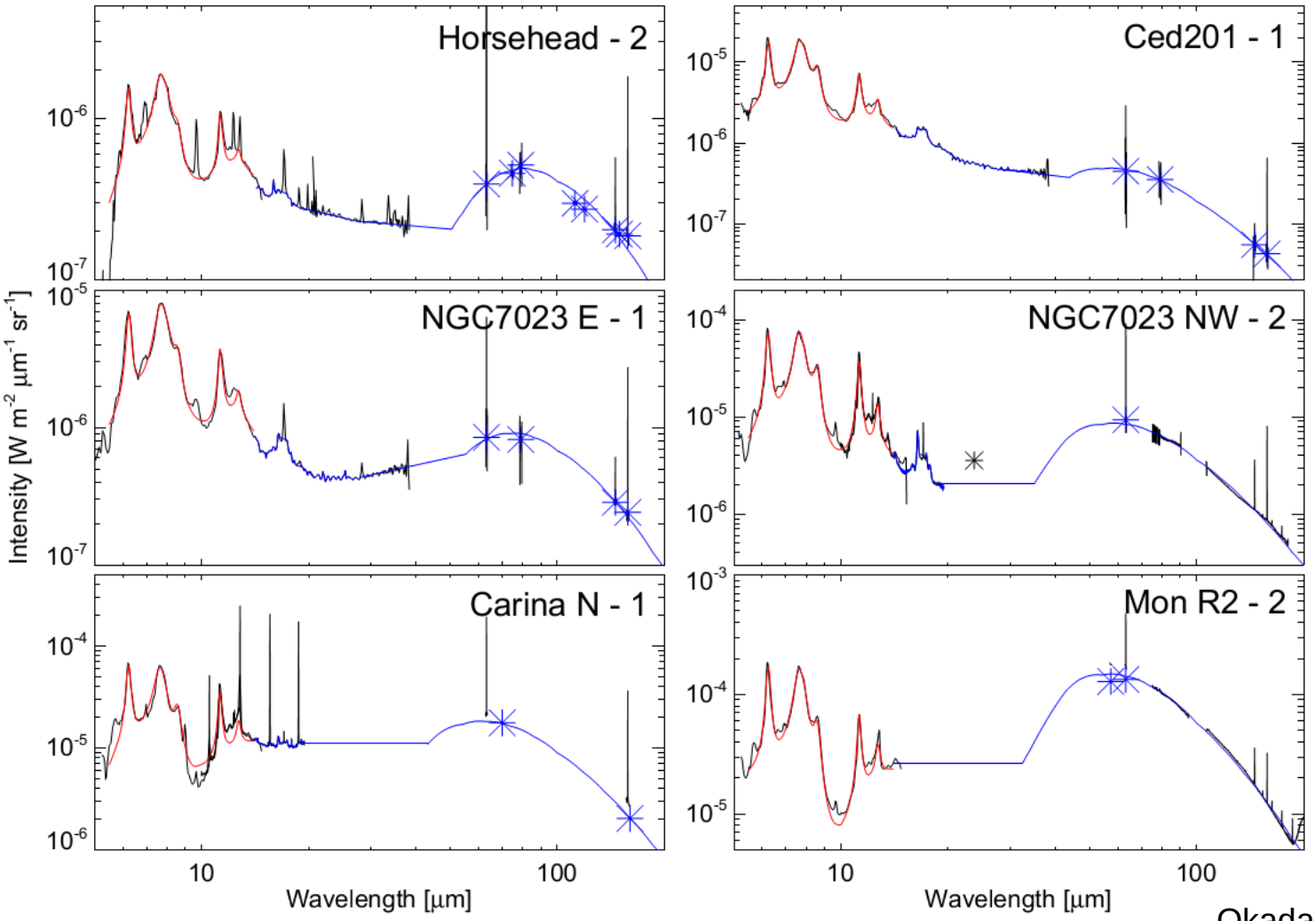
However, using PAH template spectra for PAH^0,PAH^+,PAH^X, and eVSG (PAHTAT, Pilleri et al. 2012) shows a wide range of PAH compositions.

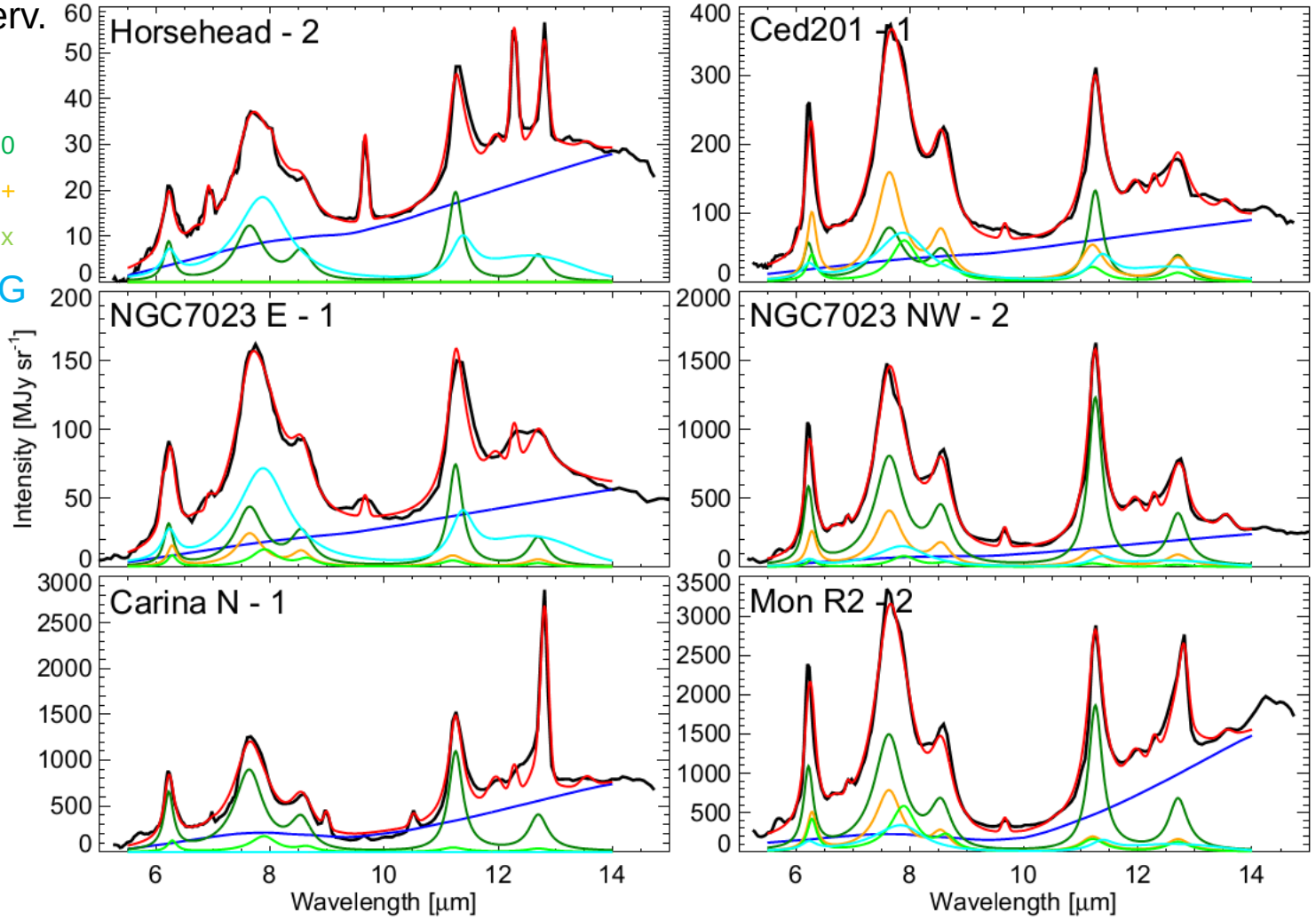


Okada et al. 2012

Combined line-continuum modeling – PDR clumps

Using PAHTAT to determine the fraction of PAH^0,PAH^+,PAH^X, and eVSG could possibly serve as an additional pre-PDR modelling step to derive the PAH composition.

black	observ.
red	total
cont.	blue
green	PAH^0
orange	PAH^+
l-green	PAH^X
l-blue	eVSG



Okada et al. 2012

Summary

- The combined line-continuum modeling is starting to take shape.
- KOSMA-τ is set up to compute SEDs for a variety of dust compositions (Weingartner & Draine 2001).
- The MIR/FIR continuum appears to pose strong constraints on the model parameters.
- The NIR PAH features vary a lot from source to source, suggesting that a fixed 50:50 ratio of neutral to ionized PAHs is a weak assumption.
- PAHTAT or similar methods could be used to constrain PAH properties
- So far we have no real experience – this is only starting now.