Interstellar Medium

Scientific topics
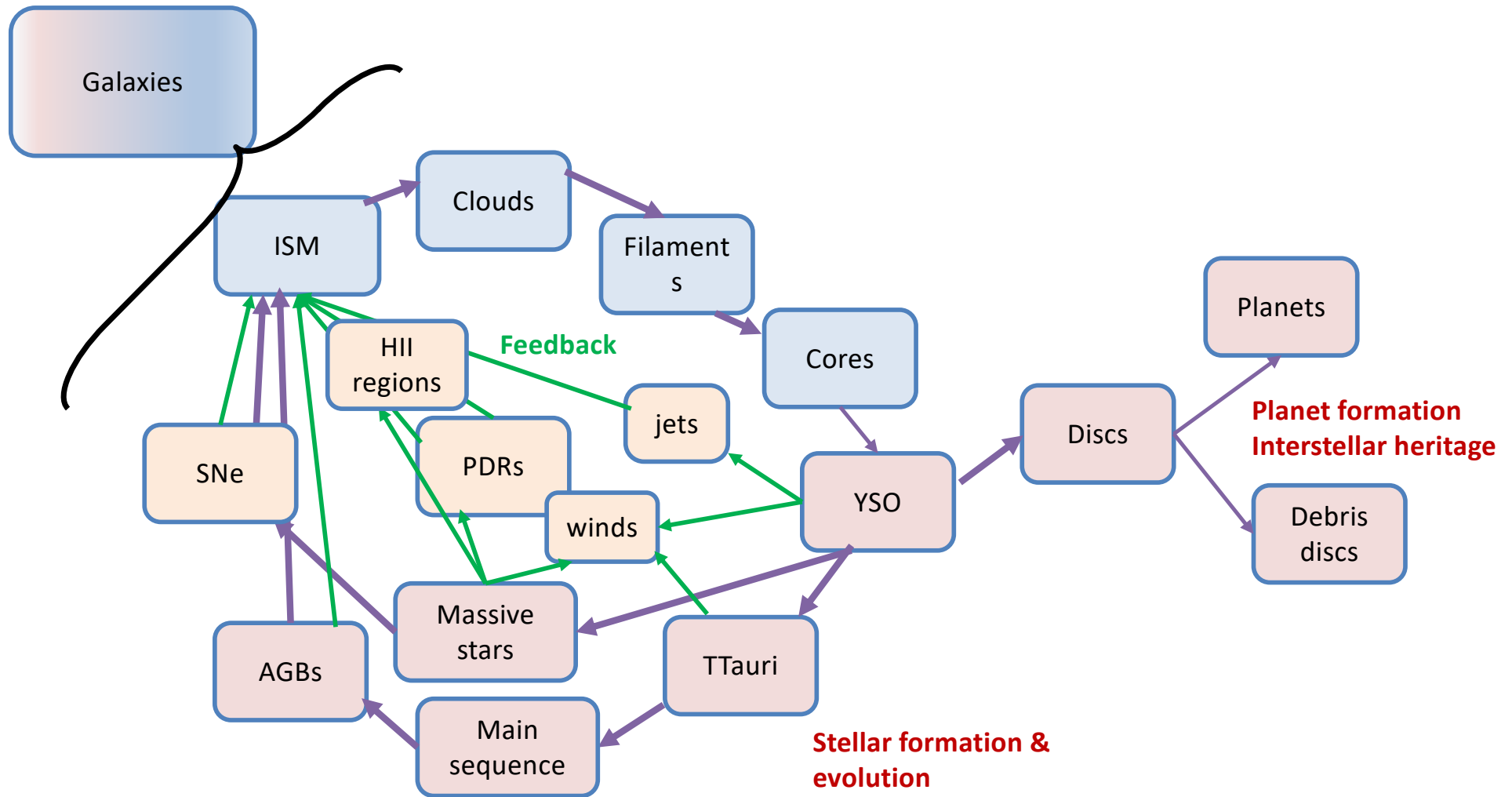
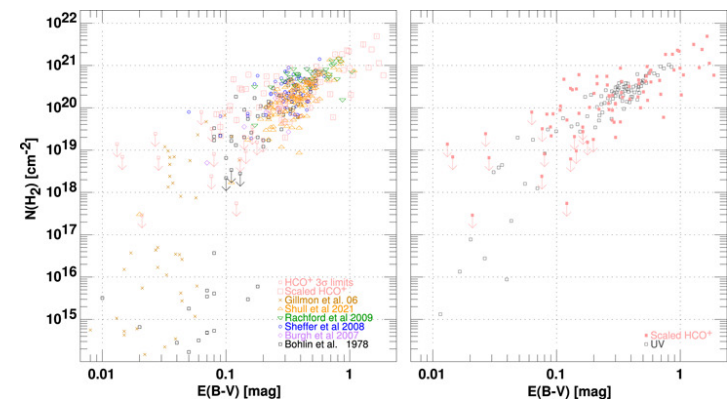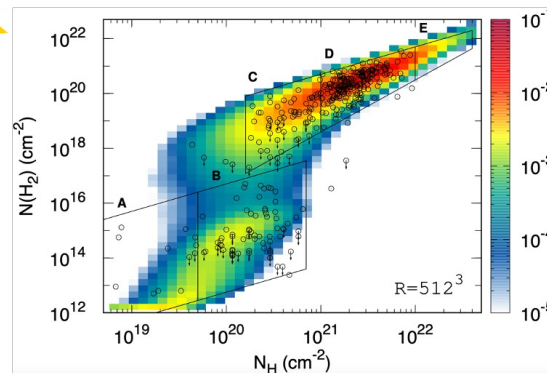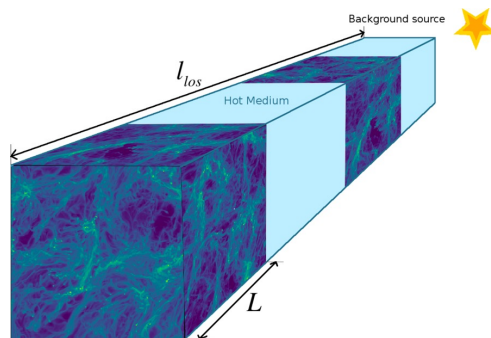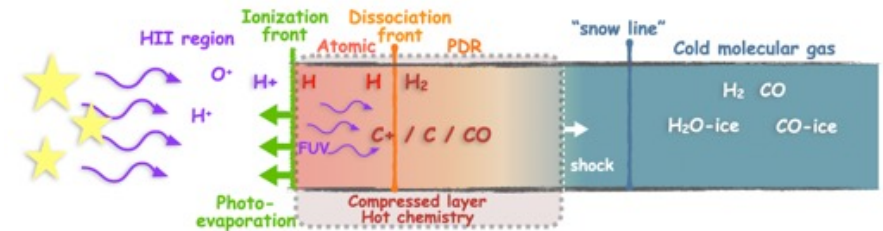- **From spatially resolved transitions at small scales to statistical samples along Galactic sight-lines**
  - The Meudon PDR code
    - Thousands of spectral lines, including H$_2$ excitation
    - Steady state ; hydrodynamic
    - Ideal for JWST observations
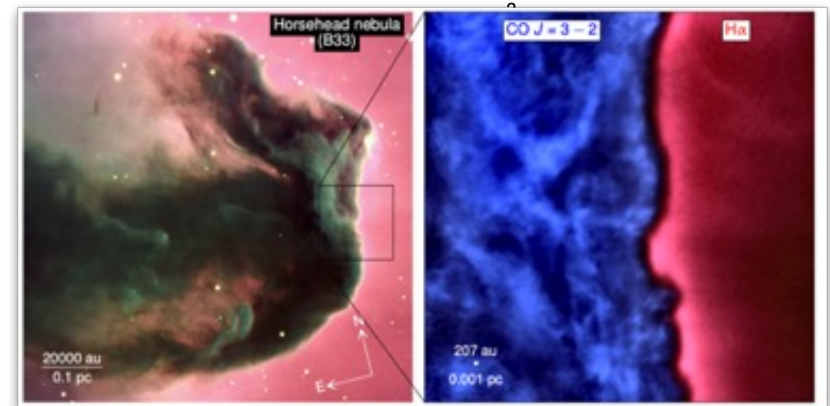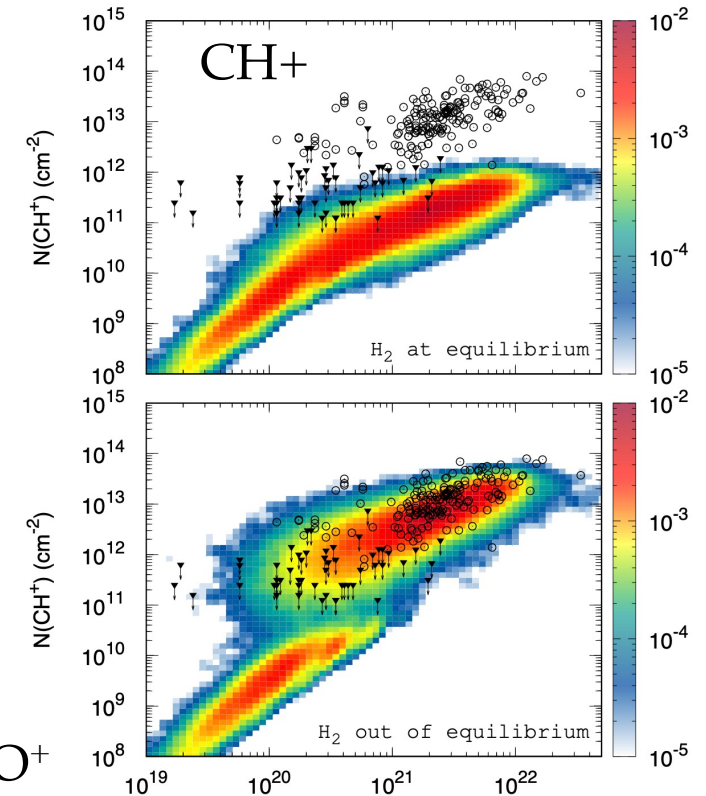 - MHD with simplified chemistry

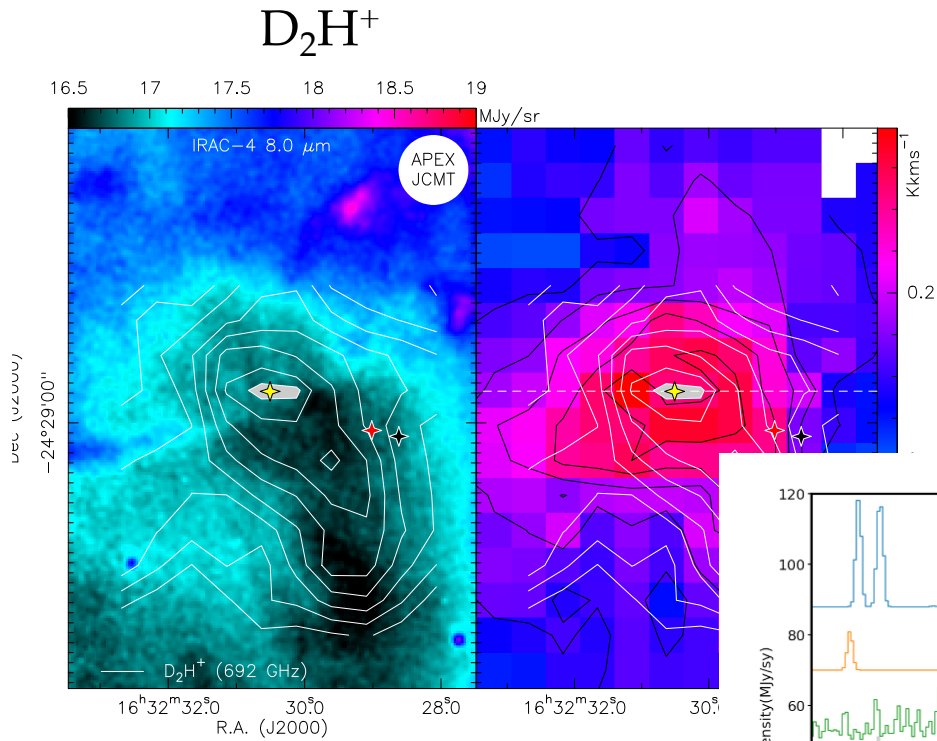*Bellomi+2020, Liszt+2023, Maillard+2021*

From simple molecules ...

- Molecules other H_2 are used as
  - Diagnostic of the physical & chemical processes
  - Tracers of H2
  - Probes of the physical conditions
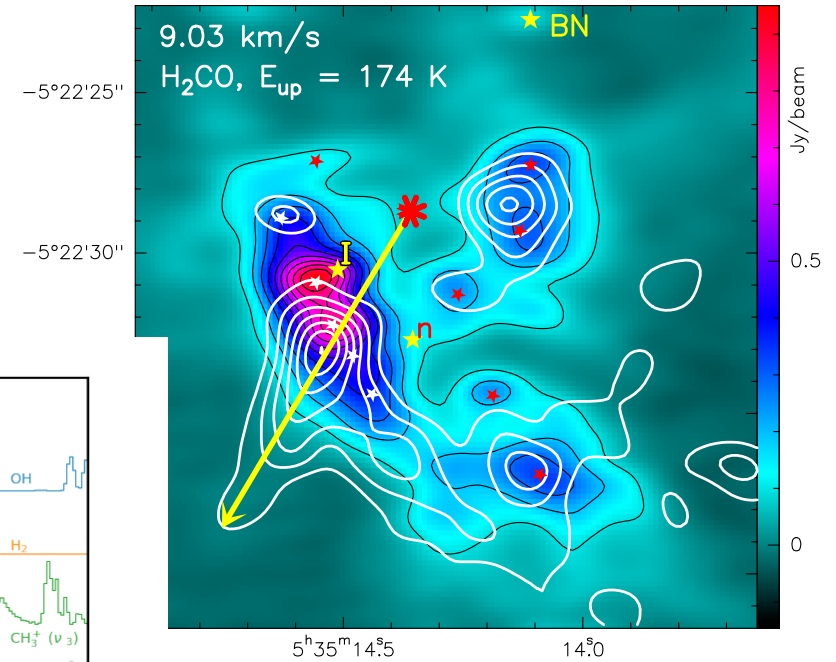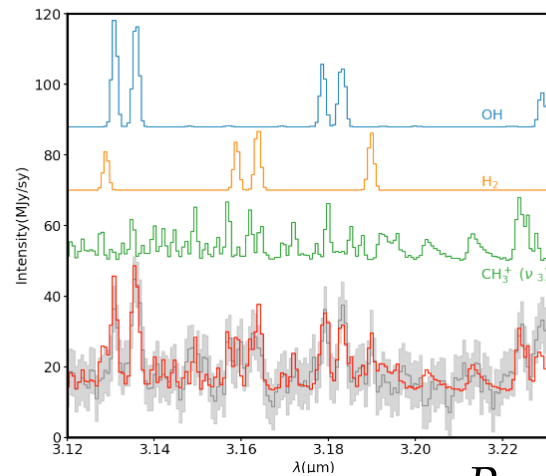 - Probes of the physical & chemical evolution
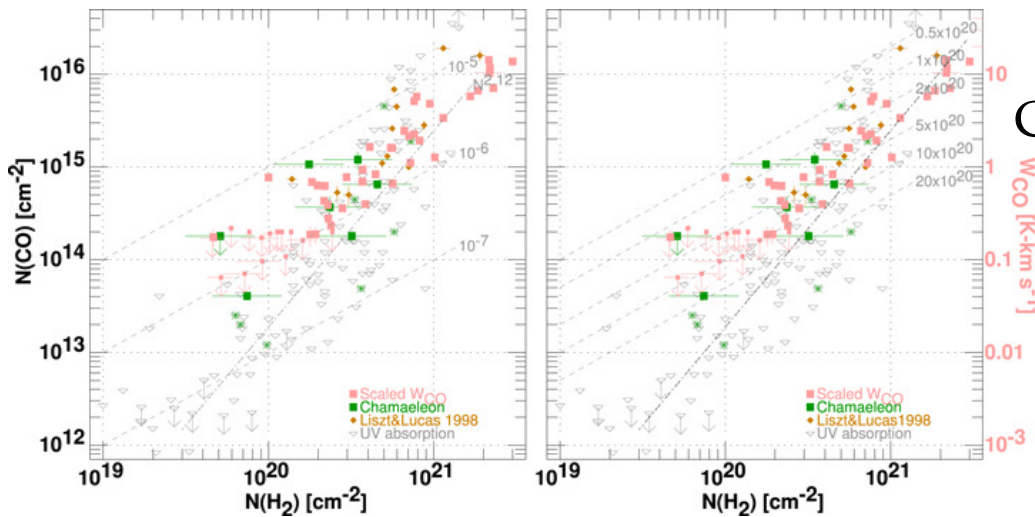
CO & HCO$^+$

Godard+2023, Liszt+2023, Hernandez-Vera+2023

# To complex organics

D$_2$H$^+$

H$_2$CO, CH$_3$COOH, CH$_3$OCH$_3$,..

CH$_3^+$

Pagani+2017, Pagani+, Berné+2023

- Variation of the chemical composition as a function of the environment

- Collaboration with Laboratory astrophysics & spectroscopy

- Extraction of the best abundance or line ratios for determination of the ionization fraction
- Exploration of model grid with Random forest
- Complementary method with recombination lines at low frequencies
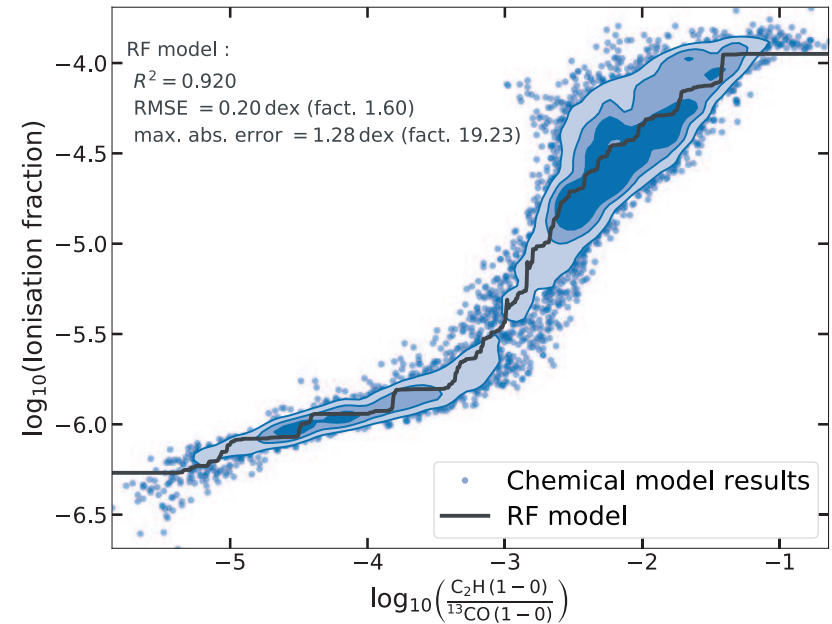
Bron+2021, Gusdorf+
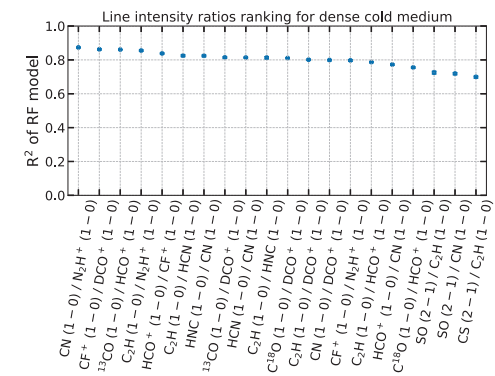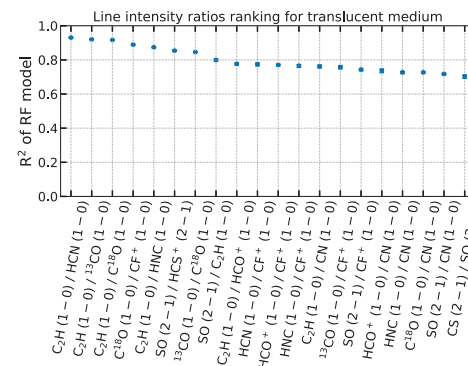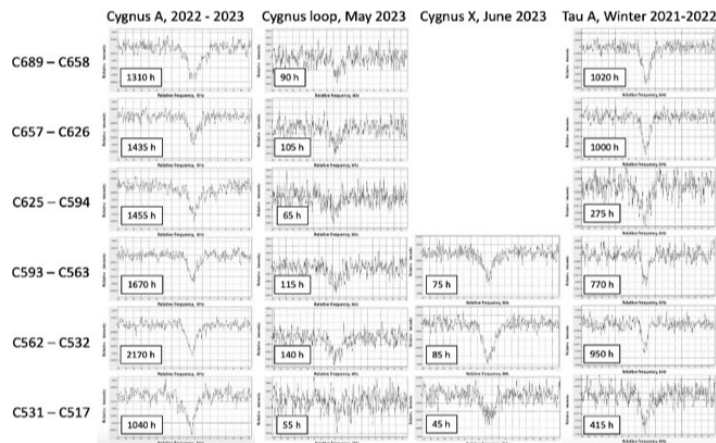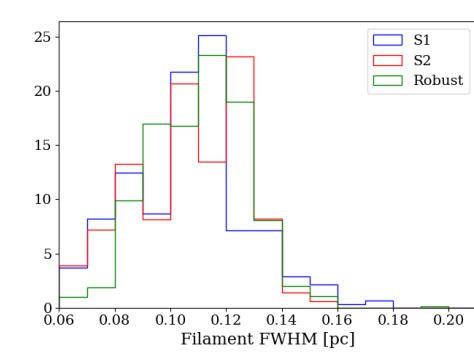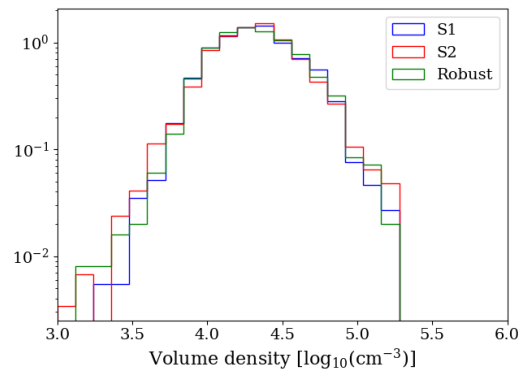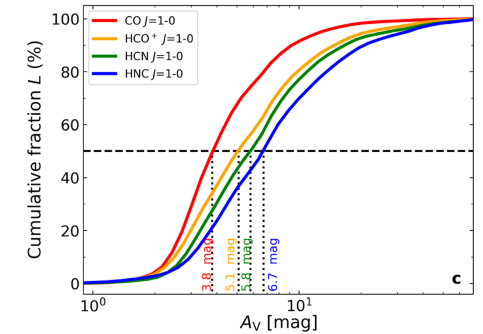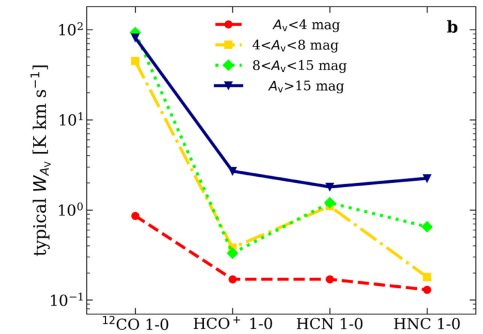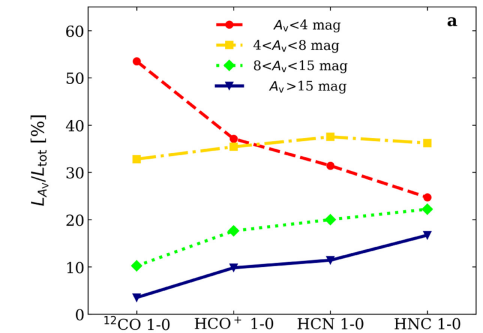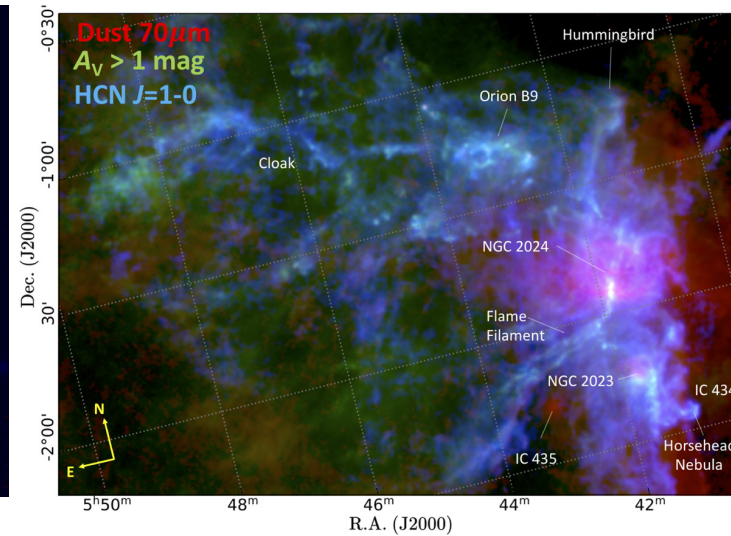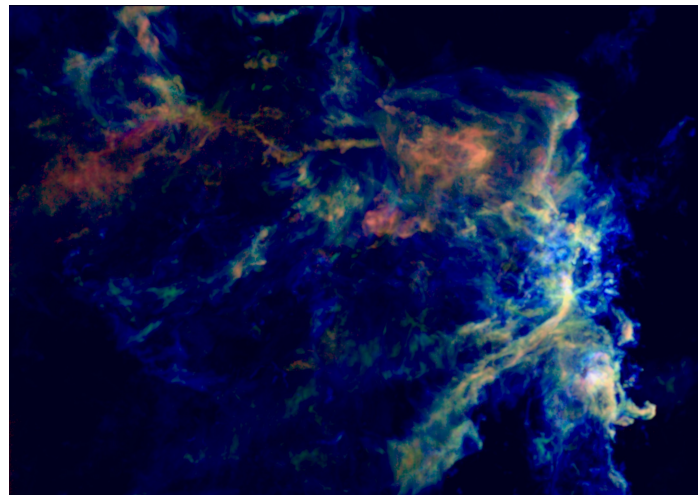
- ORION-B IRAM Program
  - Detailed study of a star forming GMC
  - Template for GMCs in galaxies

Santa-Maria+2023, Orkisz+2019
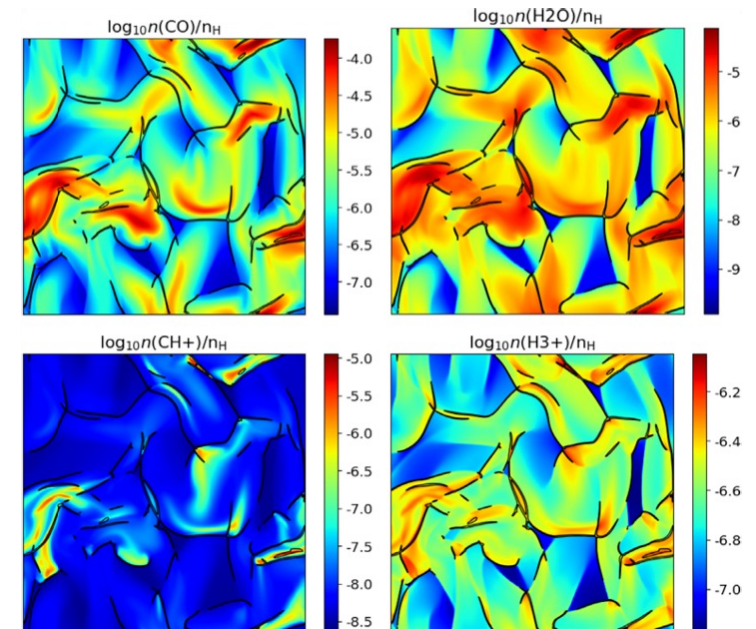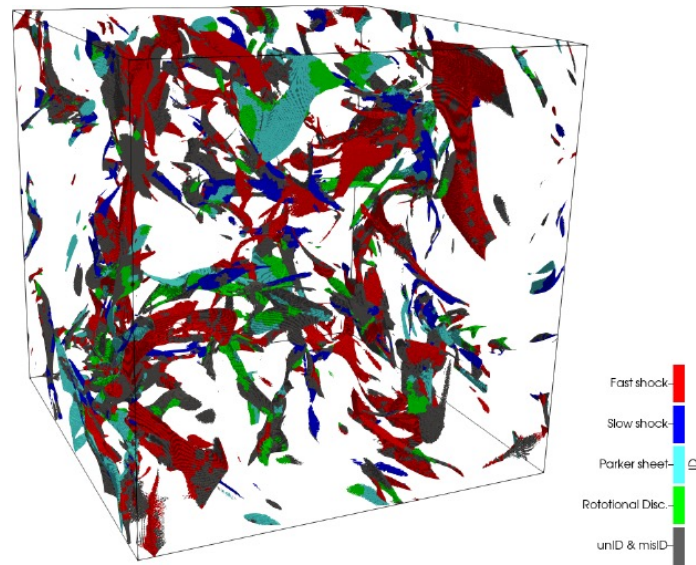
Lesaffre+2020, Richard+2022

- ▪ MHD Turbulence is
  - • Turbulence parameters, scaling laws, dissipative structures
  - • Turbulence & chemistry : molecule formation

Star formation
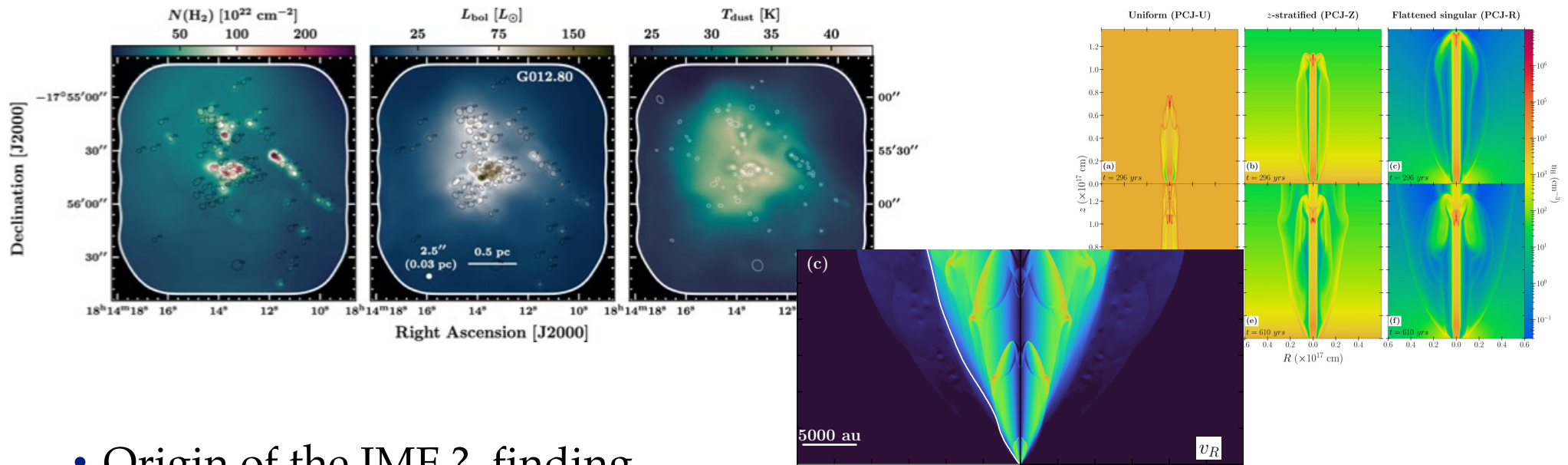
- Origin of the IMF ?, finding massive star progenitors
- Disks, jets and outflows
  - Interstellar heritage
  - Mechanical, radiative and CR feedback and

Tabone+2020, Rabenanahary+2022 , Armante+,
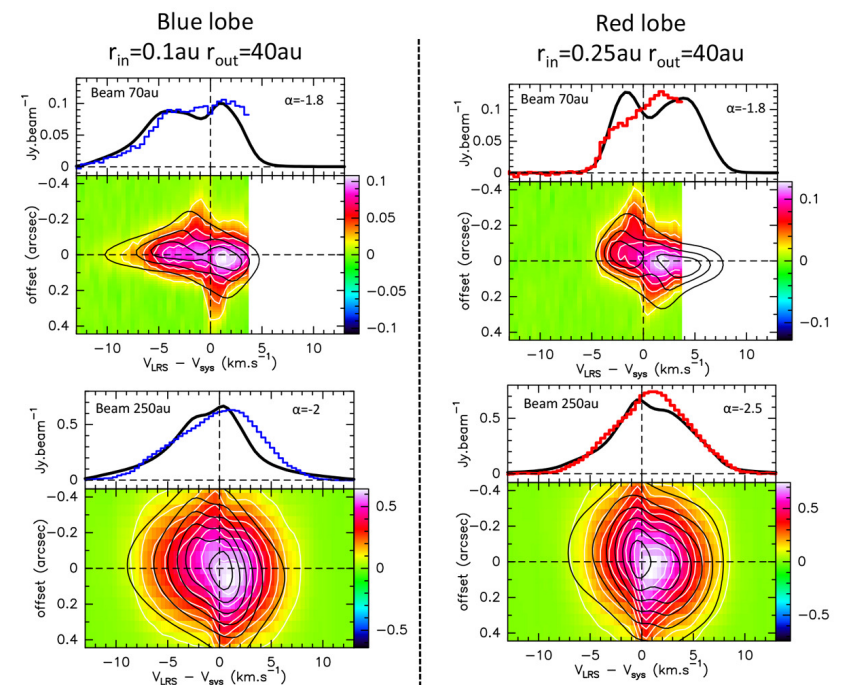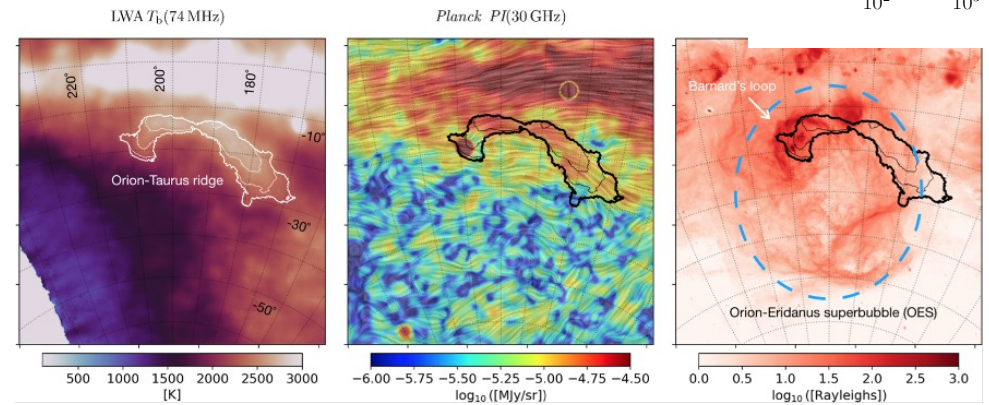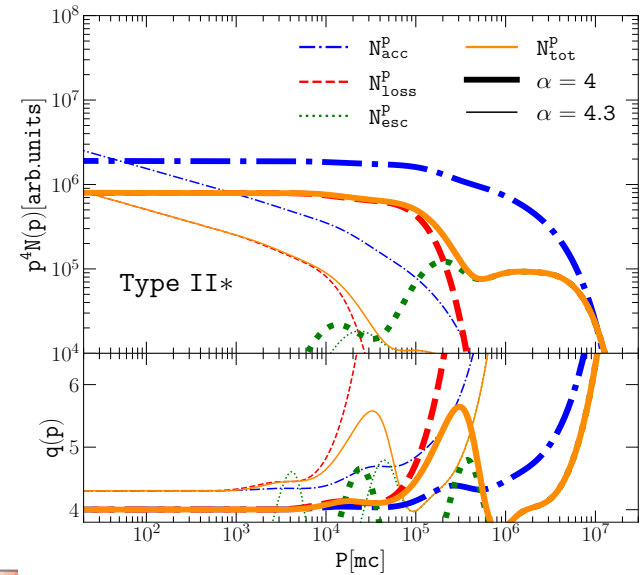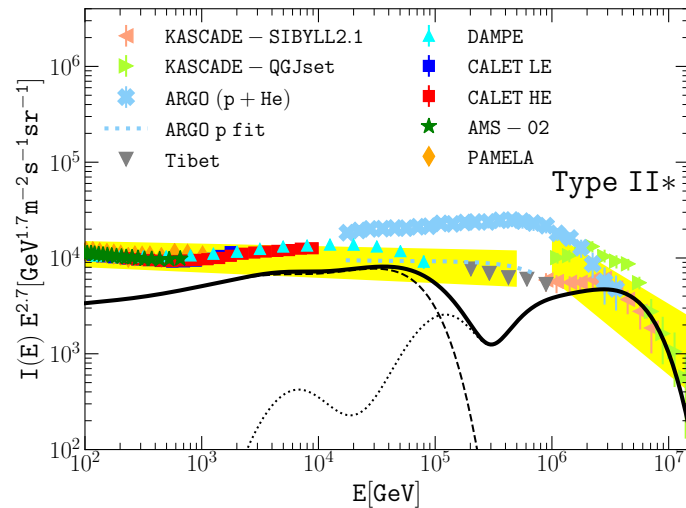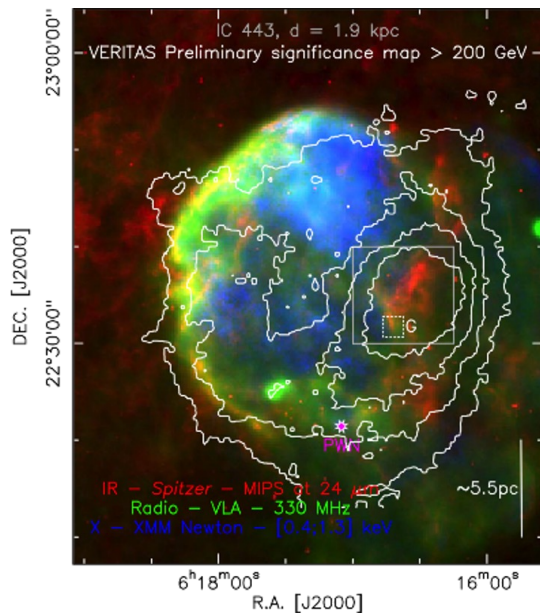
- Synchrotron radio loopA synchrotron radio-loop in the Orion-Eridanus superbubble
- Cosmic ray sources, CR acceleration & propagation

Bracco+2020,2022, Dell'Ova+, Cristofari+2020,2021

Physics of the multi-phase ISM

Multi-phase MHD numerical simulation Fielding+(2022)

$N\,[10^{20}\,\mathrm{cm}^{-2}]$

Dust polarization Planck data

Faraday tomography LOFAR data Bracco+(2020)

8 degrees

LOFAR primary beam
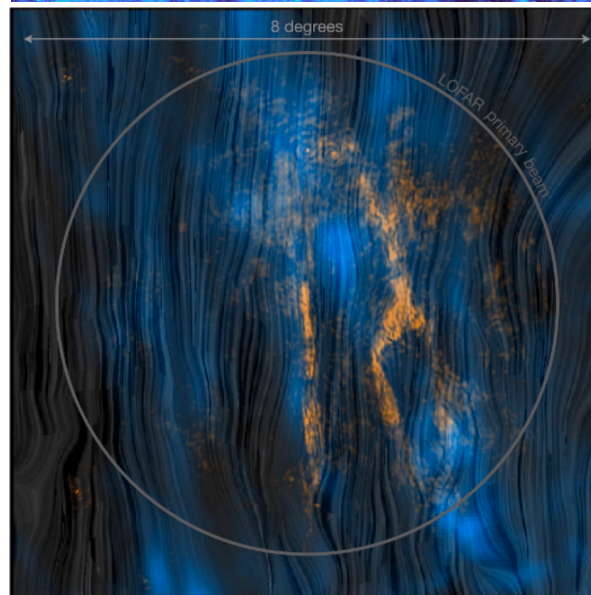
HI phase separation ASKAP 21 cm data Marchal+(2021)

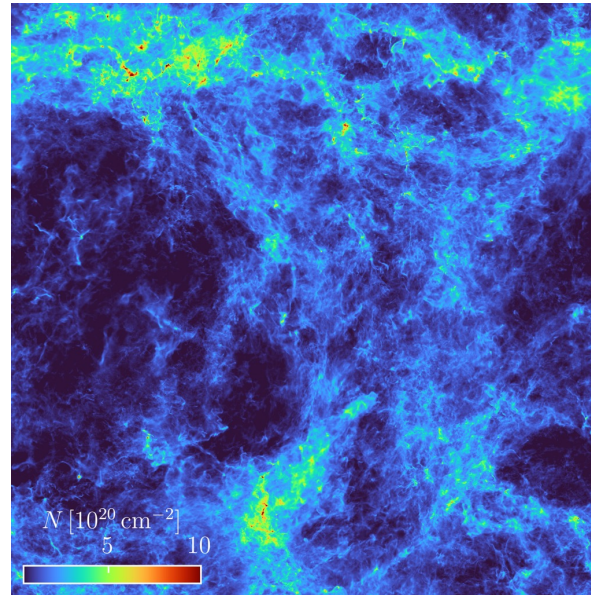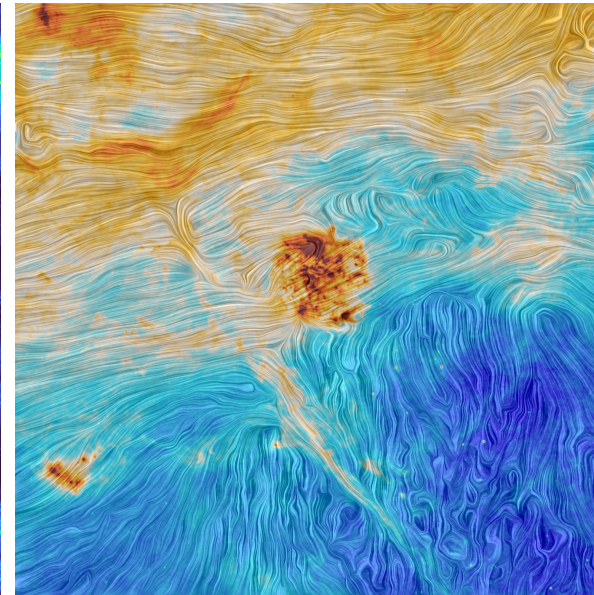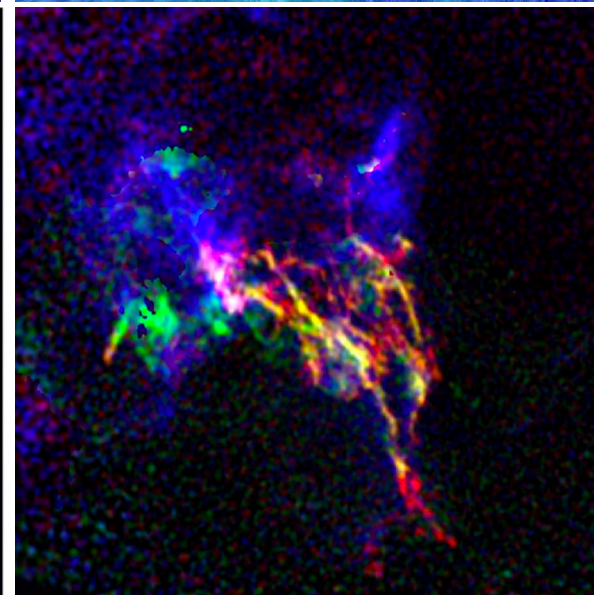**LPENS** : Marc-Antoine Miville-Deschênes, Jack Bérat, Andrea Bracco, Frances Buckland-Willis, Benjamin Godard, Erwan Allys, François Boulanger, Pierre Lesaffre, François Levrier…

Australia : GASKAP collaboration, Antoine Marchal, Noami McClure-Griffiths, Callum Lynn

USA : Susan Clarck, Joshua Peek…

column density
in diffuse clouds at high Galactic latitudes

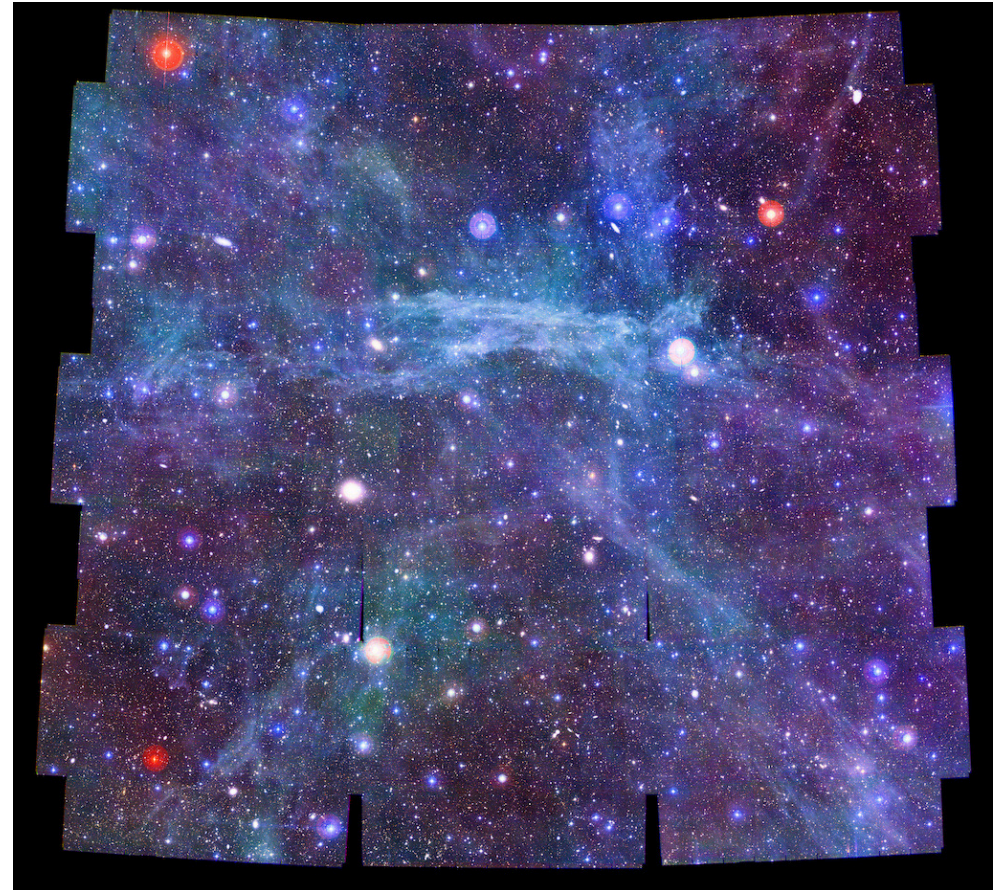Dust emission - Herschel SPIRE 250 micron
14" resolution

Scattered Light - CFHT MegaCam - g,r,i
1" resolution (Euclid 0.1")
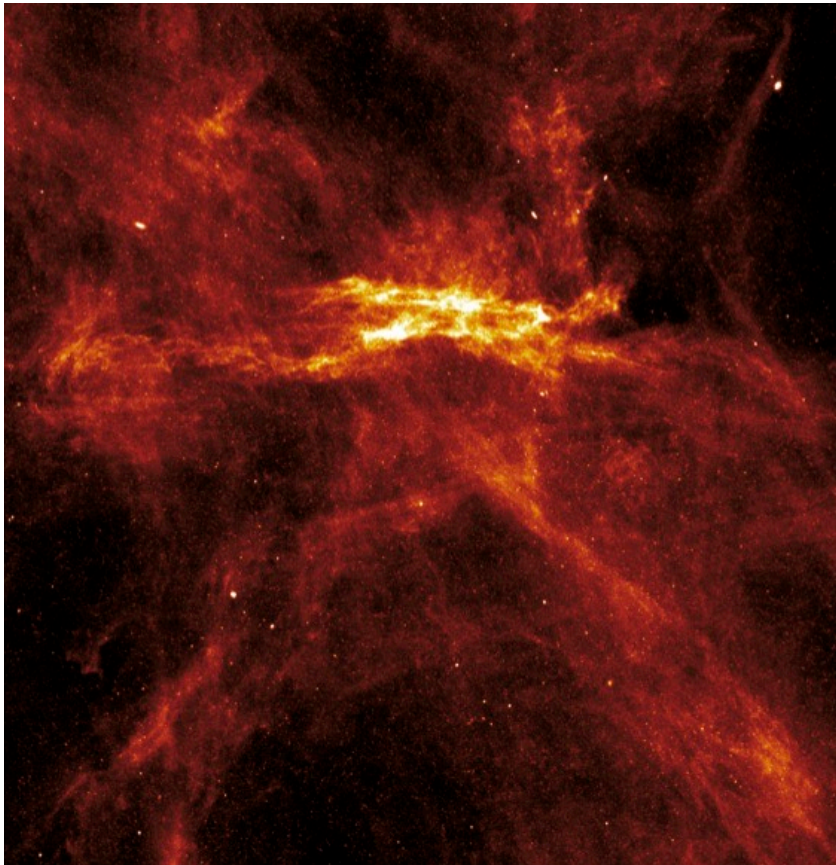
Scientific exploitation of UNIONS and Euclid data

Team : M-A Miville-Deschênes (LPENS), Nathalie Ysard (IRAP), Frederic Galliano (AIM),
Jean-Charles Cuillandre (AIM), Emmanuel Bertin (AIM)

- Many subjects for which an enhanced collaboration will be beneficial
- State of the art Numerical Codes, developed & improved for new applications
- Data analysis, extraction of physical information, interpretation
- Observation programs : from low radio frequencies to high energies

Merci de votre attention