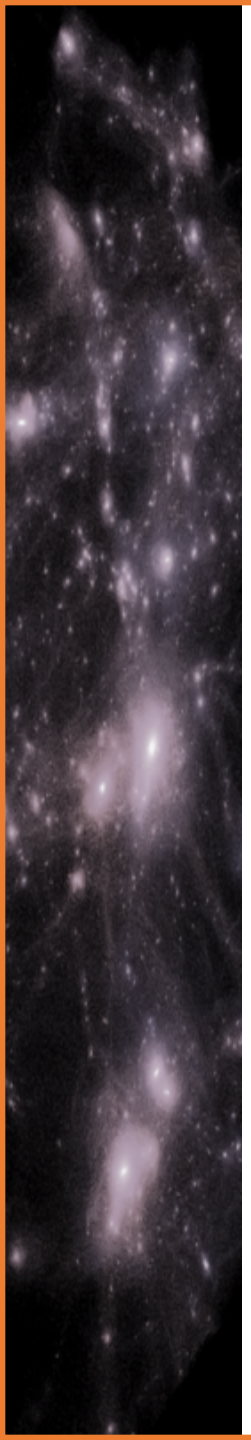
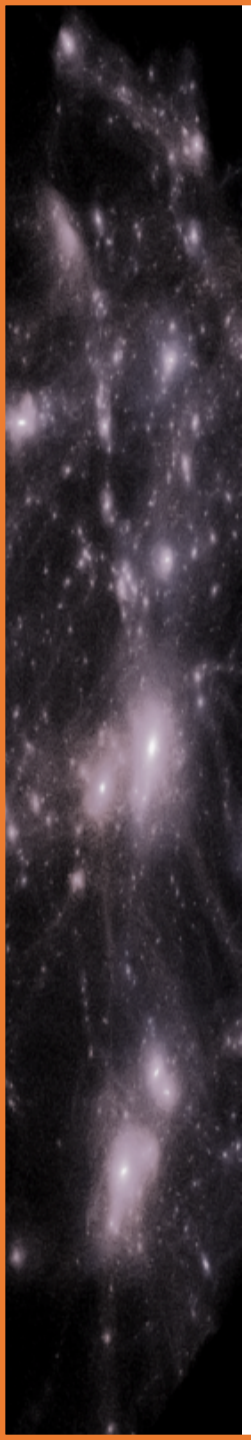
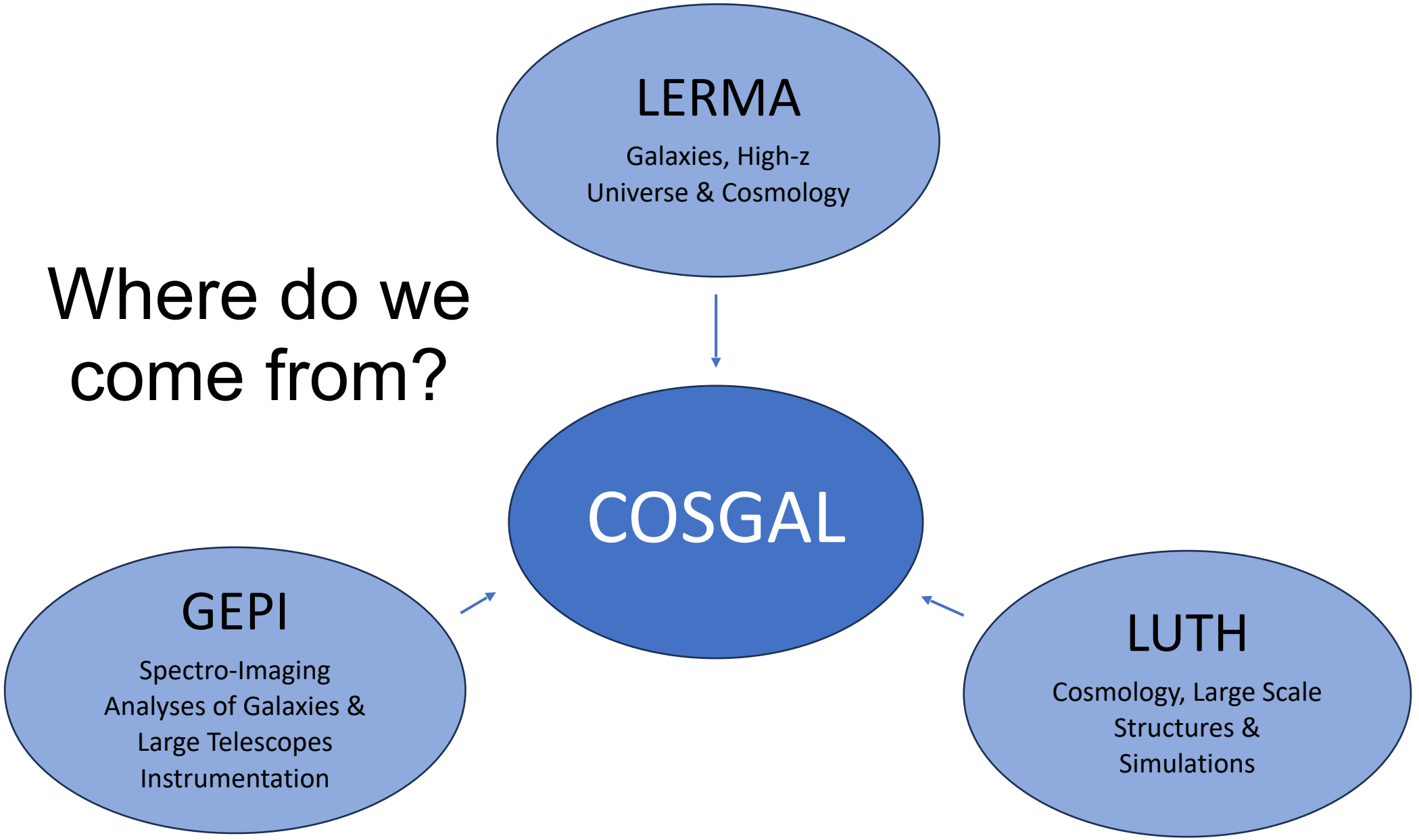
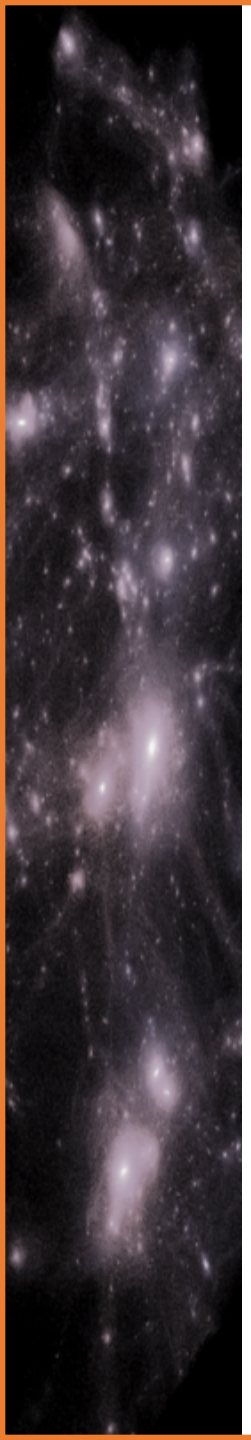


COSGAL Group



Where do we come from?





Organigram

Researchers

Alimi, J.M.
Cattaneo, A.
Combes, F.
Corasaniti, P.S.
Flores, H.
Hallé, A.
Huertas, M.
Le Brun, A.
Martin, J.M.
Melchior, A.L.
Puech, M.
Rasera, Y.
Salomé, P.
Semelin, B.
Tasse, C.
Trebitsch, M.
Valls-Gabaud, D.

Research Engineers

Ba, Y.A.
Corioni, M. (CDD)
Doussot, A.
Moreau, N.
Sainton, G.

Emeritus

Lestrade, J.F.
Van Driel, W.
Viallefond, F.

Postdocs

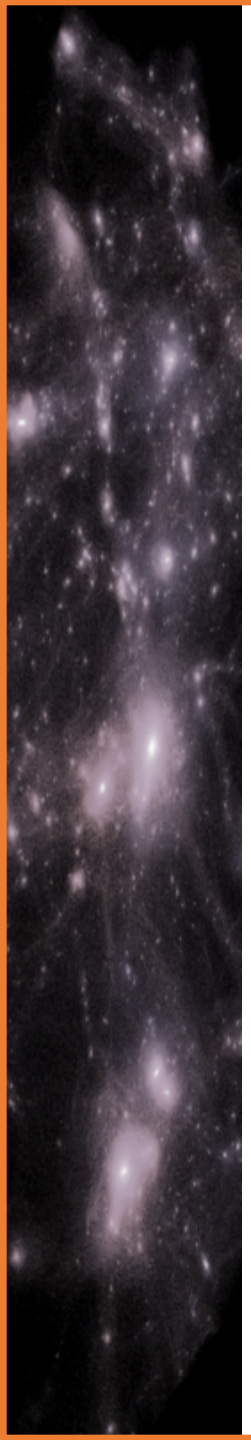
Beslic, I.
Cornu, D.
Ganjoo, H.
Mertens, F.

PhD

Cologni, R.
Gayoux, T.
Luke, K.
Meagher, N.
Shaji, A.A.
Tornatore, F.

Sites:
Paris & Meudon Campus

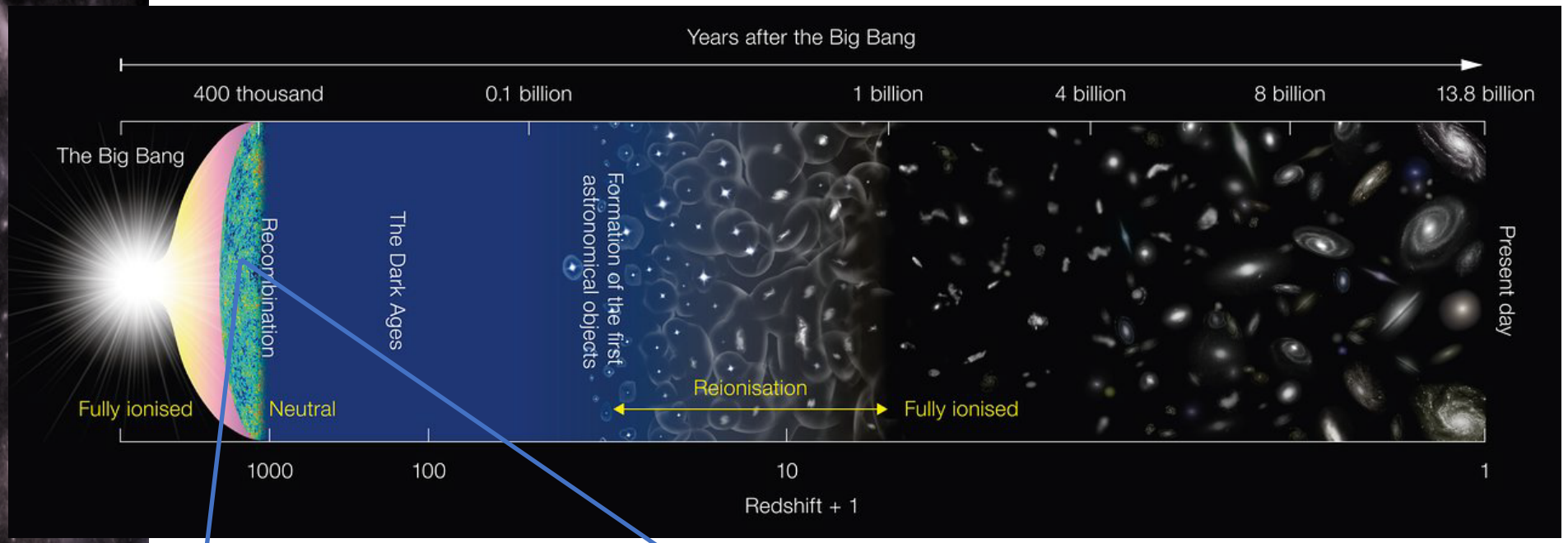
Total #: 35
(Comparable to INSU's groups in Ile-de-France)

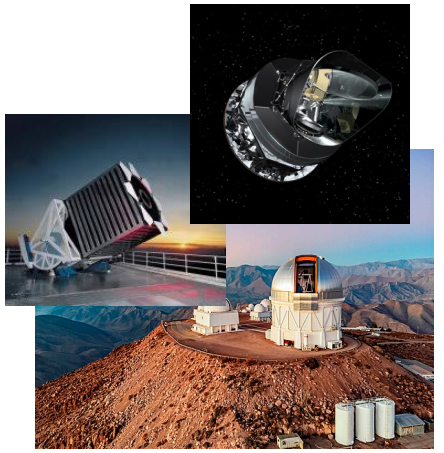


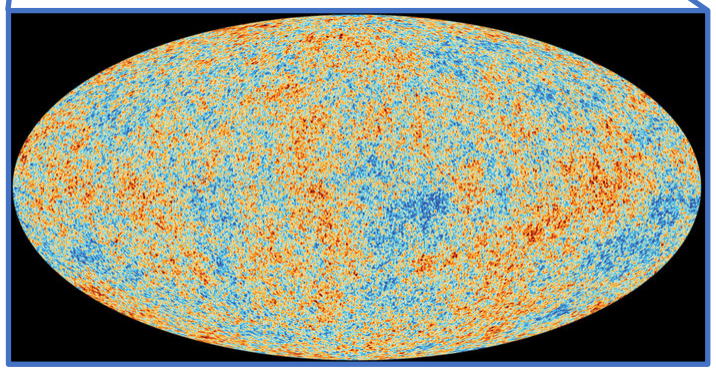
Keywords

Observations
AGN
Theory
Spectra
Clusters
Large Scale Structures
Interactions
Cosmology
Galaxies
Dwarfs
Stochemistry
Dark Matter
Dark Energy
Formation & Evolution
Surveys
Simulations
N-body
Radio
Machine-Learning
Hydro
Spectro-Imaging

Context



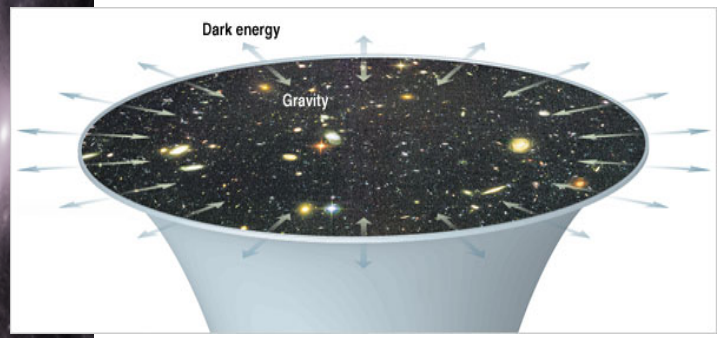


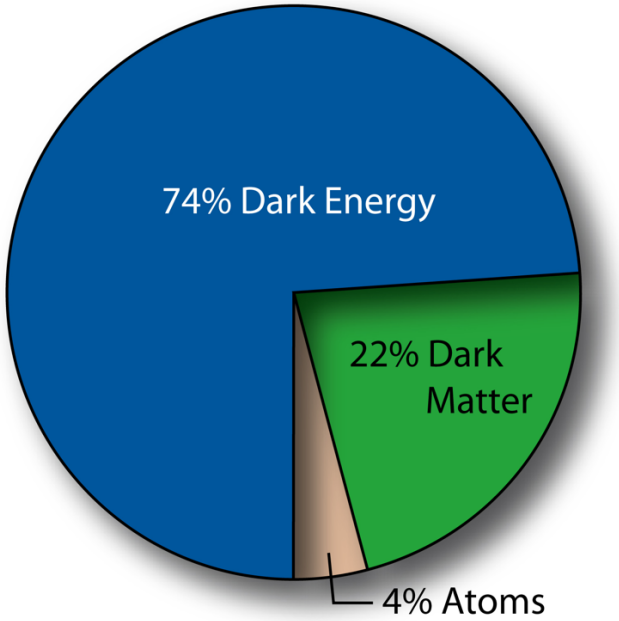


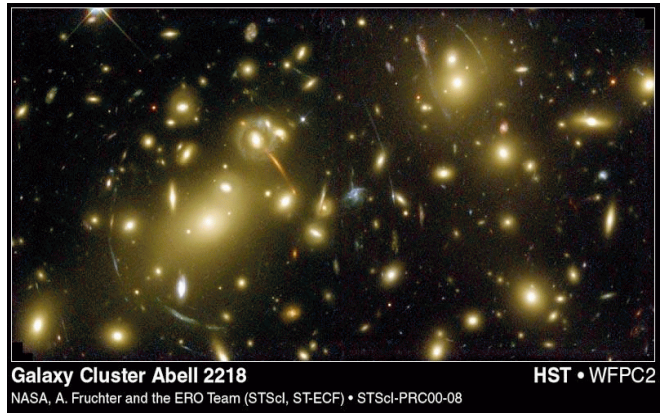
- Cosmic Expansion
- Primordial Hot State
- Spatially Flat
- Small Matter Density Fluctuations

The Standard Cosmology Model

Dark Energy: Repulsive gravitation, trigger accelerating expansion





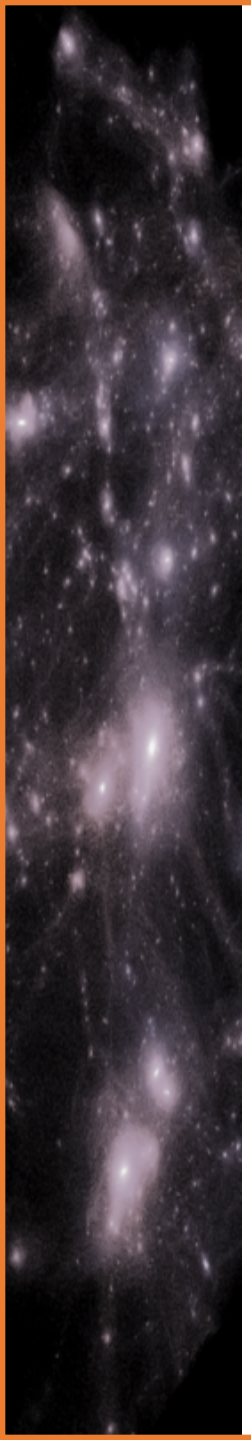


Dark Matter: Gravitational Glue, oppose the cosmic expansion

Cosmological constant in Einstein's equations of GR

Λ CDM

Collisionless particles with gravitational interactions only



Open Questions

1) What is the nature of the invisible component in the universe?

1.1) New fields beyond SM or modification of GR?
1.2) How do they shape the cosmic expansion?
1.3) How do they affect the formation of cosmic structures?

2) In such a context how do stars and galaxy form?

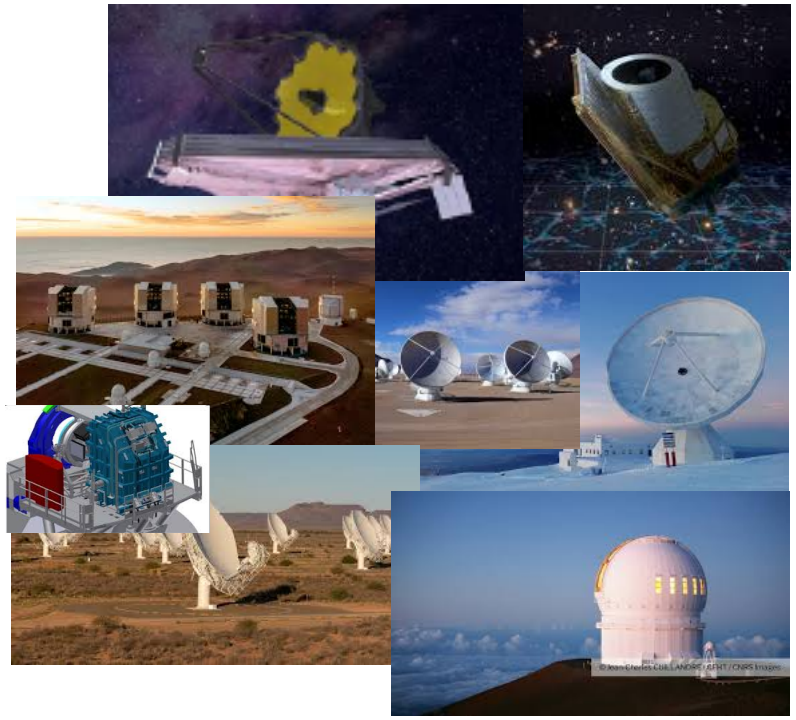
3) What process are responsible for the variety of galaxy properties?

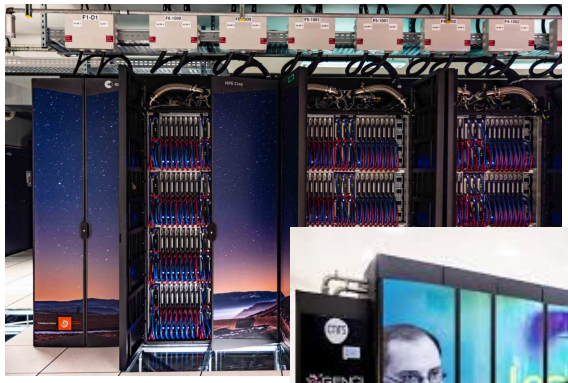
3.1) What regulates the star formation in galaxies across time?
3.2) How super-massive BH forms and co-evolve with host galaxies?
3.3) What role do AGN play in determining the properties of galaxies and their environment

4) How and when the universe got reionized?

Methodologies

Gather - Extract - Interpret



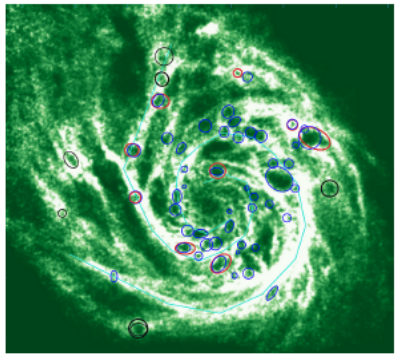


- Instrumentation
- Observations

- Simulations
- Data Analysis

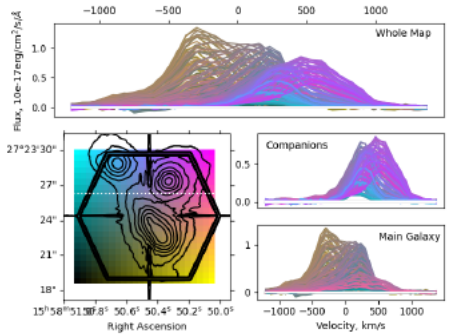
Local Galaxies

- Physics and Dynamics (Melchior, Halle, Combes)



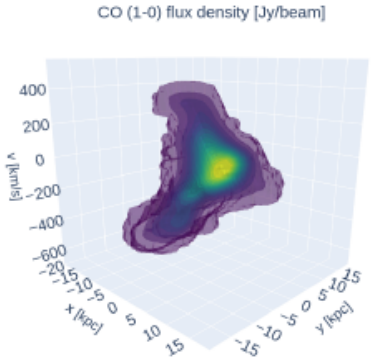
Multiwavelength Observations:

- Holes in HI image of M101 from “The HI Nearby Galaxy Survey”



- Emission lines of galaxy group falling into cluster from the “Mapping Nearby Galaxies at APO” (MaNGA) data

(Shaji et al., in preparation)



- NOEMA observations of CO distribution of merging galaxies

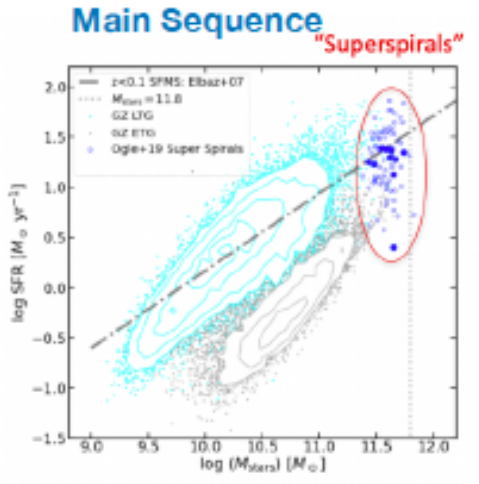
(Halle et al., in preparation)

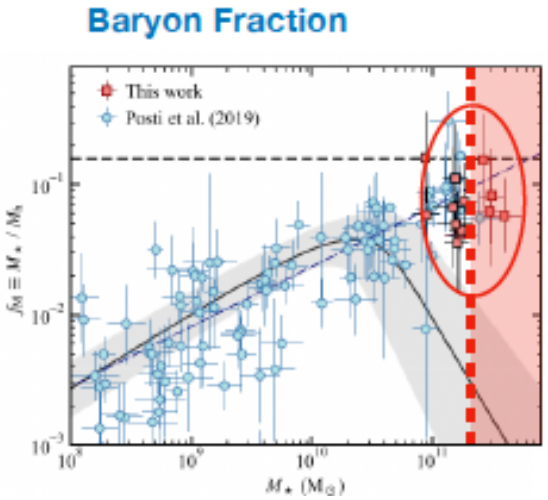
- Dynamical modelling (Halle, Combes)

- RAMSES simulations and synthetic observations of gas accretion on SMBH and comparison with ALMA & JWST (Florian Dedieu & Estelle Salibur - M2 interns)

Star Formation in Galaxies

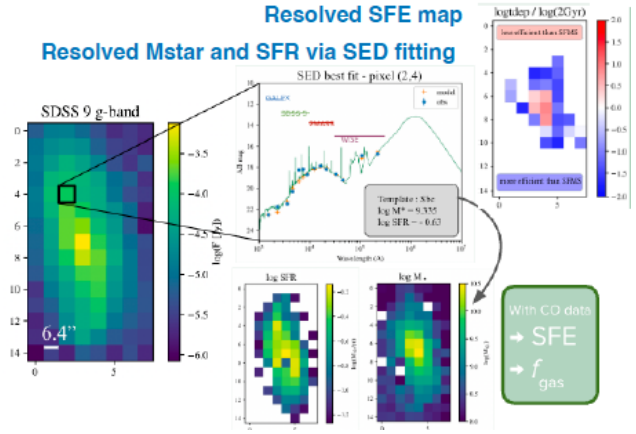
- Failed Quenching in Giant Spiral Galaxies (Cologni, PhD – Salome)

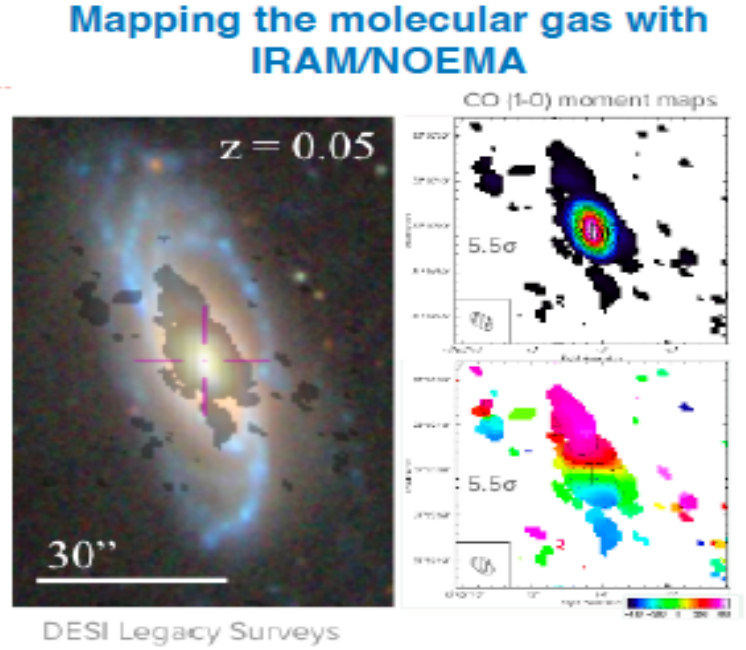




- Massive Spirals with high SFR
- Large reservoire of gas fueling SF
- NOEMA observations 16 spirals

- Measure gas mass fraction & SFE



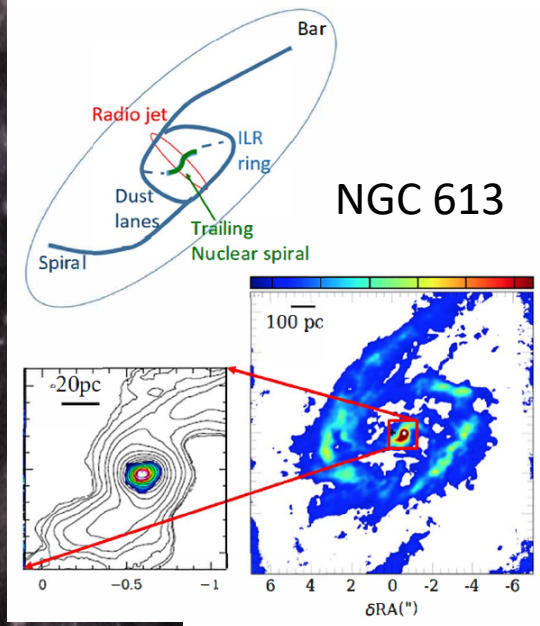


- NIKA2 Observations High Star Forming Galaxies (Lestrade, core team NIKA2)

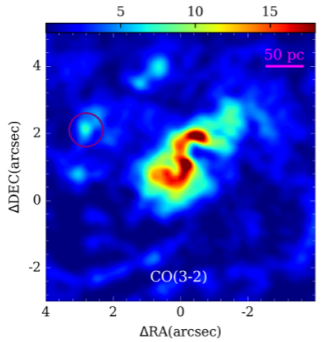
AGN and ISM interactions

- AGN winds & jets (Combes)

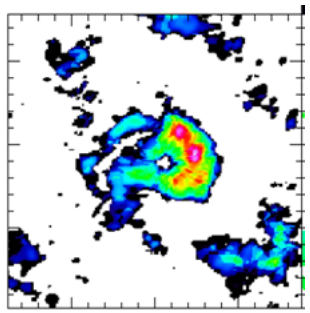
- Discovery of nuclear trailing spiral and molecular tory surrounding AGN with ALMA (Combes et al. 2019, Audibert et al. 2019, 2021)

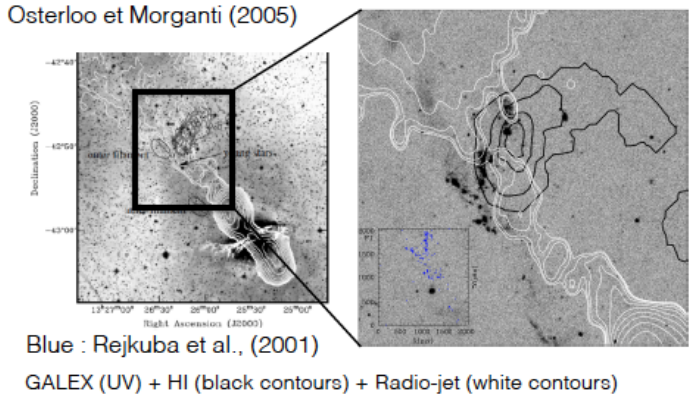


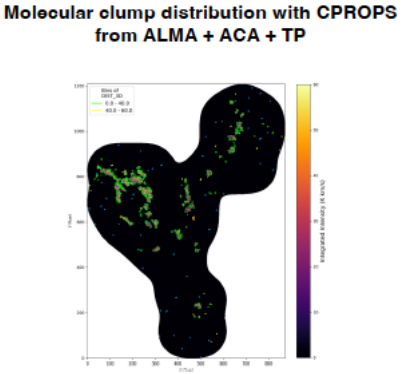
NGC 1808



NGC 1365







- AGN positive feedback in Cen A (Flesch, M2 - Salome)

- Triggering of SF in regions of interaction between jets and ISM

- Mapping molecular regions in the vicinity of Cen A radio-jets with ALMA

MOONS

- Multi-Object Optical and Near-infrared Spectrograph for the VLT (Flores, Puech, Vergani, Luke – PhD, Vignoni - PhD)

- ~1000 fibers spectrograph: R~4000 to 18000

- ~300 nights of granted time (starting 2026)
- 2 surveys: Galactic (incl. GAIA follow-up) / Extra-galactic (local & high-z galaxies)
- Study of Dwarf Galaxies: mass assembly, relation between morphology evolution

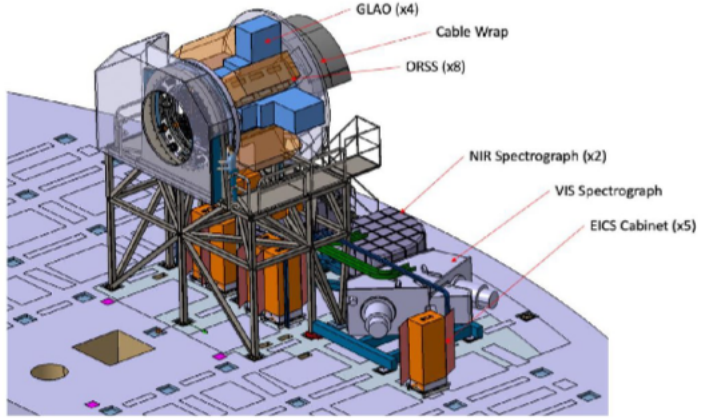
MOSAIC

- ELT Multi-Object Spectrograph (PI: R. Pello/LAM, co-PI: M. Puech/LUX)

- Optimized for high survey speed and high surface brightness sensitivity

- LUX implication: science, hardware & software

- Currently preliminary design phase; first light 2034

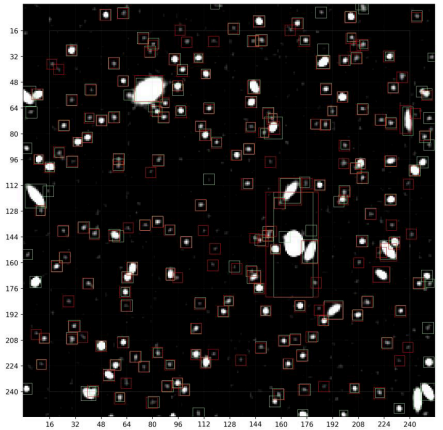


Machine Learning (MINERVA project)

- SKA data processing

- YOLO-CIANNA ML algorithm for visualization, identification and classification of HI sources (Cornu et al. 2024)

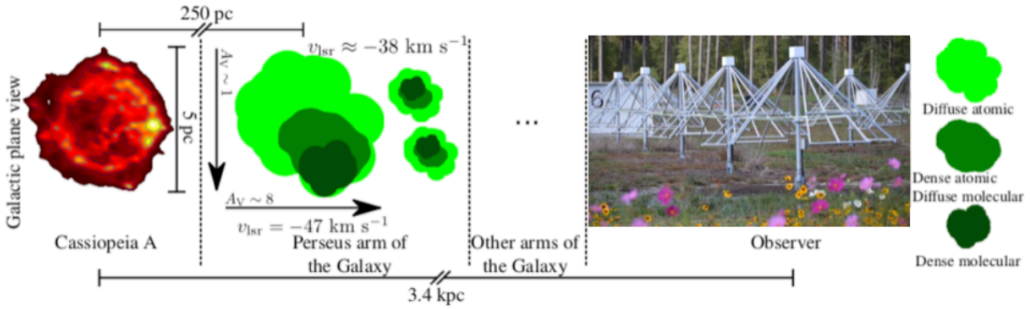
- Winner of SKA Science Data Challenge 2 (Cornu et al. in preparation)



- NENUFAR

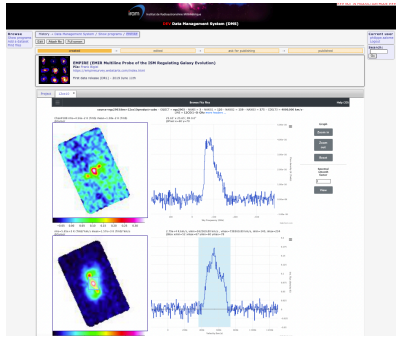
- Detection of Radio Recombination Lines

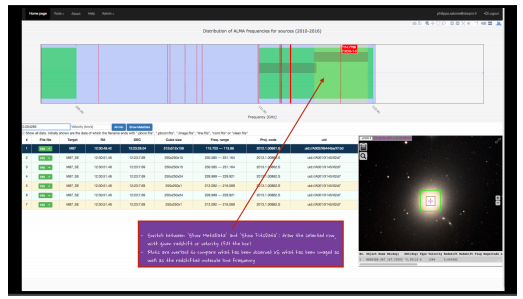
- Study of the ISM



- SNO/IRAM & ARC-ALMA (Moreau, Ba)

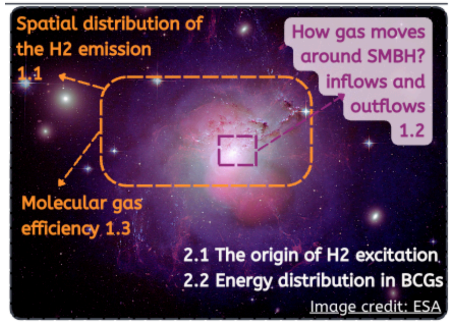
- YAFITS: visualization tool of IRAM archival data
- ARTEMIX: exploitation ALMA archive
- visualization of SKA data (SNO/SKATE)





Galaxy Clusters (I)

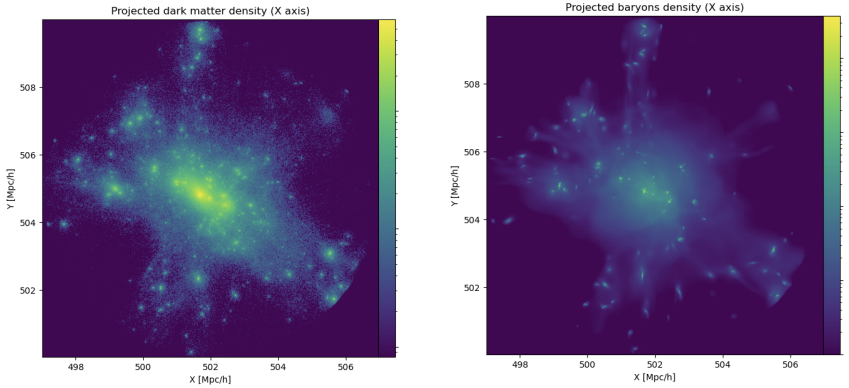
- Baryon Cycle in BCGs (Beslic, Salome)



- Gas circulation in and out of brightest cluster galaxies and interaction with SMBH

- JWST 20h for 7 BCGs with MIRI (PI: Salome, co-PI: Donahue)

- Zoom-in hydrodynamics simulations (Tornatore – PhD, Le Brun, Corasaniti)



- Observational imprints on cluster properties

- Suite of zoom-in simulated clusters with RAMSES

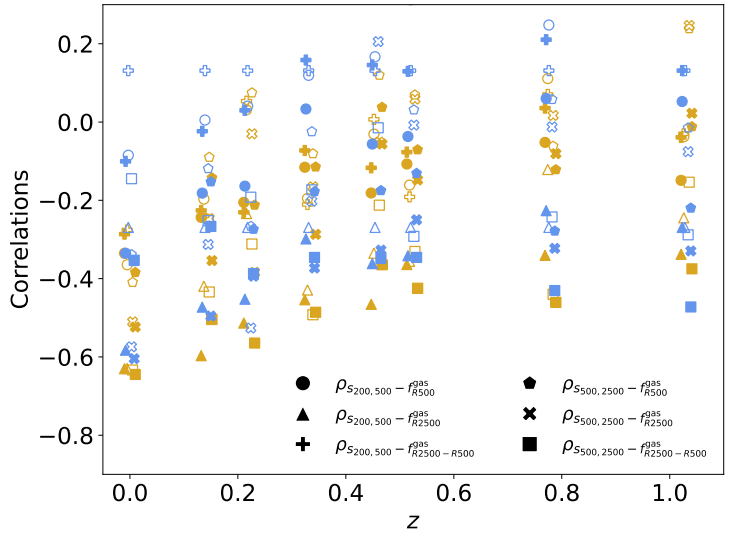
- Study interplay between astrophysical processes and cosmological model (vary feedback parameters and dark energy scenario)

- SNO/RAMSES (corr: Le Brun)

- Development Halo Finder for Hydro Simulations (Roy, Le Brun, Tornatore)

Galaxy Clusters (II)

- Mass Profiles, Gas Distribution & Structural Properties (Corasaniti, Le Brun)



(Corasaniti et al. submitted A&A)

- Sparsity statistics from The300 simulated clusters (2 AGN scenarios)

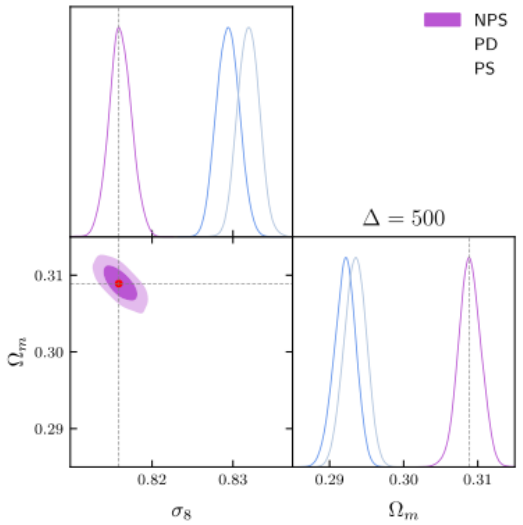
$$\frac{\Delta \log M}{\Delta \log R} \equiv \frac{3 \log s_{\Delta_1 \Delta_2}}{\log\left(\frac{\Delta_1}{\Delta_2} s_{\Delta_1, \Delta_2}\right)}$$

- Profile inner cluster regions highly correlate with gas content
- Slope depends on feedback scenario
- No correlations in outer regions -> Sparsity and f_{gas} probes of cosmology

- Euclid CG-SWG Standard Project (Gayoux - PhD, Corasaniti)

- Systematic Errors on Cluster Number Counts analysis from mass conversion of the HMF
- Assuming NFW with c-M relation induce significant bias
- No bias using sparsity statistics

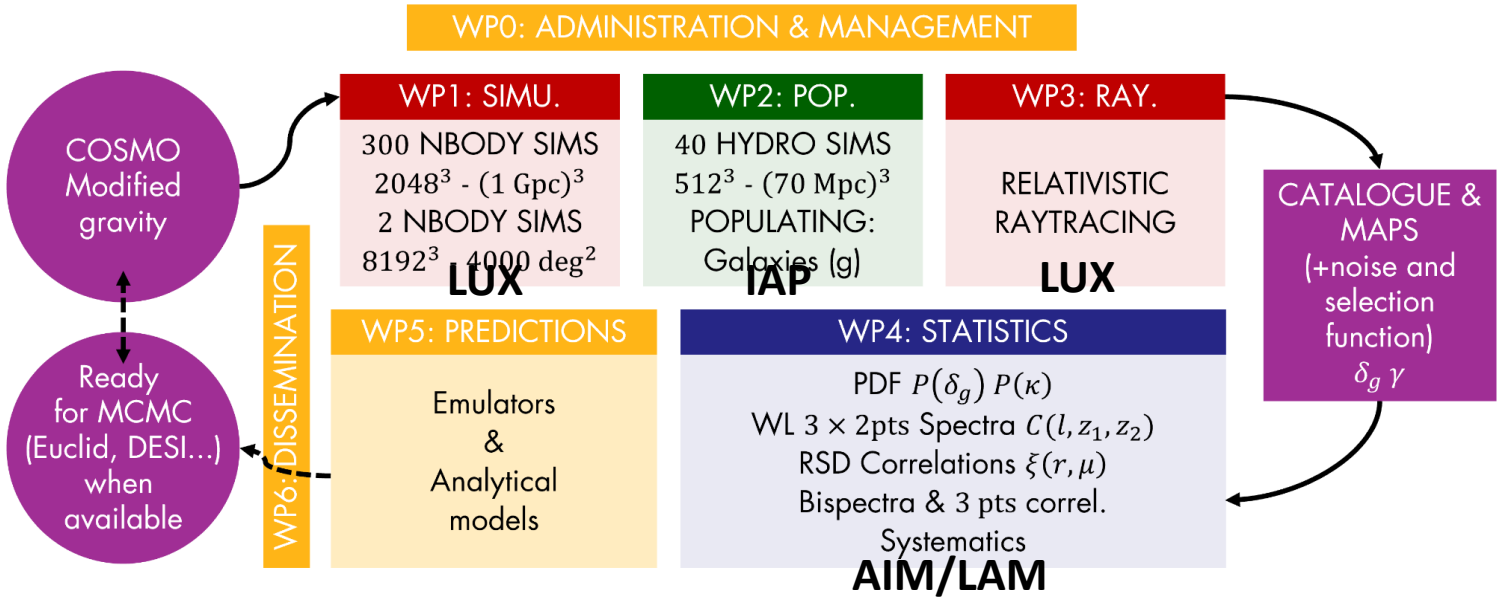
(Gayoux et al. in preparation)



Large Scale Clustering

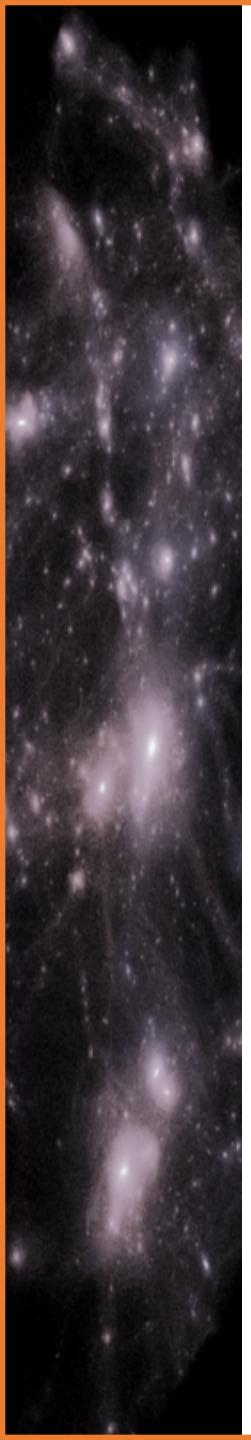
- ANR-ProGraCeRAY (PI: Y. Rasera)

"Probing GRAvity at Cosmological scalEs with relativistic RAY-tracing"



Current work: Solver for the non-linear elliptical system of partial differential equations

- Fast Python N-Body Particle Mesh code: Pysco (Breton 2025) (in the future RAMSES)
- Non-linear Multigrid Solver (H. Ganjoo, Y. Rasera)
- Relativistic Effects on Cosmic Scales (M. Corioni, Y. Rasera)



Conclusions

- Scales investigated: 0.3 < scales [Mpc] < 21000
- Methodologies: Instrumentation, Observations, Simulations
- Complementarity & Interdependence
- Collaborations on several topics (e.g. cosmology – clusters – EoR – hydro simulations)
- Participation to key survey program: Euclid & SKA
- LUX collaborations – e.g. S. Vergani' group in ASTRE
- Group Meeting: every Wednesday morning @Paris Bat. A