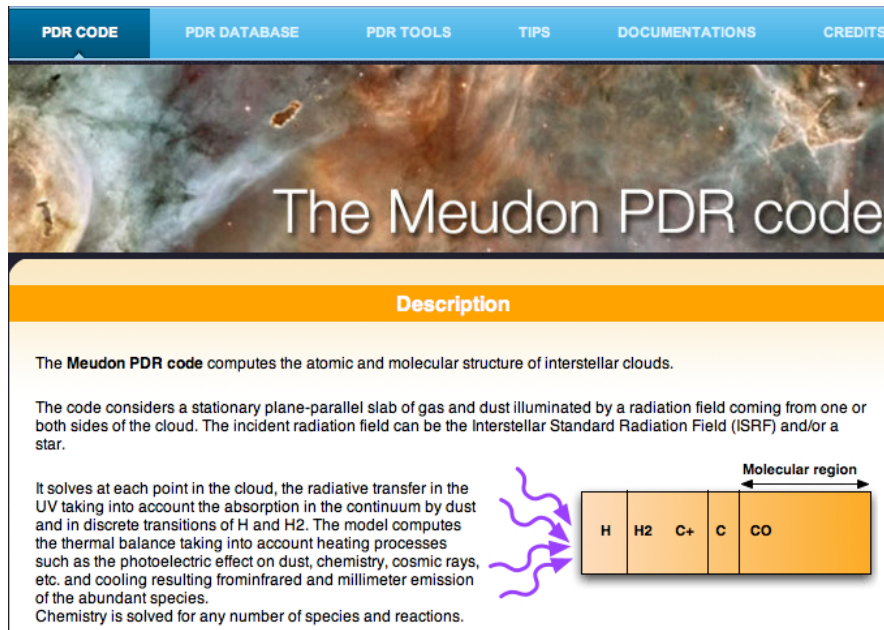


# PDR & StarFormat

## Recent developments on Paris Observatory's theoretical VO services

Benjamin Ooghe, Nicolas Moreau  
Franck Le Petit, Patrick Hennebelle



**PDR CODE** | PDR DATABASE | PDR TOOLS | TIPS | DOCUMENTATIONS | CREDITS

### The Meudon PDR code

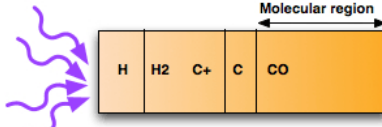
**Description**

The **Meudon PDR code** computes the atomic and molecular structure of interstellar clouds.

The code considers a stationary plane-parallel slab of gas and dust illuminated by a radiation field coming from one or both sides of the cloud. The incident radiation field can be the Interstellar Standard Radiation Field (ISRF) and/or a star.

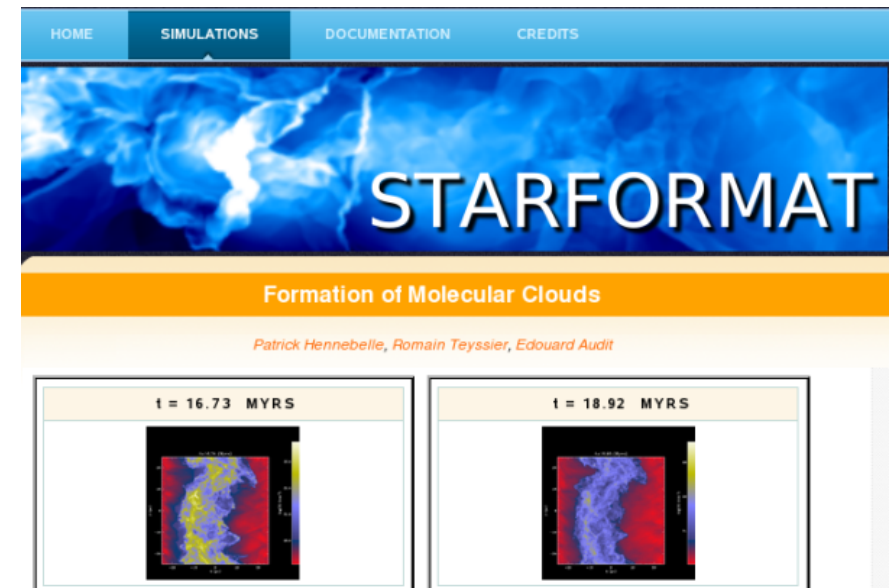
It solves at each point in the cloud, the radiative transfer in the UV taking into account the absorption in the continuum by dust and in discrete transitions of H and H<sub>2</sub>. The model computes the thermal balance taking into account heating processes such as the photoelectric effect on dust, chemistry, cosmic rays, etc. and cooling resulting from infrared and millimeter emission of the abundant species.

Chemistry is solved for any number of species and reactions.



Molecular region

H H<sub>2</sub> C<sup>+</sup> C CO



HOME | **SIMULATIONS** | DOCUMENTATION | CREDITS

### STARFORMAT

Formation of Molecular Clouds

*Patrick Hennebelle, Romain Teyssier, Edouard Audit*

t = 16.73 MYRS

t = 18.92 MYRS

# PDR WebSite & DataBase

• Download Code with Doc

• Run Online Code

CPU-demanding

=> Publish DataBase  
of grids of models:

- diffuse clouds
- dense clouds
- extragalactic medium
- ...

Back to : [Index - Previous Page](#)

To query the PDR models, select first a code version and then choose at least one search criteria :

Code version : Pdr 1.4 - Drscnosd  
Test

Select at least one criteria on parameters :

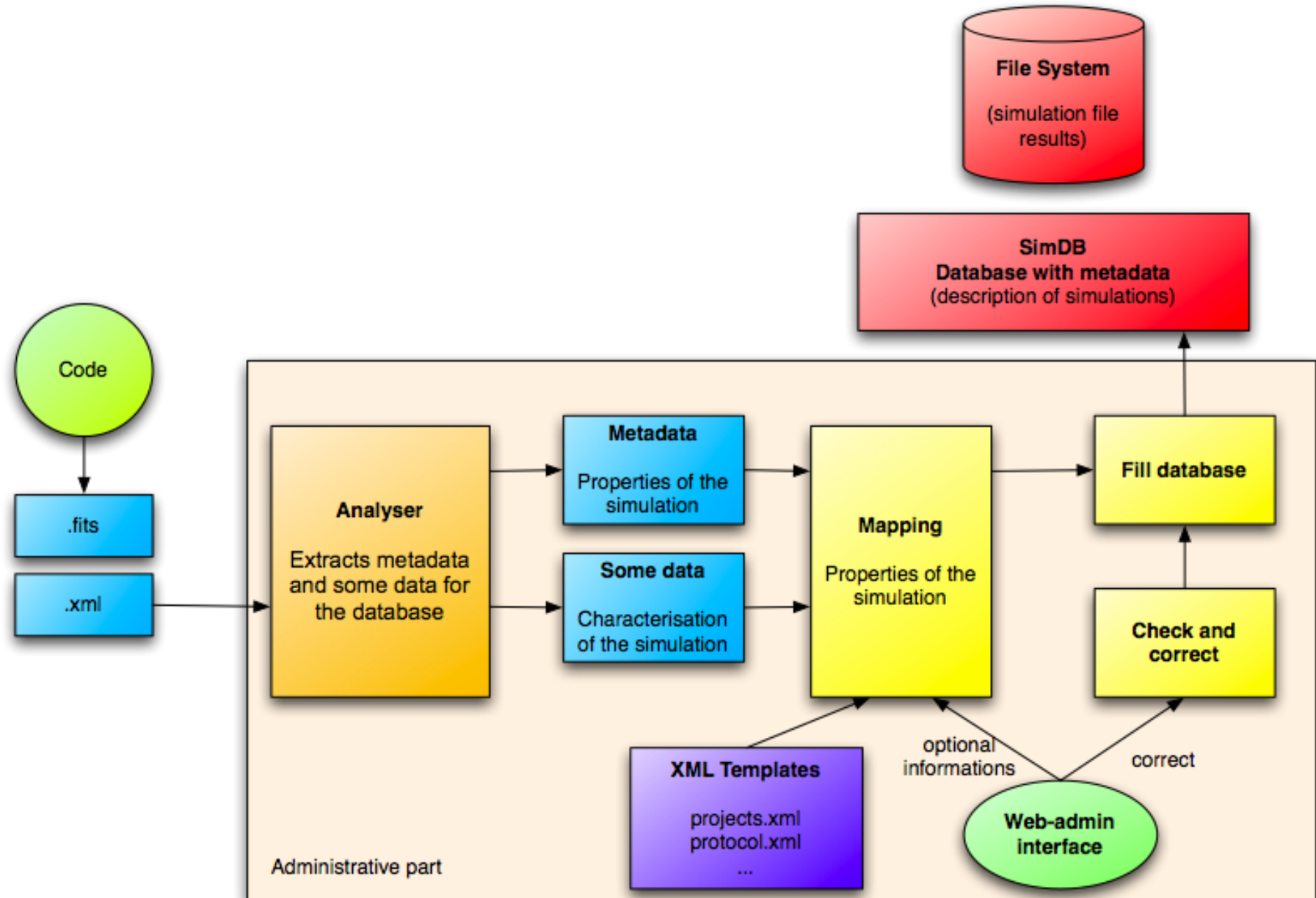
Parameter	Possible values	User value
Proton density (initial)	100.0, 200.0, 300.0, 500.0, 700.0	<input type="text"/>
ISRF factor (Obs. side)	0.5, 1.0, 2.0, 3.0, 5.0	<input type="text"/>
ISRF factor (Back side)	0.5, 1.0, 2.0, 3.0, 5.0	<input type="text"/>
Av of the cloud	0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0	<input type="text"/>

**Scientists** : F. Le Petit, J. Le Bourlot  
**VO-services** : L. Bourges, J. Normand,  
N. Moreau, B. Ooghe

Tue, Oct 12th, 2010

<http://pdr.obspm.fr>

# Simple model ingestion process



# Queries for Modelers & Observers

Query the Pdr models

Back to : [Index - Previous Page](#)

To query the PDR models, select first a code version and then choose at least one search criteria :

Code version : PDR 1.4 Chimie08.chi

**PDR 1.4** : The 1.4 version corresponds to the PDR code described in Gonzalez Garcia M. et al. (2008, A&A, 485, 127). It includes a new radiative transfer method computing in details I.R. pumping due to line and dust emission.

**Chimie08.chi** : This chemistry is a short network based on various rates found in the literature and on OSU05. For carbonated molecules, it includes chains up to 3 carbon so we only recommend to consider results for chains with 2 carbon.

Query on Parameters
Query on Column densities

Select at least one criteria on parameters :

Parameter	Possible values	User value
Proton density (initial)	1000, 3000, 7000, 1.000E04, 3.000E04, 7.000E04, 1.000E05, 3.000E05, 7.000E05, 1.000E06	<input type="text"/>
ISRF factor (Obs. side)	100, 300, 700, 1000, 3000, 7000, 1.000E04, 3.000E04, 7.000E04, 1.000E05, 3.000E05, 7.000E05	<input type="text"/>
ISRF factor (Back side)	0	<input type="text"/>
Av of the cloud	20	<input type="text"/>

Select at least a criteria on column densities :

Range(s) for the chosen column density (cm-2) :

- H2 - min :  - max :

- HD - min :  - max :

- C+ - min :  - max :

- C - min :  - max :

- CO - min :  - max :

- O - min :  - max :

- S - min :  - max :



# Browse models information

Name	n1e3r7e5A20_10	n1e3r7e4A20_10	n1e3r7e3A20_10
Actions	<a href="#">View</a> <a href="#">Download</a>	<a href="#">View</a> <a href="#">Download</a>	<a href="#">View</a> <a href="#">Download</a>
<b>Cloud parameters</b>			
Av of the cloud[mag]	20	20	20
Proton density (initial)[cm-3]	1000	1000	1000
Flag : 1 or 2 side(s) model	1	1	1
ISRF factor (Obs. side)	7.00E05	7.00E04	7.00E05
ISRF factor (Back side)	0	0	0
Distance of the point UV source[pc]	0	0	0
Flux of cosmic rays[1E-17 s-1]	5	5	5
Micro-turbulent velocity[cm s-1]	2.00E05	2.00E05	2.00E05
<b>Chemistry parameters</b>			
Chemistry file name	chimie08.chi	chimie08.chi	chimie08.chi
He / H	1.00E-01	1.00E-01	1.00E-01
C / H	1.32E-04	1.32E-04	1.32E-04

Model : n1e3r3e4r0A2e1\_10

Description :  
One face simulations of bright and dense PDRs with visual extinction of Av = 20. Proton density ranges from 1E3 to 7E6 cm-3 and Rad from 1E3 to 1E7 (Draine's unit). - Galactic values for grain properties and elementary abundances - Standard UV transfer  
[Download full simulation for the PDR analyzer](#)

[Model](#) | [Structure](#) | [Column densities](#) | [Line intensities](#)

Cloud parameters		Chemistry parameters	
Av_max	2.000E01 mag	Chemistry file name	chimie08.chi
nH_init	1.000E03 cm-3	He/H	1.000E-01
isoneside	1	C/H	1.320E-04
radm_ini	3.000E04	N/H	7.500E-05
radp_ini	0	O/H	3.190E-04
d_sour	0 pc	D/H	0
External source name		C13/H	0
ifeqth	1	N15/H	0
tg_init	1.000E02 K	O18/H	0
ifisob	0	PAH/H	0
presse	6.000E03 cm-3 K	F/H	0
nH - Temp profile file name		Na/H	0
fsrc	5.000E00 1E-17 s-1	Mg/H	0
vturb	2.000E05 cm s-1	Al/H	0
			0
			0
			1.860E-05
			0
			0
			1.500E-08
			0
			0
			2
			4

[Model](#) | [Structure](#) | [Plot](#) | [Column densities](#) | [Line intensities](#) | [Spectra](#)

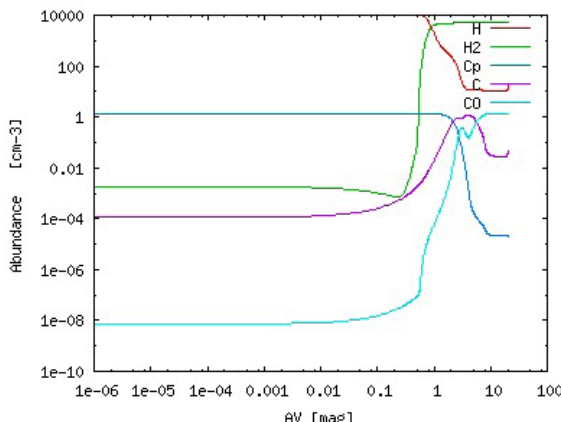
Choose a property to plot

CO

Abundance  Log

AV  Log

Selected elements		
Element	Column density	Deletion
H	1.73e+21 cm-2	<input type="button" value="Delete"/>
H2	1.78e+22 cm-2	<input type="button" value="Delete"/>
C+	5.40e+17 cm-2	<input type="button" value="Delete"/>
C	8.71e+17 cm-2	<input type="button" value="Delete"/>
CO	3.49e+18 cm-2	<input type="button" value="Delete"/>



	0
	0
	1.860E-05
	0
	0
	1.500E-08
	0
	0
	2
	4

Information	
	1.475E04
	0
	1.852E04
	0 phot cm-2 s-1
	5.000E03 s-1

Data	
VOTable	<a href="#">View</a> <a href="#">Send</a>
Ascii	<a href="#">View</a>



**VOTable**

Tue, Oct 12th, 2010

SAMP

# Download & manipulate full results

## Download service

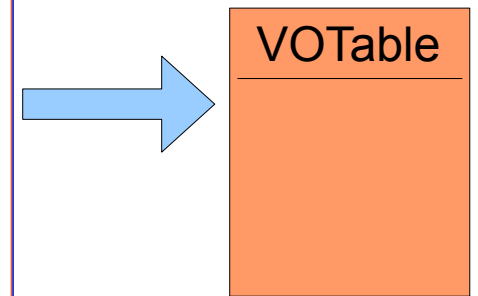
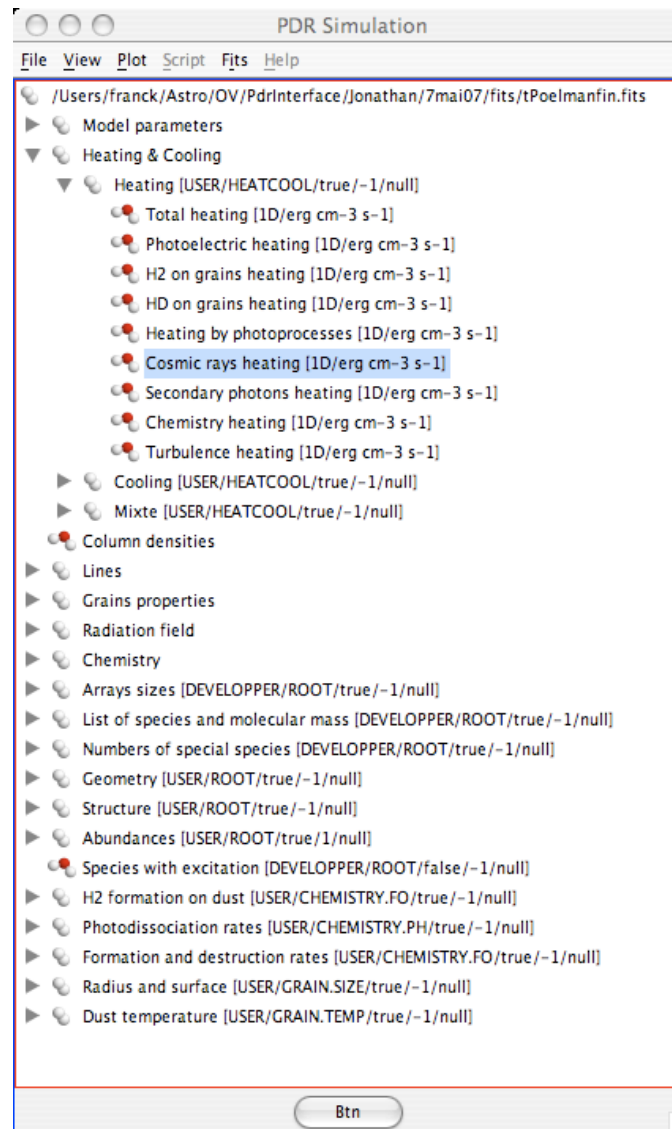
- Get full results of a model
- FITS file : data
- XML file : metadata

## PDR Analyser

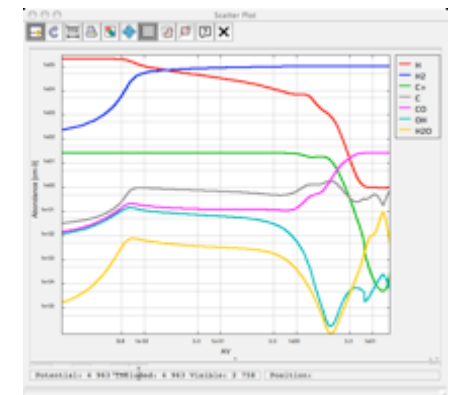
- Read & draw data
- Compute line intensities as a function of angle
- Chemistry analyser

## Extraction ASCII/VOTable

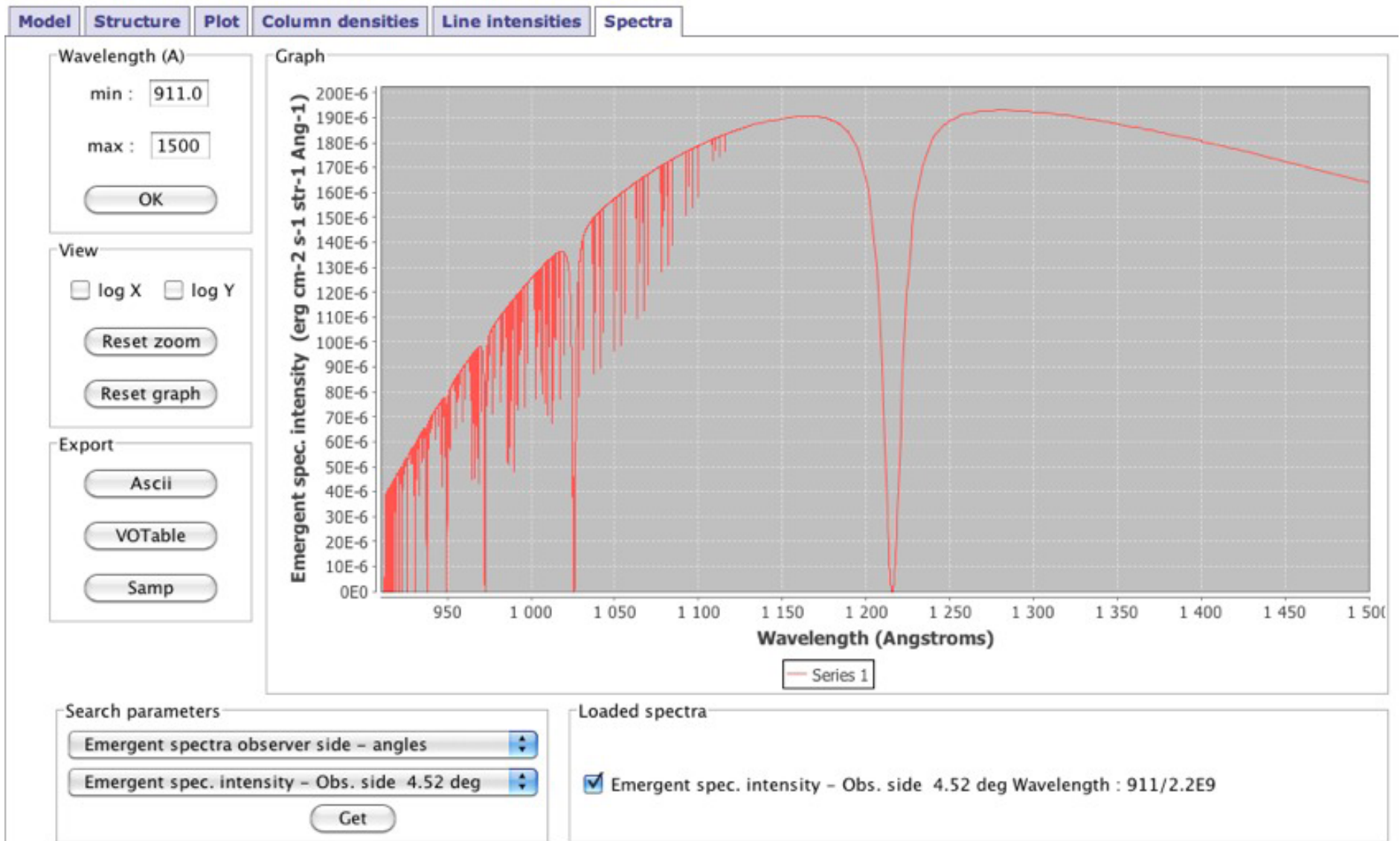
→ TopCat/SAMP



SAMP



# Online Spectra Browsing



# StarFormat

[HOME](#)[SIMULATIONS](#)[DOCUMENTATION](#)[CREDITS](#)

# STARFORMAT

Browse simulations by project

The StarFormat database groups many simulations performed with different codes in various laboratories in France and Germany.

These simulations are grouped within multiple projects which you can browse and query separately with the links below :

PROJECT	DESCRIPTION
<a href="#">Evolution of Molecular Clouds with Decaying Turbulence (Patrick Hennebelle)</a>	blablabla
<a href="#">Formation of Molecular Clouds (Patrick Hennebelle)</a>	This project aims at describing self-consistently the formation of molecular clouds starting from the very diffuse atomic interstellar medium.
<a href="#">Solenoidal vs. Compressive Turbulence Forcing (Christoph Federrath)</a>	This project investigates the influence of different forcing (i.e., kinetic energy injection) on turbulent flows in the interstellar medium.
<a href="#">Chemistry simulations (Simon Glover)</a>	blablabla

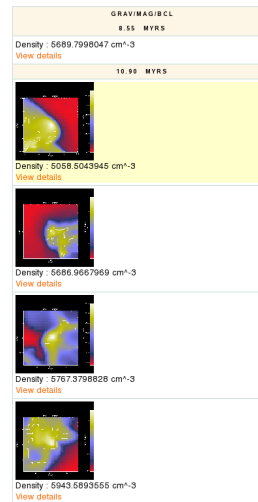
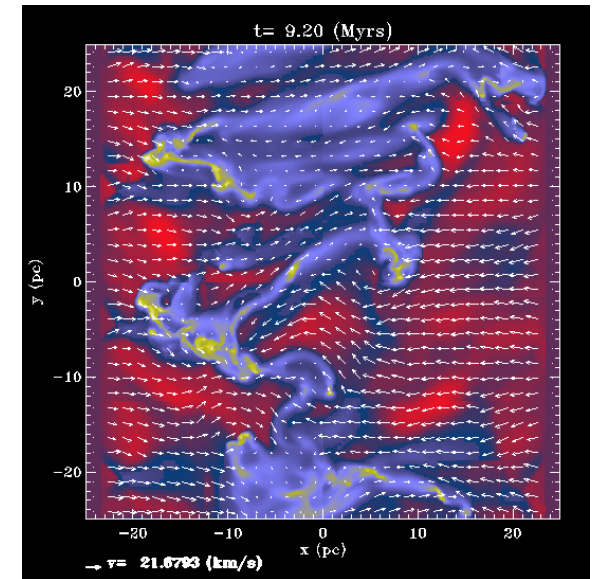
[top of page](#)

**Scientists** : P. Hennebelle, R. Klessen, R. Banerjee, C. Dullemond, S. Glover, E. Falgaronne, F. Le Petit  
**VO-services** : B. Ooghe, N. Moreau

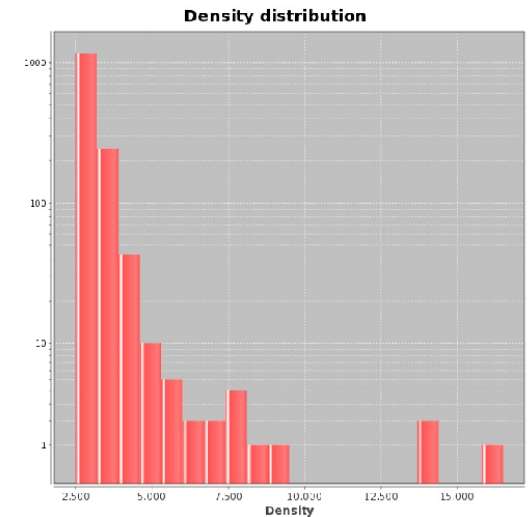


# RAMSES-MHD Simulations

- LERMA-ENS Project
- 2 Projects (Formation, Evolution)  
=> 7 simulations
- 2 snapshots x 2 clump extractions
- Browse properties statistics and PDF on each snapshot
- 40 000 clumps
- Search clumps by characterization
- Extract raw results data

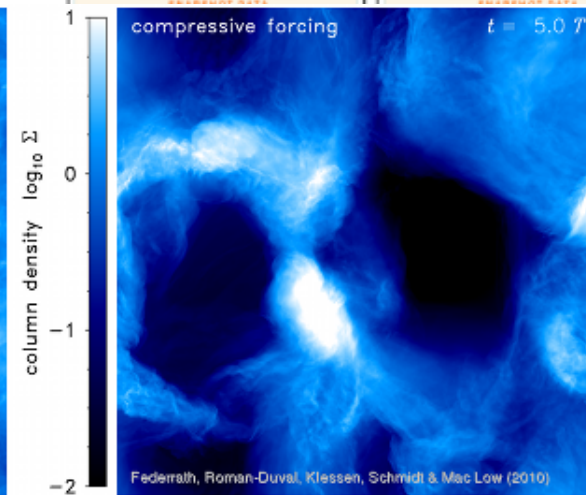
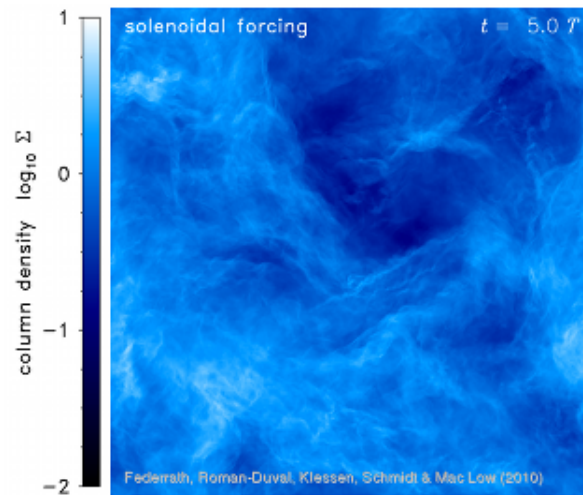


PROPERTY	VALUE
Angle	2.7305533886
AngMomx	9.85028185356E18 cm <sup>2</sup> s <sup>-1</sup>
AngMomy	-4.4419813701E19 cm <sup>2</sup> s <sup>-1</sup>
AngMomz	-2.1517642907E20 cm <sup>2</sup> s <sup>-1</sup>
Density	5058.6043945 cm <sup>-3</sup>
First eigenvalue of the inertia matrix	0.66806958827 solar mass pc <sup>2</sup>
Highest Density	27674.957031 cm <sup>-3</sup>
Kinetic energy	7.5403970395E-12 erg cm <sup>-3</sup>
Magnetic energy	4.2395098372E-12 erg cm <sup>-3</sup>
Mass	22.847071526 solar mass
Mass above threshold 1	0.15318713595 solar mass
Mass above threshold 2	0.0 solar mass
mass_flux	4.5506814965
Number of cells	816.0
Pressure	1.01856859598E-11 erg cm <sup>-3</sup>
rms value of the x-component of the magnetic field	5.060433711 microGauss
rms value of the y-component of the magnetic field	3.562148509 microGauss
rms value of the z-component of the magnetic field	3.667254012 microGauss
Second eigenvalue of the inertia matrix	1.2484574195 solar mass pc <sup>2</sup>
SigX	25118.610989 cm s <sup>-1</sup>
SigY	16085.651258 cm s <sup>-1</sup>
SigZ	19817.100794 cm s <sup>-1</sup>
Structure size	1.025390625 pc



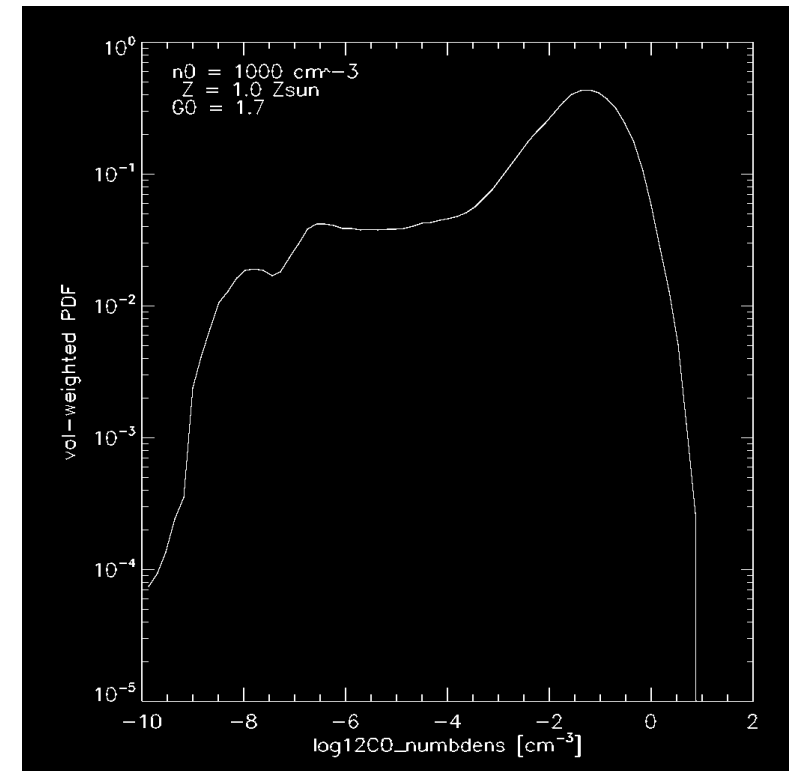
# FLASH Turbulence Simulations

- ZAH Project
- 2 concurrent simulations
- 9 snapshots / simulation
- Extract raw results data



# ZEUS Chemistry Simulations

- ZAH Project
- First tryouts on 2 simulations out of a few dozens considered
- 5-6 snapshots / simulation
- Browse PDF on each snapshot

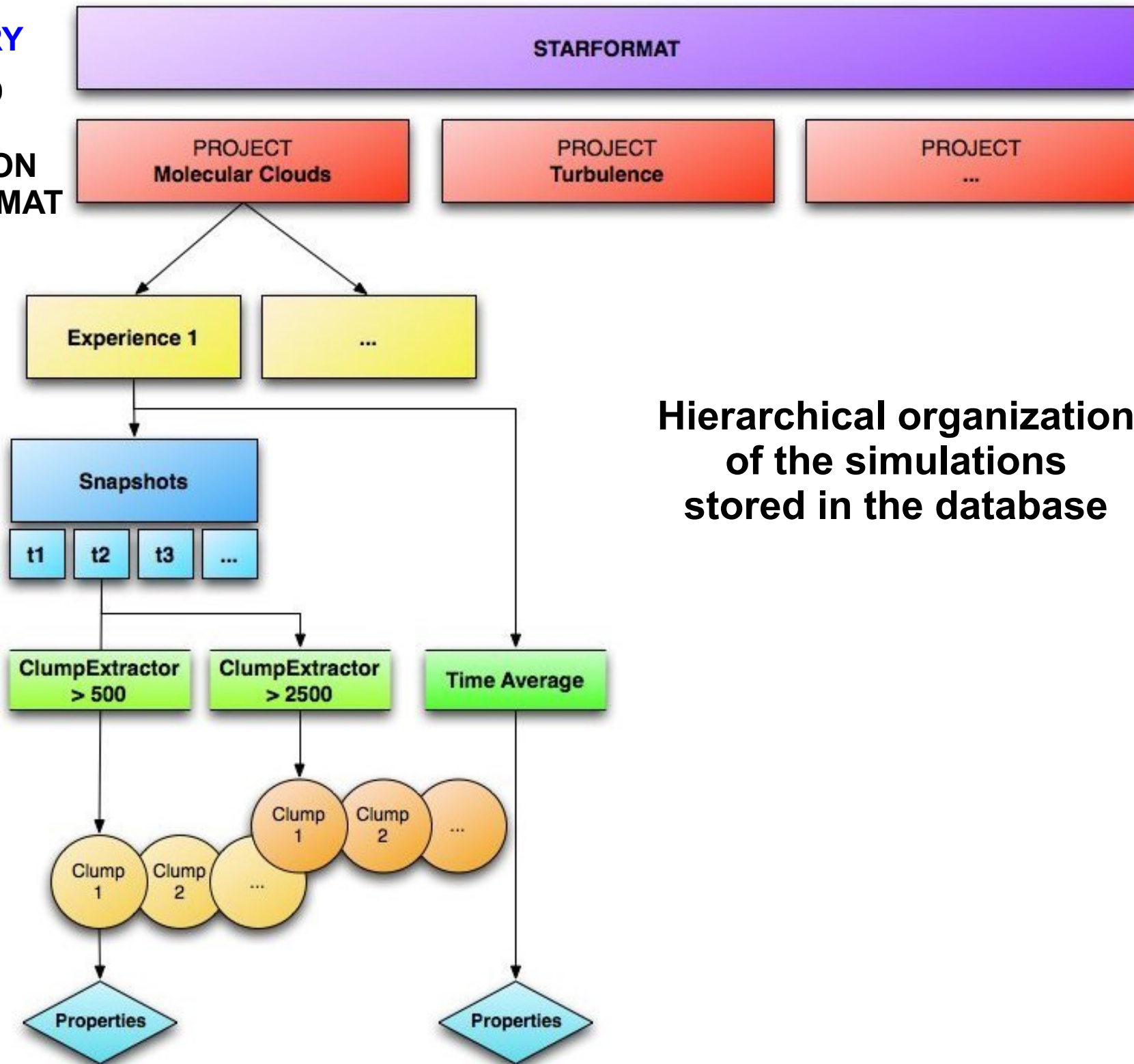


- Extract raw data?
- Chemistry applications?

# IVOA THEORY

## SIMPLIFIED MODEL

## ORGANIZATION FOR STARFORMAT



**Hierarchical organization  
of the simulations  
stored in the database**

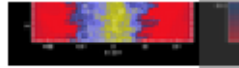


# Snapshot info, statistics & images

## Formation of Molecular Clouds

This project aims at describing the formation of molecular clouds

GrowHydroBcl    GrowMagBcl    Jades



### STATISTICS FOR DENSITY THRESHOLD OF

10  $\text{cm}^{-3}$

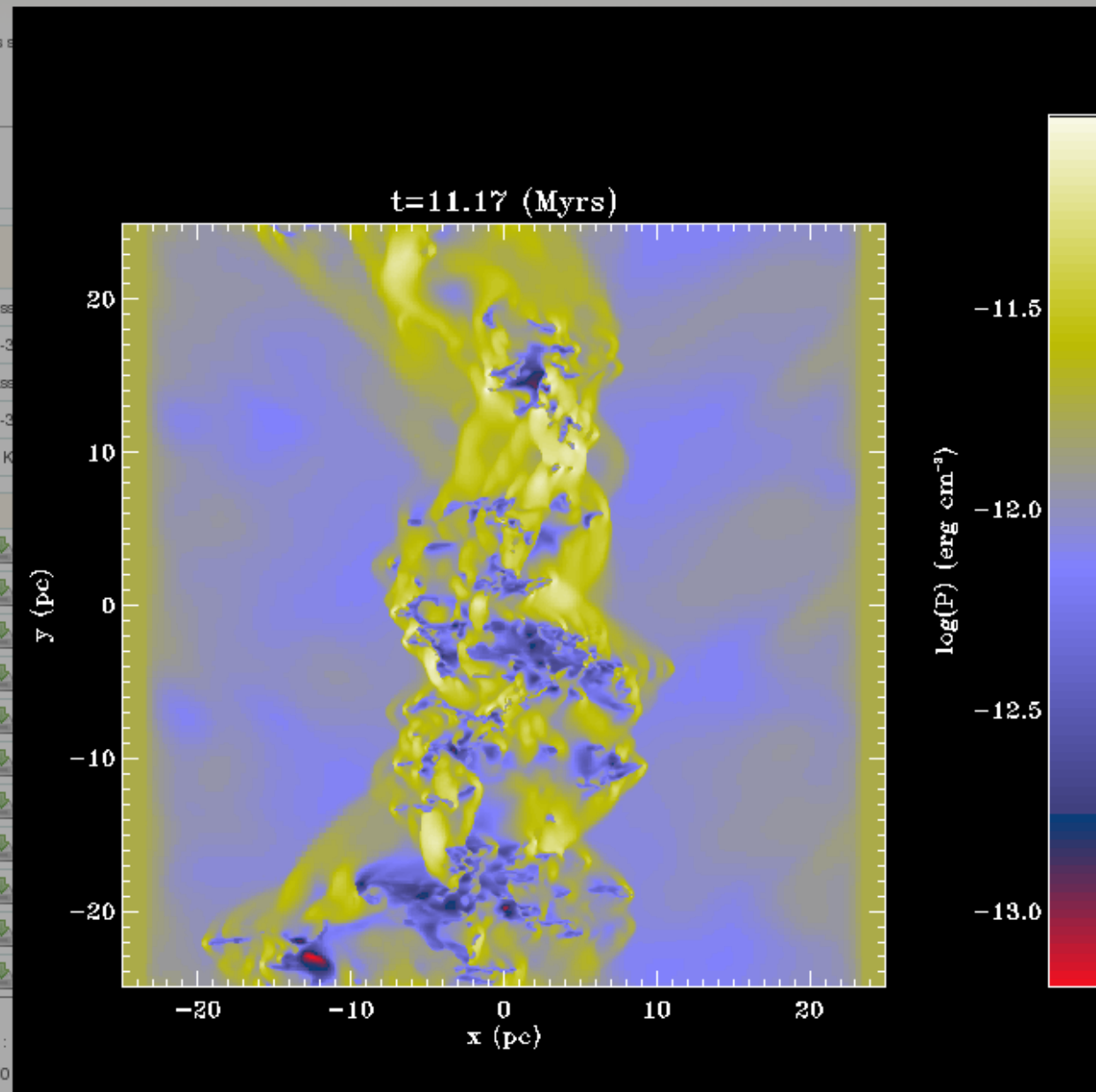
mean magnetic intensity	0.00 microGauss
Mean Density	90.32 $\text{cm}^{-3}$
Total Mass	20 331.26 solar mass
Mean pressure	0.00 $\text{erg cm}^{-3}$
Mean temperature	89.62 K

### SNAPSHOT IMAGES FILES

- column density in xy
- column density in xz
- column density in yz
- density cut2 in xy
- density cut in xy
- density cut in xz
- density cut in yz
- hist\_B
- hist\_col\_dens
- hist\_dB
- hist\_dens

Choose density threshold (in  $\text{cm}^{-3}$ ):

500.0    2500.0    10000.0



# Dense cores research by property

Choose density threshold (in  $\text{cm}^{-3}$ ) :

500.0  2500.0  10000.0

SNAPSHOTS TO QUERY	
EXPERIMENTS	SNAPSHOTS
Grav/Hydro/Bcl	8.38 Myrs <input type="checkbox"/> 11.17 Myrs <input type="checkbox"/>
Grav/Mag/Bcl	8.55 Myrs <input checked="" type="checkbox"/> 10.90 Myrs <input checked="" type="checkbox"/>
Jades	16.74 Myrs <input type="checkbox"/> 18.93 Myrs <input type="checkbox"/>

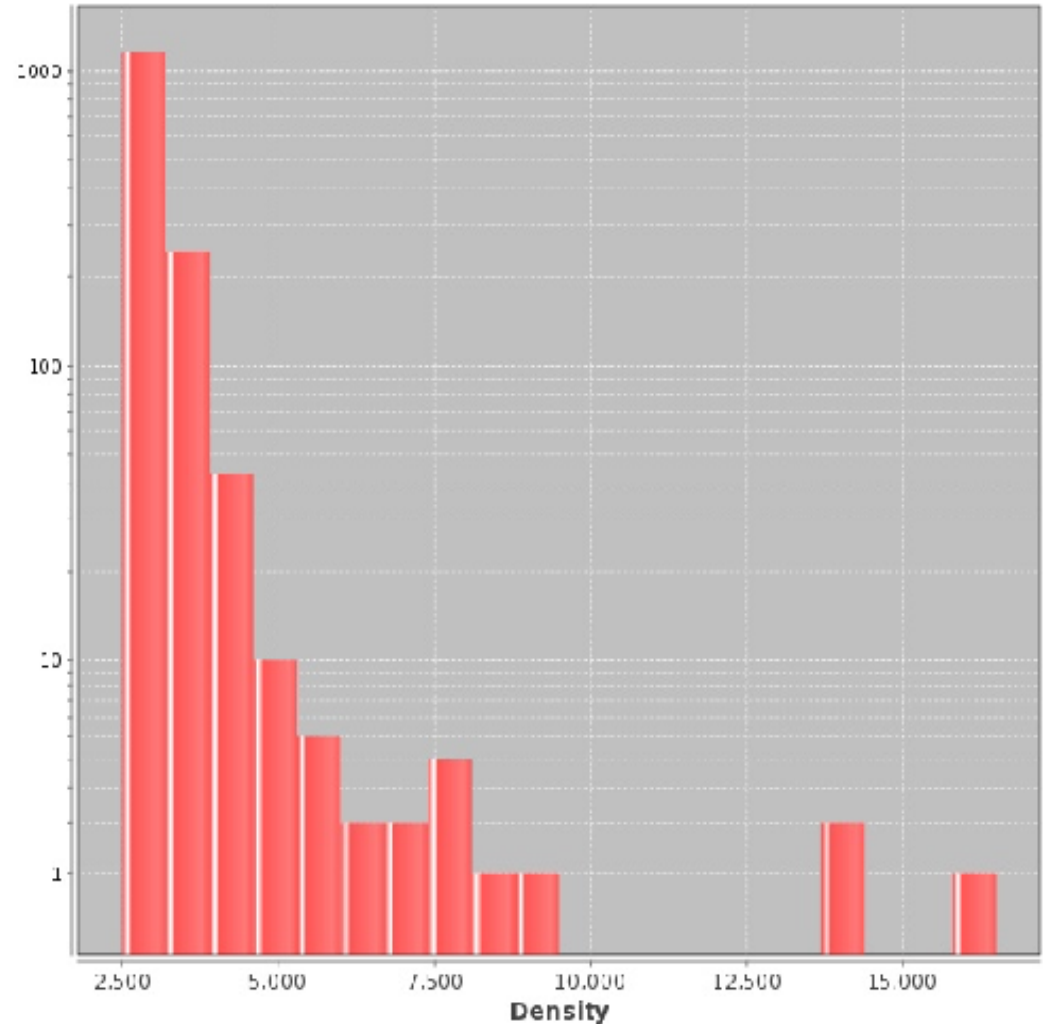
Select

Search in 1476 clumps

PROPERTY	MINIMUM VALUE	MAXIMUM VALUE
Mass(solar mass)	<input type="text"/>	<input type="text"/>
Density( $\text{cm}^{-3}$ )	<input type="text" value="5000"/>	<input type="text" value="8500"/>

Search

Density distribution



# Clump results & raw data extraction

DECAY\_HYDRO  
t = 1.16 MYRS

Mass : 5.08 solar mass  
[View details](#)

Mass : 6.5  
[View](#)

Mass : 9.9  
[View](#)

Mass : 20.0  
[View](#)

Mass : 20.0  
[View](#)

Mass : 25.97 solar mass  
[View details](#)

[BACK TO THIS CLUMP IN SEARCH RESULTS](#)  
[EXTRACT AND DOWNLOAD CLUMP DATA](#)

CLUMP PROPERTIES	
Angle	0.66 rad
Density	64.48 cm <sup>-3</sup>
	4.41 cm <sup>-3</sup>
	croGauss
	croGauss
	croGauss
	croGauss
	solar mass
	28.14
	57000
	3.33 pc
	1.75 pc
	1.85 pc
	3.27 pc
	1.72 pc
	1.79 pc
	0.42 pc
	38 cm.s <sup>-1</sup>
	05 cm.s <sup>-1</sup>
	04 cm.s <sup>-1</sup>
	04 cm.s <sup>-1</sup>

**CLUMP IMAGES**

Column Density in XY

http://starformat.obspm.fr - Extract StarFormat Data from Simulation - Mozilla Firefo: ...

File Edit View History Bookmarks Tools Help

**Extract a subset of clump data from the simulation**

What kind of values do you want to extract?

a projection of column density  
 a cube of density  
 a cube of pressure  
 a cube of velocity  
 a cube of magnetic field

which component?

X  
 Y  
 Z

Extraction box size:  pc (4.00 pc for the whole simulation)

Centered on: X  (pc) Y  (pc) Z  (pc)

Precision L<sub>max</sub>:  corresponding to a resolution of 0.003 pc/cell  
(maximum L<sub>max</sub> allowed for this size of extraction: 10)

E-mail address (to receive a link to download the results):

If you need access to bigger sets of data, please e-mail the PI of the project.

Done

# Next ...

- Connect services together through GILDAS
- Advanced search queries & SIMDAL access
- Display extraction outputs online with VISIVO?
- Services for an InterStellar Medium Platform
  - Radiative transfer (RADMC)
  - Grains
  - Shocks
  - Turbulence
  - ...

