INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna

Extragalactic Astronomy and Cosmology @ INAF-OAS Bologna

Thesis day – 05/02/2024 – Roberto Decarli – roberto.decarli@inaf.it

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INAF OAS BOLOGNA

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Proposte di tesi

Pagina a cura di Roberto Decarli - Aggiornata il 08/02/2021

Qui di seguito, le presentazioni con alcune proposte di tesi di laurea da svolgere a INAF OAS Bologna (cliccare sul titolo della presentazione per scaricare le slides). La lista completa e aggiornata delle proposte è disponibile qui. I seguenti link puntano alle presentazioni tenute durante il "Tesi Day" tenutosi il 9 Febbraio 2021.

[pagina in fase di aggiornamento]

Cosmologia e astronomia extragalattica (pdf)

Popolazioni stellari risolte e astrofisica galattica (pdf)

Astrofisica Relativistica e Particelle (pdf)

Strumentazione e software (pdf)

Edit

LINEE DI RICERCA OAS

- Cosmologia e astronomia extragalattica
- Popolazioni stellari risolte e astrofisica galattica
- Strumentazione e software

PUBBLICAZIONI OAS

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- Papers 2020 su ADS
- Papers 2019 su ADS
- Papers 2018 su ADS

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Master Thesis projects from INAF

Extragalactic astronomy & Cosmology
Stellar populations and Galactic astronomy
High energy astrophysics
Instruments and software

Title of the project	Contact person	email	University contact	Brief description [opti
Strong Lensing Properties of Galaxy Clusters: zooming high redshift Universe	Massimo Meneghetti & Carlo Giocoli	massimo.meneghetti@inaf.it	Lauro Moscardini	Characterization strong lensing propert clusters. The work will be focused in a numerical simulated clusters in differen
Weak Lensing Simulations for future wide field surveyes (Euclid)	Carlo Giocoli & Massimo Meneghetti	carlo.giocoli@inaf.it	Lauro Moscardini Federico Marulli	The large dataset expected to be deliv wide field surveys like Euclid and LSST consistent tools to model weak lensing
Characterization of galaxy clusters with Machine Learning methods in the next generation of galaxy surveys	Carlo Giocoli Micol Bolzonella	carlo.giocoli@inaf.it micol.bolzonella@inaf.it	Lauro Moscardini Federico Marulli	We propose to apply Machine learning clusters, in particular in the context of t also multi-wavelength datasets, from th
Continuity model for the evolution of the galaxy stellar mass functions and its application in anticipation of Euclid	Micol Bolzonella Elena Zucca	micol.bolzonella@inaf.it elena.zucca@inaf.it	Andrea Cimatti	With the advent of next extragalactic s techniques to determine the evolution datasets should be devised. The paper

Raggruppamento Scientifico Nazionale 1

Multi-band surveys of galaxies

AGN at multi-wavelengths

Galaxy clusters: physics and cosmology, lensing

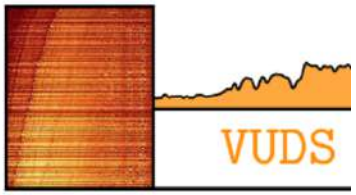
Study of the cosmic microwave background

Multi-band surveys of galaxies

Main goal:
Understanding galaxy evolution through cosmic time

Leading role in past / present / future
spectroscopic and photometric
surveys of galaxies:
GMASS, VVDS, zCOSMOS, VIPERS,
VUDS, VANDELS,
WEAVE+STePs, Euclid, MOONS, MOSAIC...

Thesis projects with M. Bolzonella, O. Cucciati, L. Pozzetti, E. Zucca



Multi-band surveys of galaxies

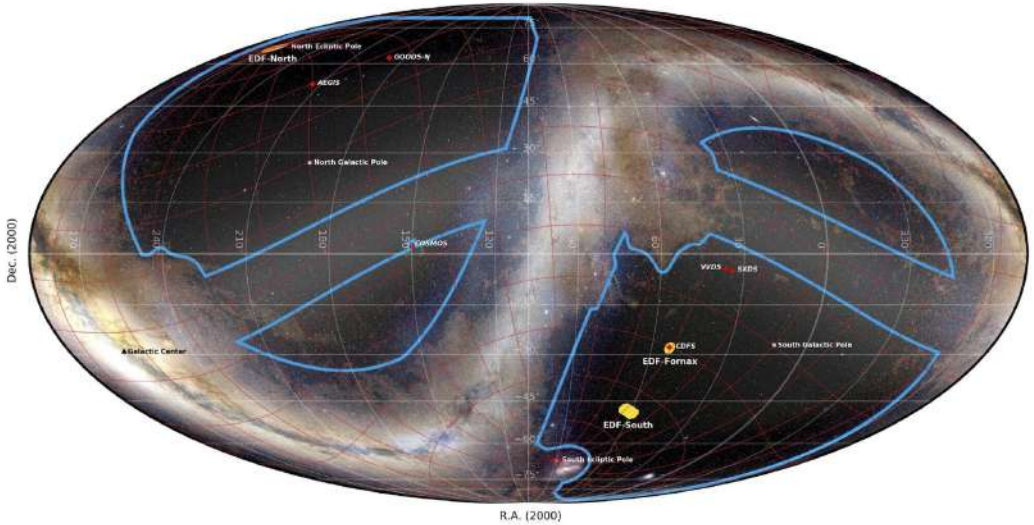
Main goal:
Understanding galaxy evolution through cosmic time

↳ Map of the accelerating Universe

Euclid: ESA mission, launch July 2023
Galaxy survey in 15000 deg^2

- Dark Energy probes (BAO, weak lensing, clusters)
- Galaxy evolution: photometry for 2 billion galaxies and 50 million spectra

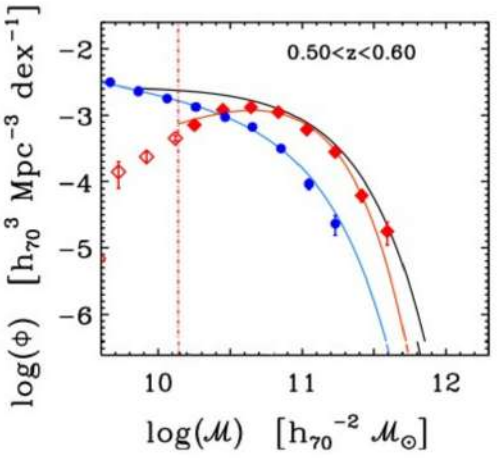
Thesis projects with
M. Bolzonella,
L. Pozzetti,
E. Zucca



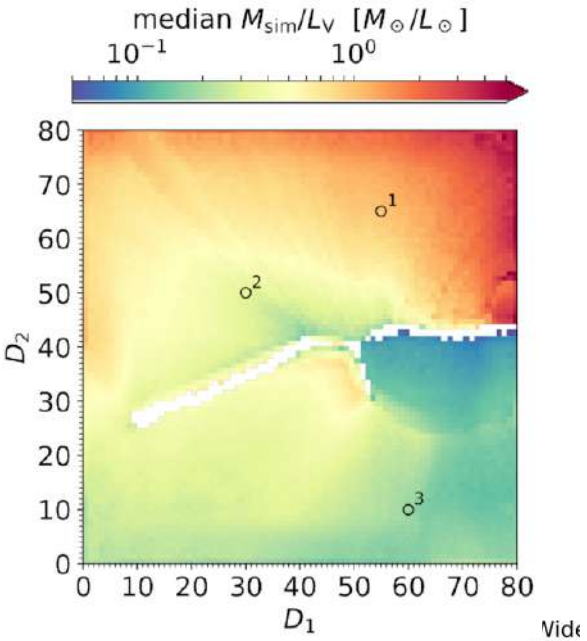
Multi-band surveys of galaxies

Main goal:
Understanding galaxy evolution through cosmic time

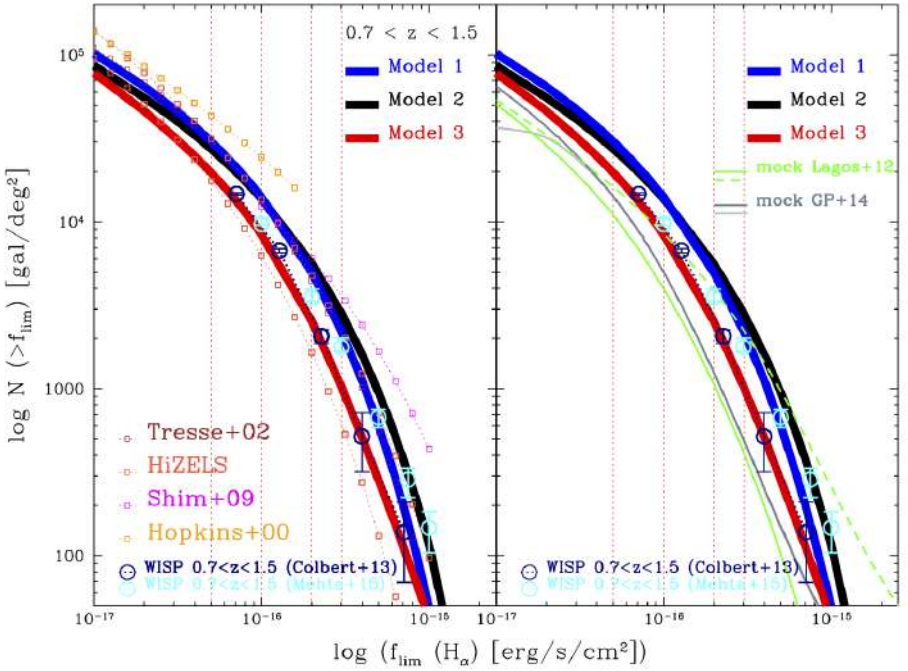
→ From DM simulations to observations to galaxy properties in Euclid



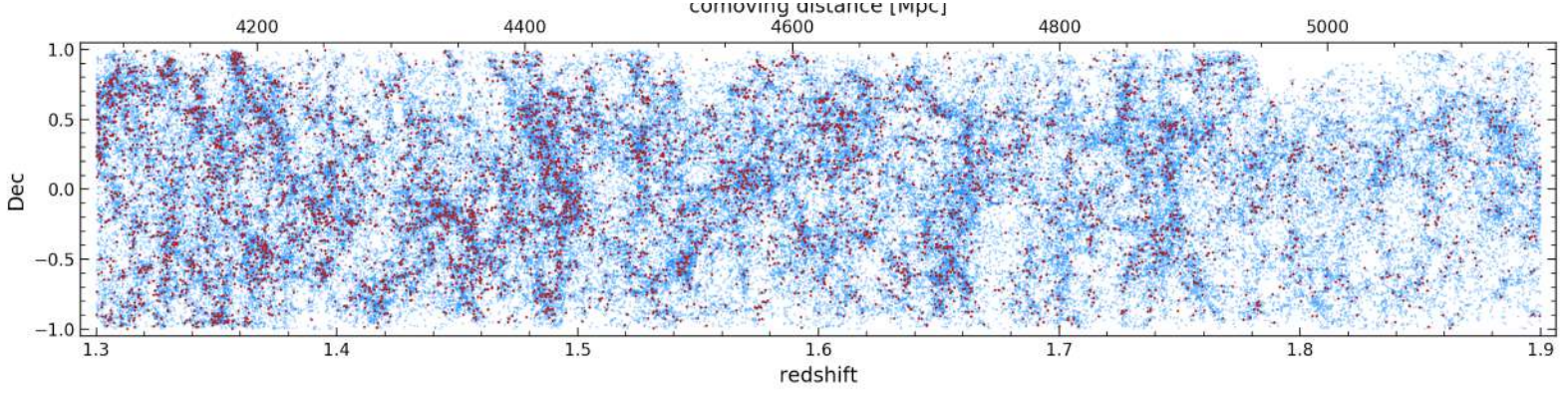
Davidzon et al. 2013, 2019



Pozzetti et al. 2016



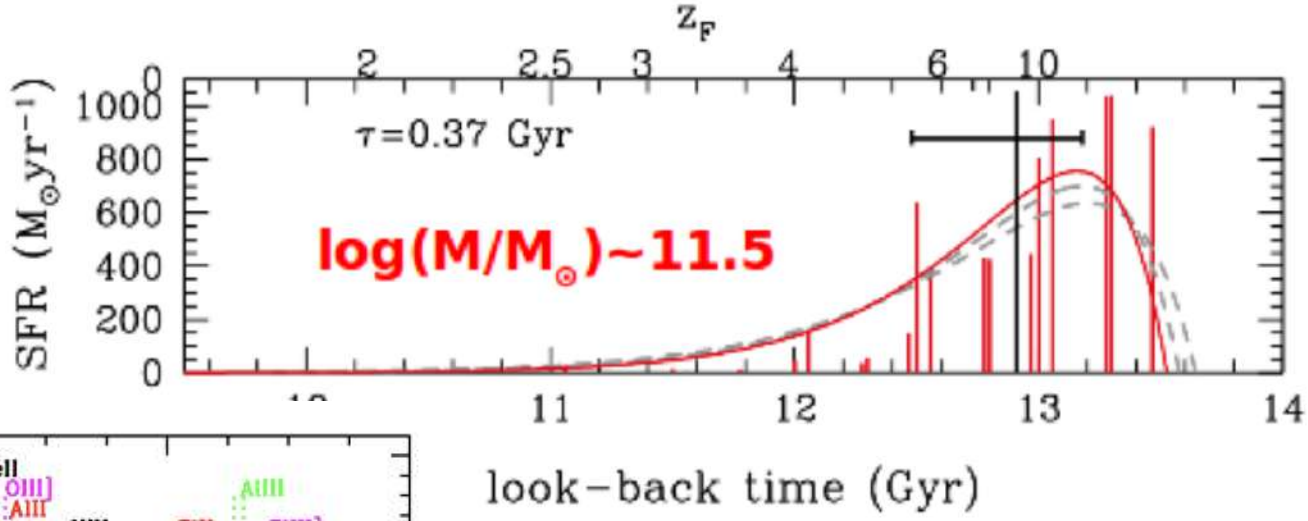
Thesis projects with
M. Bolzonella,
L. Pozzetti,
E. Zucca



Multi-band surveys of galaxies

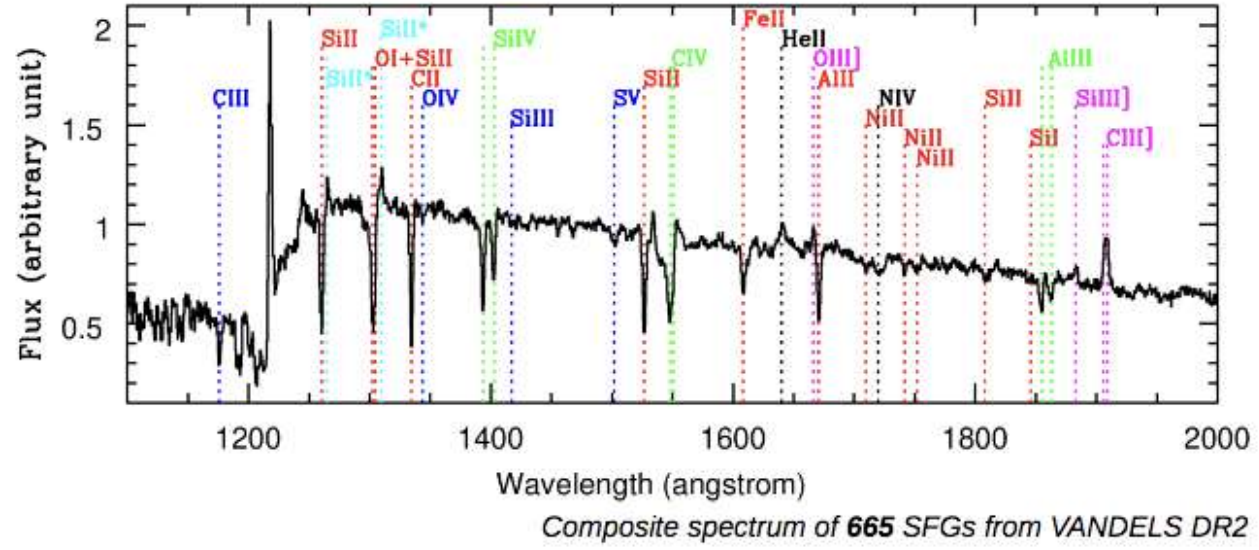
Main goal:
Understanding galaxy evolution through cosmic time

↳ From galaxy spectra to star formation histories, ISM properties and stellar mass assembly



Talia et al. 2021

Citro et al 2016



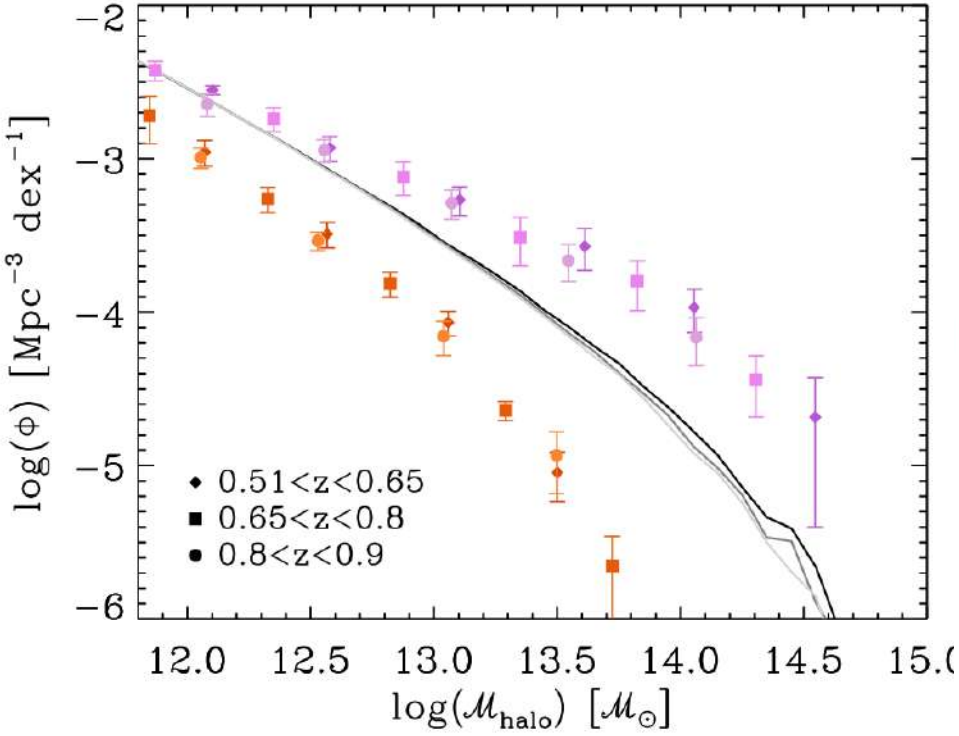
Thesis projects with
M. Bolzonella,
L. Pozzetti, E. Zucca

Multi-band surveys of galaxies

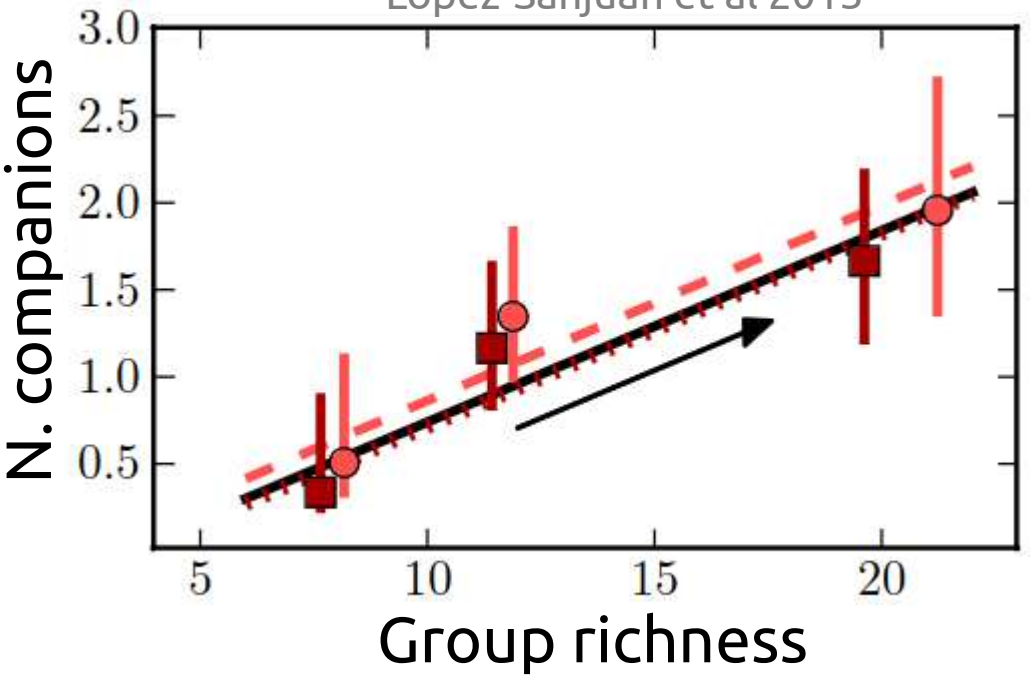
Main goal:
Understanding galaxy evolution through cosmic time

↳ Contribution of mergers to the mass assembly of massive galaxies; evolution of the merger rate as a function of large scale environment

Davidzon et al 2016, Cucciati et al. 2014, 2018



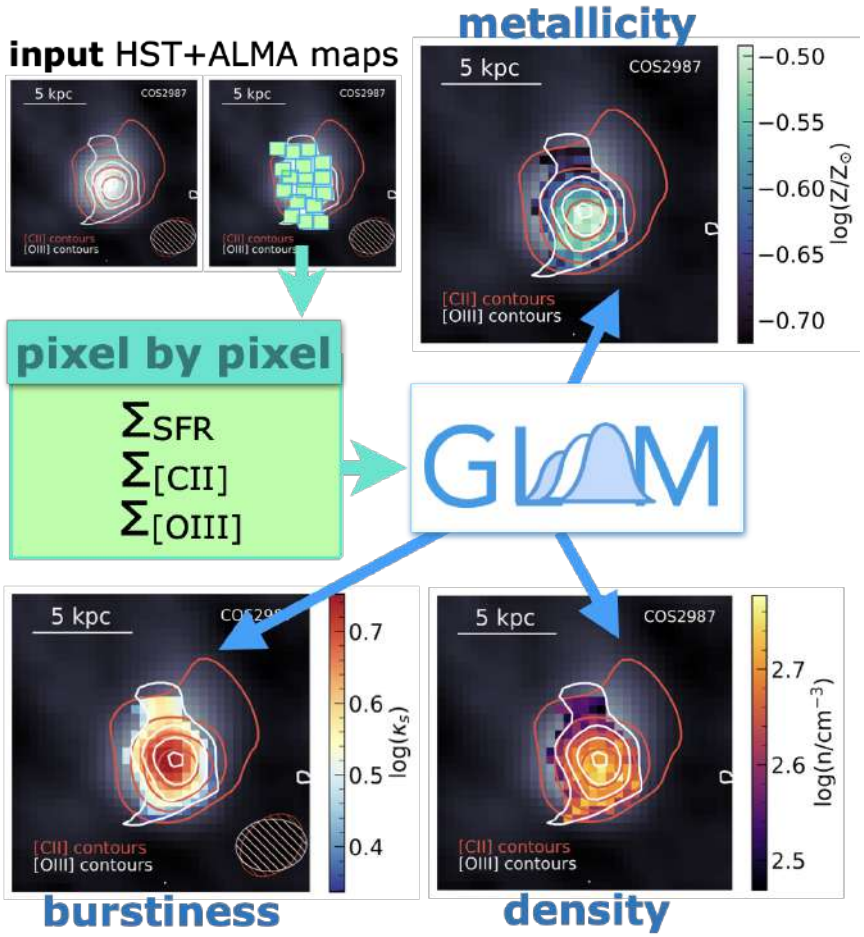
Lopez-Sanjuan et al 2013



Thesis projects with M. Bolzonella, A. Cappi, O. Cucciati

The ISM of galaxies in the Epoch of Reionization and their connection with the Kennicutt-Schmidt law

Goal: Characterize the gas density, metallicity, and the Kennicutt Schmidt law in galaxies likely responsible to the Reionization by using a semi-analytical tool called GLAM. GLAM is able to connect [OIII] and [CII] emission pixel by pixel to the underlying ISM conditions.

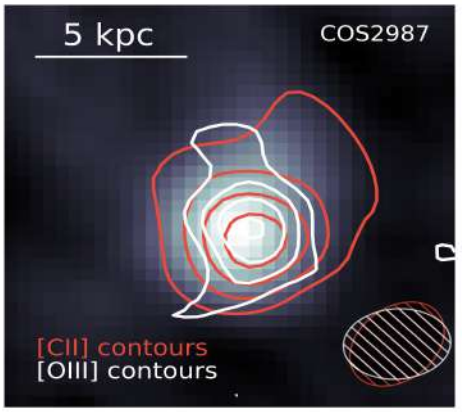


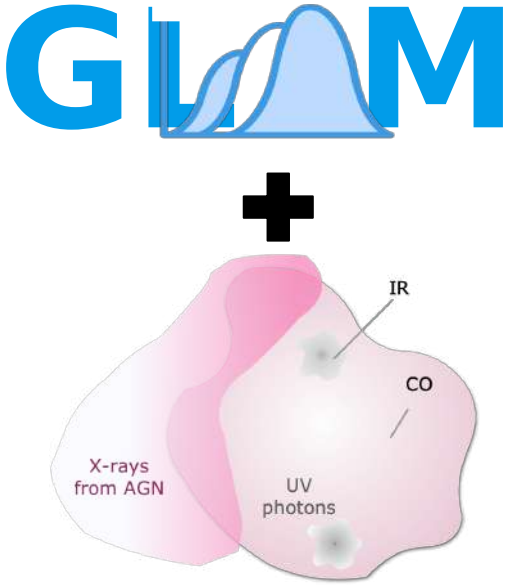
The code (GLAM - **G**alaxy **L**ine **A**nalyzer with **M**CMC) and **Jupyter Notbooks** are released at: https://lvallini.github.io/MCMC_galaxyline_analyzer/

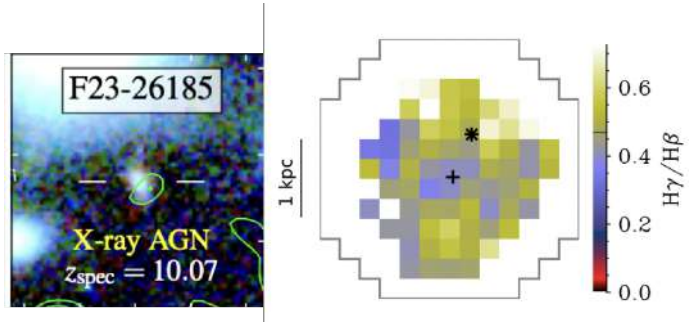
L. Vallini, C. Gruppioni, F. Pozzi

Modelling the effect of AGN vs Star formation on surface brightness ratios in galaxies at the Epoch of Reionization

Goal: Including the AGN effect in the semi-analytical **GLAM** that is already able to infer the ISM properties (gas density, metallicity, etc) from surface brightness of lines excited by star formation. The new features will be used to derive the ISM properties pixel by pixel in JWST + ALMA maps from known AGN







The code (GLAM - **G**alaxy **L**ine **A**nalyzer with **M**CMC) and **Jupyter Notbooks** are released at: https://lvallini.github.io/MCMC_galaxyline_analyzer/

L. Vallini, C. Gruppioni, F. Pozzi

The molecular gas properties in high-z galaxies using CO lines

Goal: Disentangling the properties of molecular gas (density, metallicity, distribution) and radiation field (FUV vs X-ray) on molecular emission by using GalaxySLED
a tool to perform CO line emission modelling considering the internal structure of GMCs.
(both on real data and on cosmological zoom-in simulations),

galaxy SLED

A new physically-motivated model for estimating the molecular line emission in active galaxies

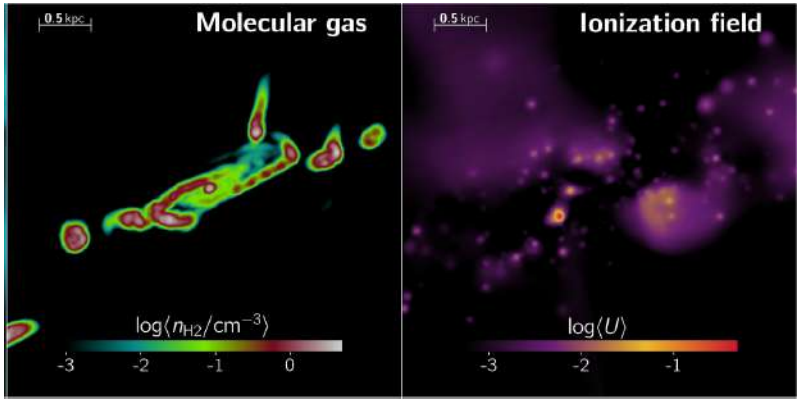
View the Project on GitHub federicoesposito/galaxySLED

galaxySLED: a code to reproduce and fit a galaxy CO SLED

A new physically-motivated model for estimating the molecular line emission in active galaxies. The underlying model is described in Esposito et al. (submitted), and it has been tested with the galaxies data presented in Esposito et al. 2022.

The model takes into account:

- the internal density structure of giant molecular clouds (GMCs)
- the heating associated both to stars and to the active galactic nuclei (AGN), respectively producing photodissociation regions (PDRs) and X-ray dominated regions (XDRs) within the GMCs
- the mass distribution of GMCs within the galaxy volume



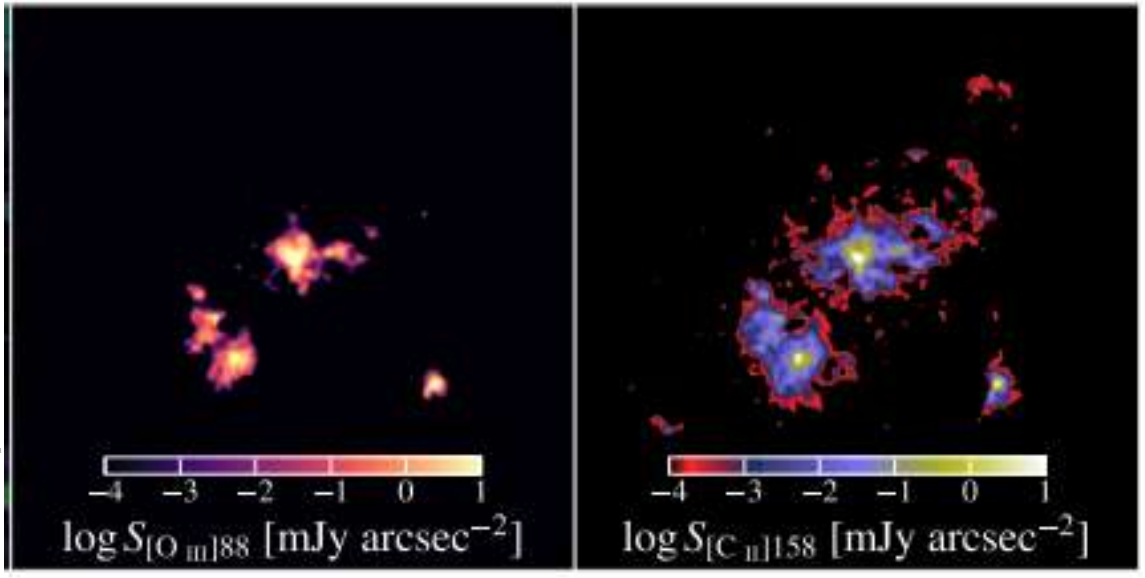
L. Vallini, C. Gruppioni, F. Pozzi

The AGN signature on ionized vs neutral gas tracers in high-z galaxies

Goal: Modelling the relation between line emission from HII regions and that from neutral gas using CLOUDY. The L_{agn} vs L_{line}predictons will be used to infer the AGN impact on the line ratios observed by ALMA and JWST. The CLOUDY models developed in this Thesis can be also used to post-process cosmological simulations and produce mock maps

Cloudy & Associates

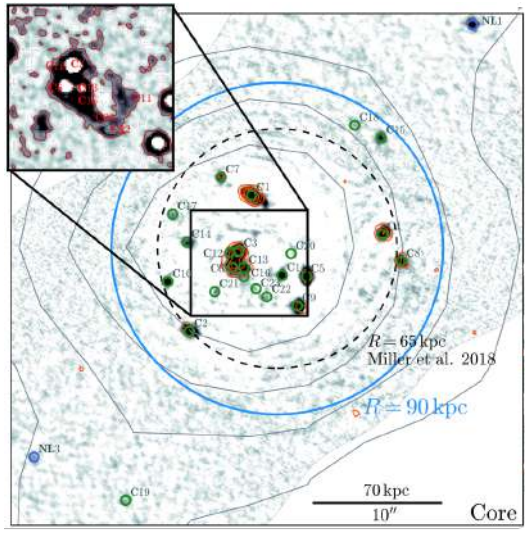
Photoionization simulations for the discriminating astrophysicist since 1978



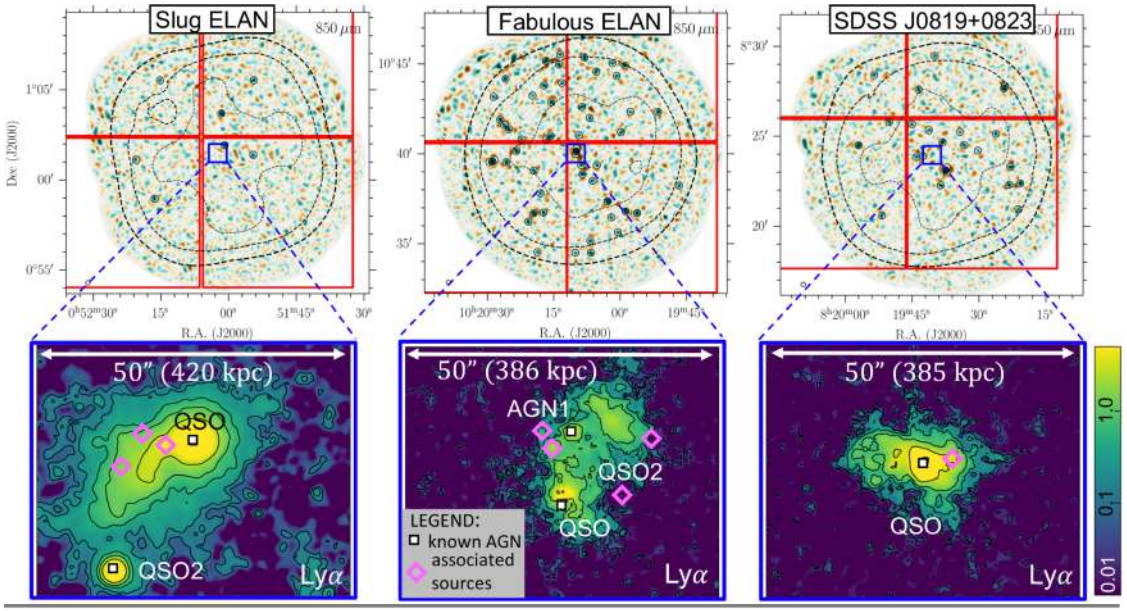
L. Vallini, C. Gruppioni, F. Pozzi

AGN in gas-rich protoclusters

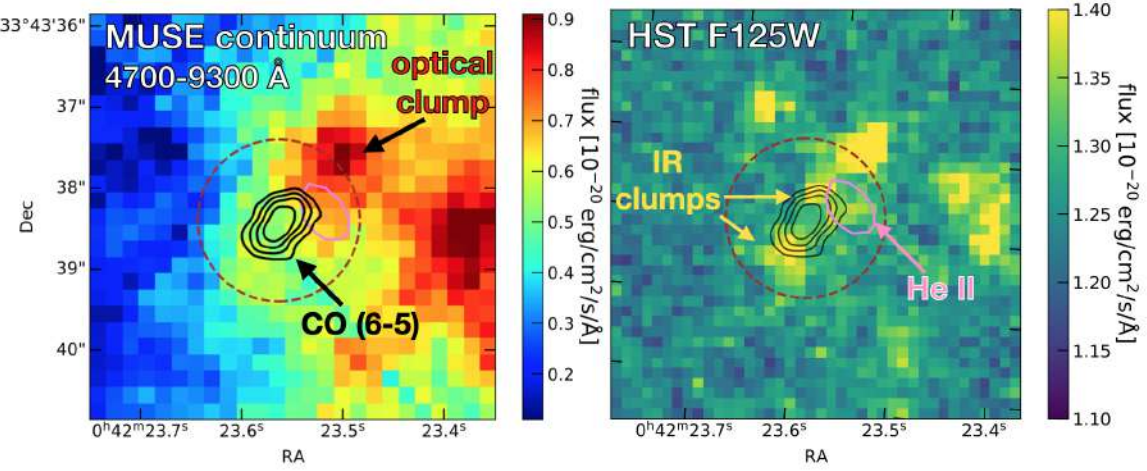
Identification of AGN in gas-rich protoclusters, investigation of their properties and environmental impact (e.g., AGN powering Ly nebulae?) using proprietary and archival multi-wavelength data.



SPT 2349 @z=4.3 (Hill+20) 200ks Chandra observations (PI: Vito), archival ALMA, MUSE:
do gas-rich protoclusters favour AGN triggering?



z=2-3 ELANs (Cantalupo+14, Arrigoni-Battaia+18,+19)
710ks Chandra Large Program (PI: Vito),
archival and proprietary ALMA, MUSE, Keck:
connection b/w AGN and Ly nebulae?



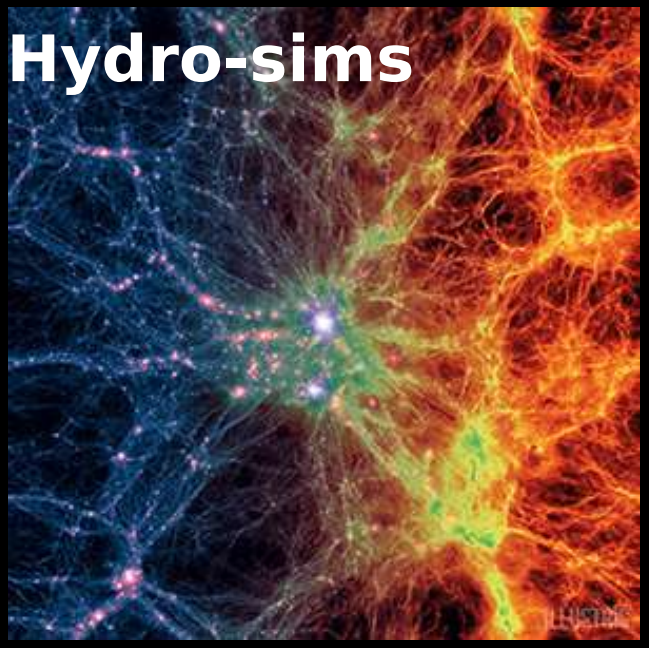
DRC @ z=4 (Oteo+18, Ivison+20, Vito+20)
New ALMA data (PI: Vito) + archival Chandra, ALMA, MUSE, HST:
physical properties of of an extremely luminous and obscured AGN in a protocluster core.

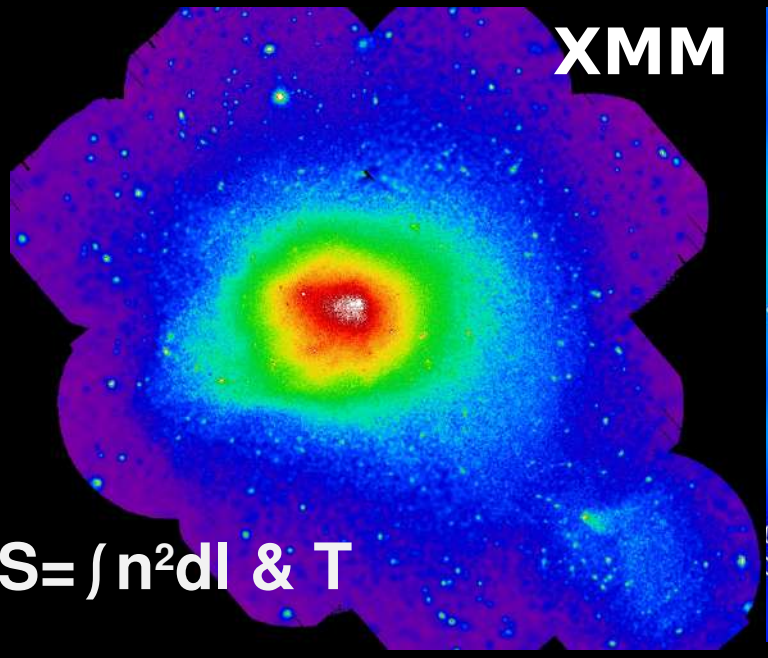
Galaxy Clusters in X-ray: Cosmology & Astrophysics

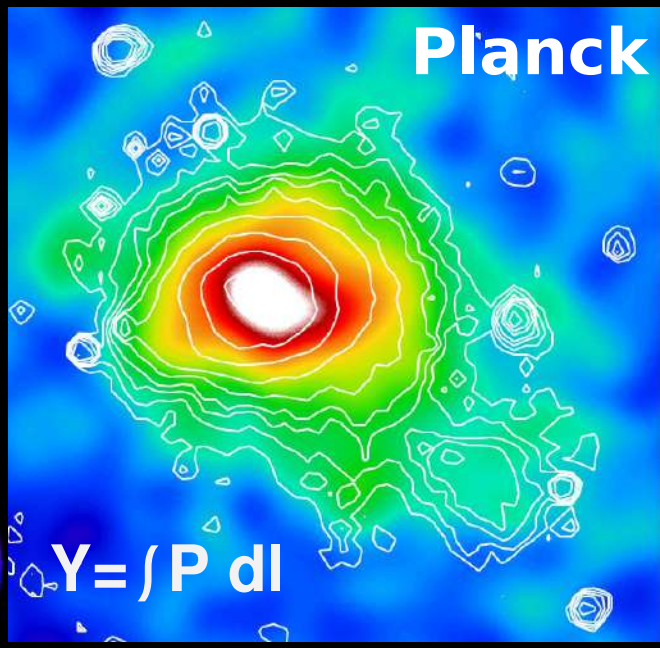
Stefano Ettori stefano.ettori@inaf.it

INAF ISTITUTO NAZIONALE DI ASTROFISICA
OAS BOLOGNA

- Properties of galaxy clusters from X-ray/SZ data & hydro-simulations: **astrophysics & cosmology**
- Paving the way for *Athena*: **turbulence, metallicity, outskirts**







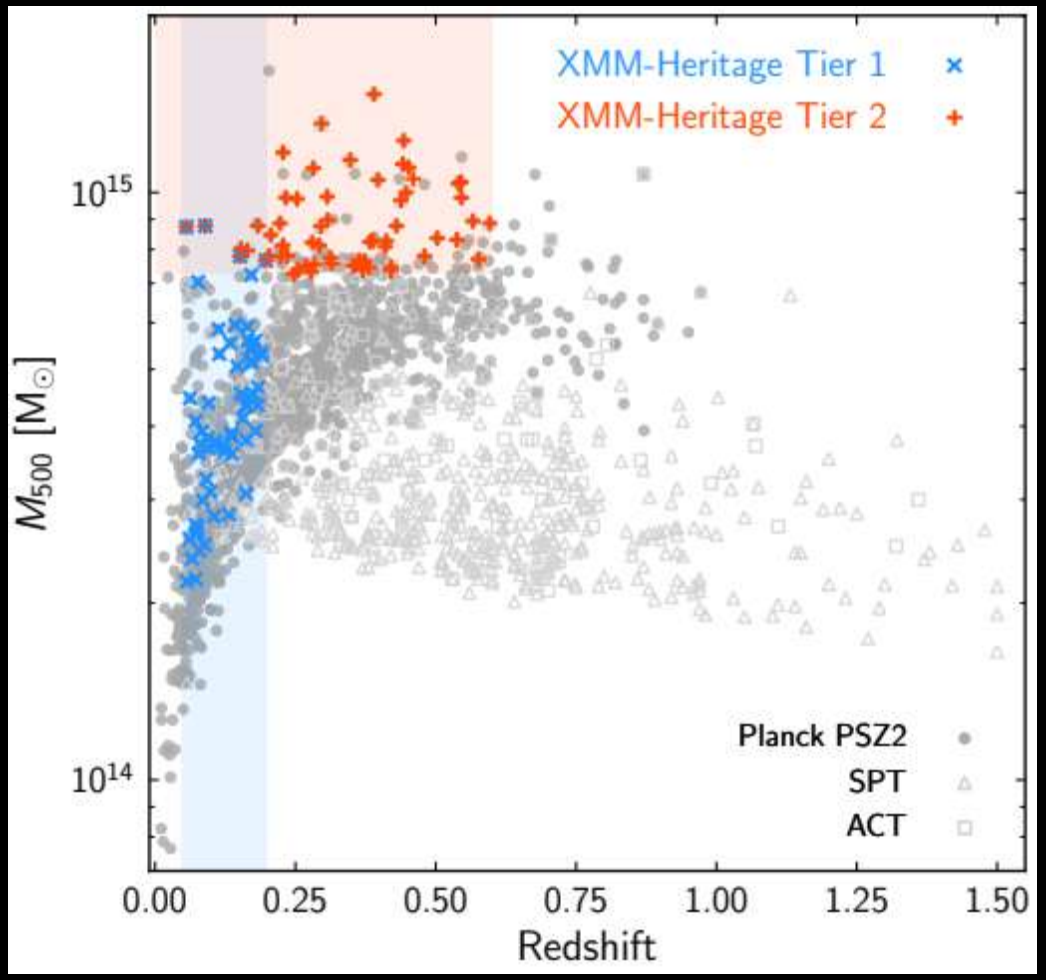
An XMM-Newton Multi-Year Heritage Program

Witnessing the culmination of structure formation in the Universe

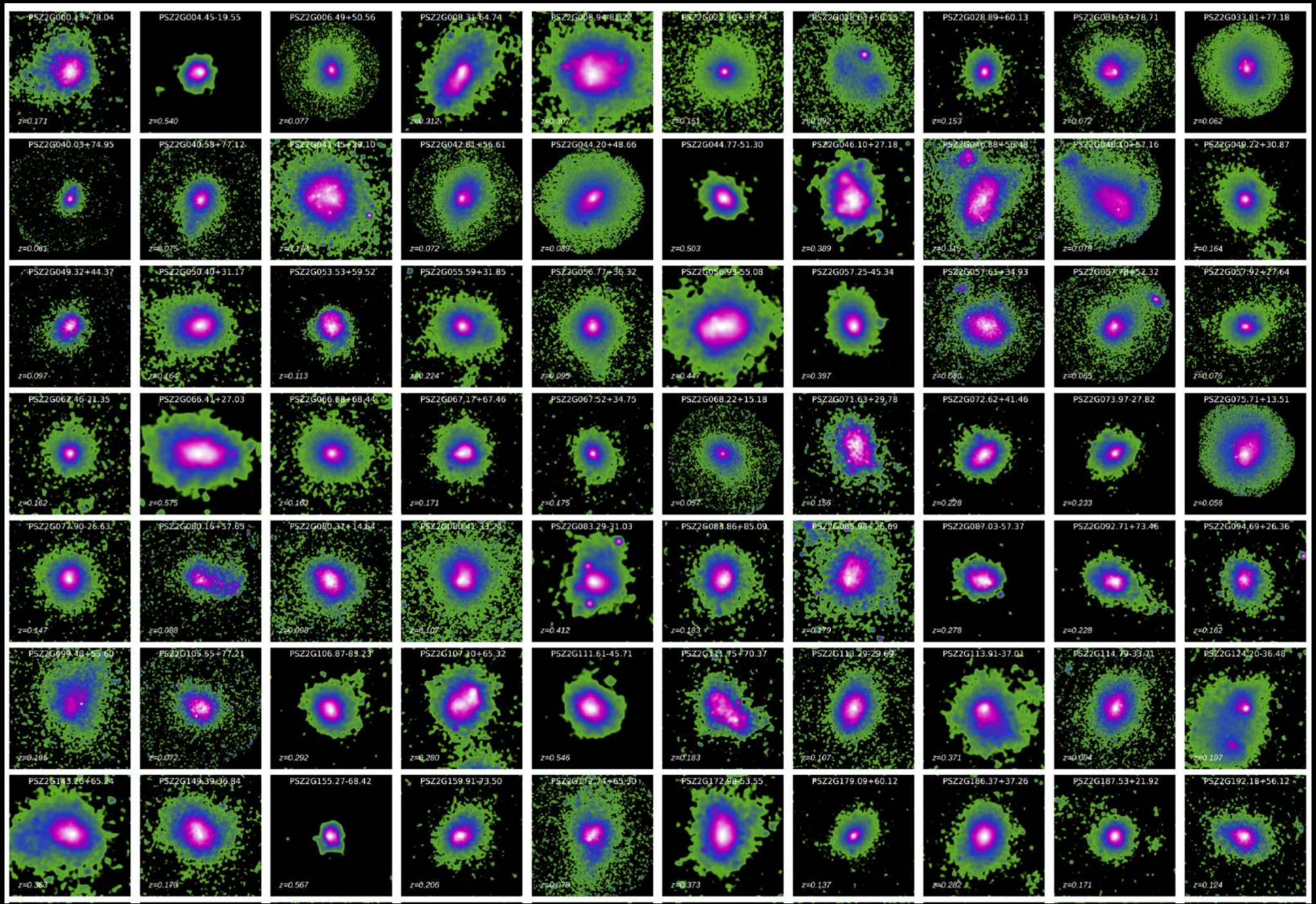
URL: xmm-heritage.oas.inaf.it

CHEX-MATE (the Cluster HEritage project with XMM-Newton: Mass Assembly and Thermodynamics at the Endpoint of structure formation):
3 Msec over the period 2018-21
to survey ***homogenously***
118 Planck-SZ selected objects
comprising an unbiased census of:

- *the population of clusters at the most recent time (z < 0.2)*
- *the most massive objects to have formed thus far in the history of the Universe*



CHEX-MATE gallery *arXiv:2010.11972*



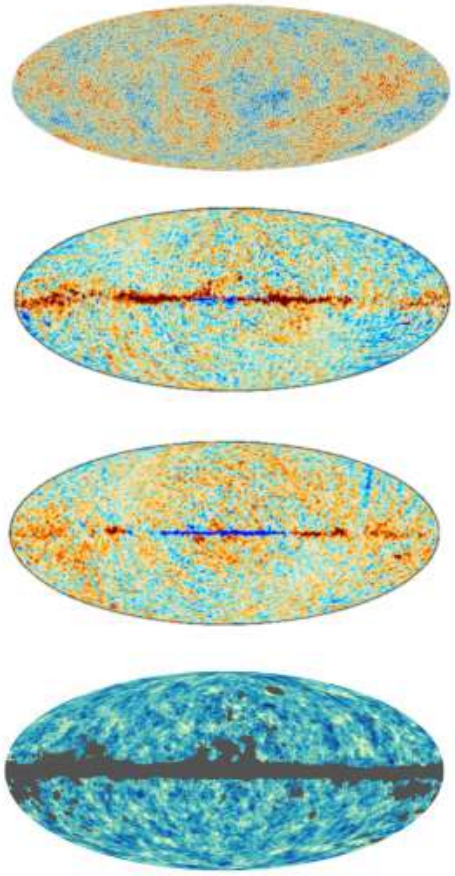
Thesis work

[contact stefano.ettori@inaf.it]

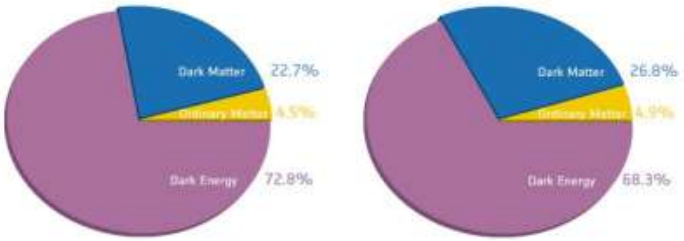
- Properties of galaxy clusters from X-ray data and hydro-simulations [e.g. “Resolving and counting subhalos in cluster’s outskirts”; “Universal profiles of the ICM: analytic models & observational constraints”; “Metal distribution in the ICM out to the viral radius”]
- Turbulence & coherent motions of the ICM: new window on the plasma physics through high resolution spectroscopy [e.g. “ICM rotation as resolved with XRISM/Athena”; “Thermodynamical properties of ICM as resolved with XRISM/Athena”]
- Mass of galaxy cluster from (X-ray, SZ & optical) scaling laws: applications to present & future surveys (***CHEX-MATE***, *eROSITA, Euclid, Athena*) [e.g. “Predictions & calibration of Mass-related scaling relations in eROSITA / Euclid”; “2D map of the thermo-dynamical quantities in CHEX-MATE”, “The joint X-ray/SZ analysis of the most massive clusters in the Universe”]

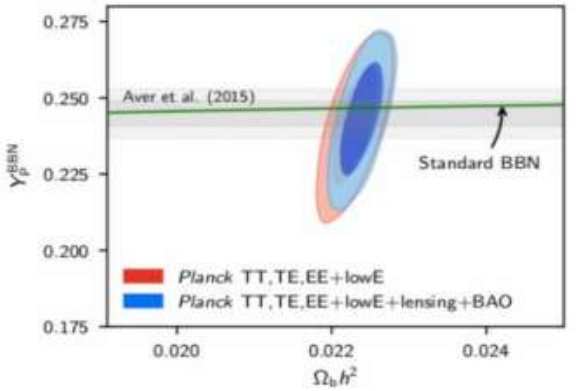
Cosmology with the Cosmic Microwave Background

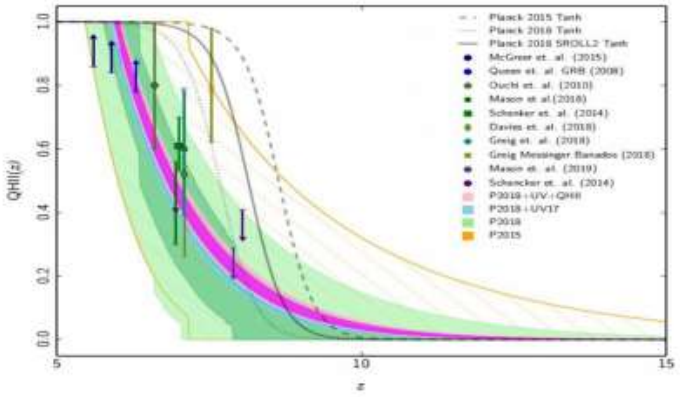
Fabio Finelli, Alessandro Gruppuso, Daniela Paoletti, Luca Valenziano

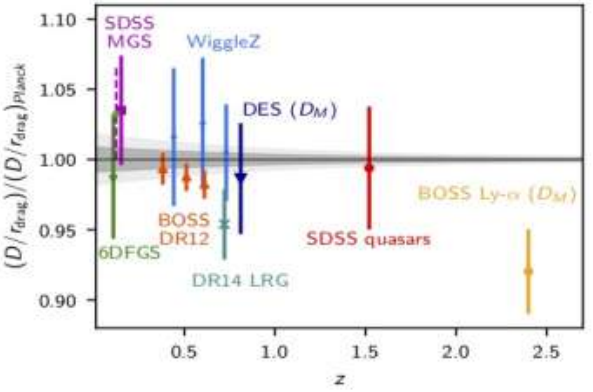


Planck 2018 T, Q, U, Lensing maps are a treasure for cosmology.





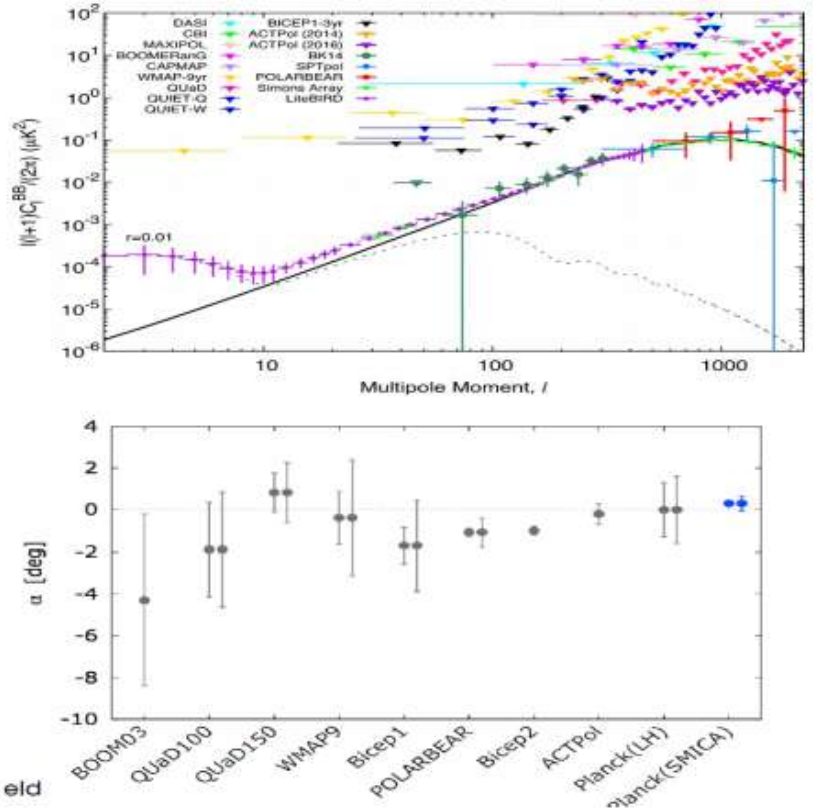


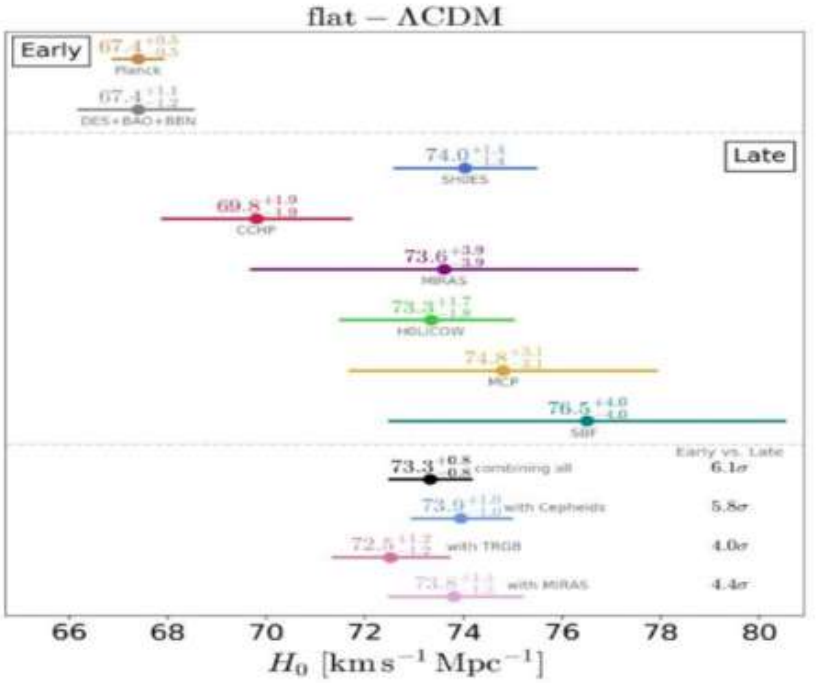


The flat ΛCDM model has emerged as a concordance model in agreement with a host of other observations such as BBN, astrophysical probes of reionization and baryonic acoustic oscillations from galaxy surveys, reaching a percent precision in the determination of the cosmological parameters.

Cosmology with the Cosmic Microwave Background

Fabio Finelli, Alessandro Gruppuso, Daniela Paoletti, Luca Valenziano





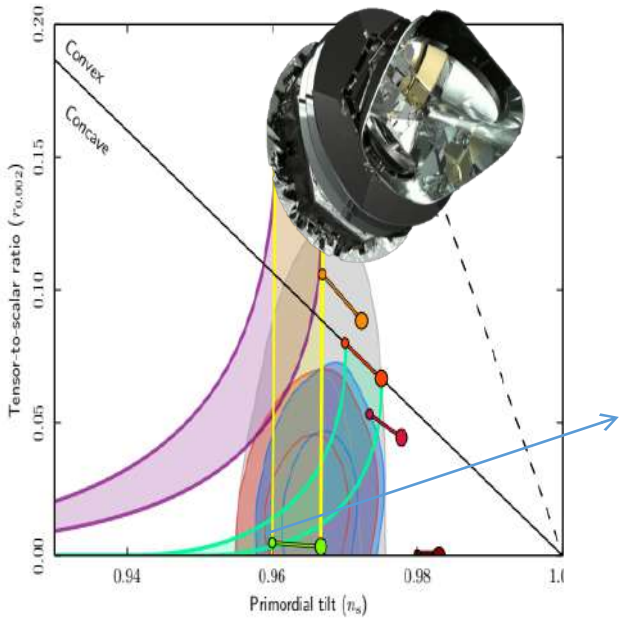
Despite the precision in the knowledge of flat ΛCDM cosmological parameters, we still have only upper limits on B-mode polarization produced by primordial gravitational waves, which encode the energy scale at which inflation occurred, or on birefringence, which could be the imprint of parity violation on cosmological scales.

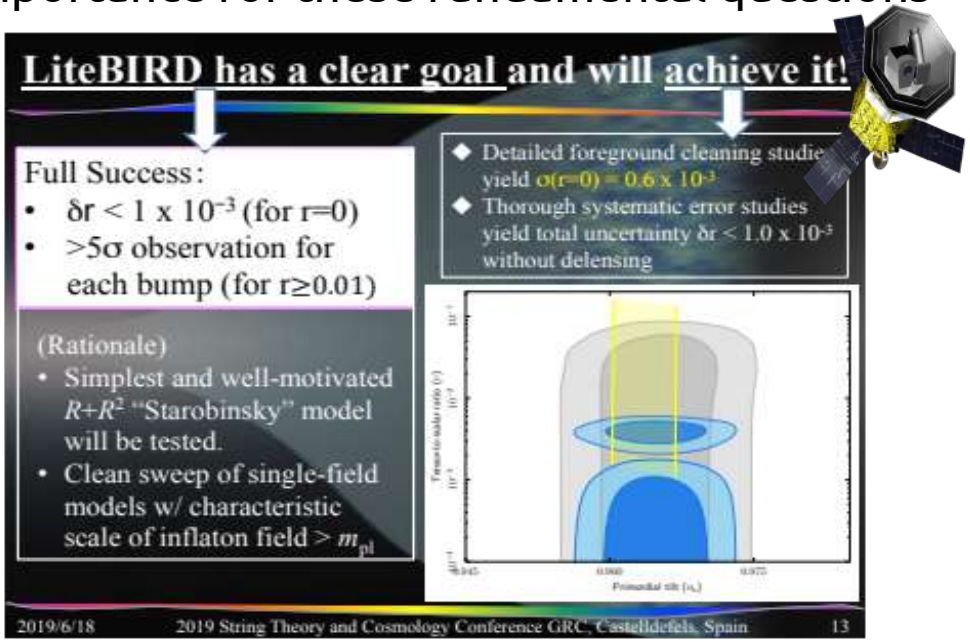
Moreover, the Hubble constant inferred by CMB for ΛCDM is in tension with some low redshift measurements such as from SNIa or strong lensing from quasars.

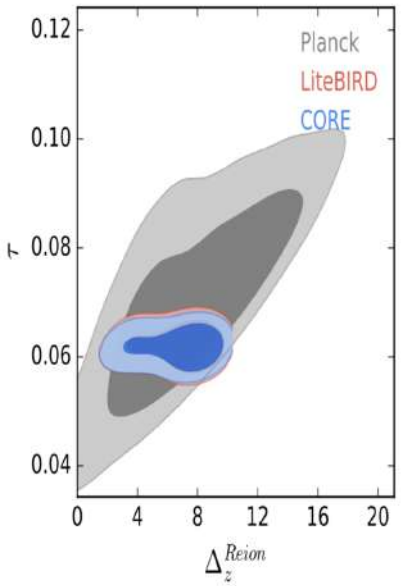
Cosmology with the Cosmic Microwave Background

Next CMB polarization experiments will be of key importance for these fundamental questions

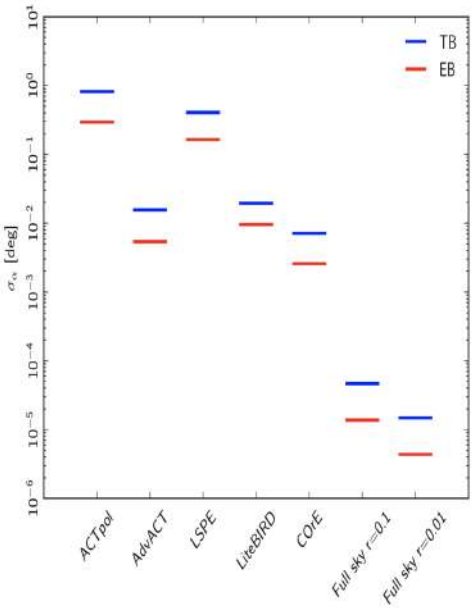
The sensitivity to B-mode polarization will improve nearly by two order of magnitude with next generation mission as the JAXA led LiteBIRD, which will allow to detect unambiguously the simplest inflationary models which are now preferred by Planck …



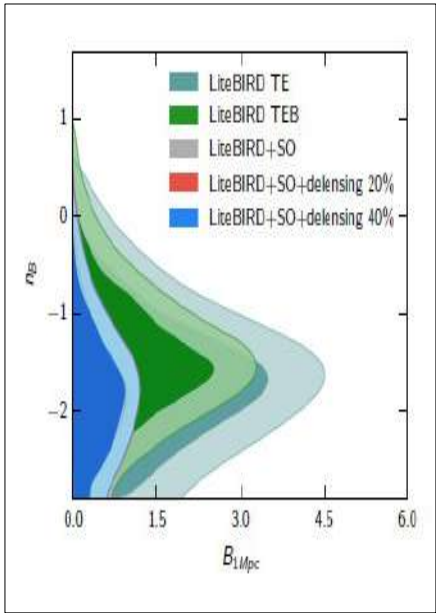




Next space experiments as LiteBIRD will not allow to perform a cosmic variance measurement of the average optical depth τ, but also to break its degeneracy with the duration of reionization …



… and to improve by many order of magnitudes the sensitivity to the birefringence angle and primordial magnetic fields.



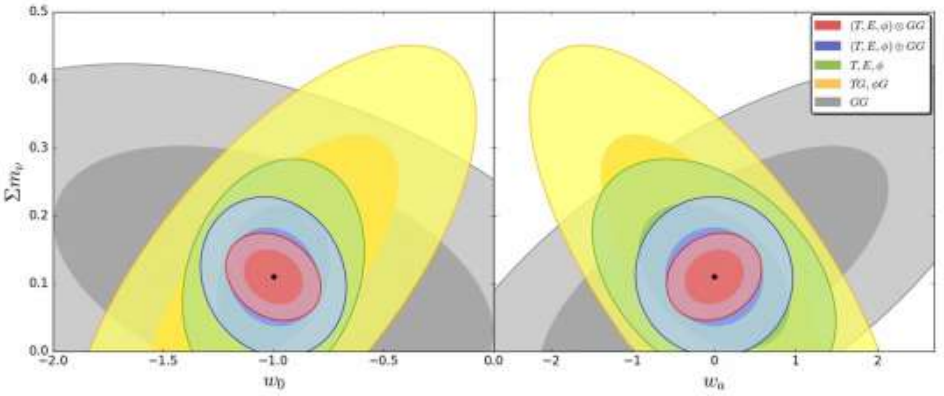
Cosmology with CMB & LSS

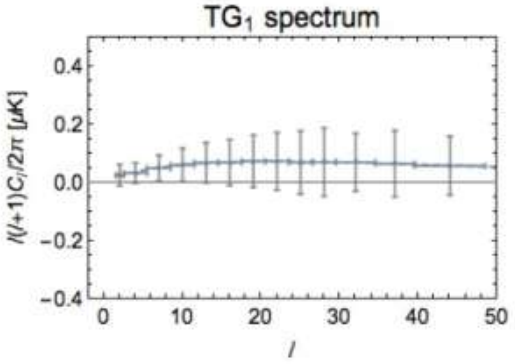
Fabio Finelli, Alessandro Gruppuso, Daniela Paoletti, Luca Valenziano

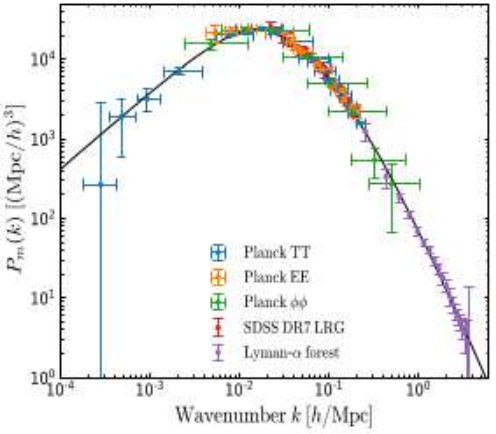
Capitalizing on the studies and analysis of CMB anisotropies we are also involved in next galaxy surveys such as Euclid.

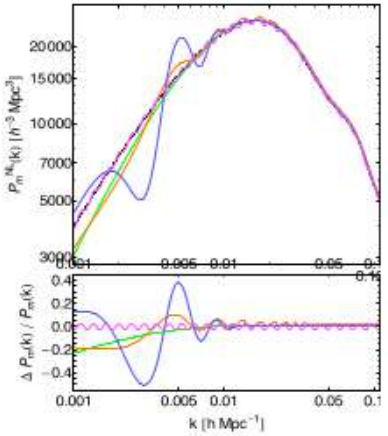
CMB and lensing cross-correlate with LSS: growing interest in understanding how much cross-correlation adds to the CMB and LSS constraints on cosmological parameters and how estimating these cross-correlation in an optimal way.

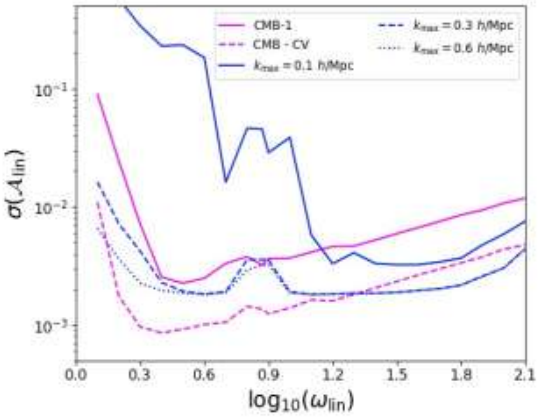
CMB and LSS are mostly sensitive to different scales and complement each other in constraining cosmological parameters and features in the primordial power spectrum.





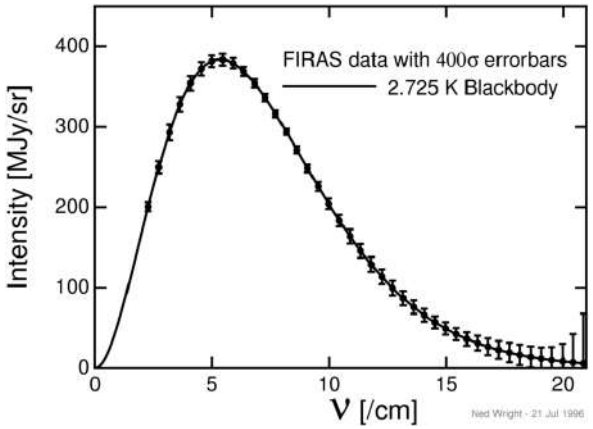


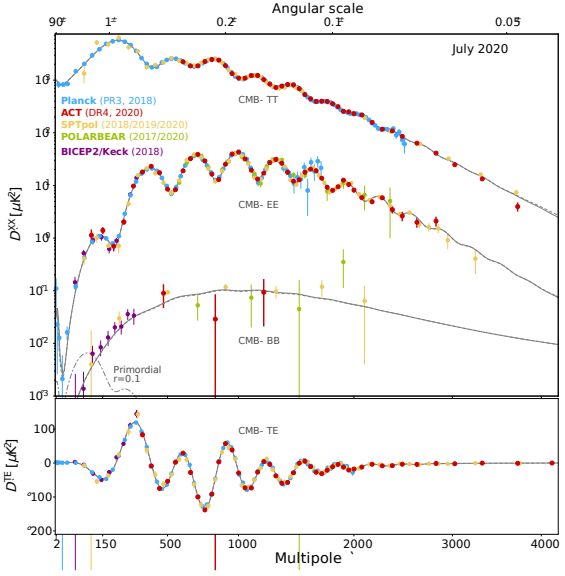




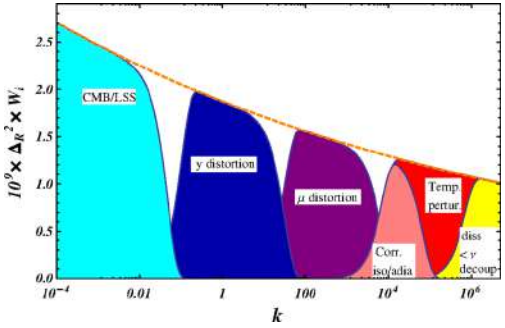
The interplay of spectral distortions and anisotropies in the Cosmic Microwave Background (CMB)

The spectral perfection and spatial imperfection of CMB was established by the COBE satellite in the early 90's and awarded by the Nobel prize in 2006 (to Mather and Smoot, respectively). Whereas the anisotropies have been charted in intensity and polarisation at a smaller and smaller resolution with increasing sensitivity through the years by several experiments from space, ballon and ground, the measurements of spectral distortions had little progress since COBE FIRAS, but are now targets for different concepts of future space experiments (Pixie, PRISM, Pristine, Voyage 2050).

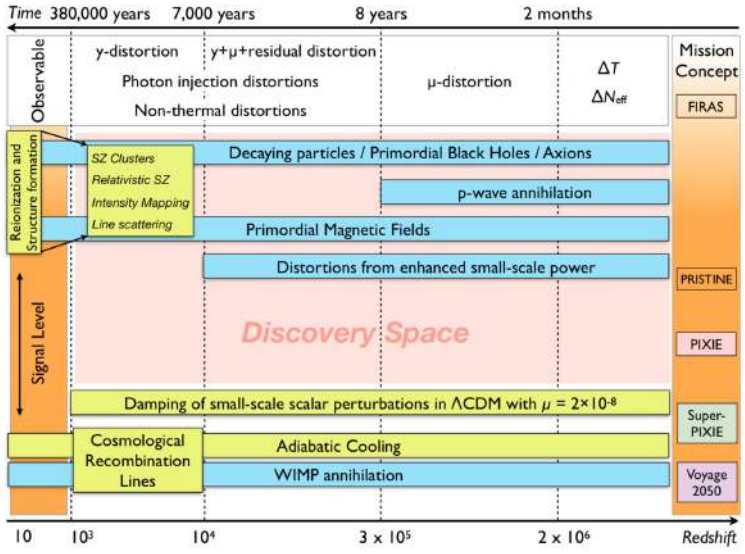




The combination and/or the cross-correlation of CMB spectral distortions and CMB anisotropies leads enable new physics



Extends the level arm for the primordial power spectrum and enable new tests for the concordance cosmology and its extensions



Knowledge of C, python and basic cosmology are required.

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