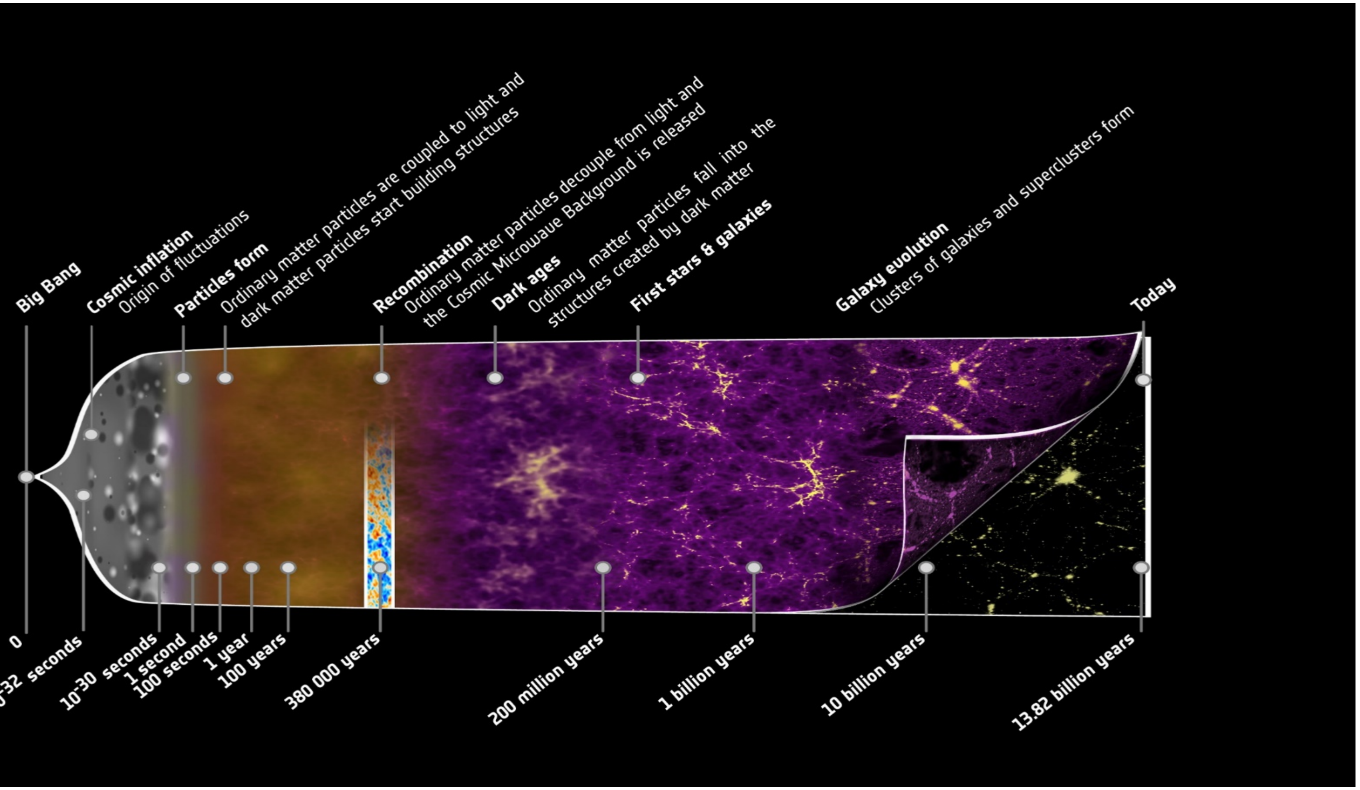
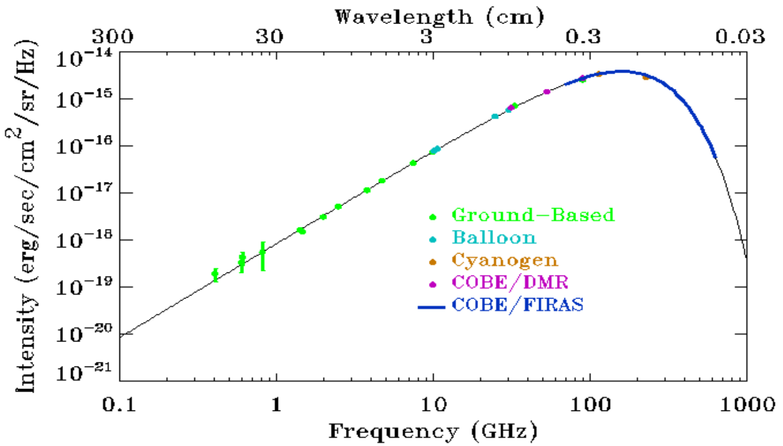
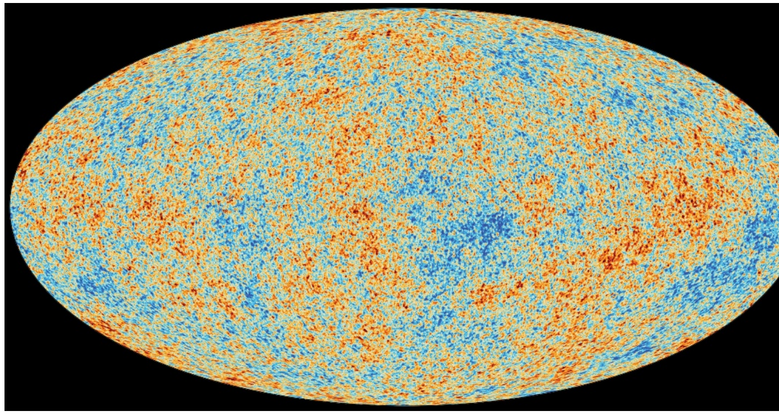
# Cosmology with the Cosmic Microwave Background

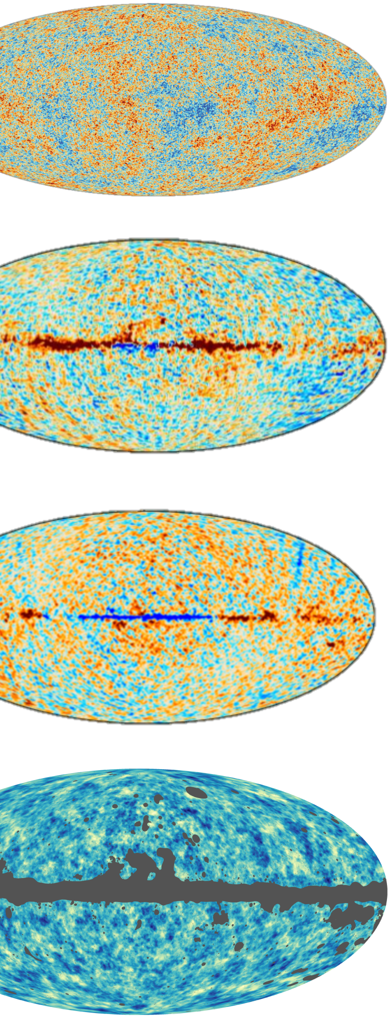


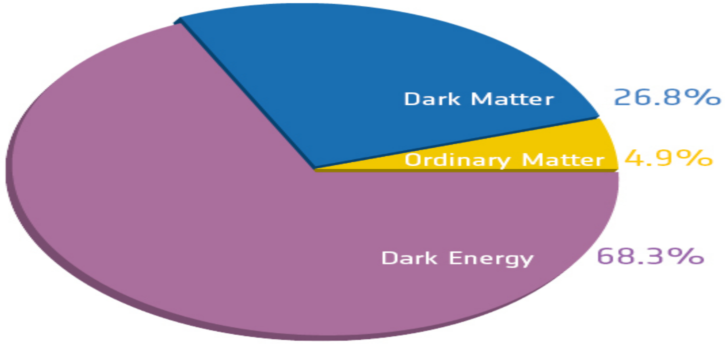



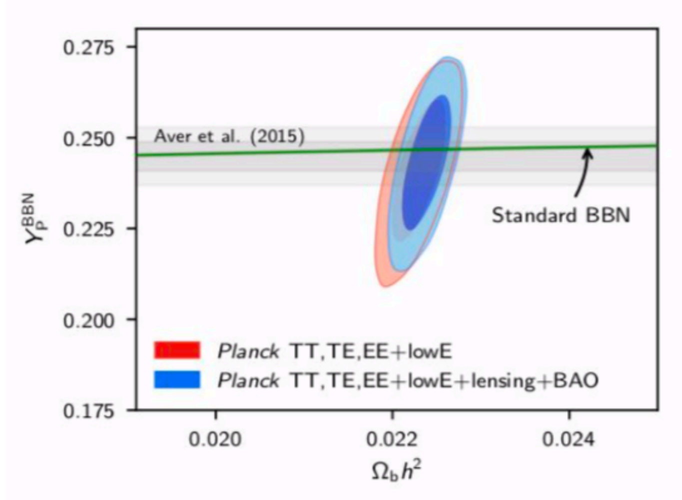



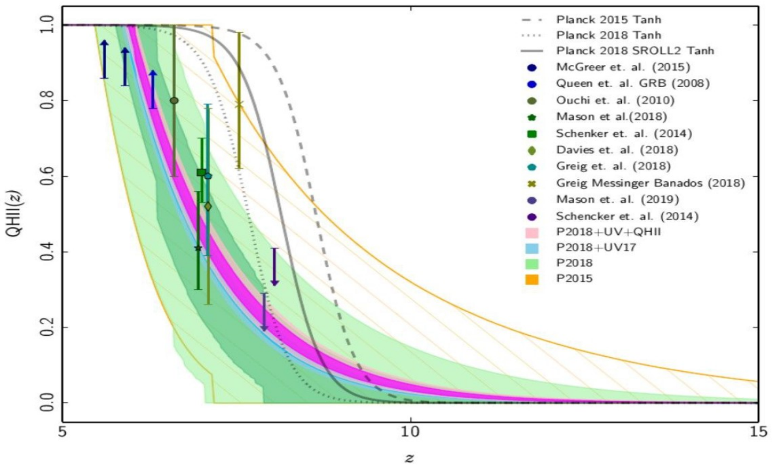
iverse became transparent to light during the cosmological recombination
drogen. These relic photons, called cosmic microwave background (CMB),
gated through dark ages and the era of the first galaxies carrying the most
ient images of our Universe in terms of the blackbody spectrum and the
anisotropy pattern.

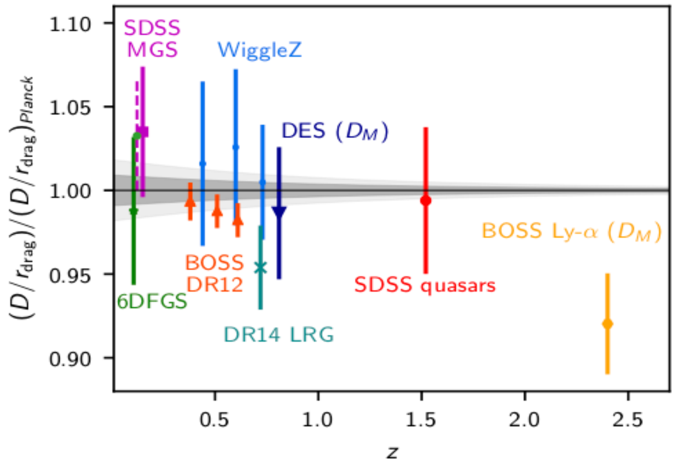
# Cosmology with the Cosmic Microwave Background





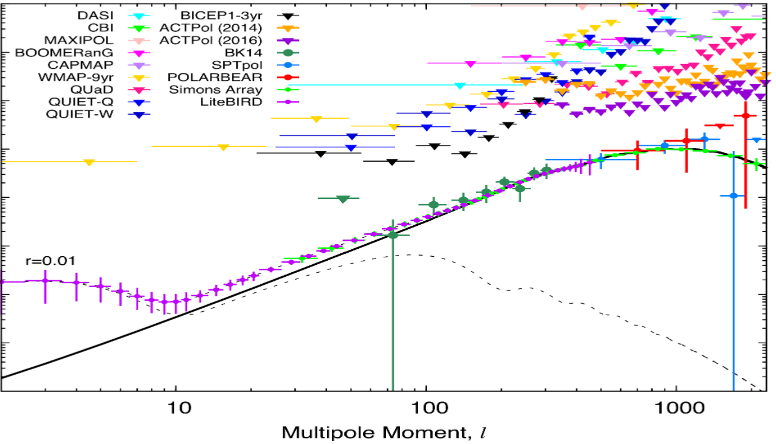



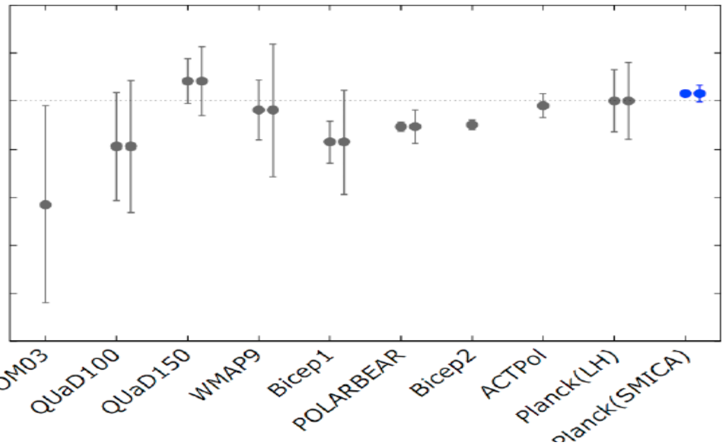



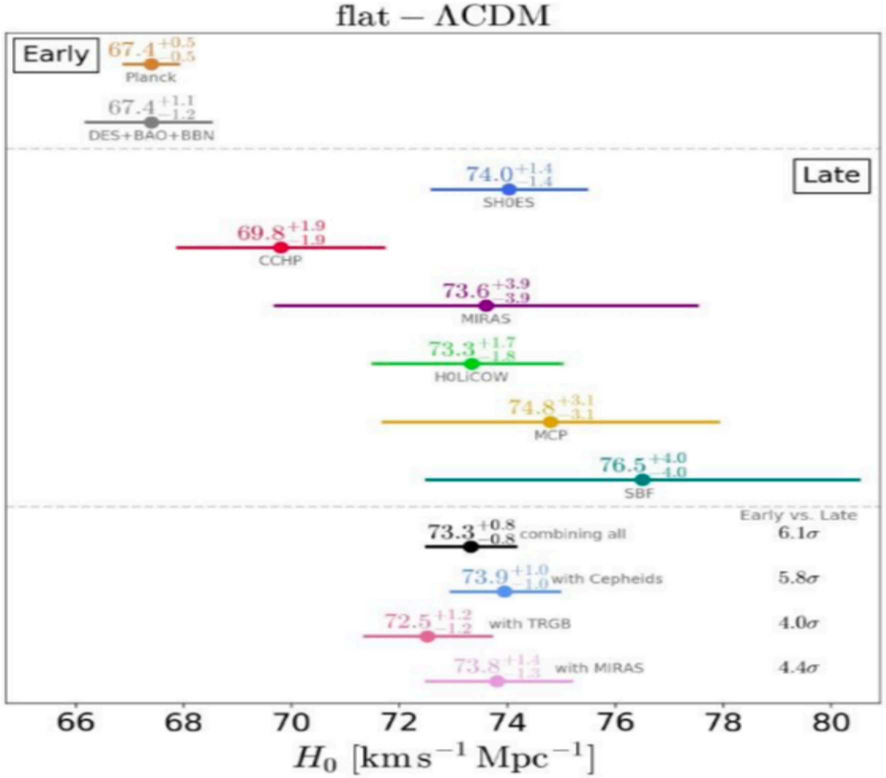

ck 2018 T, Q, U, Lensing
ps are a treasure for
cosmology.

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

# Cosmology with the Cosmic Microwave Background




te the precision in the knowledge of flat ΛCDM cosmological neters, we still have only upper limits on B-mode polarization uced by primordial gravitational waves, which encode the y scale at which inflation occurred, or on birefringence, which 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

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

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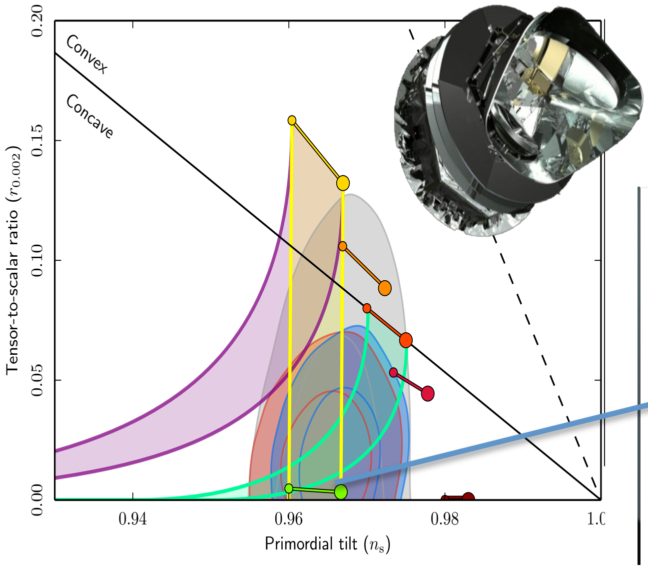
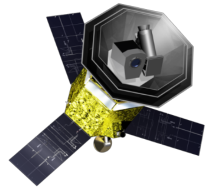
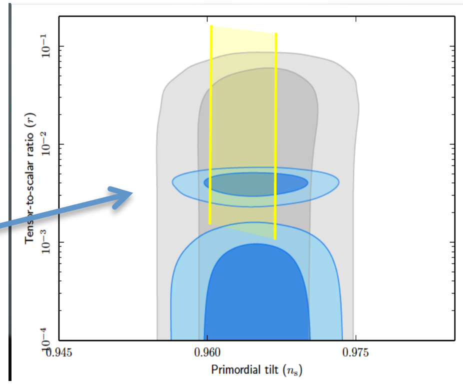
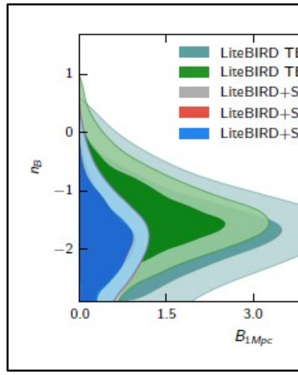
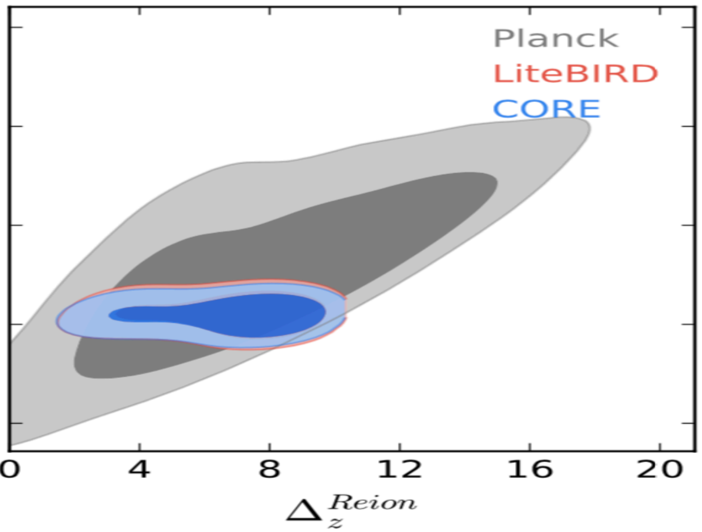


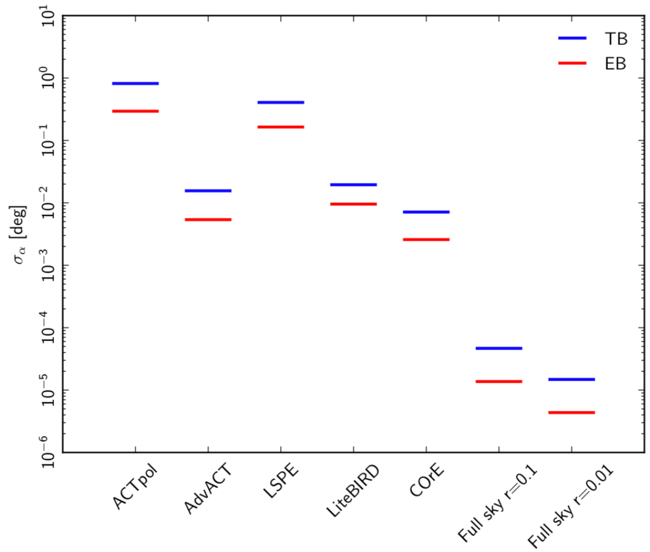



… and will allow to improve the constraints on primordial magnetic fields.




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 impr
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# Cosmology with the Cosmic Microwave Background

alizing on the studies and analysis of CMB anisotropies we are also involved in next galaxy surve
as Euclid.

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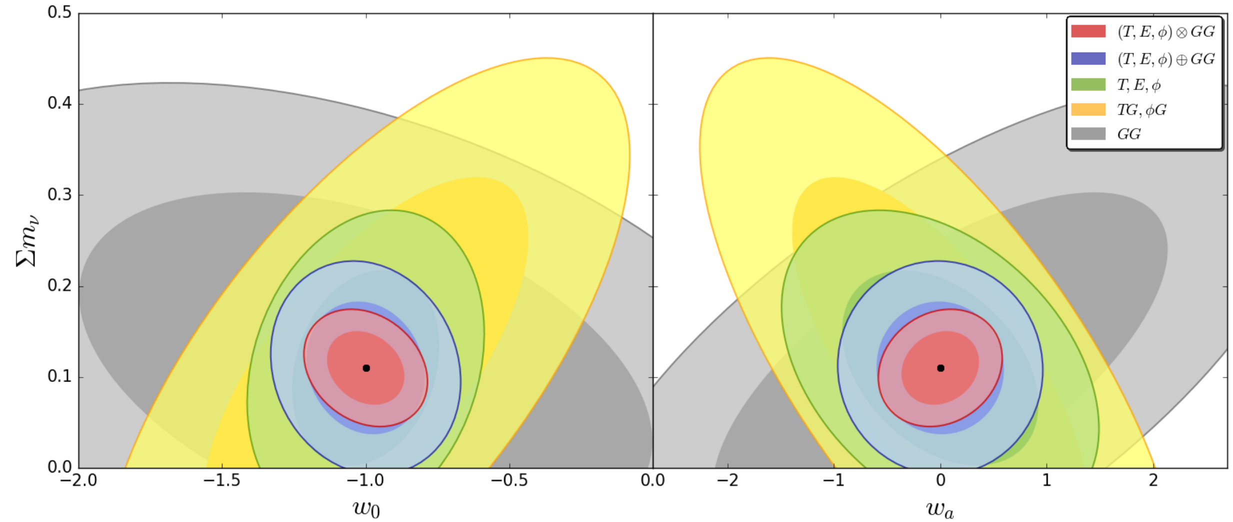


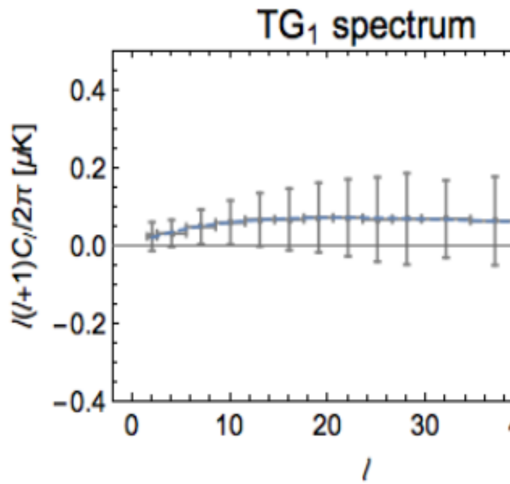


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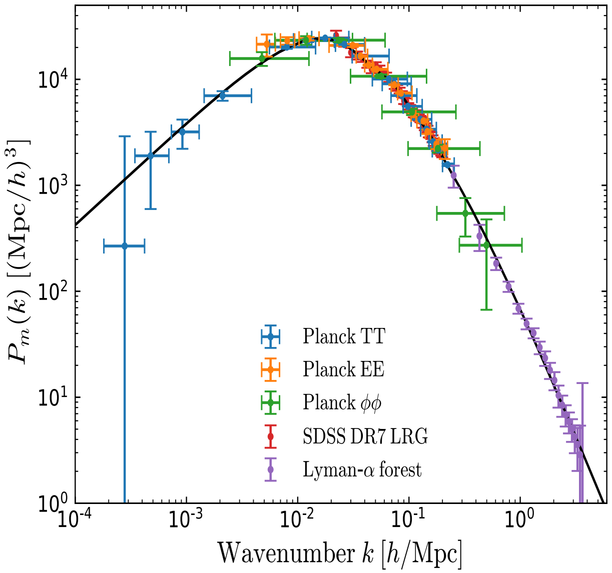
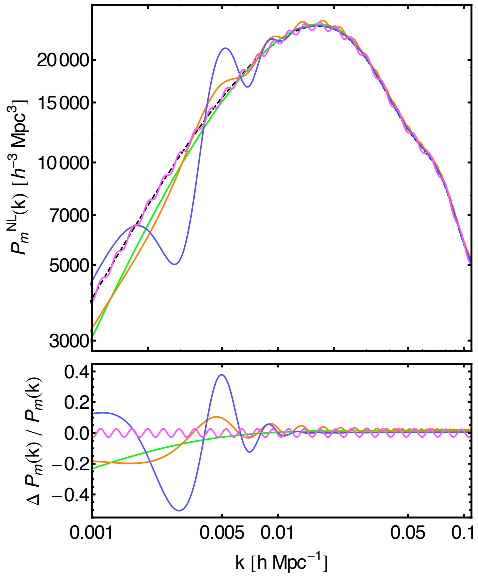
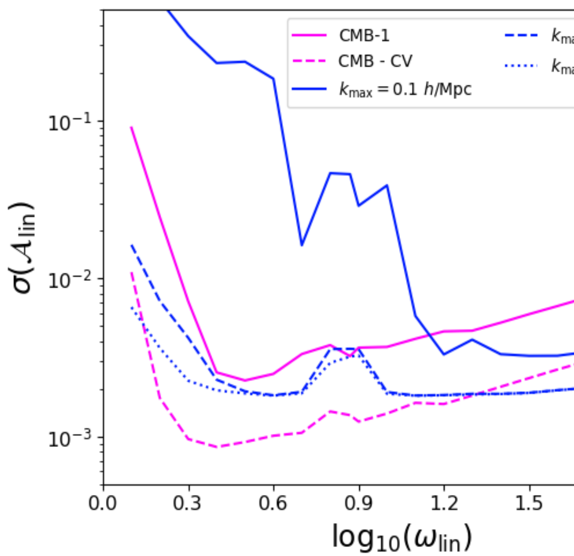
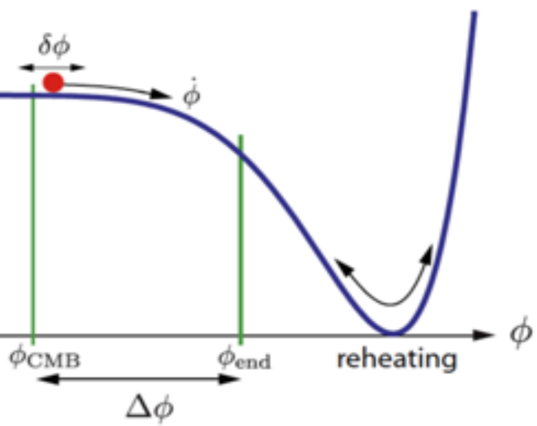


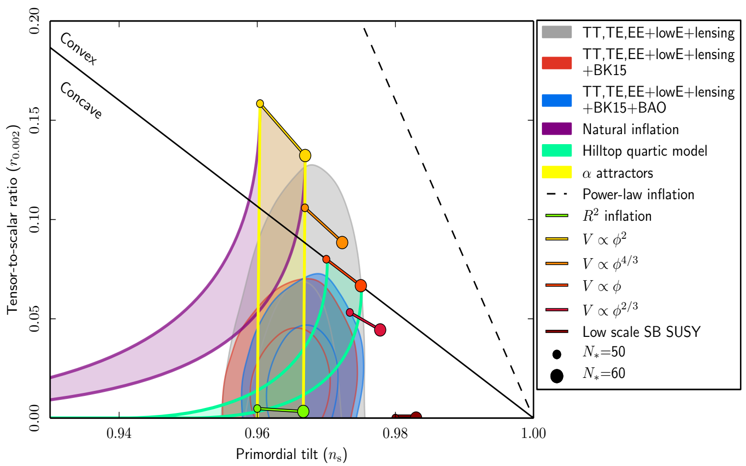



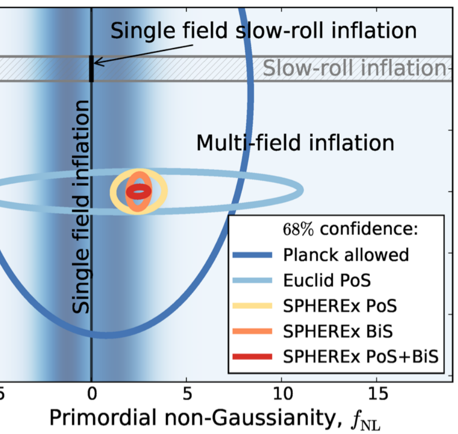
# Inflationary models with the next generation of cosmological experiments

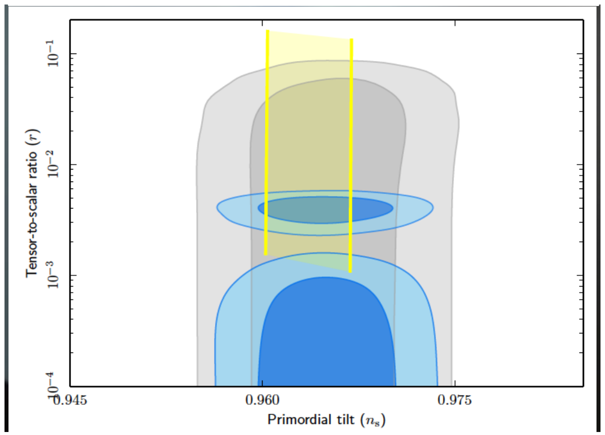



Cosmic inflation is the minimal Early Universe framework which solves the puzzles of the Hot Big Bang Cosmology providing a generation mechanism for the generation of density fluctuations and gravitational waves.




Current data as from Pla have started to discrimi among the simplest inflationary models, tha the precise determinatio scalar tilt ns, the constra the running, non-Gaussi and on the tensor-to-sca ratio, ie the relative abu of gravitational waves.




We propose to use the most recent platform Cobaya (https://cobaya.readthedocs.io/en/latest/), to update the data analysis pipeline for the Bayesian comparison of inflationary models already used in Planck 2015 XX, Planck 2018 X Constraints on inflation, to the next generation of cosmological experiments (mainly LiteBIRD, Simons Observatory, Euclid)

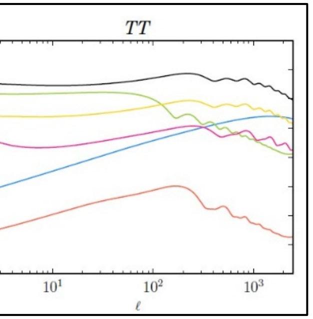
cosmological experiments will further tighten these constraints. LSS will further measure the scalar tilt, running and non- ssianity, whereas CMB next polarization experiments will be itive to smaller tensor-to-scalar ratios.

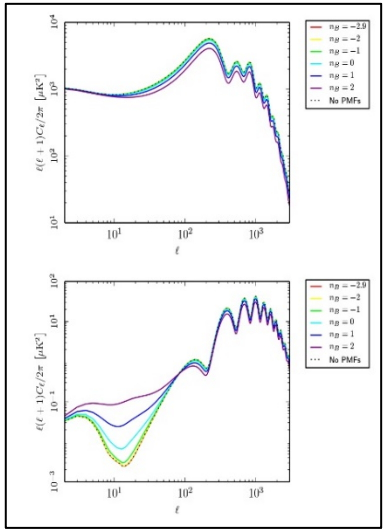
Co-advisors: M. Ballardini (DIFA&OAS),
F. Finelli, D. Paoletti (OAS)
Advisor: L. Moscardini (DIFA)

# Study of primordial magnetism and its properties

nordial Magnetic Fields (PMFs) generated in the early Universe may provide the seeds for large scale magnetic fields we observe
xies, clusters, filaments and voids. The properties of PMFs – such as their depedence on the wavelength and their helicity – depe
the generation mechanism and represent therefore a new window on the physics of the early Universe. The Cosmic Microwa
kground (CMB) is an excellent laboratory for this study: PMFs can leave several imprints on CMB, such as gravitational, therm
n different statistical properties.

Theoretical Predictions

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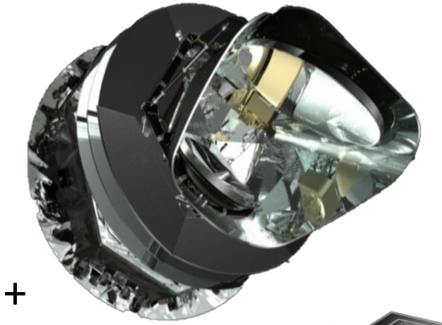
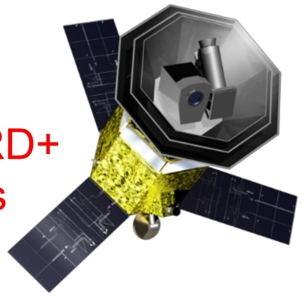


Planck



LiteBIRD+ Simons Obs.

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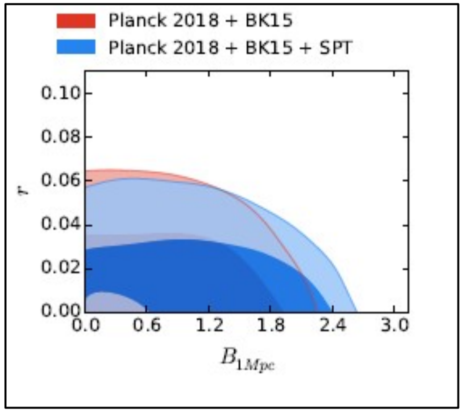
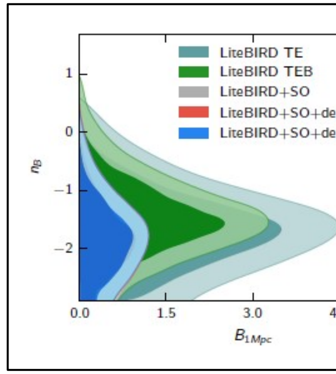



Constraints

Forecasts

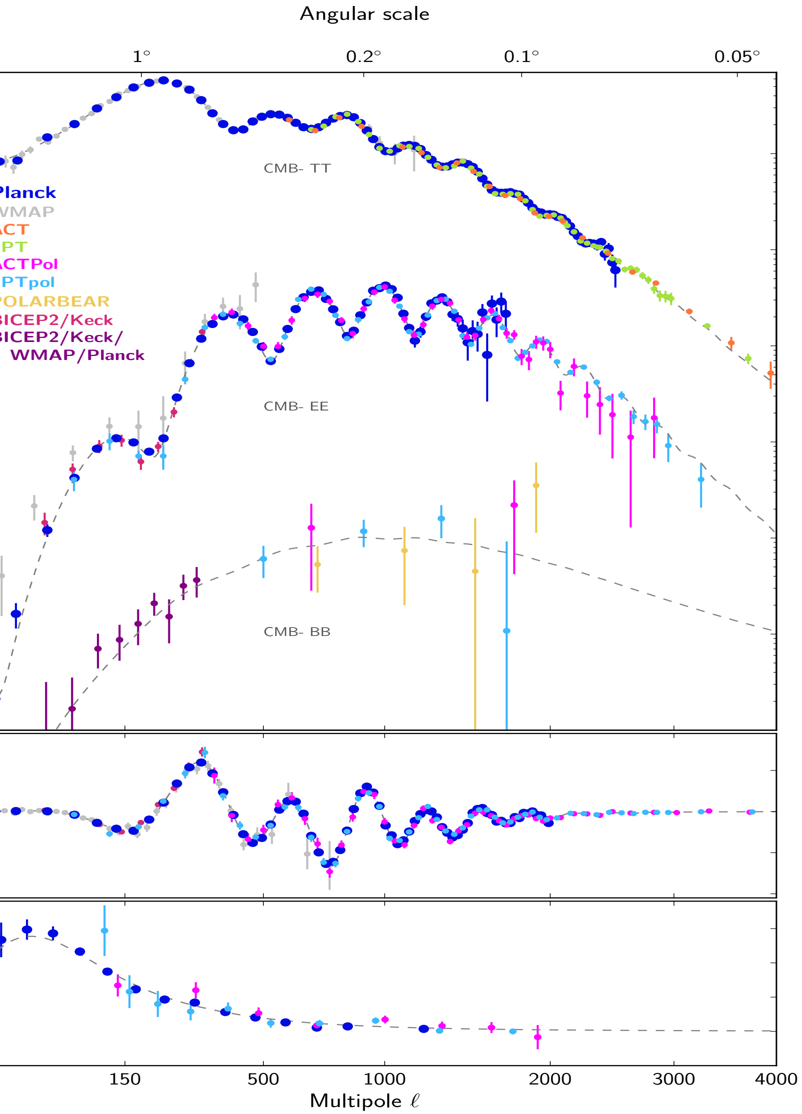



these effects strongly depend on the model of the suppression of PMFs by radiation
osity at small scales. The project we propose is to study different models of suppression
their relevance for current publicly available data and for future CMB experiments.

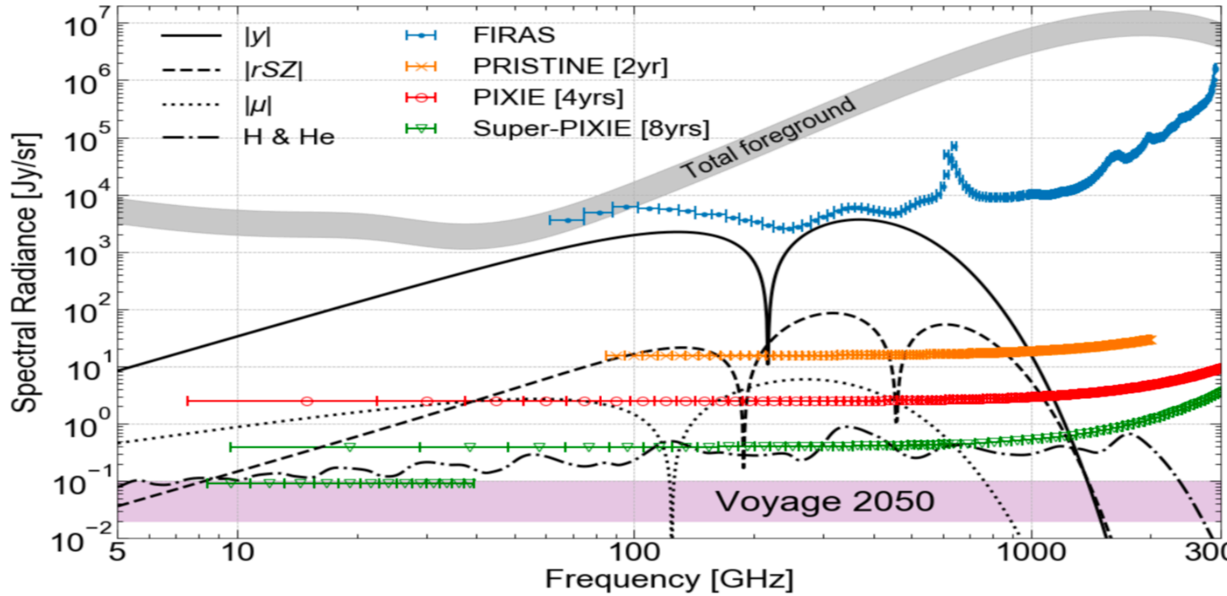
NAF OAS we have a long experience in modelling PMFs and constraining their
perties with CMB data.. Co-supervisor: D. Paoletti, F. Finelli. Supervisor: L. Moscardini.

# Synergy between CMB spectral distortions and anisotropies

ve fantastic measurements of CMB anisotropies in
rature, polarization, their cross-correlation and lensing!




We have instead only upper limits to CMB spectral distortio
which we know are present as anisotropies are!



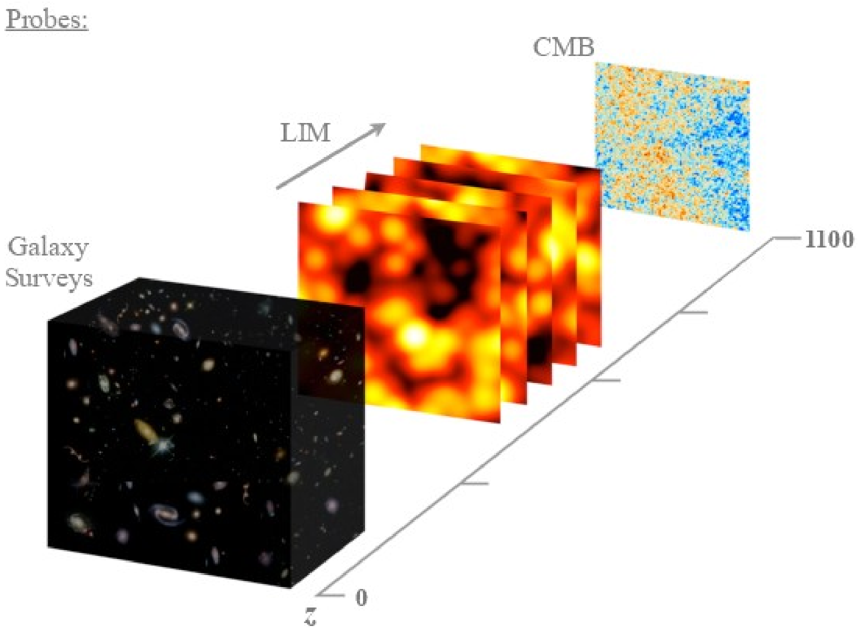

We propose to study jointly spectral distortions and CMB anisotropies with the code CLASS (arXiv:1910.04619).

Co-advisors: M. Ballardini (DIFA&OA
F. Finelli, D. Paoletti (O
Advisor: L. Moscardini (DIFA)

# 21 cm intensity mapping as laboratory for cosmology

with Mario Ballardini, Fabio Finelli, Lauro Moscardini (DIFA & INAF/OAS)

Line-intensity mapping (LIM) is an emerging technique to explore galaxy and structure evolution over cosmic times by collecting all incoming photons along the line of sight at a given frequency, without resolving the underlying galaxies position, and measuring the spatial fluctuations in emission.




The fluctuation maps provide a tracer of both the underlying density fluctuations and of the physical processes that govern the radiation sources.

**The proposed project is to study the future cosmological constraints on the latter, e.g. on the parameters related to the hyperfine structure transition for the 21 cm line.**