INTERNATIONAL SYMPOSIUM AND WORKSHOP ON ASTROCHEMISTRY

Understanding extraterrestrial molecular complexity
through experiments and observations

Effects of the X-rays from stellar source and UV from external radiation field on the astrophysical ices survival in protostellar environments

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FAPESP

Outline

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2.0 Case for Elias 29

3.0 Methodology

4.0 Results

4.1 Disk

4.2 Envelope (Temperature)

4.3 Envelope (half-life)

5.0 Where are the ices?

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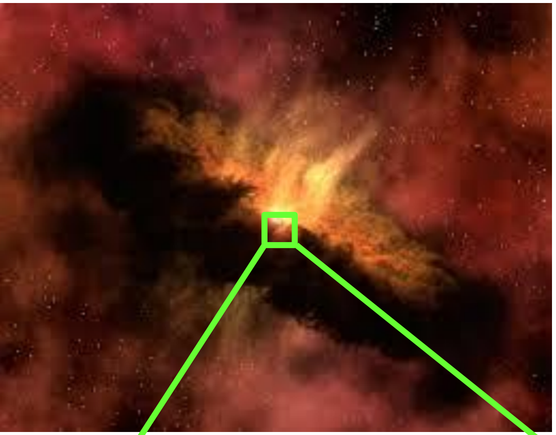
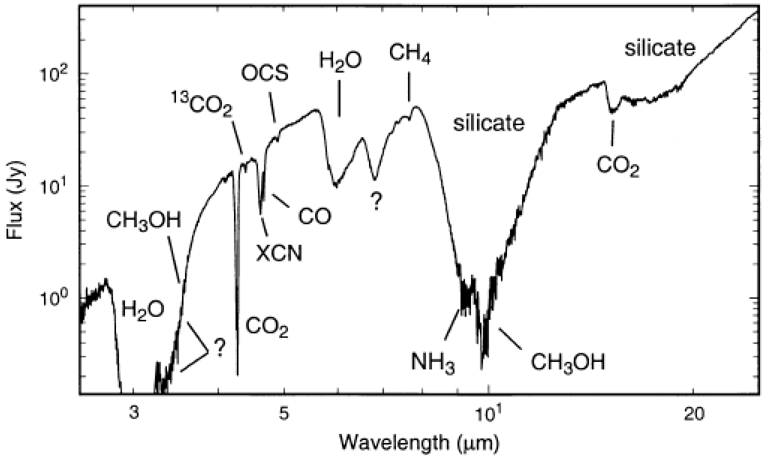
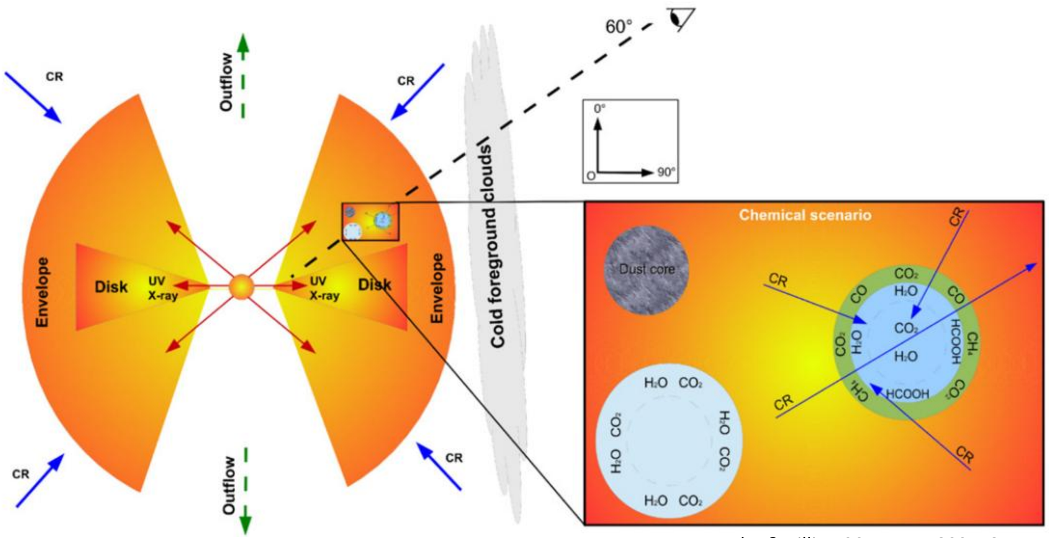
1. Introduction and Motivation



Gibb et al. 2000, ApJ, 536, 347

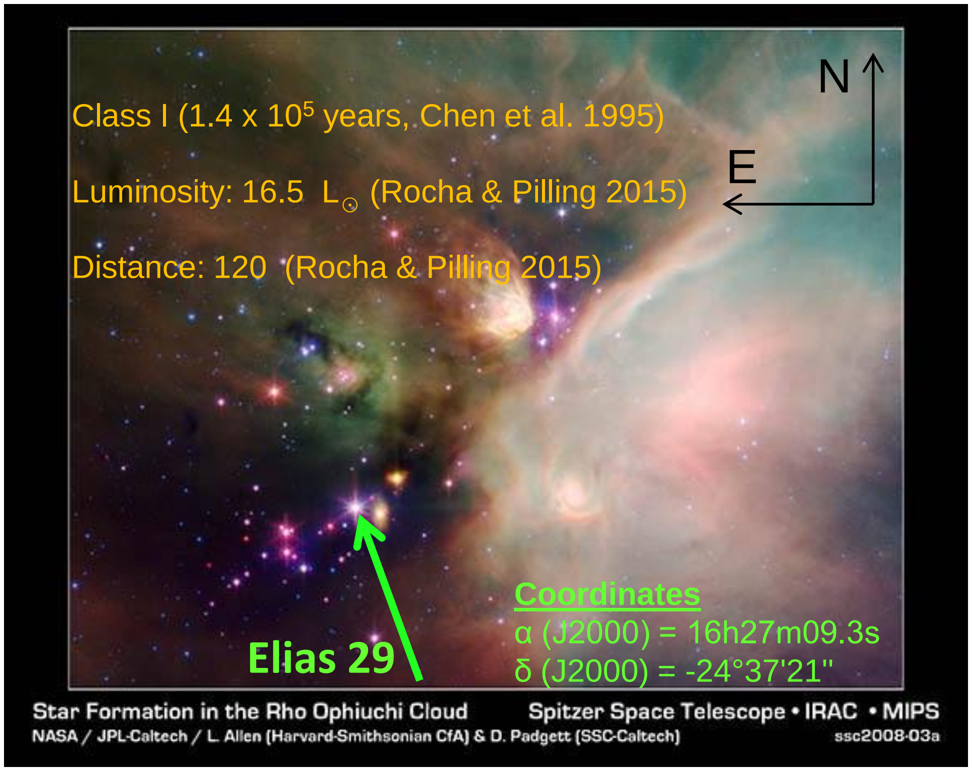


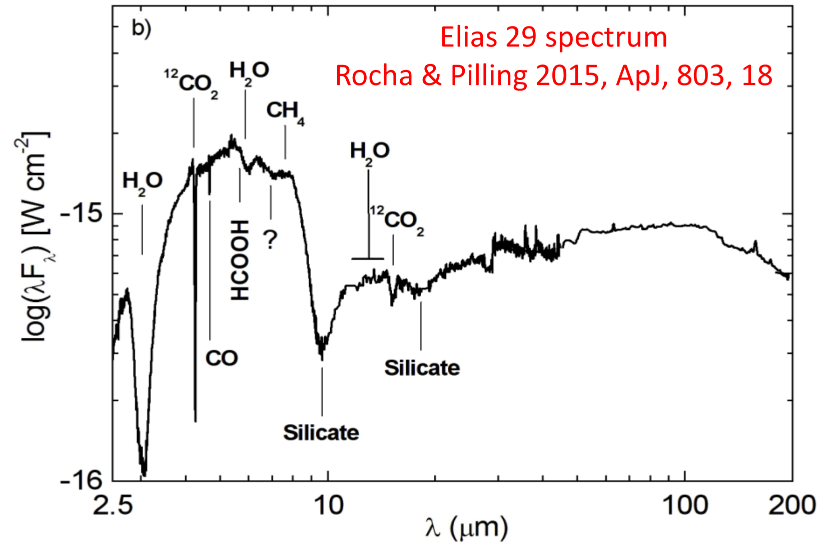
https://www.youtube.com/watch?v=X_jSenHTqFw

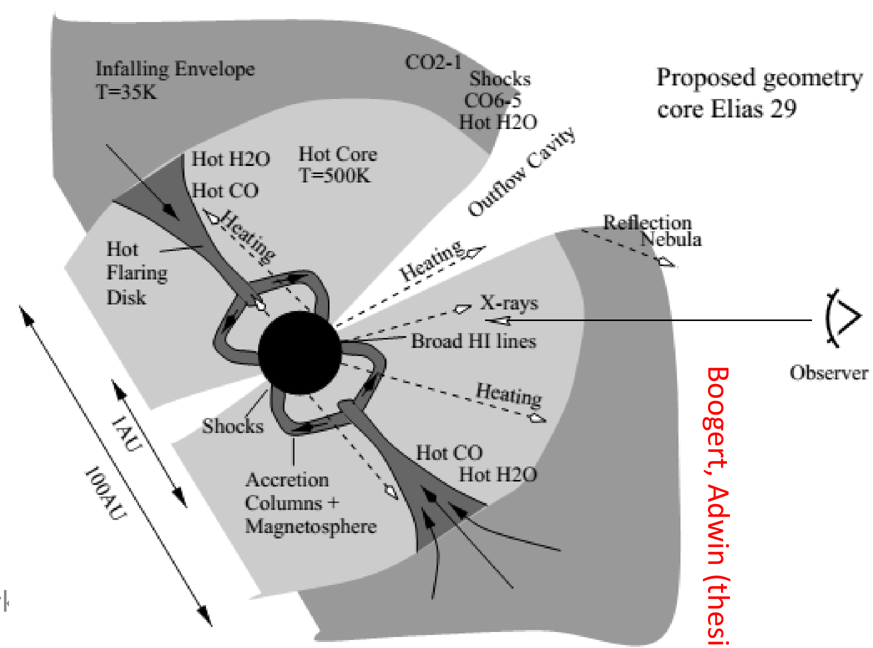


Rocha & Pilling 2015, ApJ, 803, 18

2. Case for Elias 29



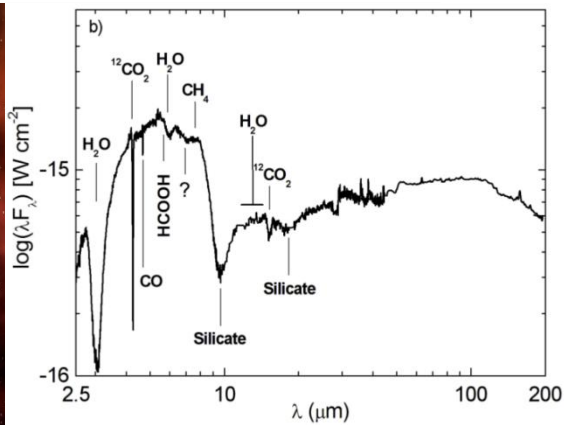




Boogert, Adwin (thesis)

3. Methodology

Astrophysical scenario



Protoestelar disk **Observed SED**

Observational part

Comparison

Laboratory (Absorbance) → **Refractive index (n e k)** → **Opacities** → **Radiative transfer** → **Syntetic SED and image**

Experimental part

Computational Part (RADMC-3D – Dullemond et al. *in prep*)

3. Methodology

- Mean intensity calculated by RADMC-3D:

$$J_\nu = \frac{1}{4\pi} \oint I_\nu(\Omega) d\Omega$$

- Photodissociation rate:

$$k_{\rm pd} = \int_{\nu_i}^{\nu_{\rm H}} 4\pi \, \mathcal{N}_{\rm ISRF}(\nu) \, \alpha_{\rm pd}(\nu) \, {\rm d}\nu.$$

Poster #4
Poster #5
Poster #24
Poster #25

- Half-life:

$$t_{1/2} = \ln(2)/k$$

3. Methodology

Table 1
Better Parameters Employed in Model 1 (Non-bombarded Ices) and Model 2 (Bombarded Ices)

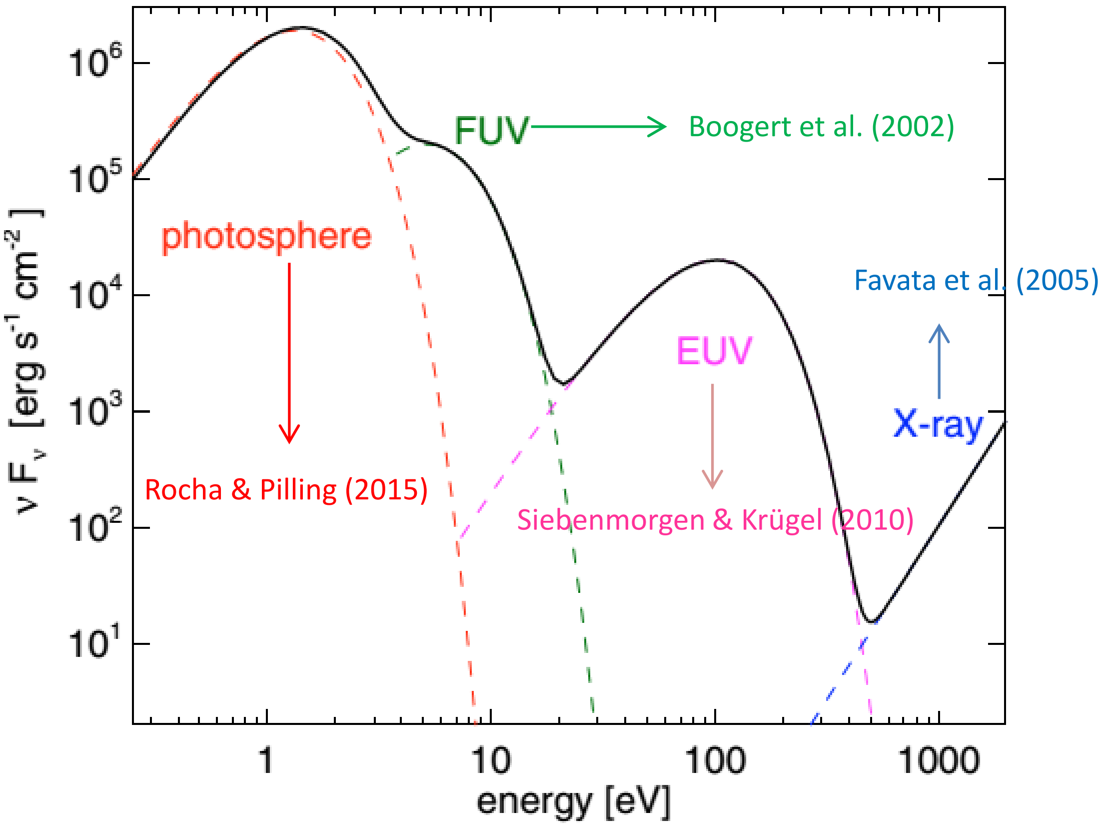
Parameter	Description	Employed Value (see text)	Estimated Range	Literature Value
M_d ($M_\odot$)	Disk mass	0.003	0.002–0.007	<0.007[e]
$R_{d,\mathrm{in}}$ (AU)	Disk inner radius	0.36	fixed	0.25[f]
$R_{d,\mathrm{out}}$ (AU)	Disk outer radius	200	fixed	200[e]
M_{env} ($M_\odot$)	Envelope mass	0.028	0.02–0.06	<0.058[e]
$R_{\mathrm{env,in}}$ (AU)	Envelope inner radius	0.36	fixed	...
$R_{\mathrm{env,out}}$ (AU)	Envelope outer radius	6000	fixed	6000[g]
θ_c (°)	Cavity angle	30	25–55	40[h]
d (pc)	Distance	120	100–160	125[i], 160[g]

Notes.
[a] McClure et al. (2010).
[b] Miotello et al. (2014).
[c] Evans et al. (2003).
[d] Chen et al. (1995).
[e] Lommen et al. (2008).
[f] Simon et al. (1987).
[g] Boogert et al. (2002a).
[h] Beckford et al. (2008).
[i] de Geus et al. (1989).

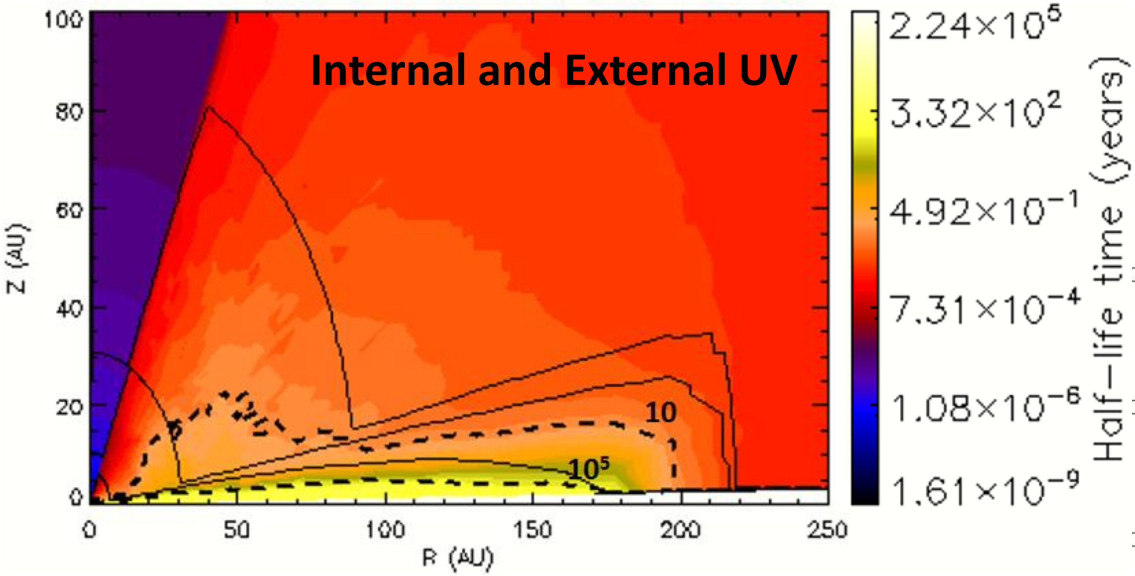
Rocha & Pilling 2015, ApJ, 803, 18

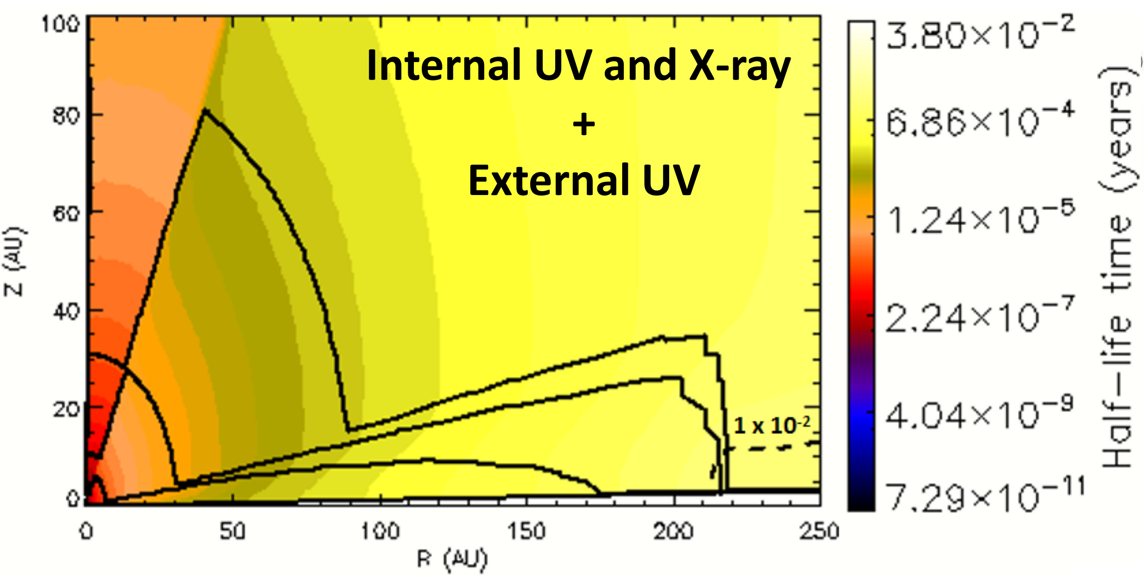
3. Methodology

Stellar SED for a typical protostar (Siebenmorgen & Krügel 2010)



4.1 Results - Disk





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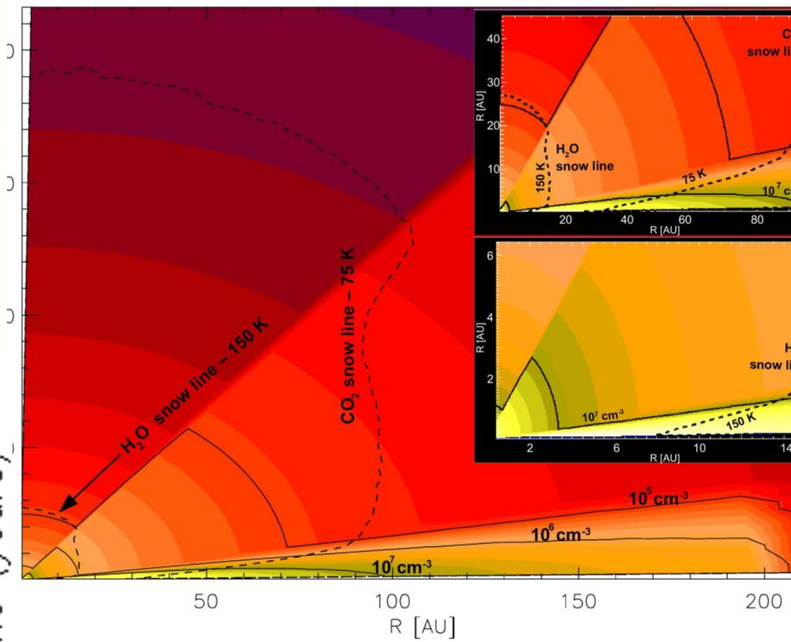
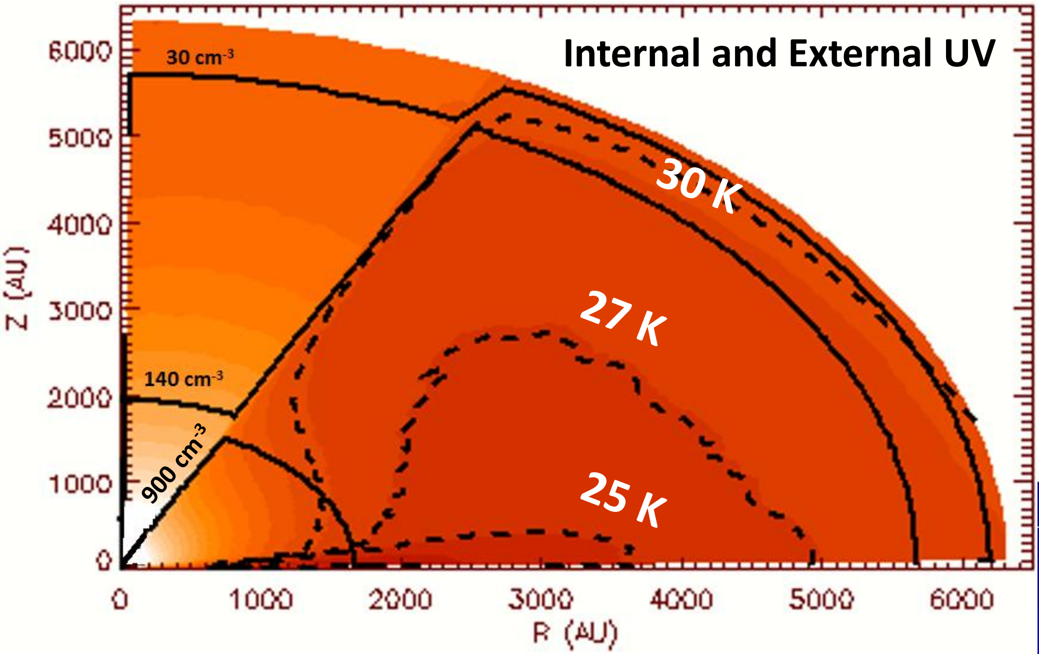
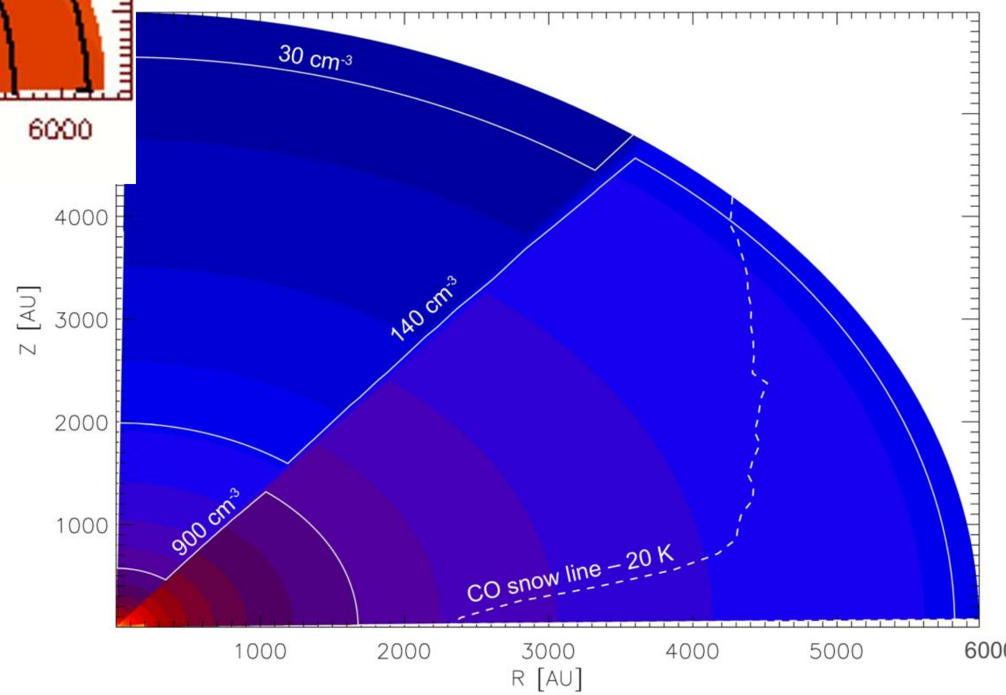


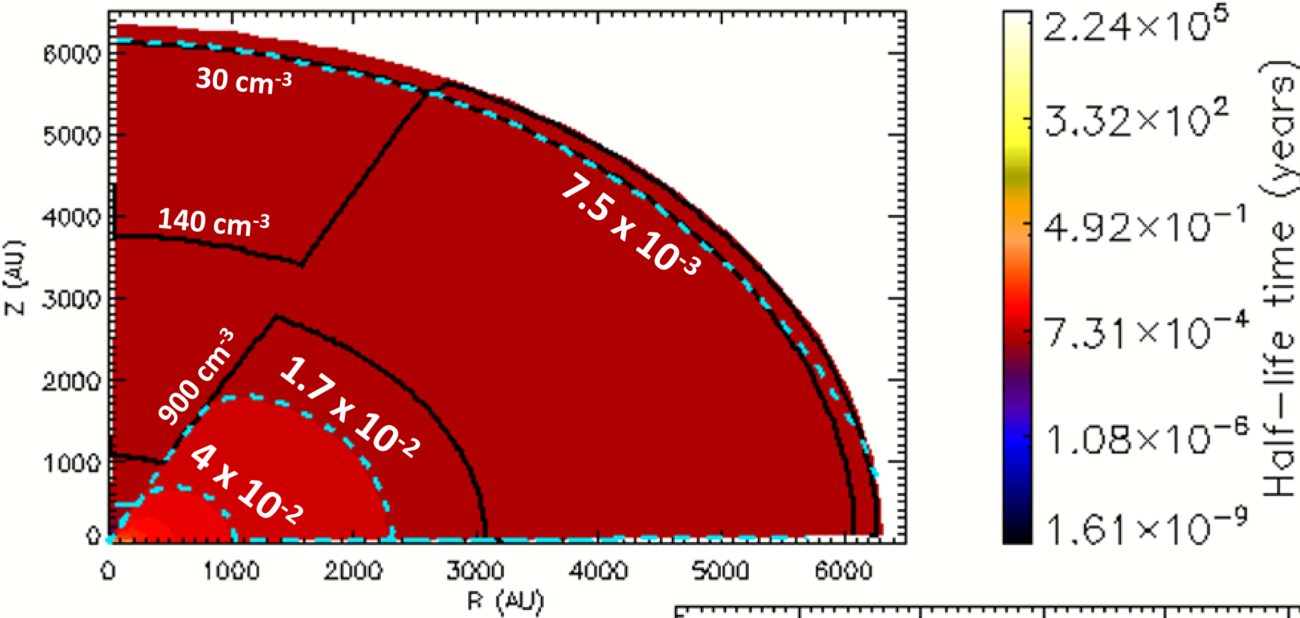
4.2 Results – Envelope (temperature)

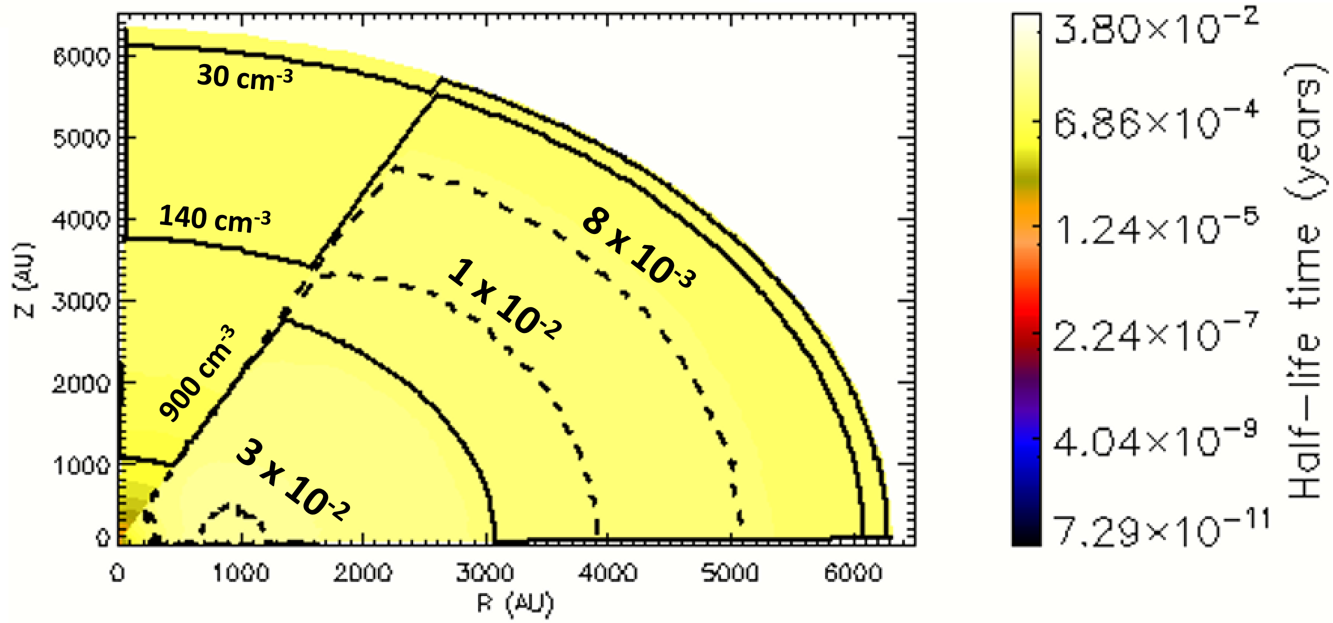


Rocha & Pilling 2015, ApJ, 803, 18

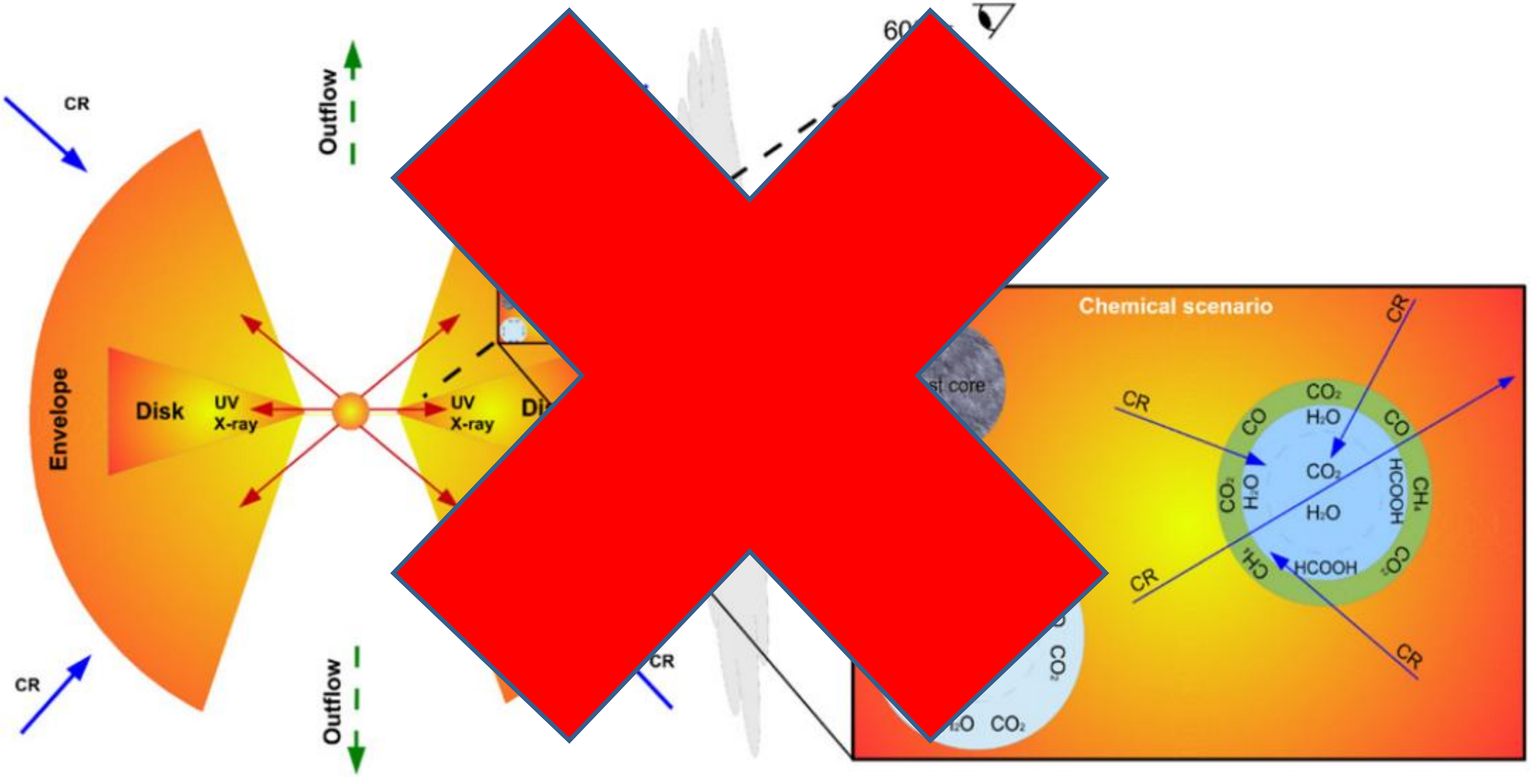


4.3 Results – Envelope (half-life)





5. Where are the ices?



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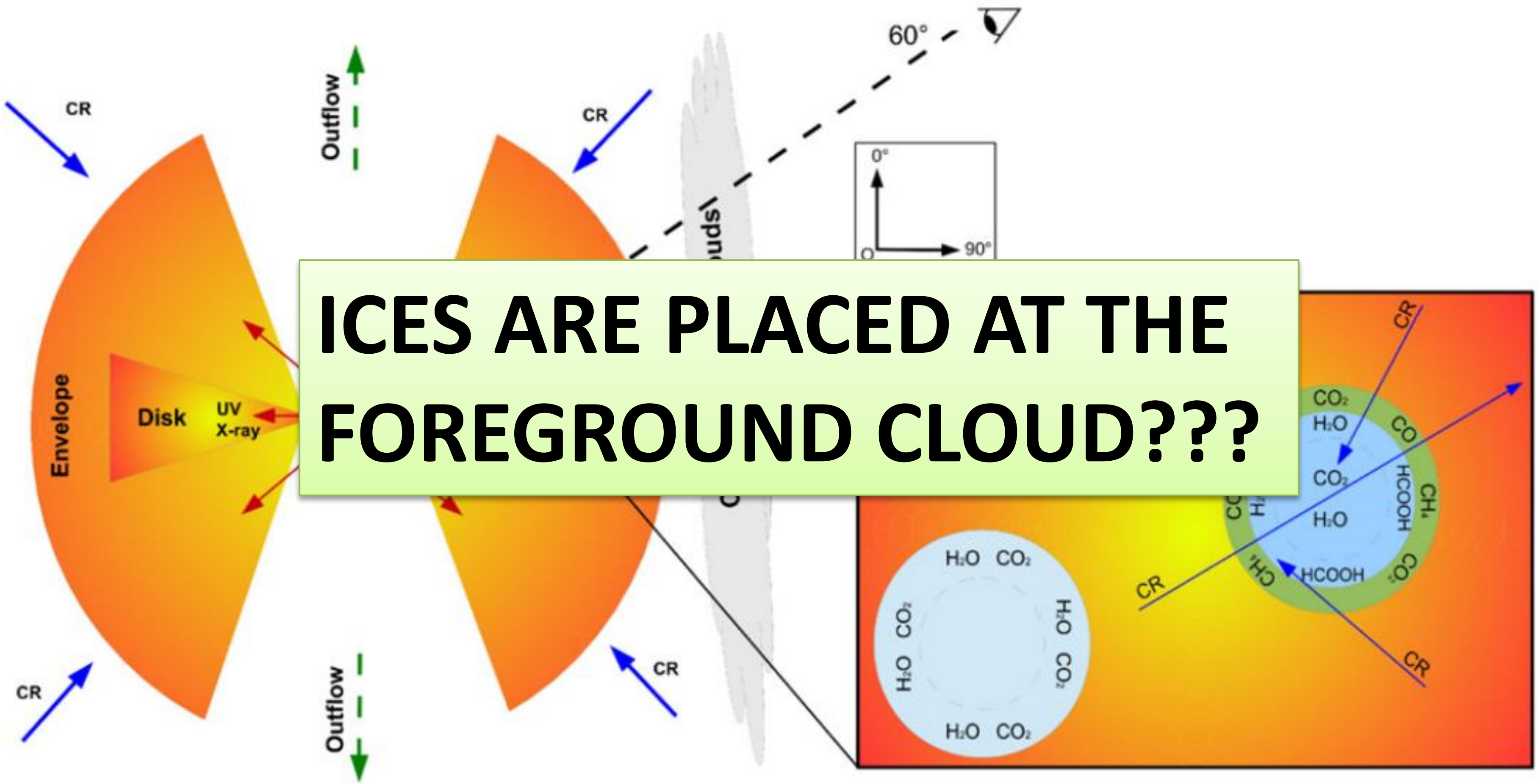

ICES ARE PLACED AT THE FOREGROUND CLOUD???

Conclusions

- External radiation field can heats the envelope, and dessorbs volatiles molecules like CO;
- Water-rich ices can survive inside the disk, when UV radiation field is considered;
- On the other hand, if X-ray are assumed, water-rich ices are thorougly photodissociated;
- Toward Elias 29, ices takes place at the foreground cloud.

Enjoy the meeting!!!