Science @ CDS

CDS Scientific Council

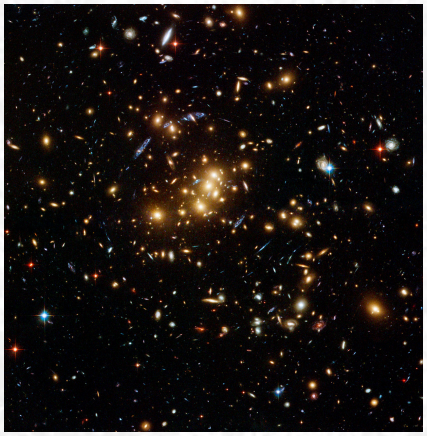
November 2023

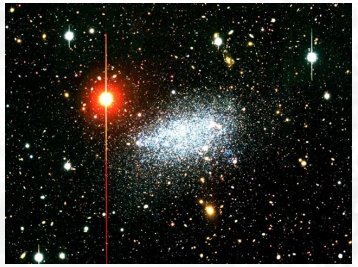
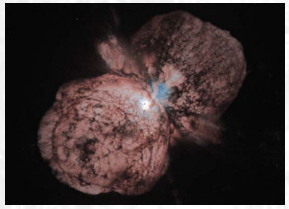
CDS content

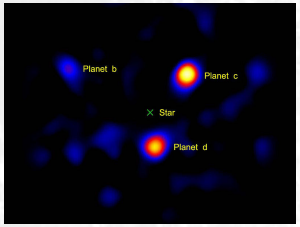
Observatoire astronomique de Strasbourg

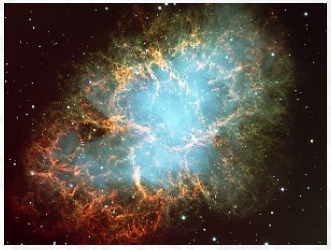
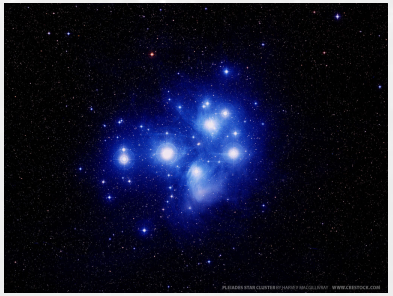
Science highlights, CDS council 2023

A wide variety of objects reflecting different scales in the universe



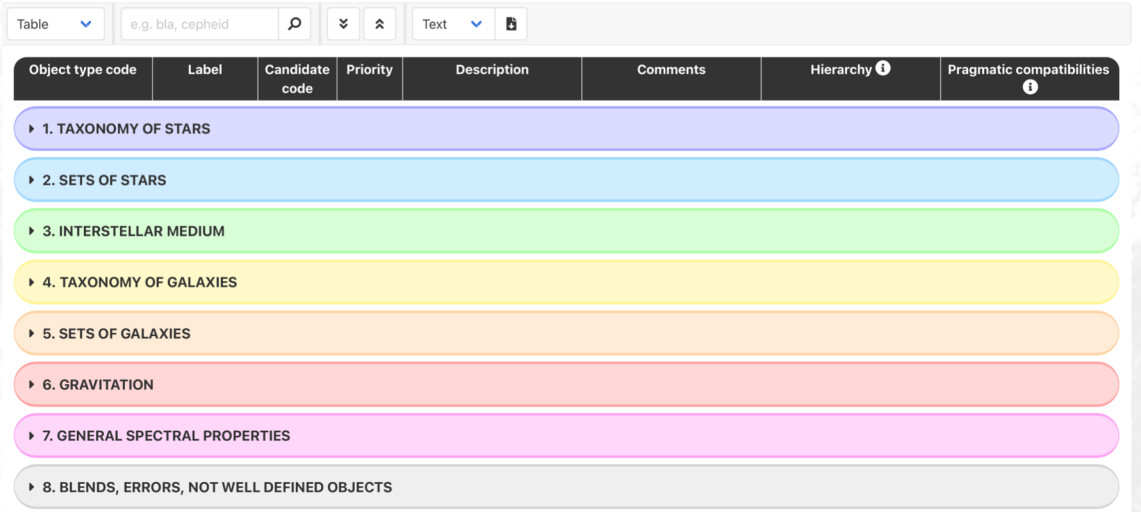



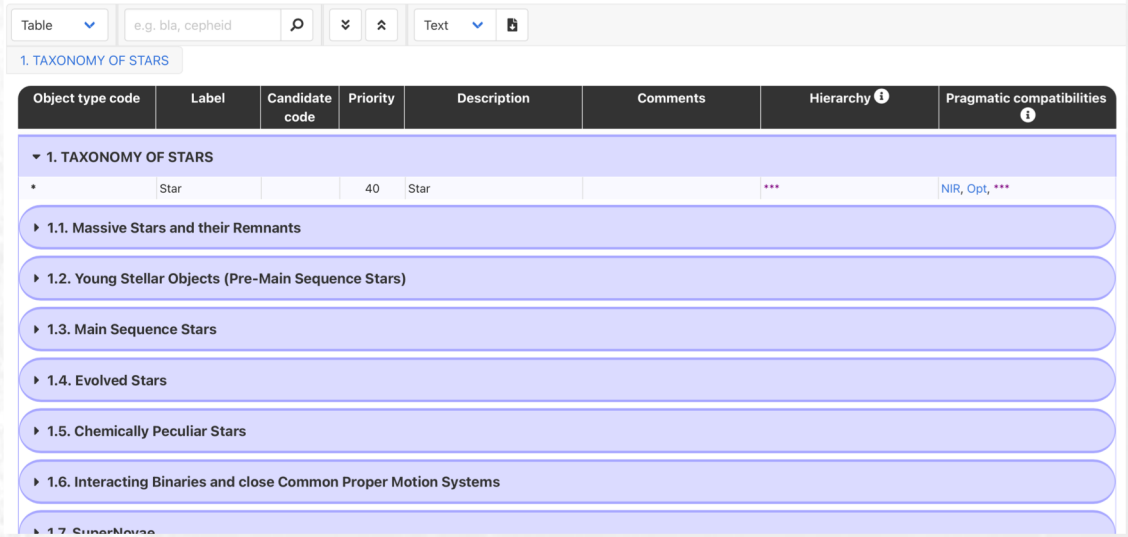
CDS content

Observatoire astronomique de Strasbourg

Science highlights, CDS council 2023

- over 200 object types in Simbad:
  - hierarchichal
  - multi-wavelength
  - Specialised
  - Based of physical properties and evolutionary stage
- Need for expert knowledge for data curation





CDS content

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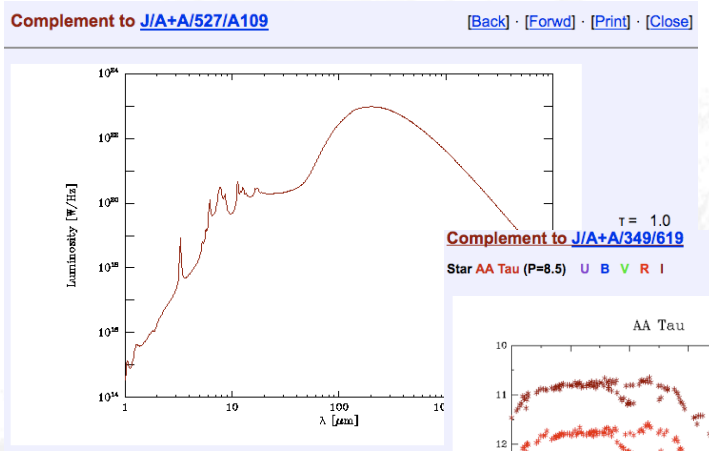
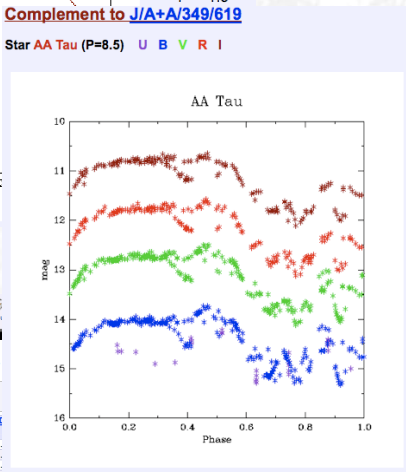
Science highlights, CDS council 2023

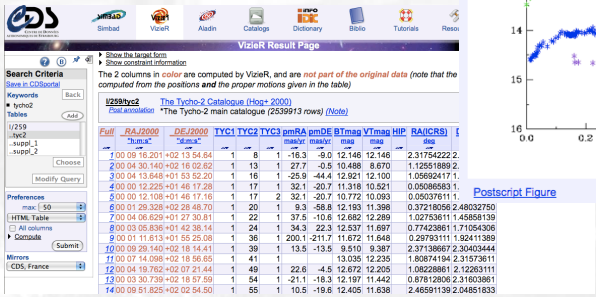
- variety in data types:
  - astrometry
  - photometry & fluxes
  - spectroscopy
  - time domain (ephemerides & light curves)

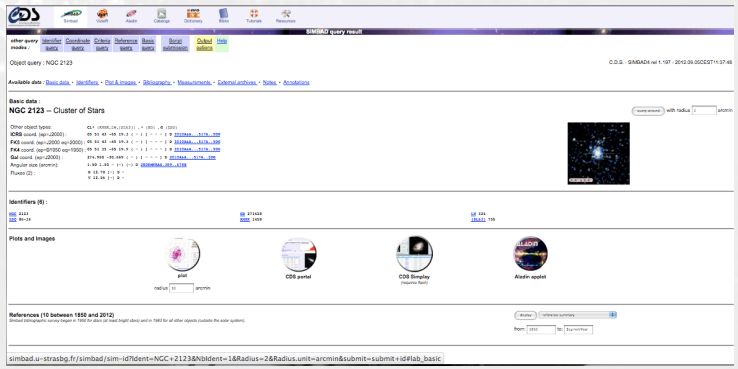
  ⇒ associated physics and techniques are different

  - individual objects
  - catalogues









A Science Team @ CDS

Observatoire astronomique de Strasbourg

- Variety of data ⇒ different techniques and different physics associated
- Amount of data produced by observations too large ⇒ a selection of important data must be made

⇒ data ingestion and curration must be “supervised” by specialists

- Need for a scientific team @ CDS to oversee these points

⇒ expertise within the team must cover as many aspects as possible

⇒ need for active scientists to follow the evolution of astronomy

⇒ intrinsically different from a standard science team

Expertise @ CDS

Observatoire astronomique de Strasbourg

Science highlights, CDS council 2023

Science Team:
- M. Allen
- C. Bot
- L. Cambresy
- S. Derriere
- A. Nebot
- C. Loup
- G. Monari
- P. Ocvirk
- A. Siebert
- B. Vollmer

Postdocs:
- Chengdong Li
- Anais Gonneau
- Pooja Sharma

PhD students:
- Mei Palanque
- Lucie Correia
- Thomas Oliveira

Expertise:
- stars & peculiar stars
- star formation
- ISM & Extinction
- Galactic dynamics
- physics of galaxies
- clusters of galaxies
- cosmology & reionisation
- numerical simulations
- catalogues
- data description and access

Participation in large projects

Observatoire astronomique de Strasbourg

Science highlights, CDS council 2023

- IVOA
- Euro-VO
- GINEA
- XMM2ATHENA

- SKA/NENUFAR
- PRIMA
- AtLAST
- VESTIGE

- WEAVE
- 4MOST
- Gaia

- Cosmic Dawn

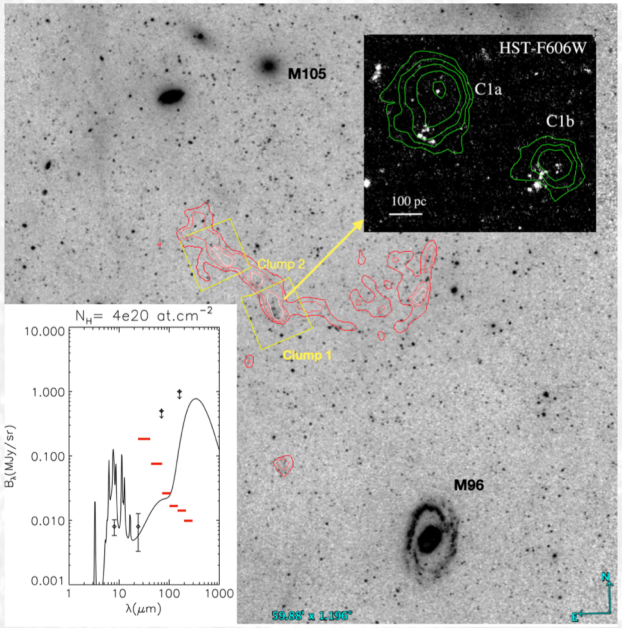
Science highlights, CDS counsil 2023

Future observations of dust in galaxies in the FIR and millimeter

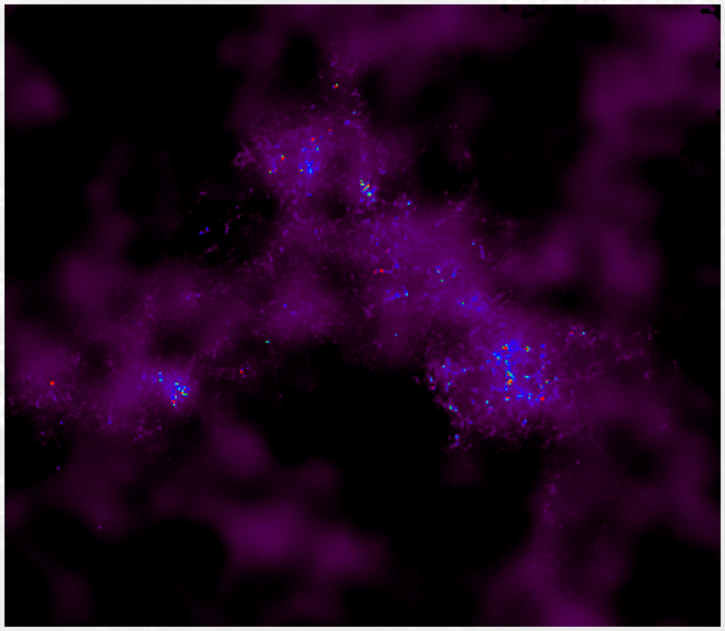
C. Bot

Observatoire astronomique de Strasbourg

- PRIMA is a project of FIR satellite for the next decade led by JPL with a French participation
  - Science case on dust in intergalactic clouds selected for the PRIMA General Observer Science Book



- AtLAST is a project of a 50m antenna for large field of view, sensitive millimeter observations
  - Science case on the Magellanic Clouds



Simulation of a 100GHz observation of the Small Magellanic Cloud

Millimeter to centimeter dust emission in nearby galaxies

L. Correia & C. Bot

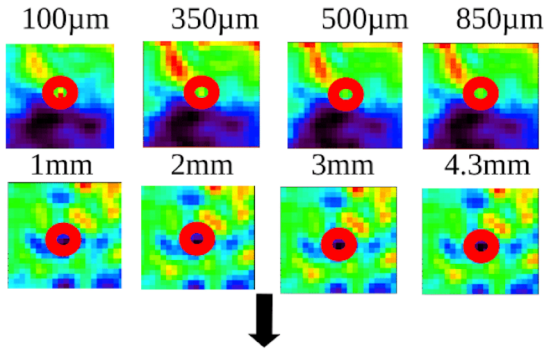
Observatoire astronomique de Strasbourg

Use of IRAS and Planck observations at 16' to study dust emission in mm-cm domain

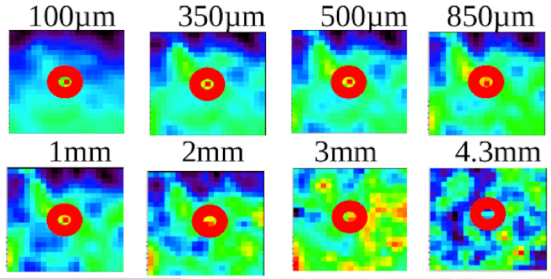
→ Need to subtract emissions from foreground and background sources dominating the emission of the galaxy observed at long ƛ

Example: NGC5194

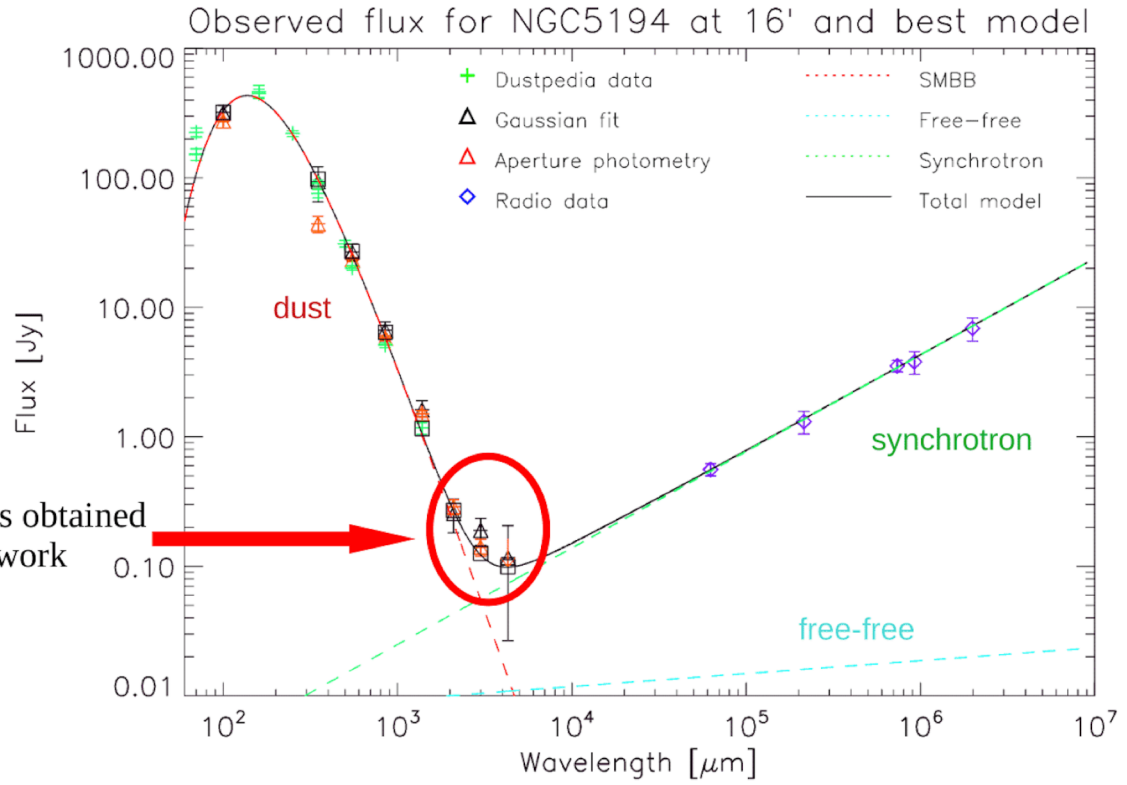
Before subtraction



After subtraction



New constraints obtained with this work

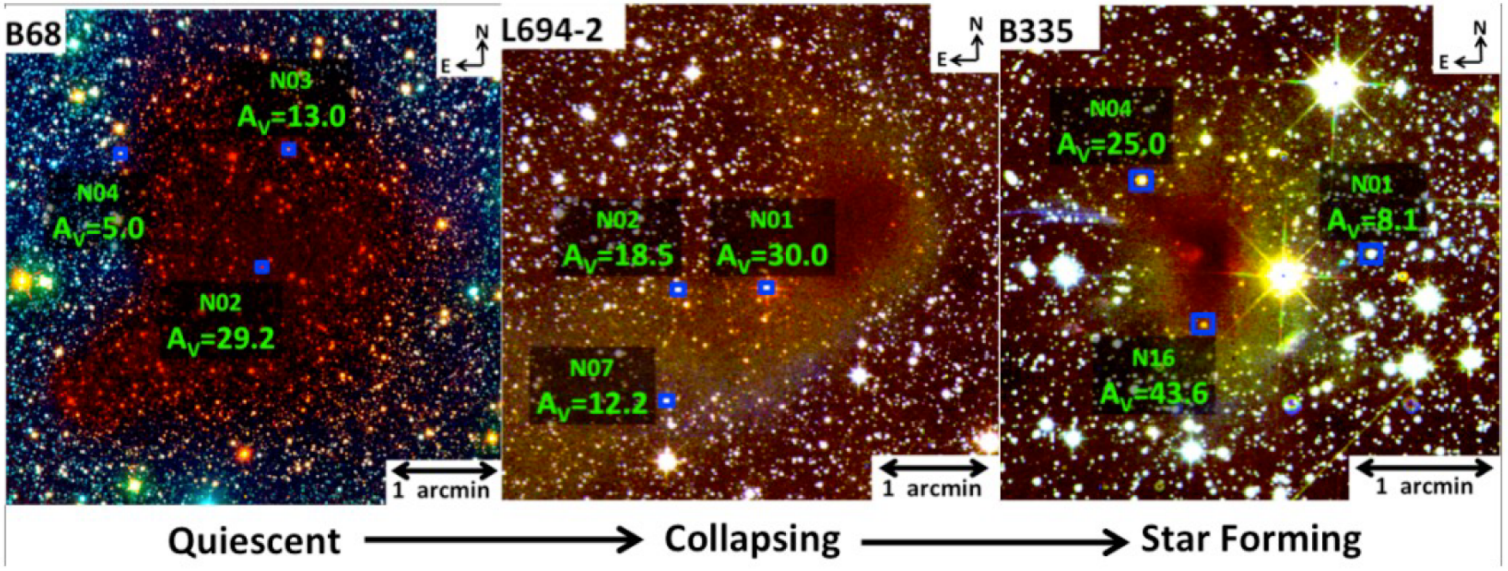


Unveiling Grain Growth in Very Dense Galactic Cores

L. Cambrésy

Observatoire astronomique de Strasbourg

- **JWST** MIRI 60 h, 4 channels from 5 to 28 µm (PI R. Paladini, IPAC/Caltech): observations completed, data processing in progress.
- 9 lines of sight in 3 cores presenting different stages in the evolution of star formation: to resolve the degeneracy between grain size, shape and porosity, in the interpretation of the dust optical properties (e.g. extinction curve flattening).



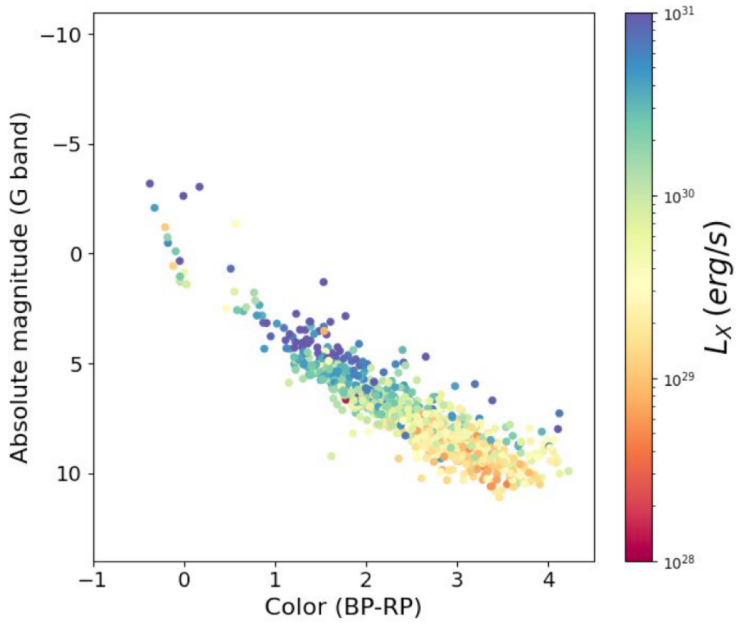
Blue squares: **targets**

Images: B,I,K (ESO), or J,H,K (UKIRT)

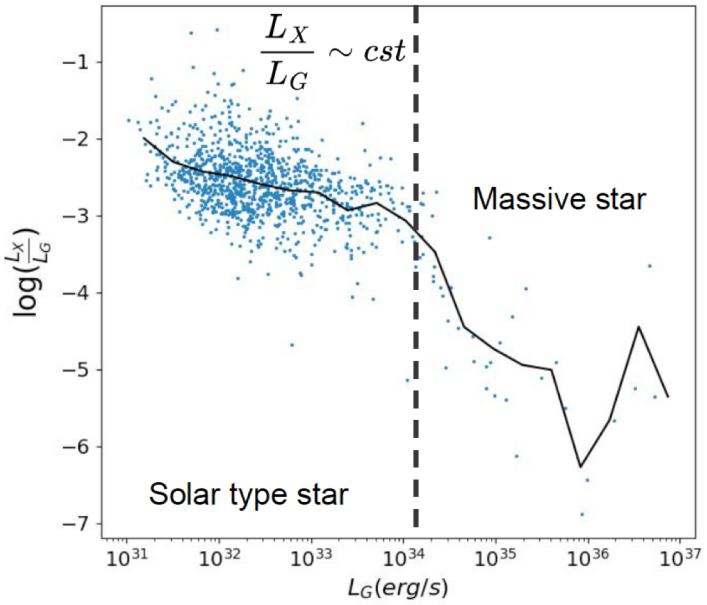
Study of YSO in Orion with XMM and Gaia

T. Oliveira, A. Nebot, L. Cambrésy

Observatoire astronomique de Strasbourg



Relationship between mass and X-ray luminosity



Points toward 2 different X-ray emission mechanisms

First step characterizing X-ray emission with stellar parameters (age,mass,...)

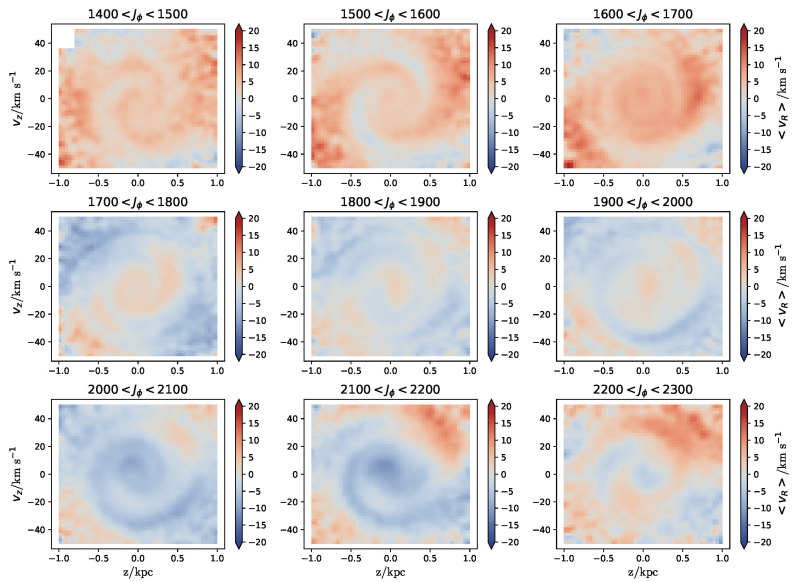
The Galactic disc features generating by a decelerating bar

C. Li - A. Siebert - G. Monari & Coll

Observatoire astronomique de Strasbourg

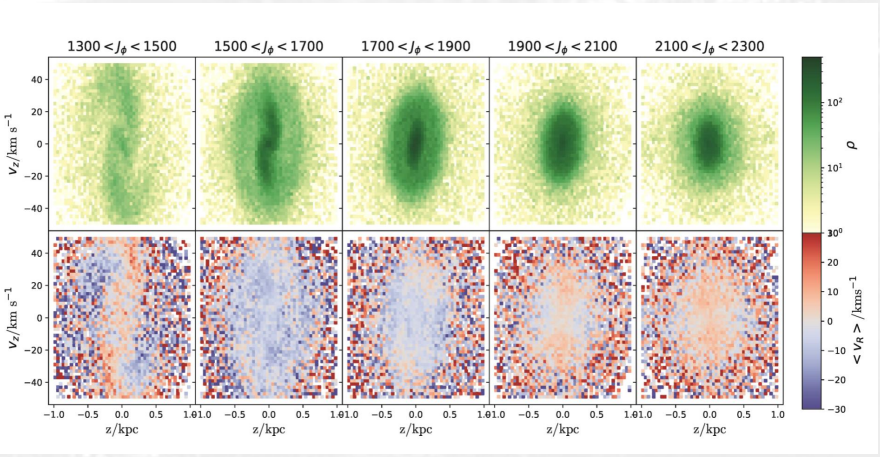
Science highlights, CDS counsil 2023

1. The origin of 2-armed phase space spiral pattern (Li et al. 2023a, MNRAS,524.6331L)



$\langle v_R \rangle (z, v_z)$ map for stars in Gaia DR3 RVS sample, 2-armed spiral patterns seen inner disc while 1-armed in outer disc

We carry out a simulation to model the response of the disc to internal plane-symmetric perturbation by the bar



Particles at T=3Gyr for decelerating bar in $z - v_z$ plane with 2-armed spiral patterns

The Galactic disc features generated by a decelerating bar

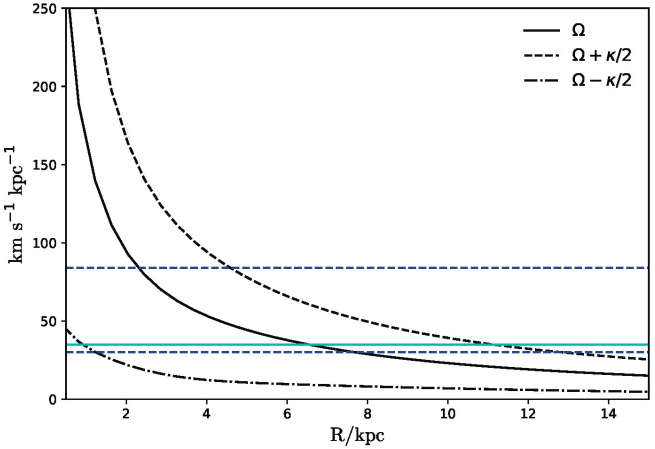
C. Li – G. Monari – A. Siebert & Coll

Observatoire astronomique de Strasbourg

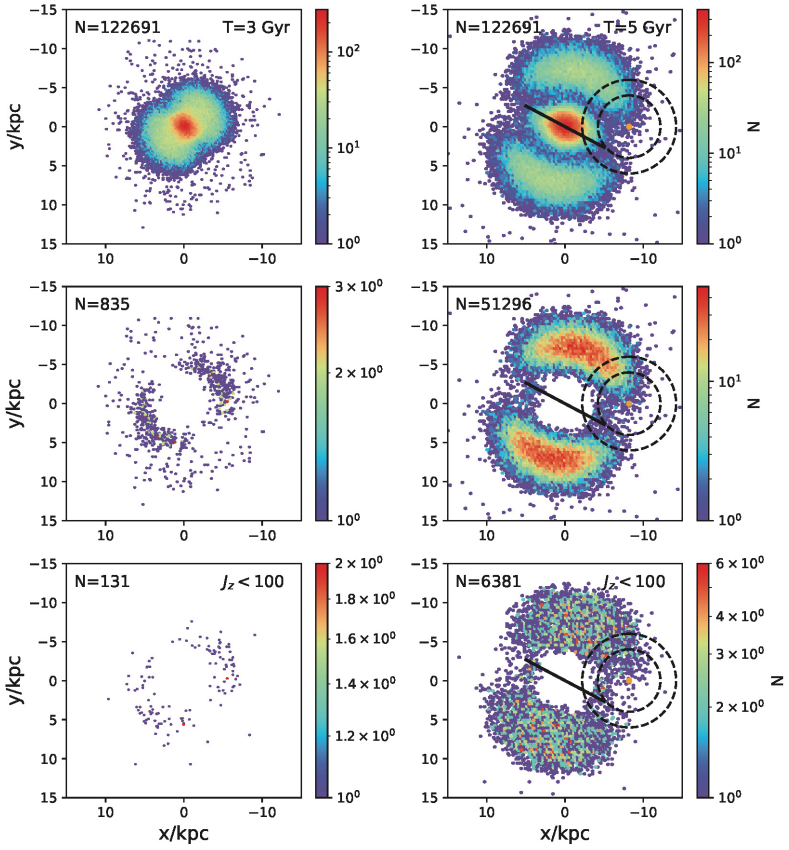
Science highlights, CDS counsil 2023

2. The origin of the kinematically prograde metal poor stars (Li et al. 2023b, in preparation)

A simulation is run to test if the prograde metal poor stars are brought outwards from the inner Galaxy by the bar



Initial and final pattern speeds versus frequencies showing the change of co-rotation radius of the bar

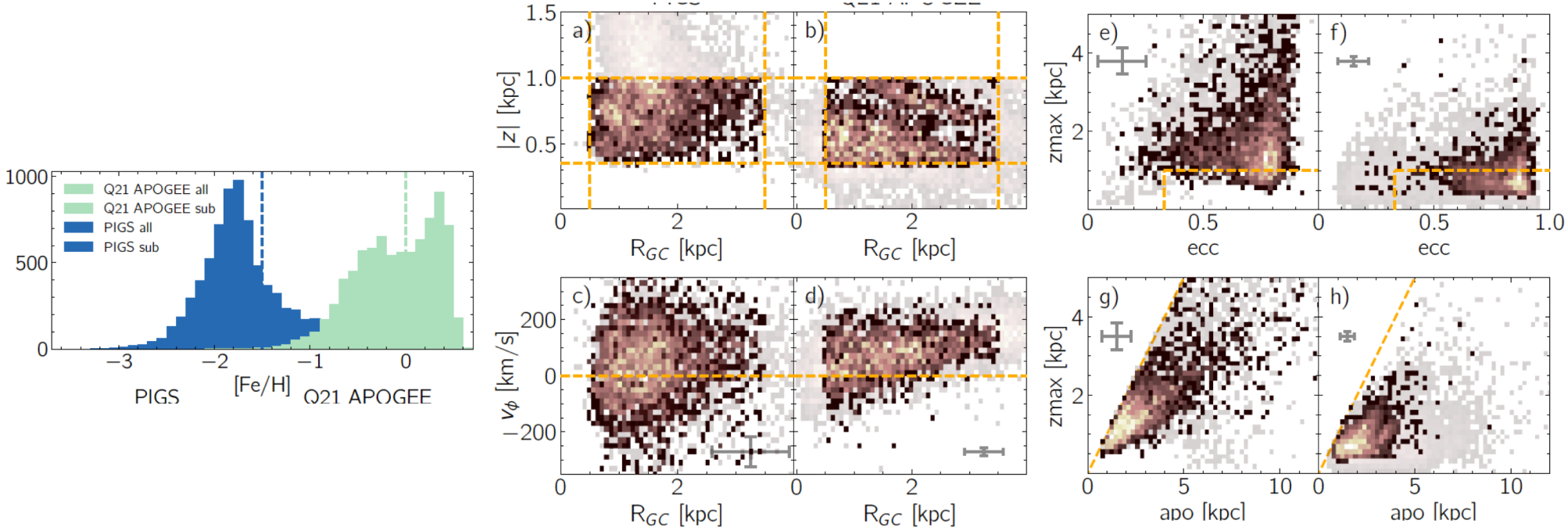


T=3 & 5Gyr for the particles with [Fe/H]<-2.5 under a decelerating bar: all in the upper, $J_\varphi > 1000$ in the middle, and $J_\varphi > 1000 \& J_z < 100$ in the lower panel

Orbits of the ancient very metal-poor inner Milky Way

G. Monari

Observatoire astronomique de Strasbourg



- Spectroscopic data from the Pristine Inner Galaxy Survey (PIGS) (Arentsen+ 20)
- PPMs and distances from Gaia/StarHorse (pretty uncertain, stars in the inner MW)
- Orbits integrated in a state of the art potential of MW with a bar (Sormani+ 22)
- Very Metal Poor stars (VMPs) from PIGS behave more like a pressure supported pop. than more metal rich APOGEE stars in the inner Galaxy.

Deciphering the radio-star formation correlation on kpc scales.
II. The integrated infrared-radio continuum and star formation-radio continuum correlations
B. Vollmer et al. 2022

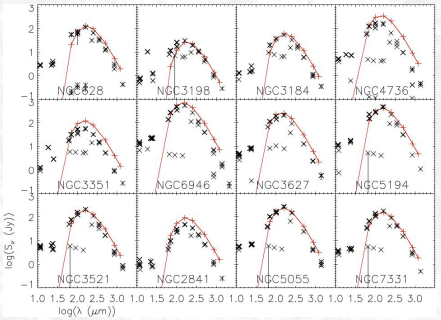
Observatoire astronomique de Strasbourg

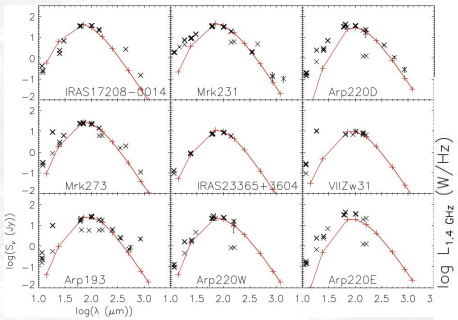
Science highlights, CDS counsil 2023

Local spiral galaxies

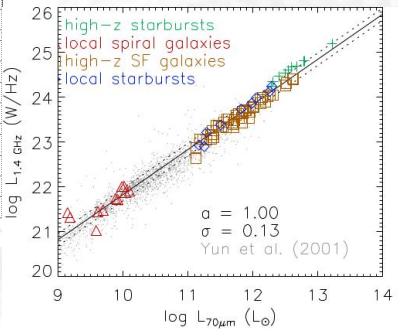
Ultraluminous infrared galaxies

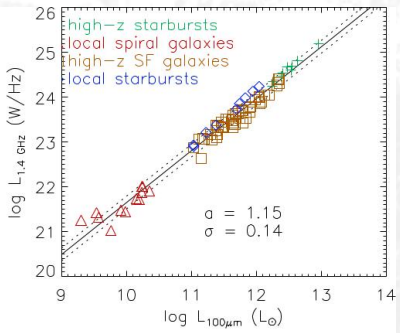
IR





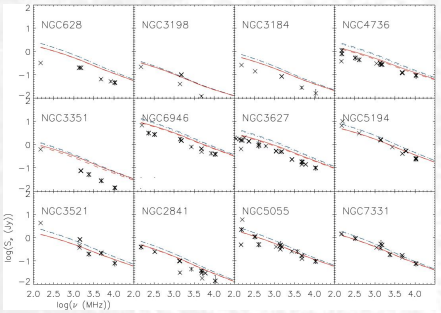
model radio – infrared correlations

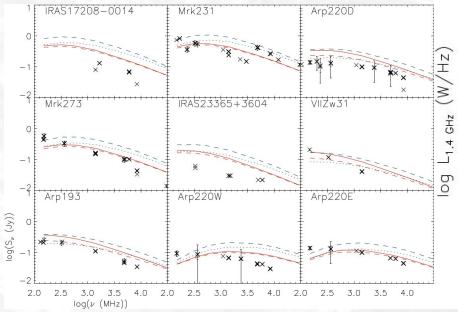


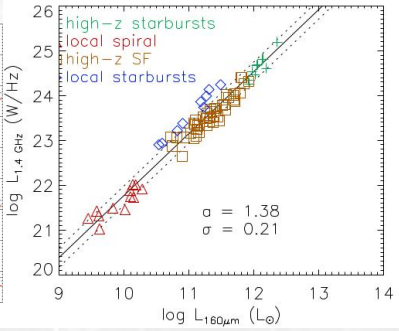


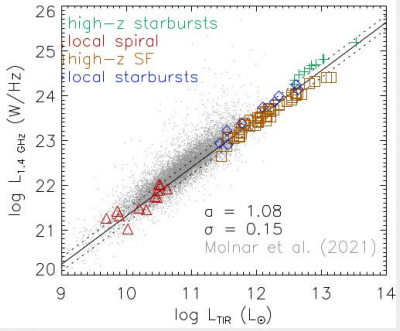
models + observations

radio









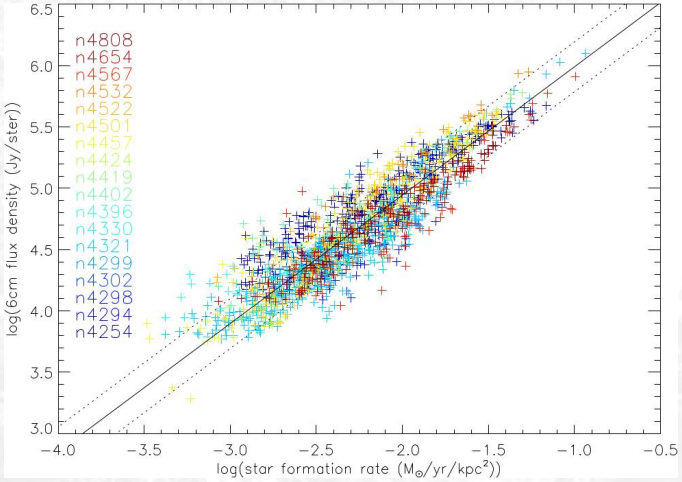
1. Equipartition between magnetic field and turbulent energy densities holds
2. Inverse Compton losses not important in starsburst galaxies because of higher turbuent velocity dispersions

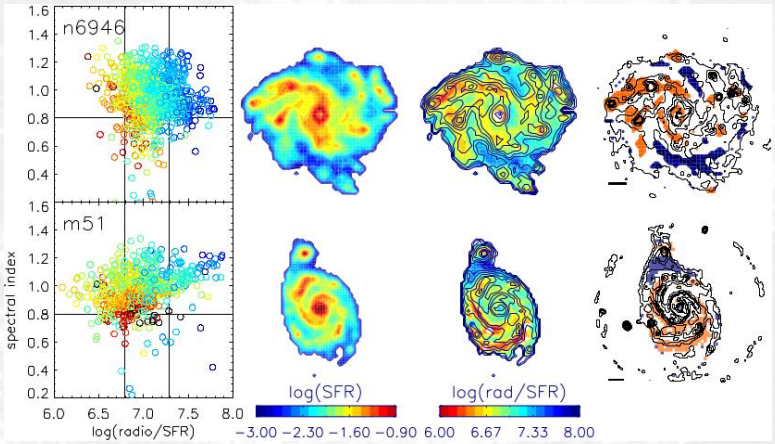
Deciphering the radio-star formation correlation on kpc scales.
III. Radio-dim and bright regions in spiral galaxies
B. Vollmer et al. (2023)

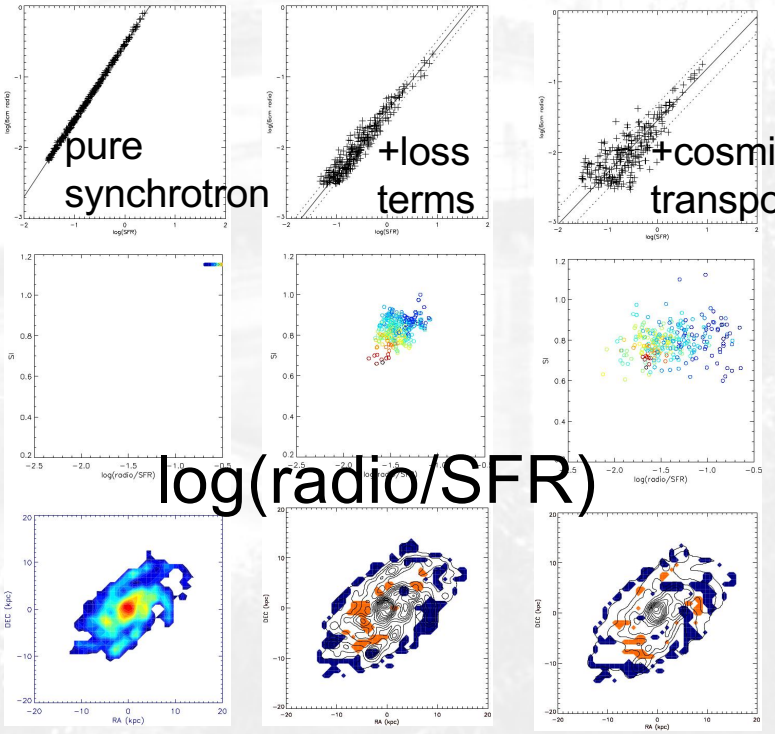
Observatoire astronomique de Strasbourg

Science highlights, CDS counsil 2023

1. Magnetic field is enhanced and ordered by these ISM compression and shear motions
2. Correlation between the polarized radio continuum emission and the radio/SFR ratio





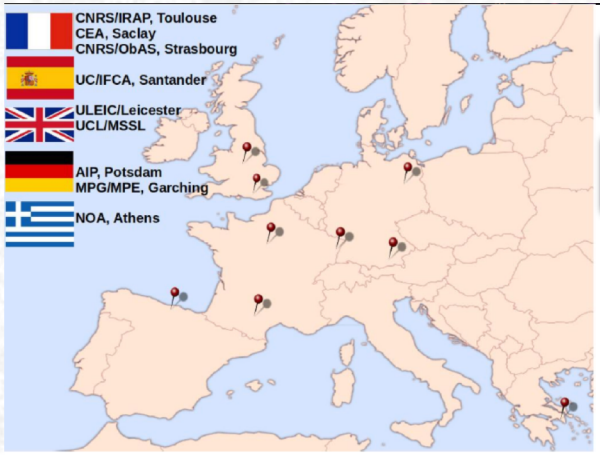


blue: radio-bright;
red: radio-dim

4XMM DR13 & XMM2ATHENA
A. Nebot & P. Sharma

Observatoire astronomique de Strasbourg

Science highlights, CDS counsil 2023



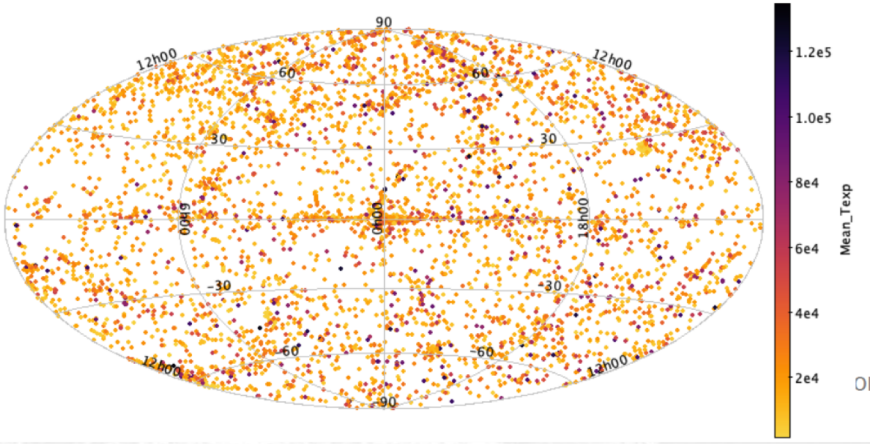
WP1 Administration	WP2 Multi-wavelength counterparts	WP3 Sensitivity estimator	WP4 Enhanced stacked catalogue	WP5 Variability
WP6 Spectra	WP7 opt / UV classification	WP8 X-ray classification	WP9 Science	WP10 Communication

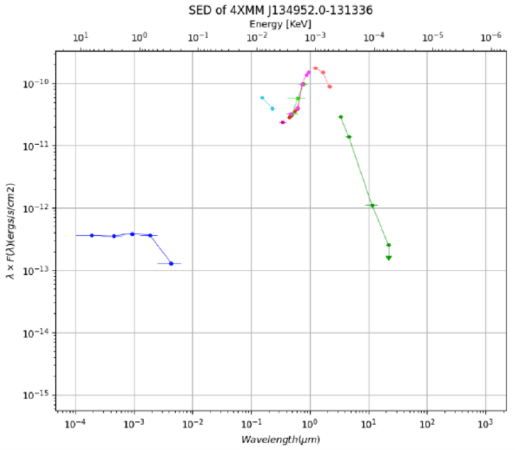
ObAS **Ada Nebot**, F-X Pineau, P. Maggi, L. Michel, C. Motch (emeritus), O. Marchal

Pooja Sharma (postdoc)

4XMM-DR13 Catalogue

- About 10^6 detections for > 650 000 unique sources covering ~ 1328 deg^2
- We provided multi-wavelength statistical identifications and SEDs (from X-ray to radio) for ~200 000 sources

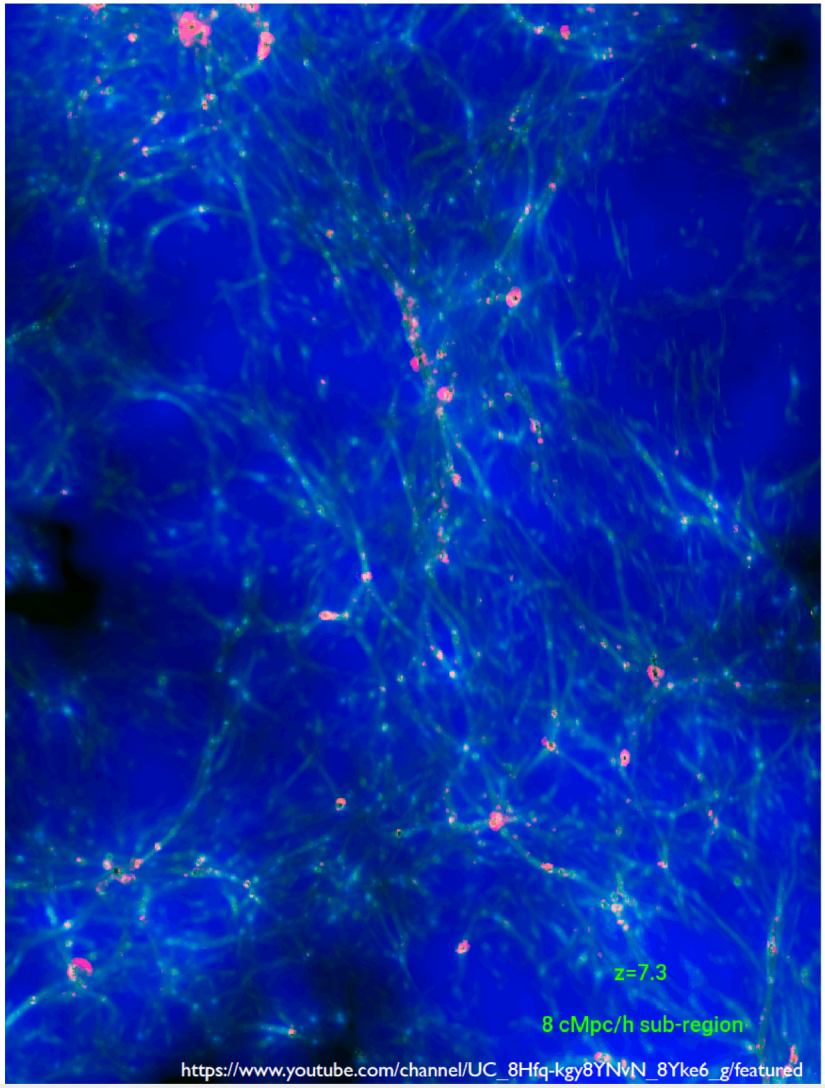




Galaxy Formation during the Epoch of Reionization
P. Ocvirk

Observatoire astronomique de Strasbourg

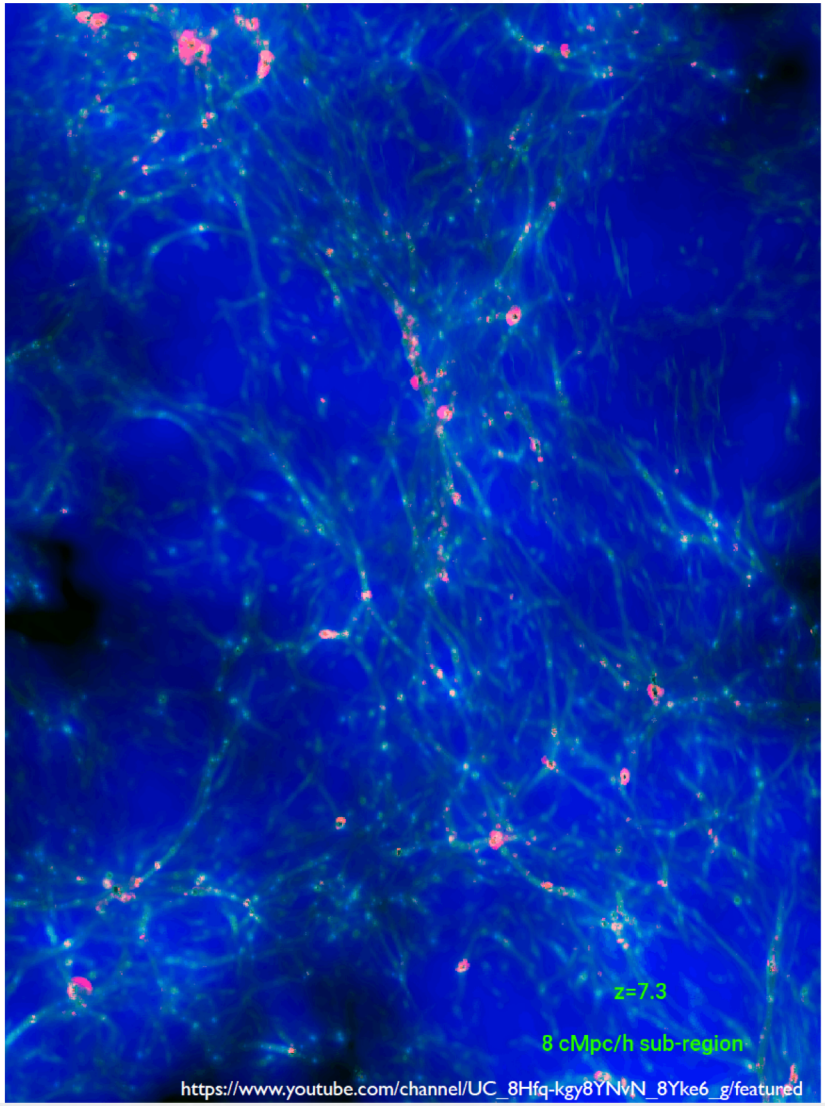
- PI of Cosmic Dawn III, Radiation-hydrodynamical sim of galaxy formation during the EoR, completed in Feb. 2021 on Summit (Oak Ridge National Laboratory). Topics include:
  - Galaxy populations, impact of rad. feedback, high-z luminosity functions
  - Calibration of sub-grid models for 21cm predictions
  - Lyman-alpha transmission in high-z IGM through EoR
- Produced 20 PB of data in 10 days
- uses Hybrid CPU/GPU computing.
- Member of SKA and NenuFAR science team



Galaxy Formation during the Epoch of Reionization
P. Ocvirk

Observatoire astronomique de Strasbourg

- PI of Cosmic Dawn simulation project
- Giant Radiation-hydrodynamical sim of galaxy formation during the EoR:
  - high-z luminosity functions
  - Calibrations for 21 cm modeling
  - Lyman-α forest through EoR's end
- ~20 PB of data in analysis
- uses Hybrid CPU/GPU computing
- Supervisor of PhD M. Palanque: new methods for radiative transfer in astro
- Member of SKA and NenuFAR science team



Limits of the current M1 radiative transfer model M1 compared to the spherical harmonics model Pn

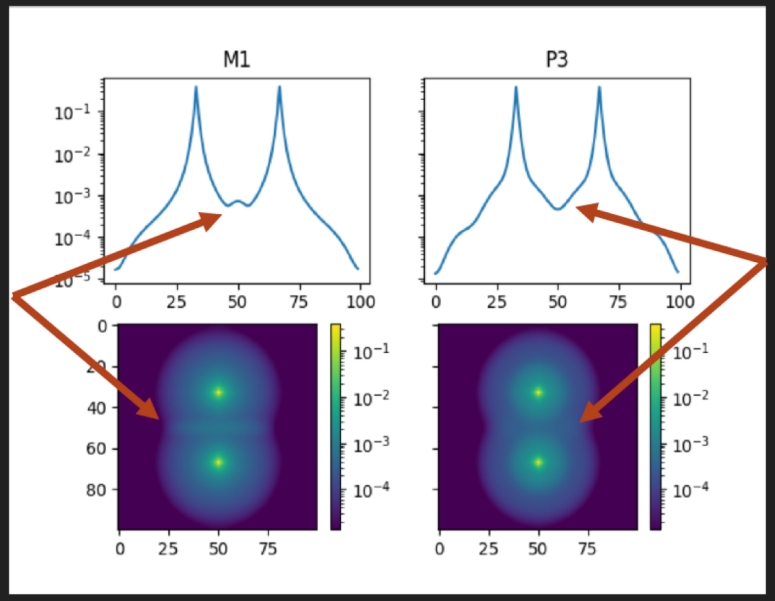
M. Palanque & P. Ocvirk

Observatoire astronomique de Strasbourg

Pn doesn't create pseudo sources when two fronts collide

Continuous response comparison profiles of 3D M1 and P3

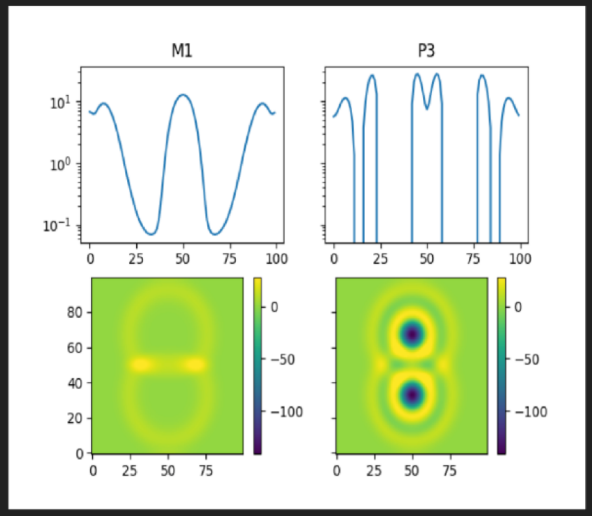
Apparition of a pseudo source when the fronts collide



No pseudo source

Pn has a bad response to impulses and can output negative energy

Pulse response comparison profiles of 3D M1 and P3



Limits of the current M1 radiative transfer model M1 compared to the spherical harmonics model Pn

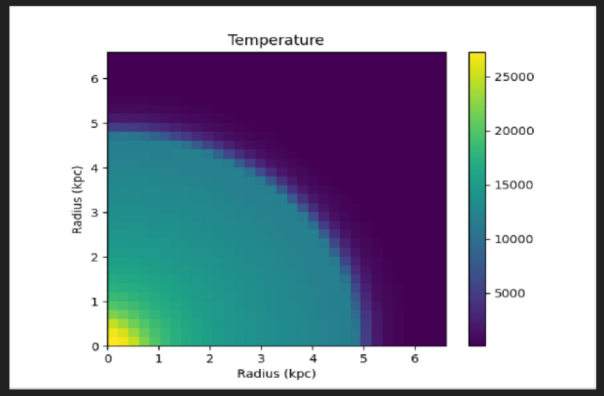
M. Palanque & P. Ocvirk

Observatoire astronomique de Strasbourg

Hydrogen Chemistry comparison

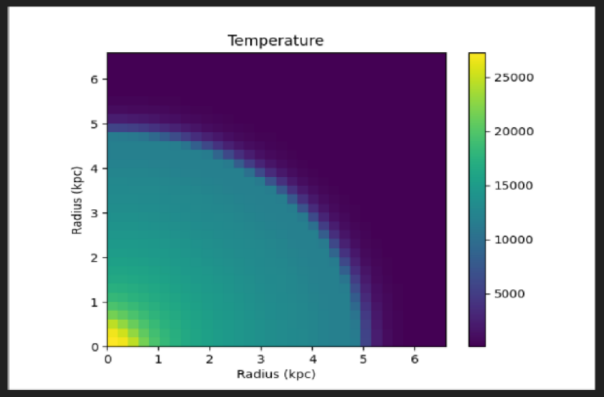
Stromgren Sphere around a continuous source after 100 MY of emission

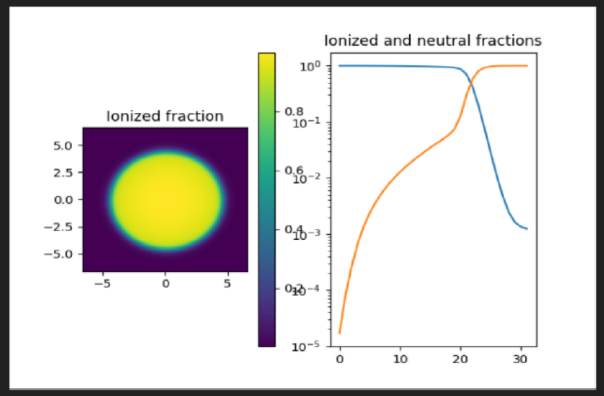
M1



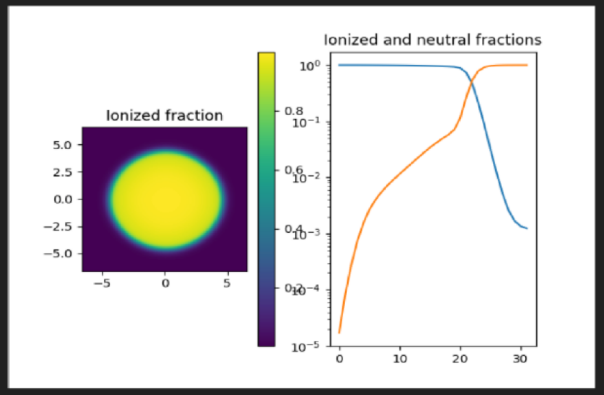
Temperature

P5





Fraction of the hydrogen ionized by the continuous source



Summary

- The scientific team @ CDS covers a wide range of expertise
  - different from a standard scientific group
  - linked to the needs of the different services
  - important to foresee the needs of the astronomical community
- Implication in many large projects, ongoing or planned
- Scientifically active researchers