Impact of ionization compression on star formation

P. Tremblin, N. Schneider, V. Minier, P. Didelon, F. Motte, E. Audit, et al. (+ HOBYS Key Program)

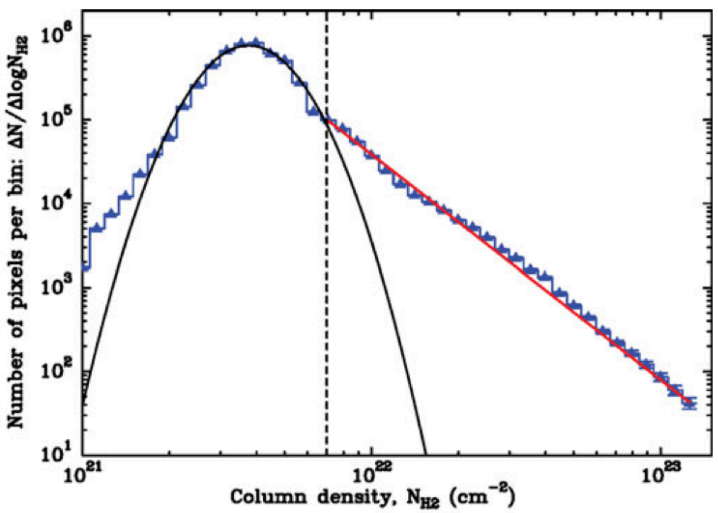
A&A 2014 564A.106T

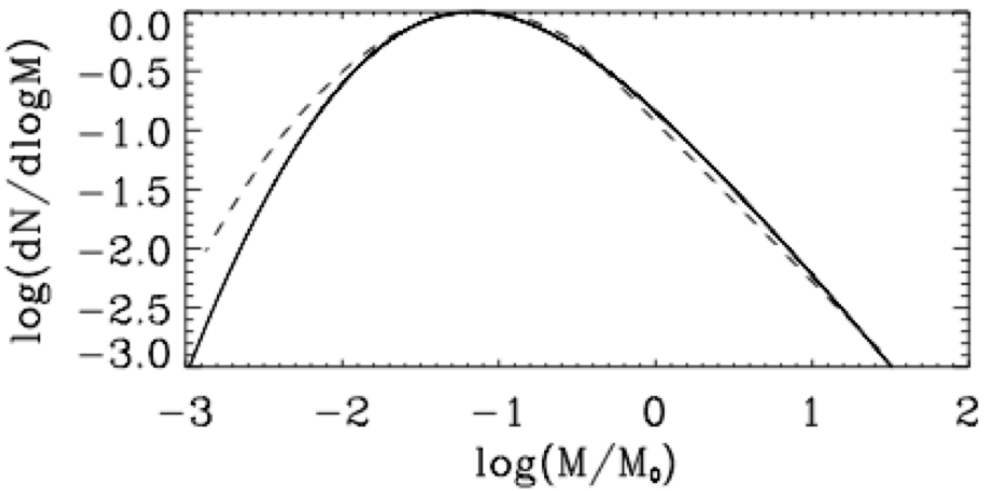
Age of OB associations in the Galaxy

P. Tremblin, L.D. Anderson, P. Didelon, A. Raga et al.

A&A 2014 568A.4T

- Is feedback and ionization important to take it into account to understand the IMF?



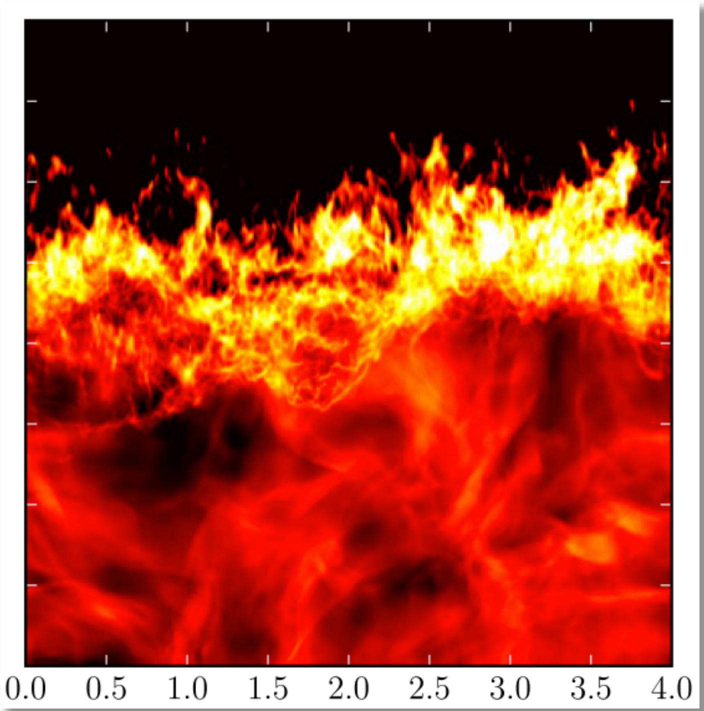


Observed PDF Aquila
André et al 2011

Modelled versus observed IMF
Hennebelle & Chabrier 2008

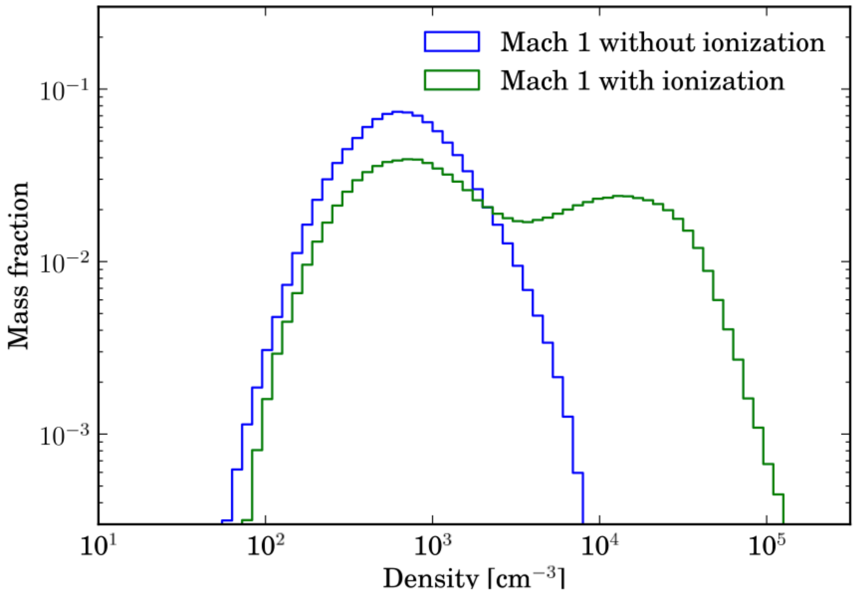
- What is ionization and compression from ionization ?

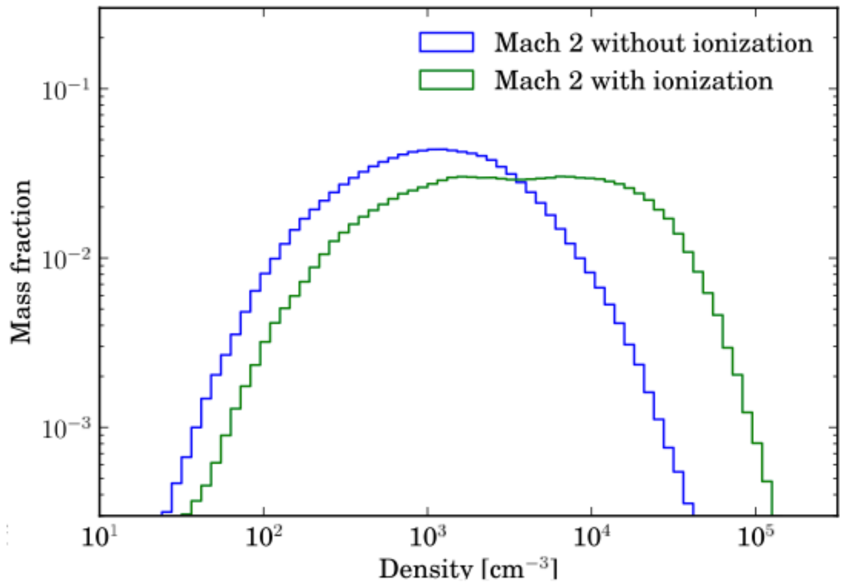
Eagle Nebula (Hill et al. 2012) HOBYS



Turbulent-ionized simulation (Tremblin et al. 2012)
HERACLES code

➢ How do we see the compression from ionization ?





Turbulent-ionized simulation (no gravity)
(Tremblin et al. 2012)

➢ Double-peaked or enlarged PDF of the gas

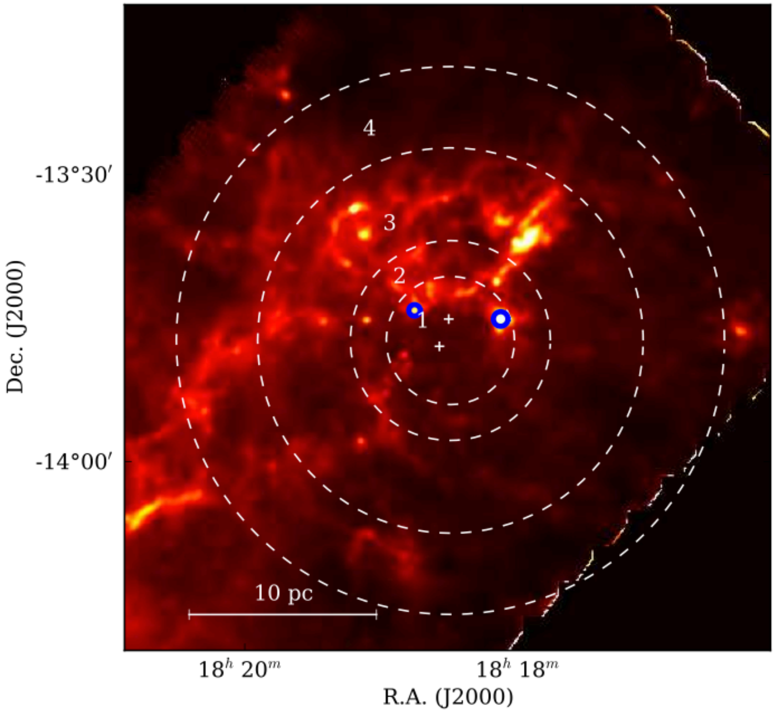
- What is the shape of the second component ?

  - If the turbulence is important in the compressed layer: lognormal shifted at higher densities by the square of the Mach number of the driven shock

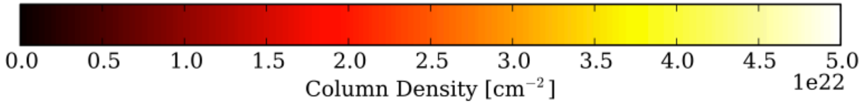
  - If the turbulence is low in the compressed layer: it is homogeneous and you expect a power-law profile in the PDF (similar to the power-law in a PDF of a spherical collapsing clump)

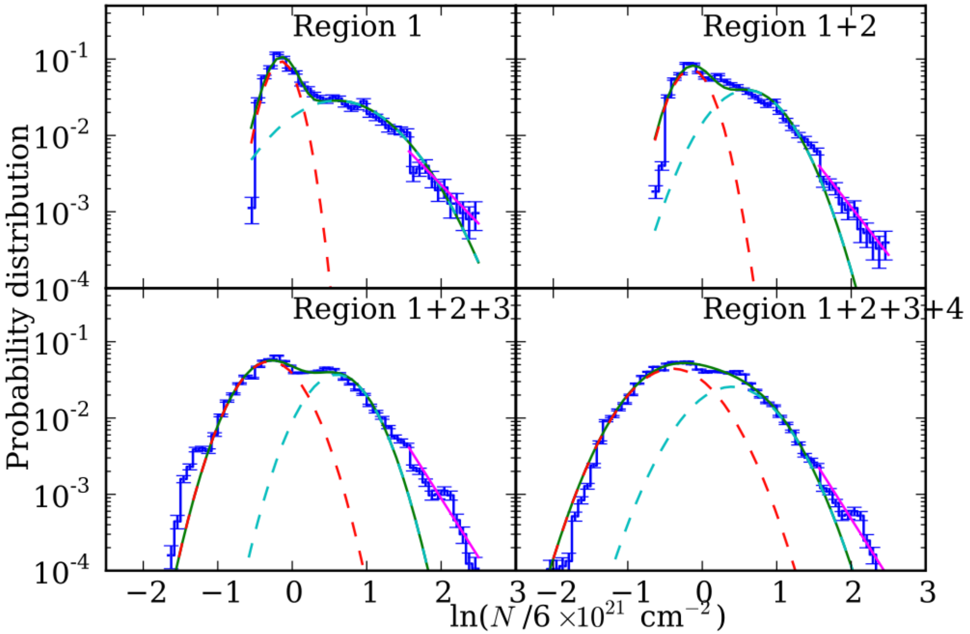
Unperturbed turbulent cloud	Compressed layer	Influence of gravity
Lognormal at low column densities	Lognormal (turbulent) or Power-law (homogeneous)	Power-law at highest column densities

- Do we see it in observations ? Herschel column densities



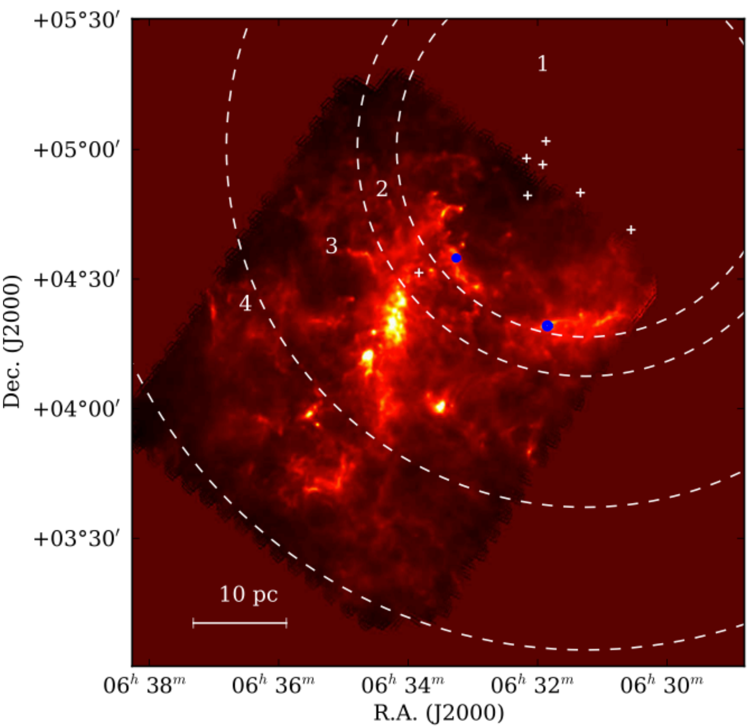
M16 column density map (Hill et al. 2012)



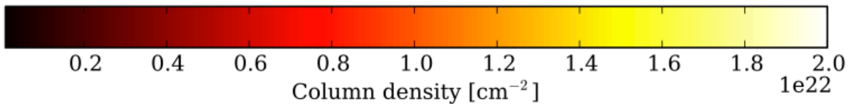


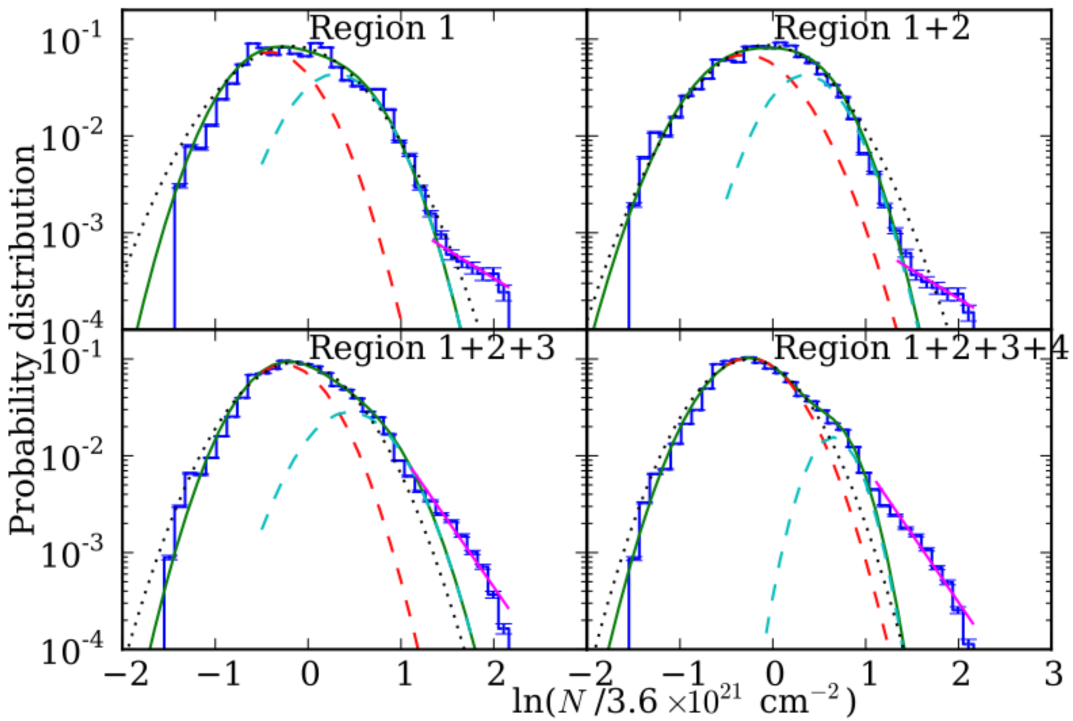
Tremblin et al. 2014

- ➢ Is a two-lognormal fit better than a single one for enlarged distribution ?



Rosette column density map (Schneider et al. 2012)

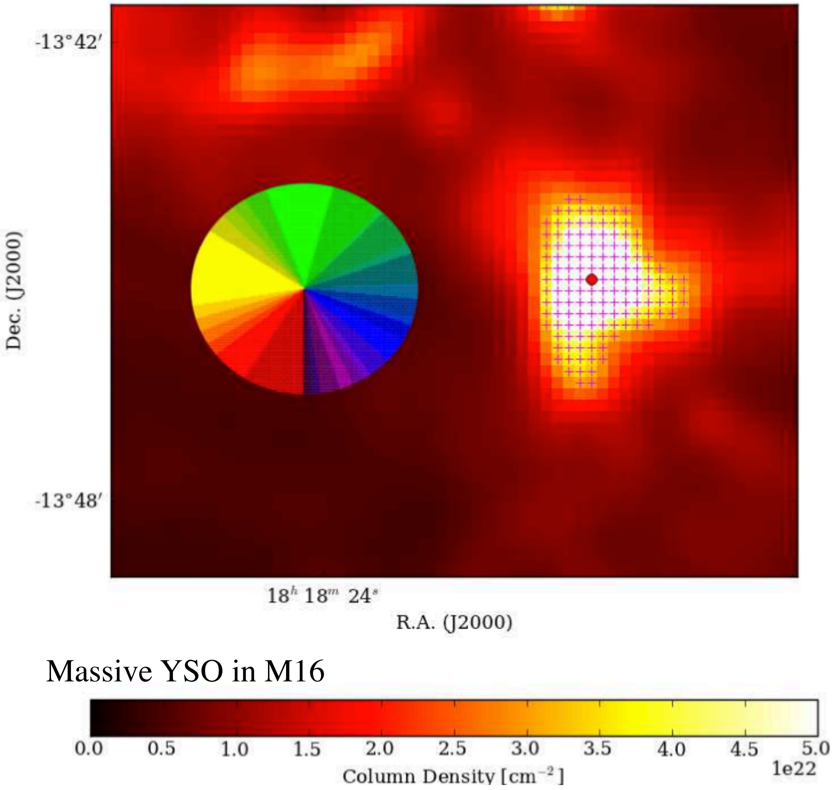


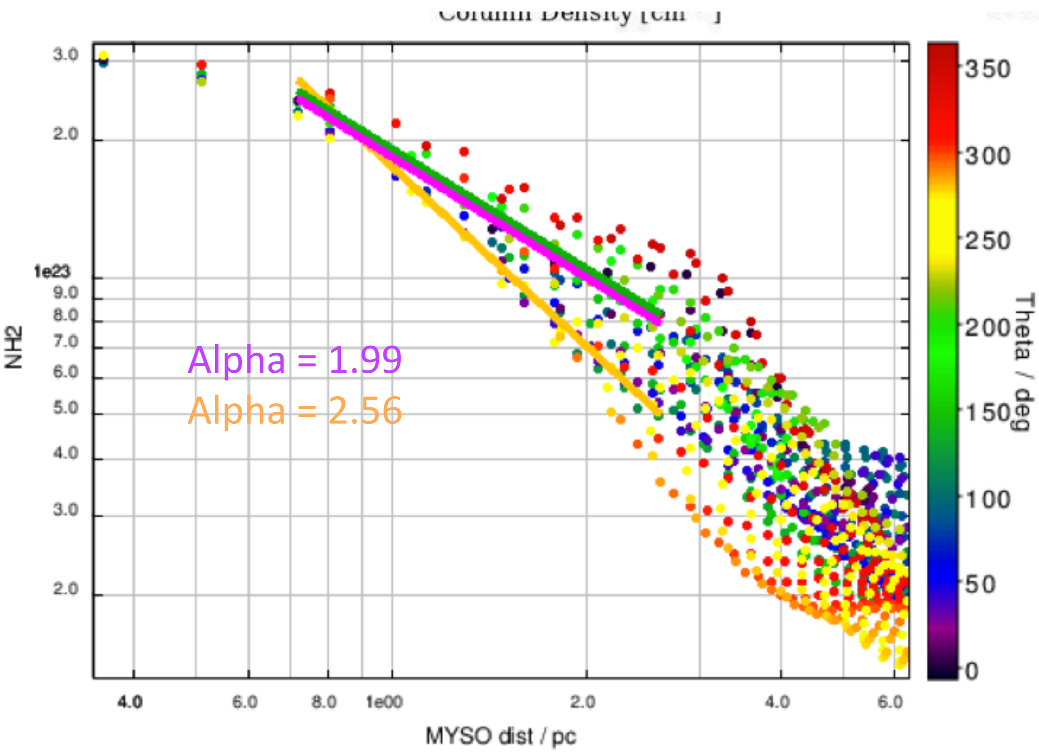


Tremblin et al. 2014

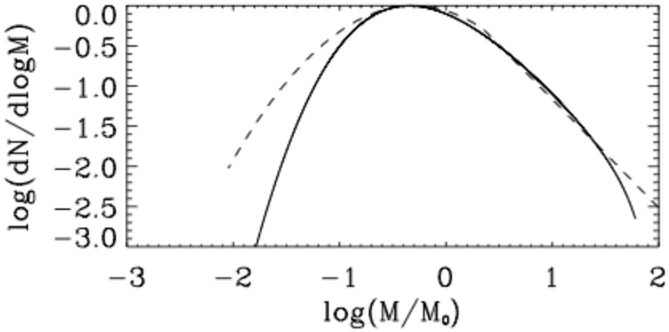
- Also small scale compression !

Steeper radial profile: distinguish between forced-fall and free-fall collapse

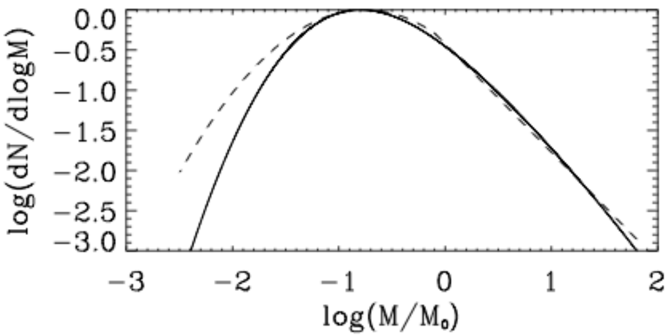




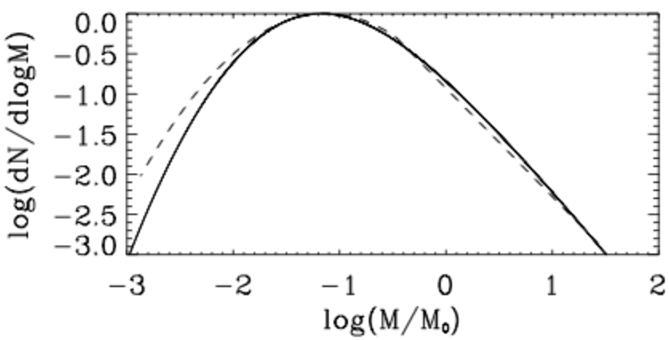
See also Russeil et al. 2013



Mach 6



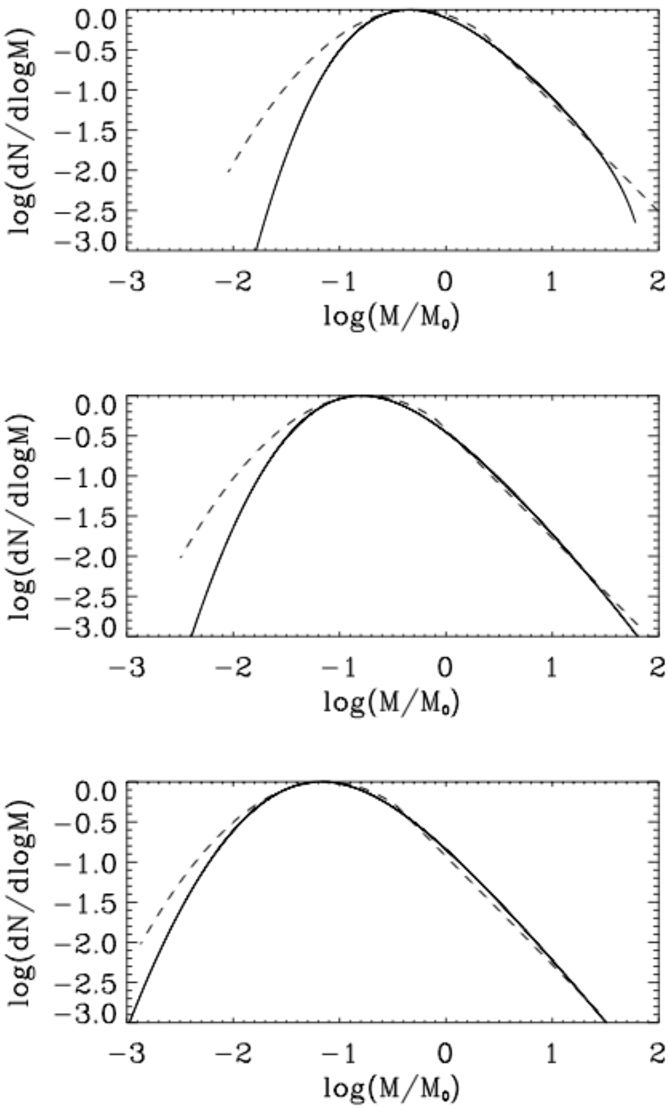
Mach 12



Mach 25

Hennebelle & Chabrier 2008

- Important for the understanding of star formation and the IMF?



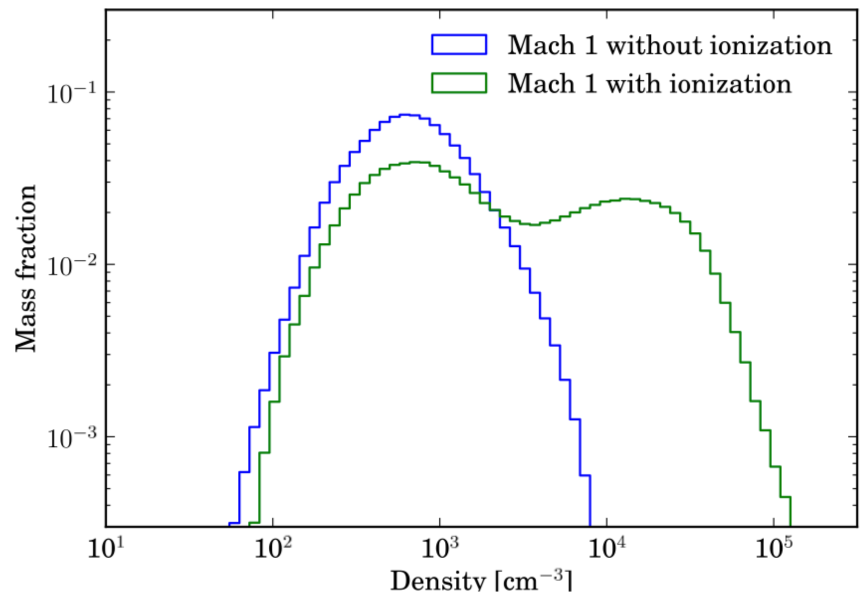
Mach 6

Mach 12

Mach 25

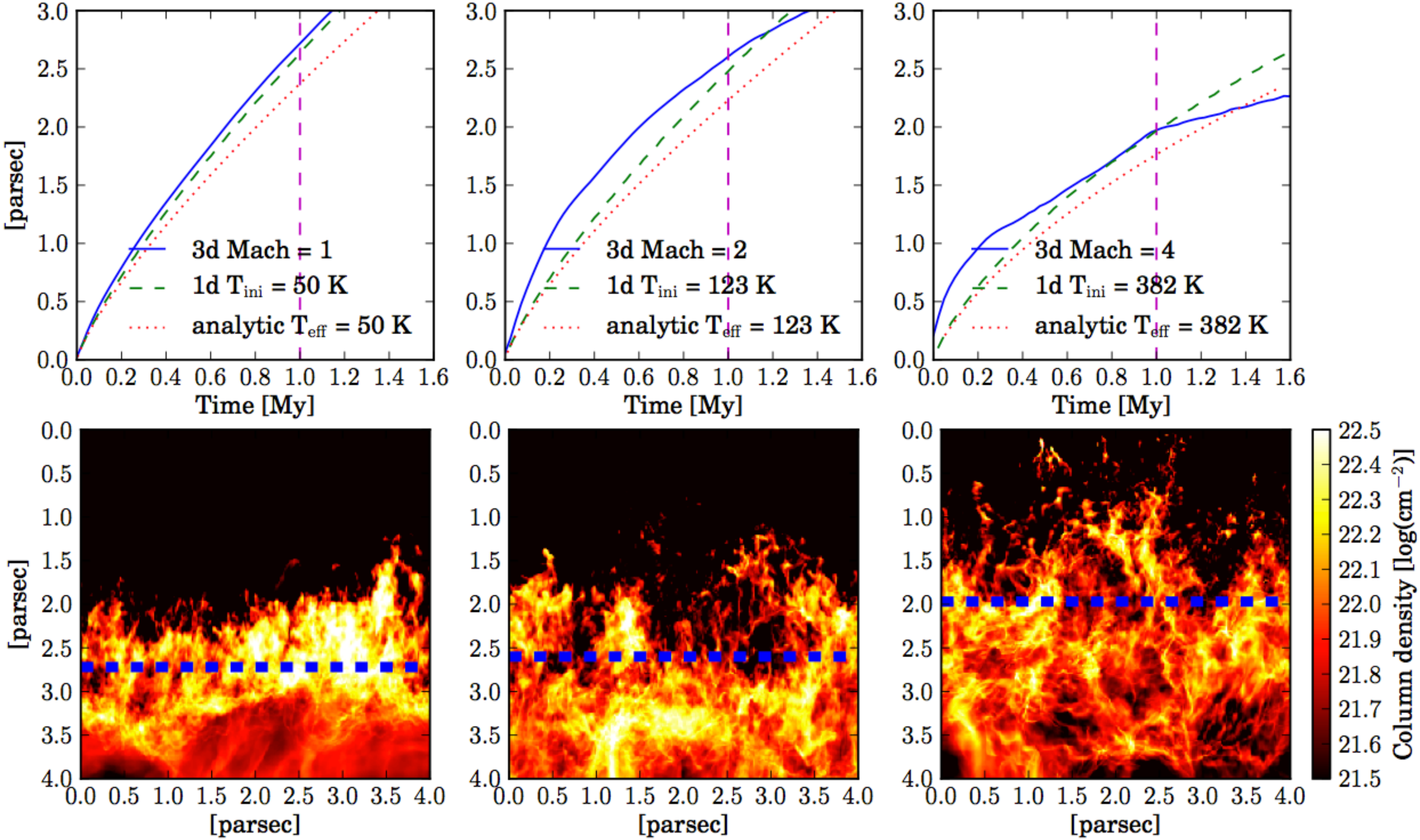
Hennebelle & Chabrier 2008

- ➢ Important for the understanding of star formation and the IMF?



- ➢ Feedback compression can enlarge PDF while keeping a realistic turbulent level for the cloud

➢ Dating of OB associations from their associated Hii regions



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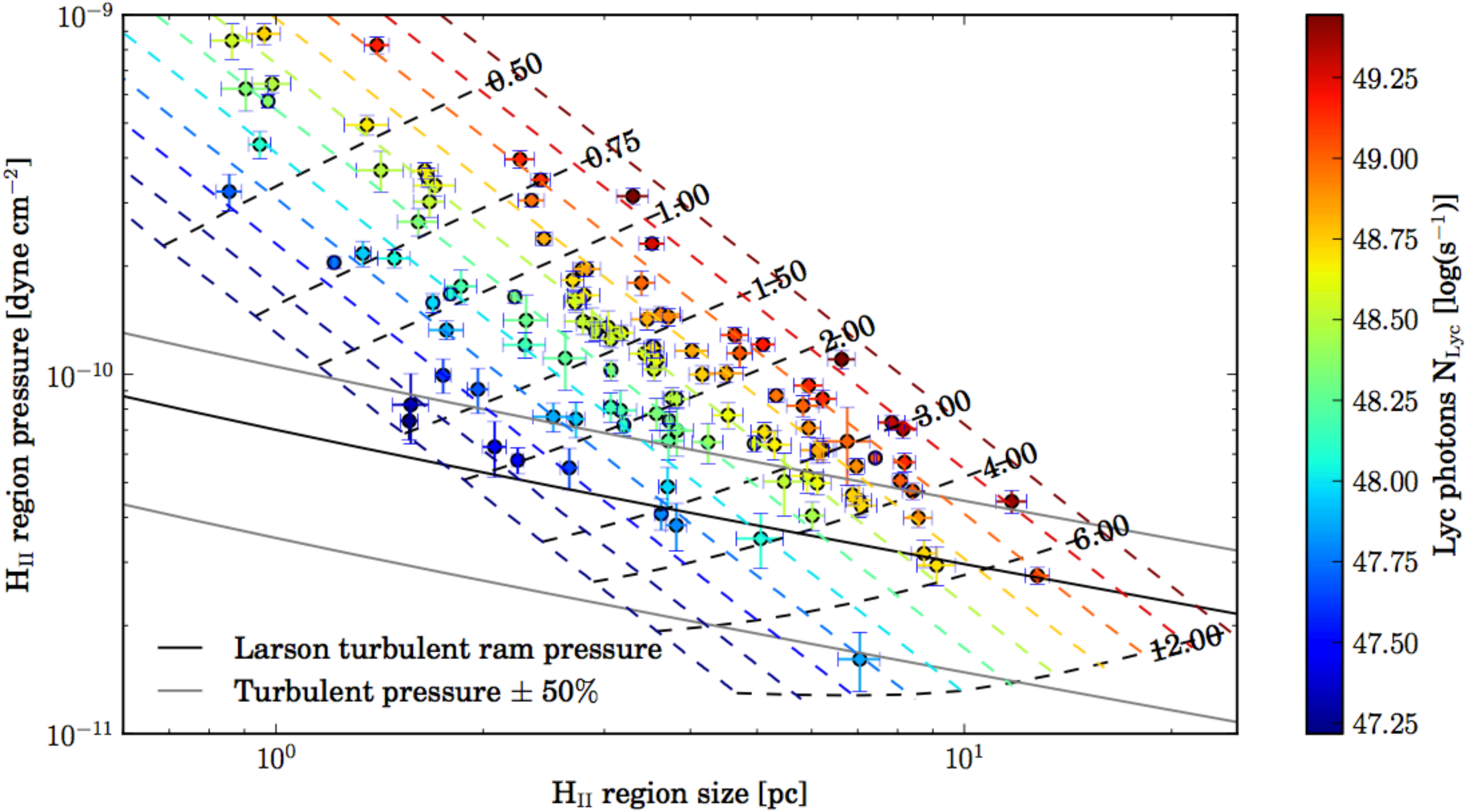

- Observations from the HRDS survey (Anderson et al 2011)

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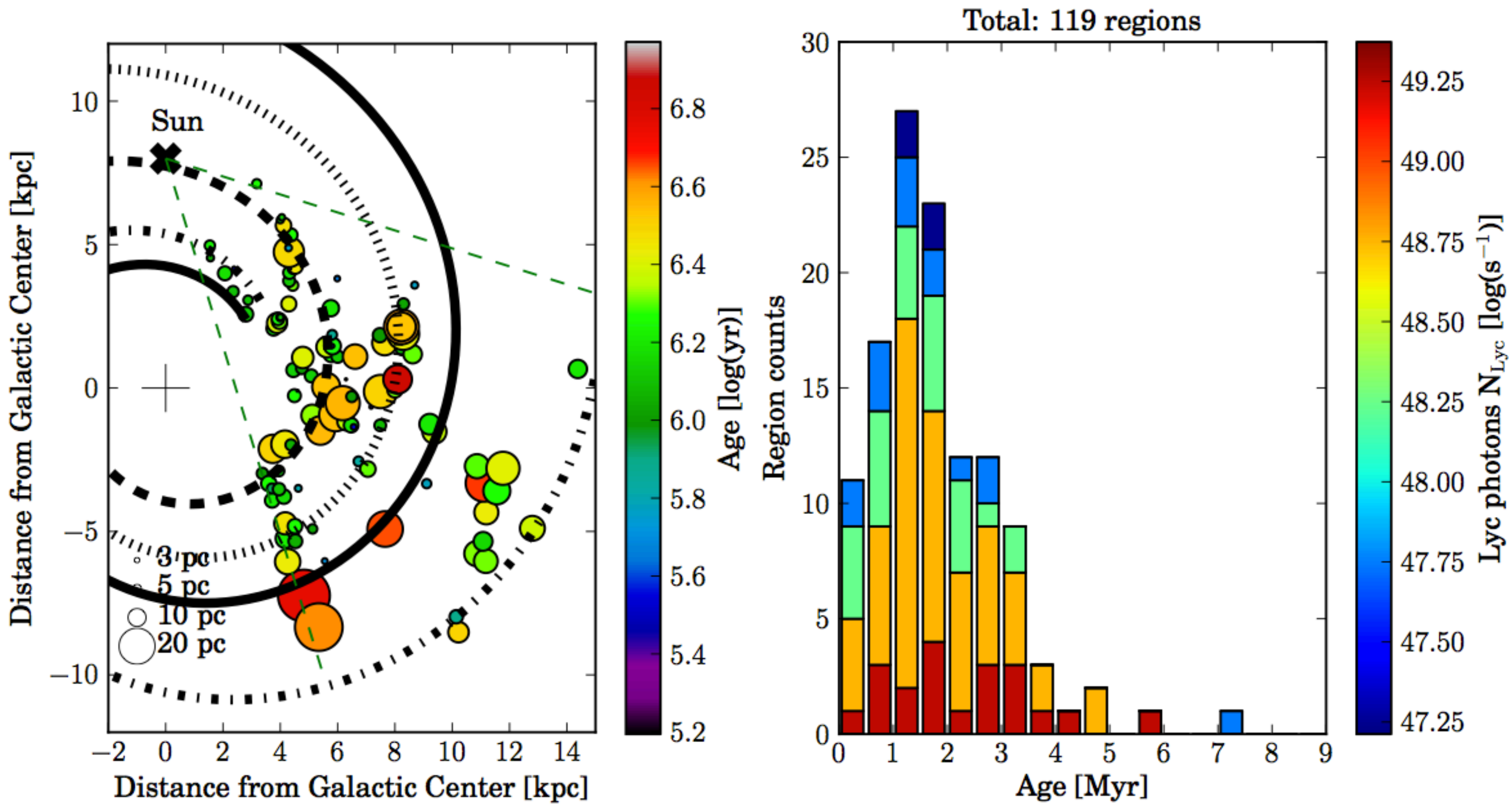

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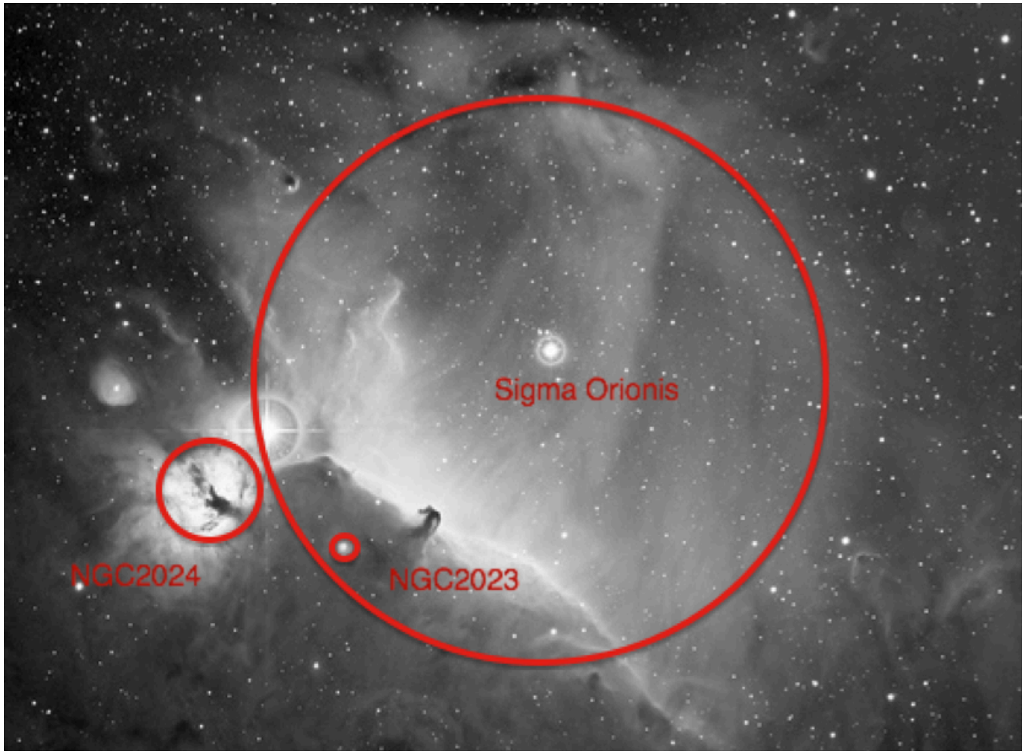

- Example age of the regions in Orion B:

Sig. Orionis: 3.8 Myrs

NGC2024: 0.2 Myrs

NGC2023: 0.1 Myrs

See the anatomy of giant molecular clouds (J. Pety)

- Summary

- Ionization compresses molecular clouds and can be identified in PDFs as a second lognormal (or power-law if homogeneous compressed layer) or enlarged distribution (if the initial turbulence is high).

- Compression is also seen on radial profiles of clumps allowing to distinguish free-fall collapse and forced-fall collapse:

  steep radial profile $r^{-\text{alpha}}$ with alpha > 2 (around 2.5)

- While the bubble expands and halt star formation in the ionized regions it forms a second generation of stars in a compressed layer. This second generation could be of importance to get a correct IMF with realistic Mach numbers in gravo-turbulent theories.