

# GENESIS and MOBS



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## GENESIS

„**GEN**eration and **E**volution of **S**tructures in the **ISm**“

- German-french collaboration project (2013...2015) since 1.5.2017
- Partners Laboratoire d'astrophysique de Bordeaux (LAB) and  
I. Physikalisches Institut, University of Cologne (KOSMA)
- PI Bordeaux: *Sylvain Bontemps*
- PIs Cologne: *Nicola Schneider, Robert Simon*
- Financed by the Deutsche Forschungsgemeinschaft (DFG) and  
the Agence National de recherche (ANR)

## MOBS

„**MO**dellierung von **Be**obachtungsdaten **SOFIA**“  
(modelling observational SOFIA data)

- German project financed by Deutsches Zentrum Luft- und Raumfahrt (DLR)
- PI *Nicola Schneider*



## **MOBS**

- Financial support to enable travelling for SOFIA projects, in particular for modellers, i.e. Paris, Heidelberg, Cardiff, and observers (Cologne, Bordeaux)

## **GENESIS**

- Project from 1.5. 2017 to 30.09. 2020
- *Bordeaux*: 1 post-doc (Arabindo Roy), 1 PhD student (Lars Bonne)
- *Cologne*: 1 post-doc (Nicola Schneider)
- financial support (e.g. travelling) available for all members
- Close collaboration between the  
**LAB and INRIA** (French National Institute for computer science and applied mathematics) **in Bordeaux**  
and the **I. Physik. Institute in Cologne**  
-> experts in ISM, molecular spectroscopy, image analysis, PDR modelling, structure analysis,....  
  
+ external partners (16 collaborators from 11 institutes), can be extended !

Theory and numerical Simulations:

**Christoph Federrath** (ANT Canberra/Australia)

- turbulence theory, MHD simulations, PDFs

**Alexei Kritsuk** (CASS San Diego/US)

- turbulence theory, energy repartition, MHD simulations

**Ralf Klessen, *Simon Glover*** (ITA, ZAH Heidelberg)

- SPH and MHD simulations with chemistry, molecular cloud formation, diffuse gas,...

***Antoine Gusdorf, Pierre Lesaffre, Benjamin Godard*** (LERMA Paris)

- irradiated shocks, low velocity/low density shocks, turbulence dissipation

**Pascal Tremblin** (CEA Saclay)

- modelling HII regions, pillar, globules

**Paul Clark** (Cardiff)

- SPH and MHD simulations with chemistry, molecular cloud formation

**Phil Myers** (CfA Harvard)

- N-PDFs, molecular cloud structure, filaments

Observations:

**Frederique Motte , *Thomas Nony*** (IPAG Grenoble)

- ALMA Large program, *Herschel*

**Juergen Kerp** (Argelander Institut Bonn)

- HI (EBHIS)

**Fernando Comeron** (ESO)

- stellar feedback, optical/IR observations

***Timea Csengeri*** (MPiR Bonn)

- Atlasgal, Apex, Sofia

**Nicolas Peretto, Ana Duarte-Cabral** (Cardiff)

- *Herschel*, ALMA, comparing simulations and observations

## GENESIS „GENeration and Evolution of Structures in the Ism“

- Disentangle the relative importance of **gravity**, **turbulence**, (**magnetic fields**), and **radiation** during the cloud- and star-formation process.
- Understanding how **dense structures** (filaments, cores,..) are forming.
- Identifying the **spatial scales** on which physical processes are happening (dissipation of turbulence, heating- and cooling, transition HI/H<sub>2</sub>...).

### What makes GENESIS different from other projects ?

- Observations covering a large parameter space of density and excitation conditions.  
Diffuse gas -> molecular clouds -> filaments -> dense cores

FIR dust (*Herschel*) + **THz spectroscopy (SOFIA)** + molecular lines + HI

- Comparison with simulations, applying the same analysis tools.
- New and innovative image analysis techniques.

## *Why this collaboration?*

For understanding the physical processes that organize the ISM, one has to identify and characterize structures in the ISM.

-> ***experts that developed tools to identify structure and sources***

- power-spectra and Delta-variance (CEA, Cologne)
- WWCC (wavelet-based cross-correlation) (Cologne)
- filament tracing algorithms (CEA)
- gaussclumps, getsources, new algorithms (Cologne, CEA, Bordeaux)

-> ***experts for image analysis*** (INRIA)

- link between structure and turbulence (singularity exponents)
- Producing high resolution column density maps from Herschel

-> ***experts in observational astronomy***(Cologne, Bordeaux)

- SOFIA
- molecular lines (IRAM, ALMA,..) + HI (Bonn)

-> ***experts in numerical simulations and theory*** (external collaborators, Cologne)

## How to cite GENESIS

... acknowledges support by the french ANR and the german DFG through the project "GENESIS" (ANR-16-CE92-0035-01/DFG1591/2-1).

## Ideas for a logo



## **Immediate Objectives (outlined in proposal)**

### **Dynamics of molecular clouds, interplay between turbulence, gravity and stellar feedback**

#### **1. Conversion of atomic into molecular hydrogen**

- > **Project started**, study of *Draco* (dust column density map, HI, CII detection)
- > extension to observe *Spider* (dust, CII)
- > **Polaris** and **Taurus** not yet worked on in detail

#### **2. Evolution of molecular clouds**

- > **Project started**, study of low- and high mass SF regions in various tracers (dust, molecular lines) in order to identify filaments, flows, clumps, cores:  
***S106, M16, MonR2, Cygnus X, G333,...***
- > more regions to cover a larger parameter space ? Extragalactic studies ?
- > no comparison to simulations yet

#### **3. Importance of cooling for dense structure formation, classical PDRs vs shocks**

- > **Project started**, CII, OI, high-J CO line observations of many regions:  
***S106, M16, Rosette, M16, Cygnus X, G333,...***
- > data mostly reduced (though still issues in calibration)
- > more regions to come (e.g. OI in Musca)
- > PDR models refined, shock models ?



First year

## Bordeaux

## Cologne

*Study of singularities*

- Singularity exponents in Polaris, Draco, **Taurus**
- **comparison to simulations**

*Spectro-imaging*

- |   |                    |
|---|--------------------|
| - Data reduction of molecular line maps: <b>DR21</b>              | <b>S106, MonR2</b> |
| - Determination velocity field for flows and infall: DR21         | <b>S106, MonR2</b> |
| - More proposals for other regions: Musca, <b>Polaris, Taurus</b> | (Draco), M16       |

*New analysis tools for Herschel*

- **Super resolution column density maps**
- **Extraction of dense structures (LAB)**

*SOFIA*

- |                           |  |
|---------------------------|--|
| - Proposals: <b>Musca</b> | - Data reduction   |
|                           | - Proposals: <b>Spider, Cygnus, M16, IVCs, Polaris, Taurus</b> |

First year

Bordeaux

Cologne

*Statistical tools*

- N-PDFs (column density): Draco, **Polaris, Spider,..**
- **PDFs molecular lines (G333)**
- **Delta-variance**
- **WWCC**

*PDR modelling*

- 1D models, ratio maps of CII, OI, CO
- **comparison to simulations + radiative transfer**
- comparison to SILCC output

*Shocks (mostly second year)*

- (Paris)
- irradiated shocks
  - low-velocity shocks