UNIVERSITY OF CAMBRIDGE

JAN 2013 – JUNE 2016
POSTDOCTORAL RESEARCH ASSOCIATE

Marina Migliaccio

Ricercatore «Rita Levi Montalcini»
Università di Roma Tor Vergata
July 2018 - onwards

Università di Roma Tor Vergata

IFCA Instituto de Física de Cantabria

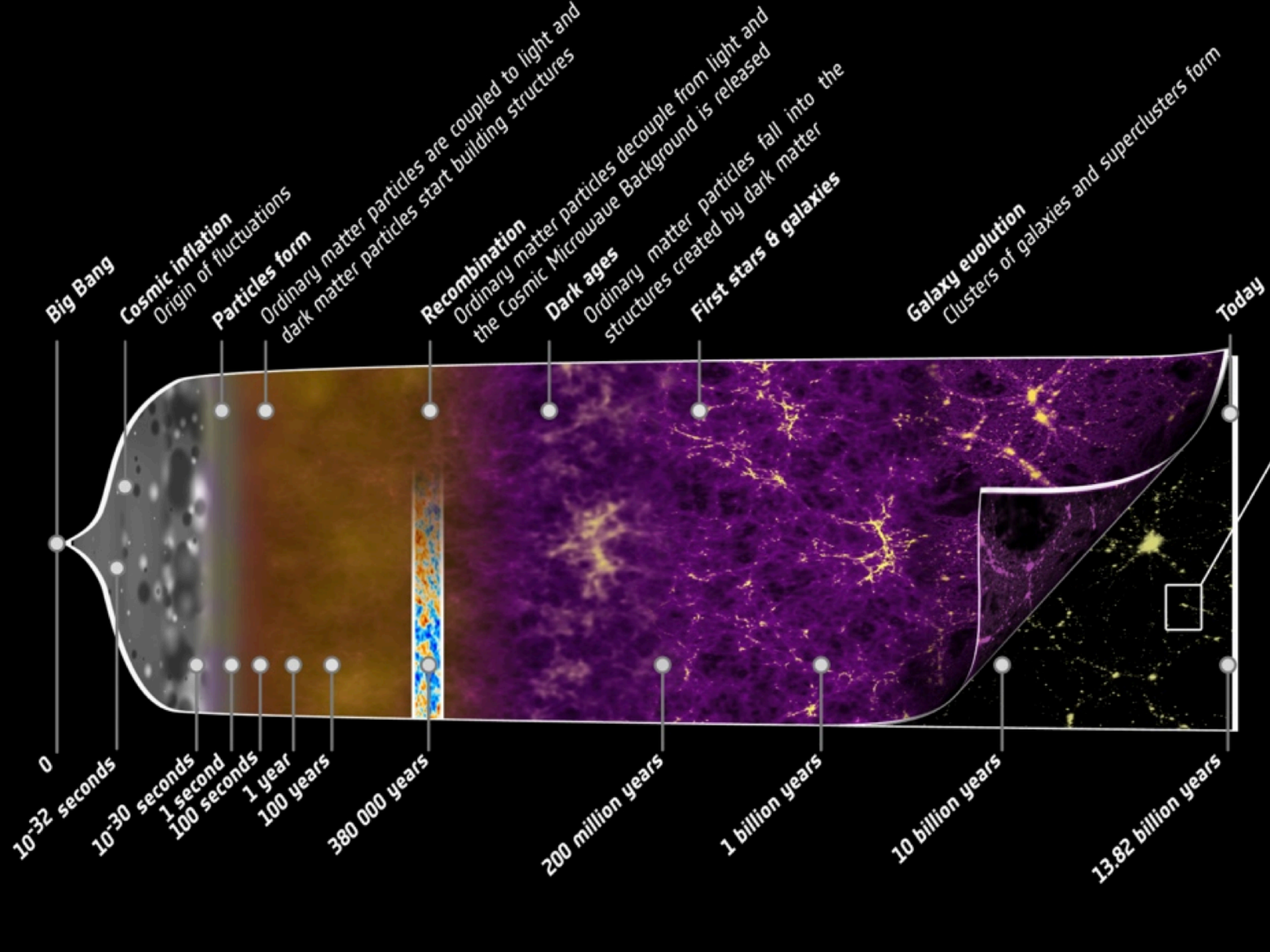
NOV 2011 – DEC 2012
POSTDOCTORAL RESEARCH ASSOCIATE

SSDC SPACE SCIENCE DATA CENTER

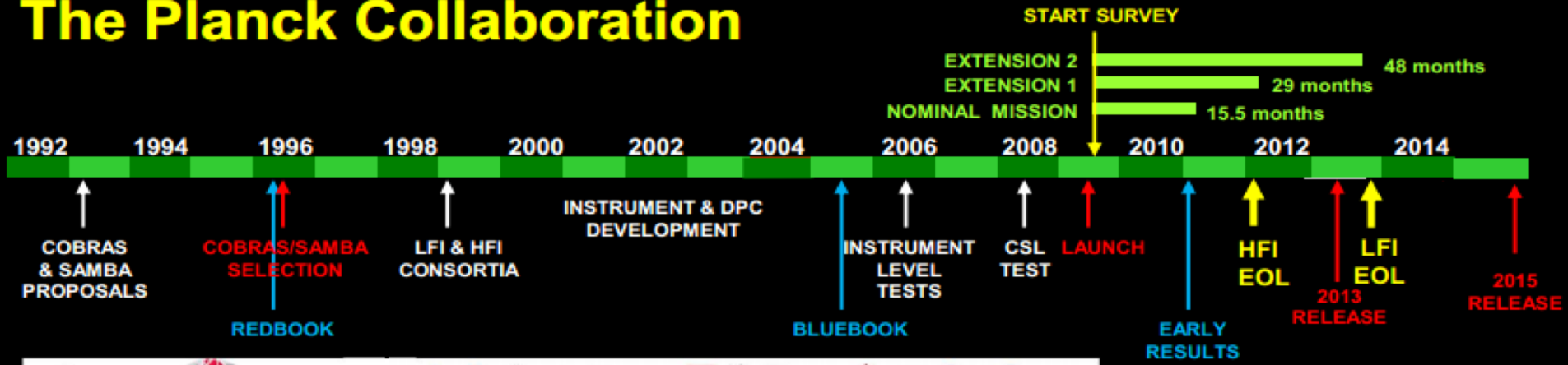
SEPT 2016 – JUNE 2018
ASSEGNISTA DI RICERCA

My research interests in a headline

Tests of the Cosmological Model and Fundamental Physics by developing novel ways to compare theoretical models of the Universe with an ever-growing body of cosmological observations, and in particular those of the Cosmic Microwave Background radiation.


Big Bang
0
Cosmic inflation
Origin of fluctuations
10-32 seconds
Particles form
10-30 seconds
Ordinary matter particles are coupled to light and dark matter particles start building structures
1 second
100 seconds
1 year
100 years
Recombination
380 000 years
Ordinary matter particles decouple from light and the Cosmic Microwaue Background is released
Dark ages
200 million years
Ordinary matter particles fall into the structures created by dark matter
First stars & galaxies
1 billion years
Galaxy evolution
10 billion years
Clusters of galaxies and superclusters form
Today
13.82 billion years

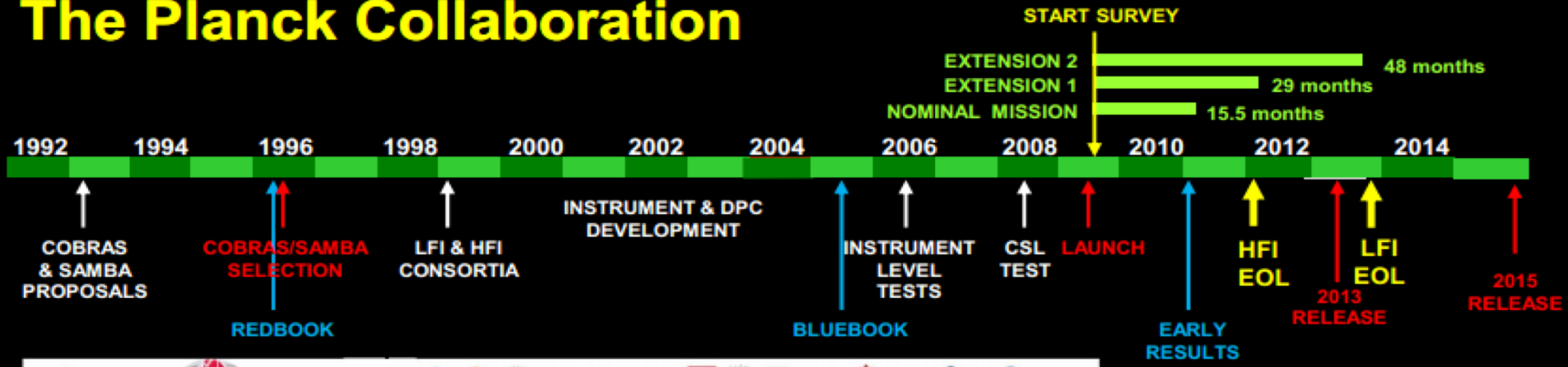
The Planck Collaboration



Space mission to map the Cosmic Microwave Background

Nov 2008: I joined the Collaboration

The Planck Collaboration



Space mission to map the Cosmic Microwave Background

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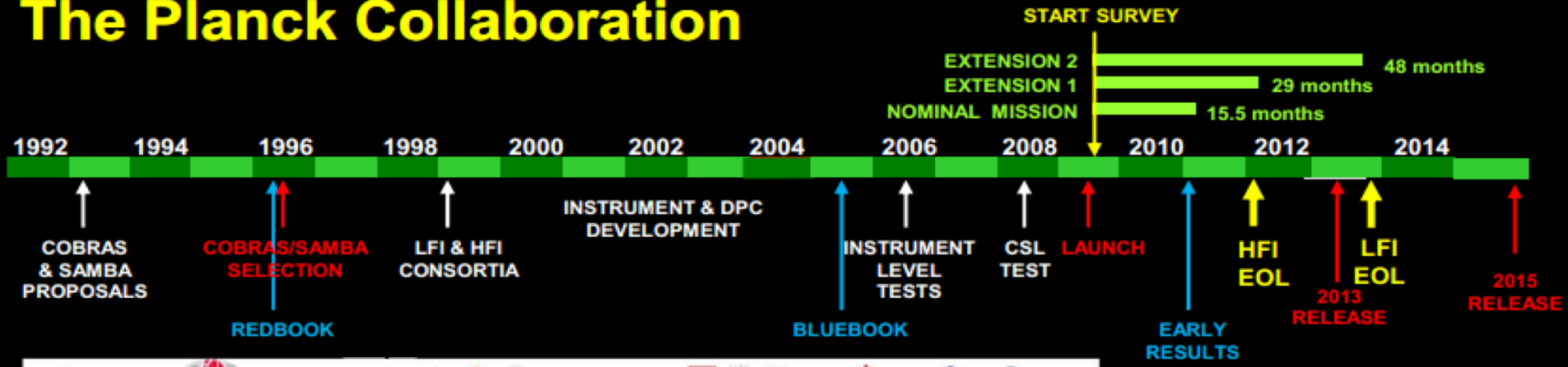
The Planck Collaboration



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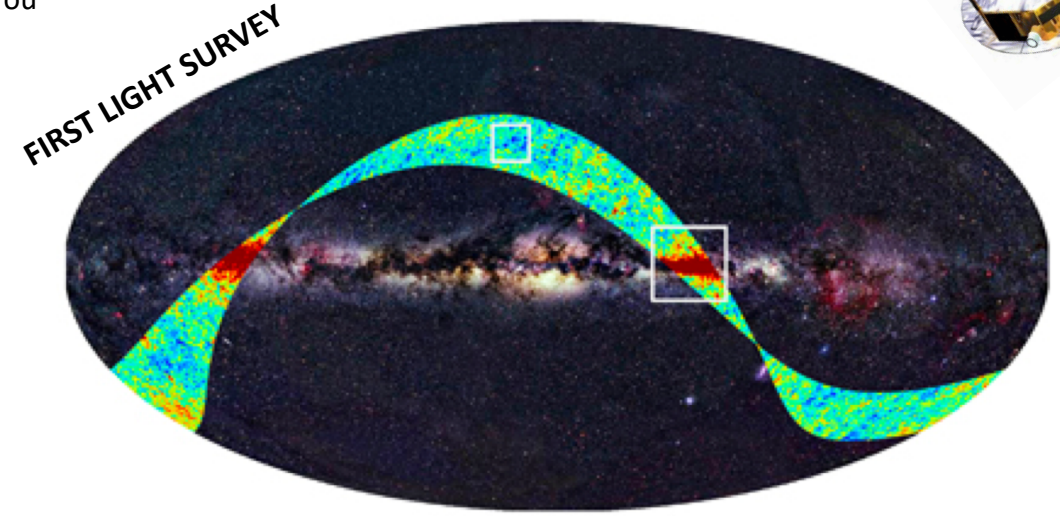
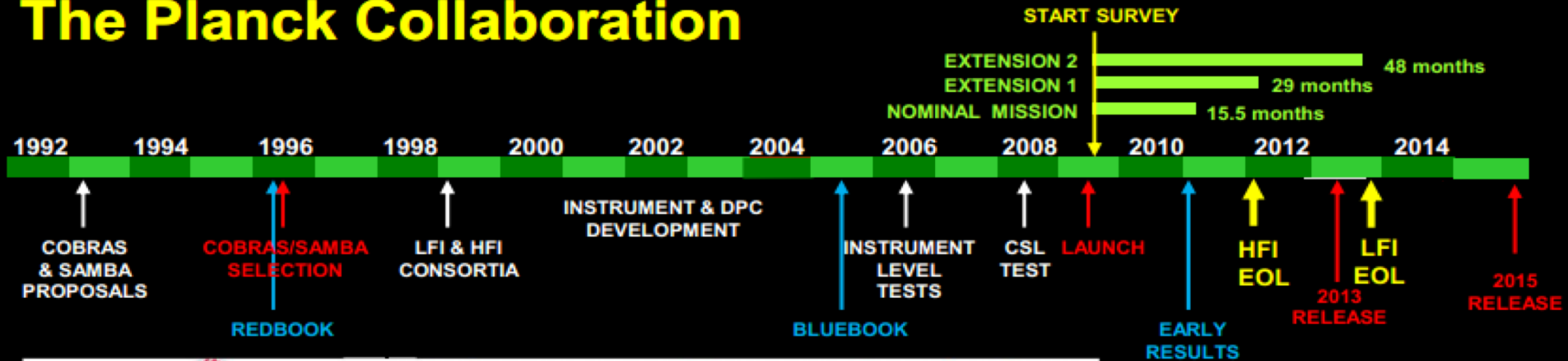


The Planck Collaboration



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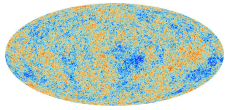
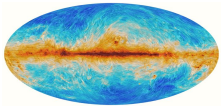


Mar 2013: Data Release and Cosmology Results
Nominal Mission Temperature data

32 papers

Oct 2013: Planck 'Shut Down'

55 papers / intermediate results



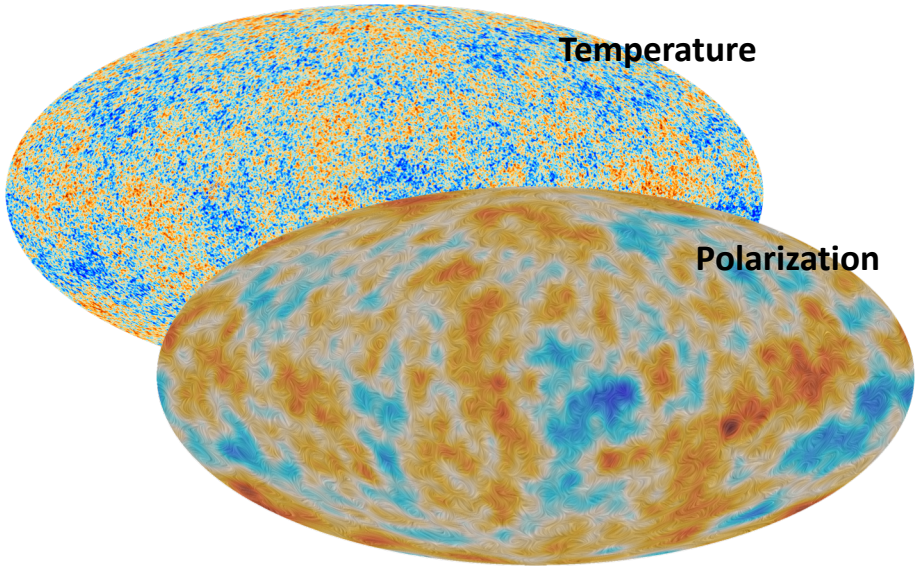
Feb 2015: Data Release and Cosmology Results
Full Mission Temperature and
(preliminary) Polarization data

28 papers

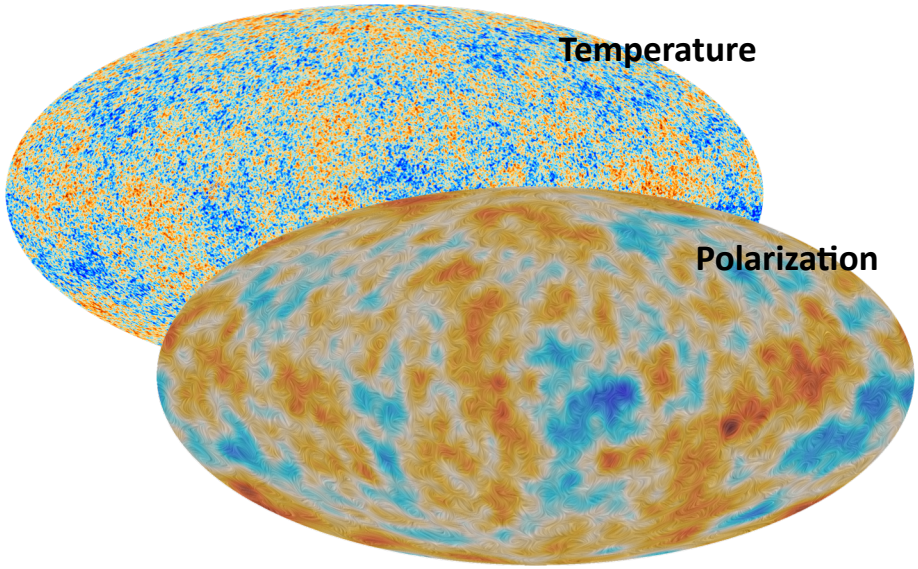
2018 - 2019: Legacy Data & Paper Release

9 papers already out

Working at the interface between Theory and Data



Working at the interface between Theory and Data



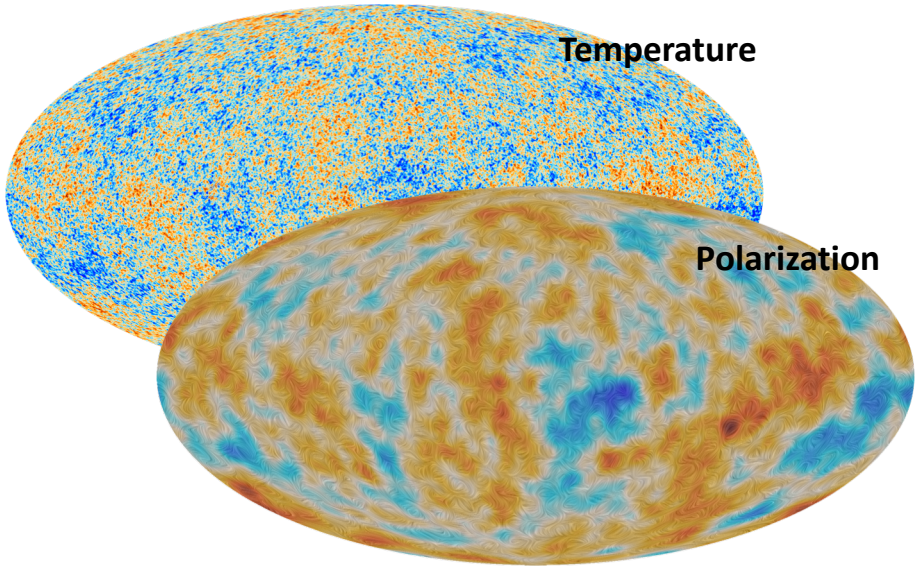
$$\Omega_b \qquad H_0$$

$$\Omega_m \qquad \tau$$

$$n_s$$

$$\sigma_8$$

Working at the interface between Theory and Data

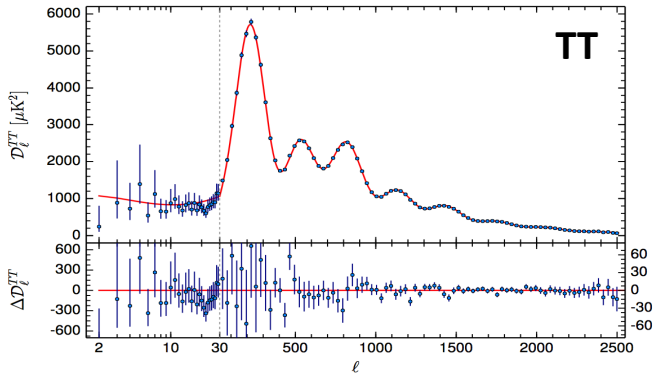


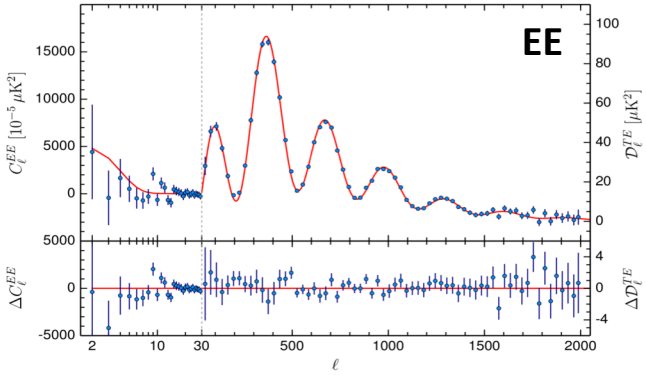
$$\Omega_b \qquad H_0$$
$$\Omega_m \qquad \tau$$
$$n_s \qquad \sigma_8$$

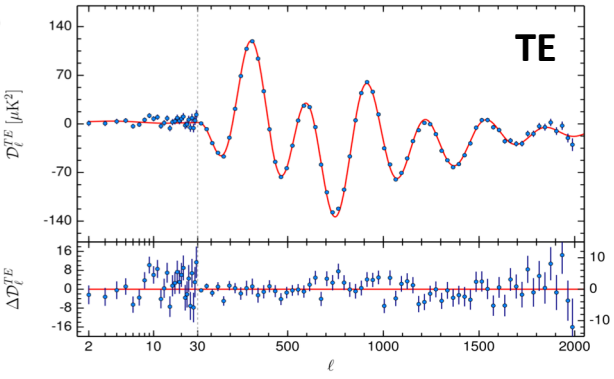
Planck Likelihood

$$P(\text{model} \mid \text{data}) \propto P(\text{data} \mid \text{model})\, P(\text{model})$$

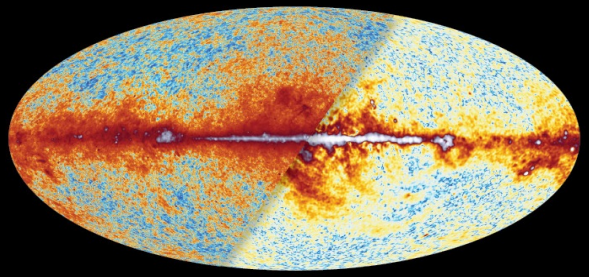
Theoretical predictions + Statistical description of the anisotropies + instrumental and astrophysical foreground models.



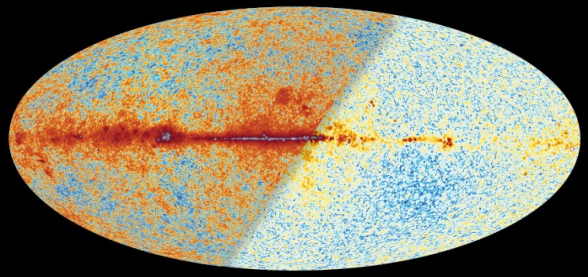




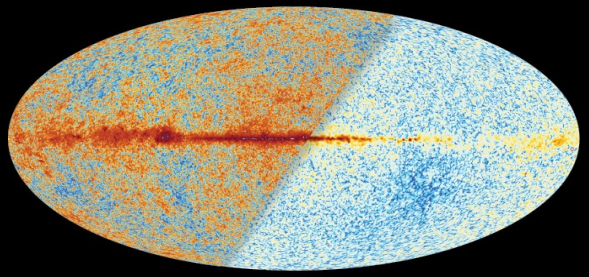
THE SKY AS SEEN BY PLANCK



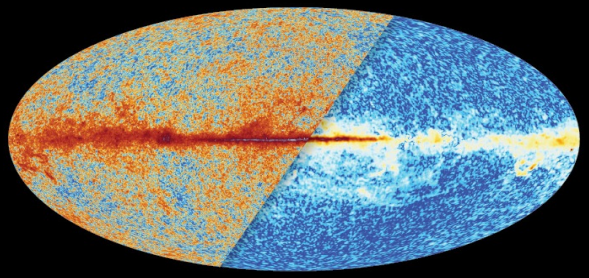
30 GHz



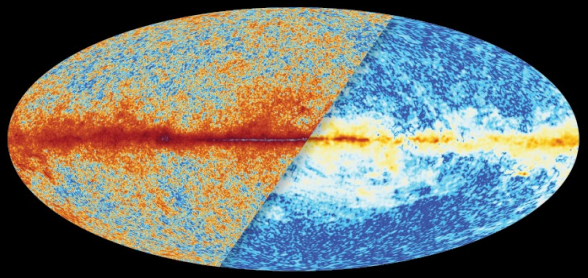
44 GHz



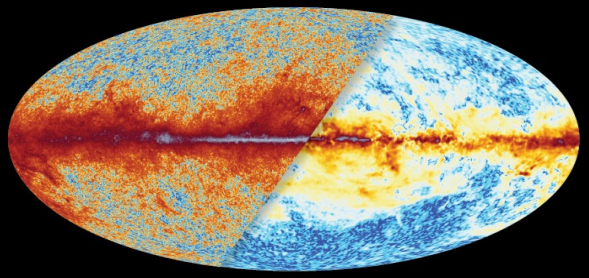
70 GHz



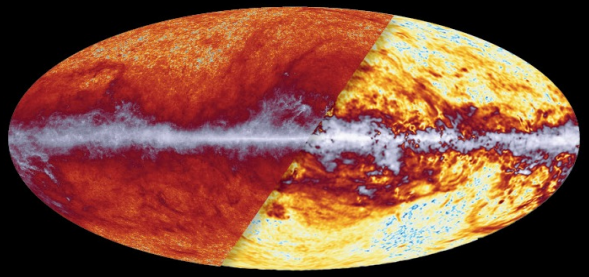
100 GHz



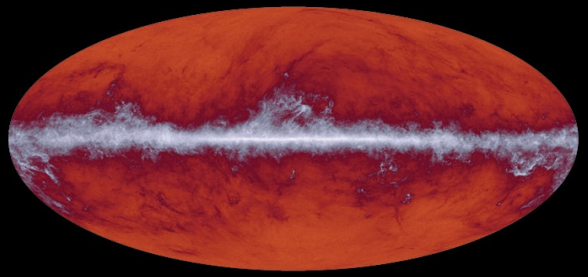
143 GHz



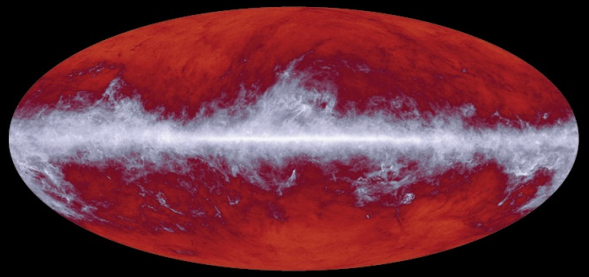
217 GHz



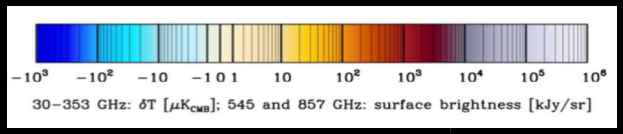
353 GHz



545 GHz

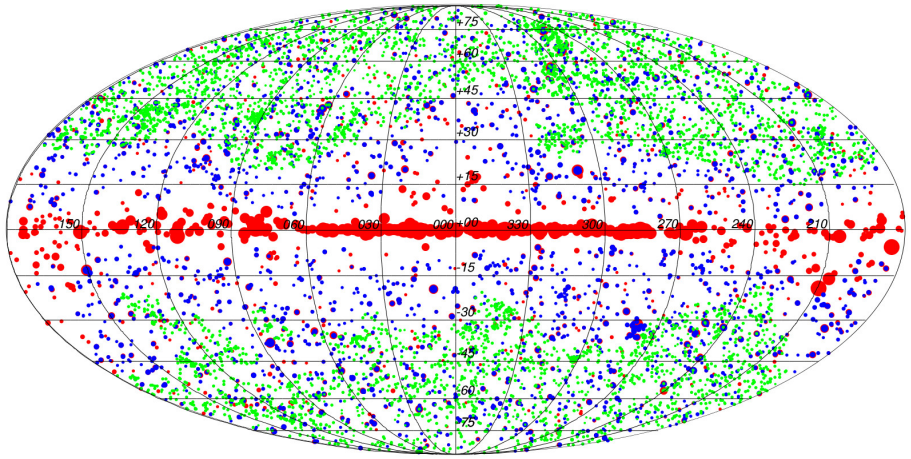


857 GHz



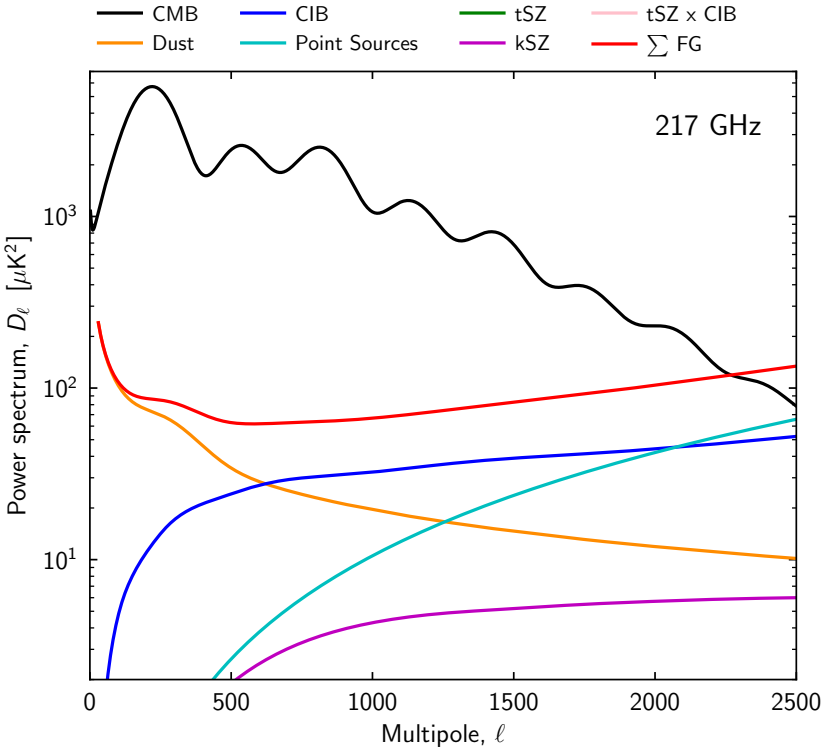
European Space Agency

PLANCK CATALOGUE OF COMPACT SOURCES



PARAMETRIC FOREGROUND MODEL

$$-\ln \mathcal{L}(\hat{\boldsymbol{C}}|\boldsymbol{C}(\theta)) = \frac{1}{2}\left[\hat{\boldsymbol{C}} - \boldsymbol{C}(\theta)\right]^{\mathsf{T}} \mathsf{C}^{-1} \left[\hat{\boldsymbol{C}} - \boldsymbol{C}(\theta)\right] + \text{const.}$$



"*Planck* 2013 results. XII. Diffuse component separation", 2014 A&A 571, A12

"*Planck* 2013 results. XV. CMB power spectra and likelihood", 2014 A&A 571, A15

"*Planck* 2013 results. XVI. Cosmological parameters", 2014 A&A 571, A16

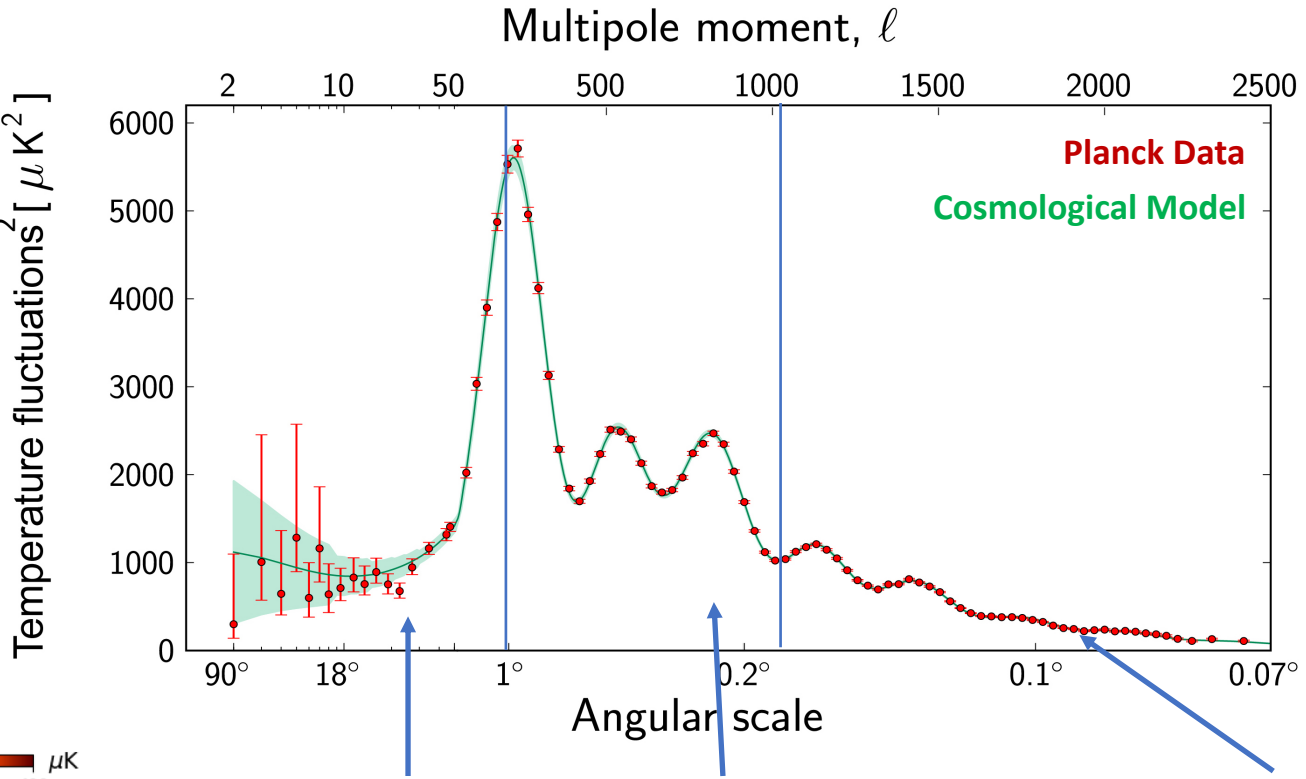
"*Planck* 2013 results. XXXI. Consistency of the Planck data", 2014 A&A 571, A31

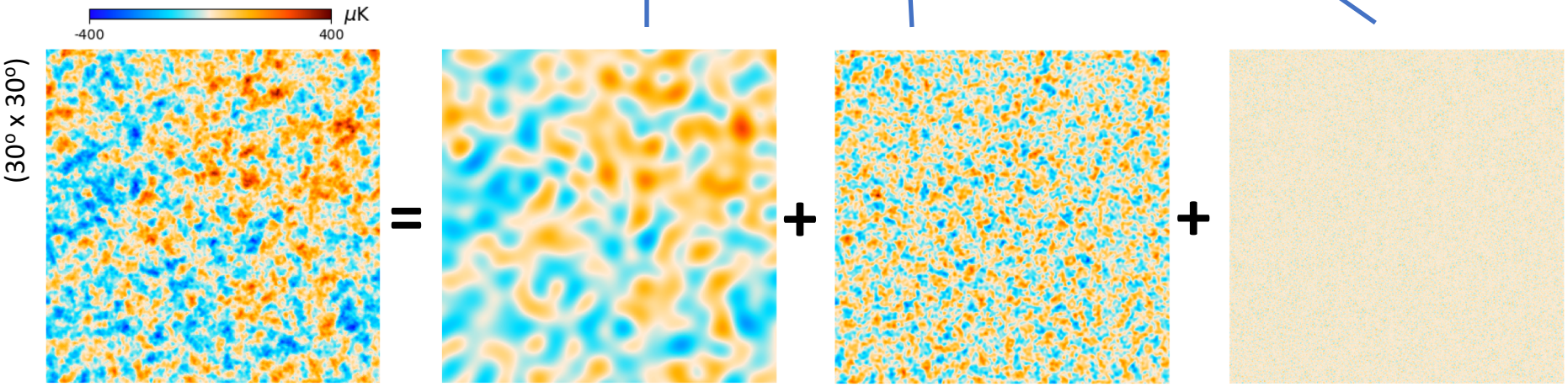
"*Planck* 2015 results. XI. CMB power spectra, likelihoods, and robustness of cosmological parameters", 2016 A&A 594, A11

"*Planck* 2015 results. XIII. Cosmological Parameters", 2016 A&A 594, A13

Efstathiou, G. & Migliaccio, M. "A Simple Empirically Motivated Template for the Thermal Sunyaev-Zeldovich Effect", MNRAS, Vol 423, Issue 3, (2012)

The *ultimate* measurement of the CMB temperature anisotropy field

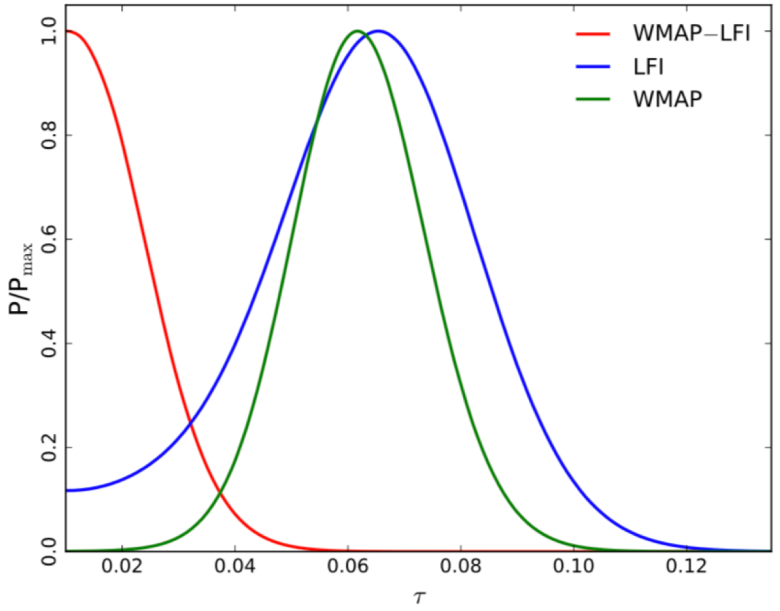




Planck: a new window on polarization science

- Full sky characterization of **polarized foregrounds** over a broad range of frequencies.
- Analysis of the large scale polarization measured with the low frequency instrument to constrain the **electron scattering optical depth due to reionization**. Important to better understand the properties of the first sources in the Universe and break degeneracies with other cosmological parameters.

For many years to come Planck large-scale polarization measurements will be the natural complement to current and upcoming ground-based experiments, and a reference for planning future space missions.



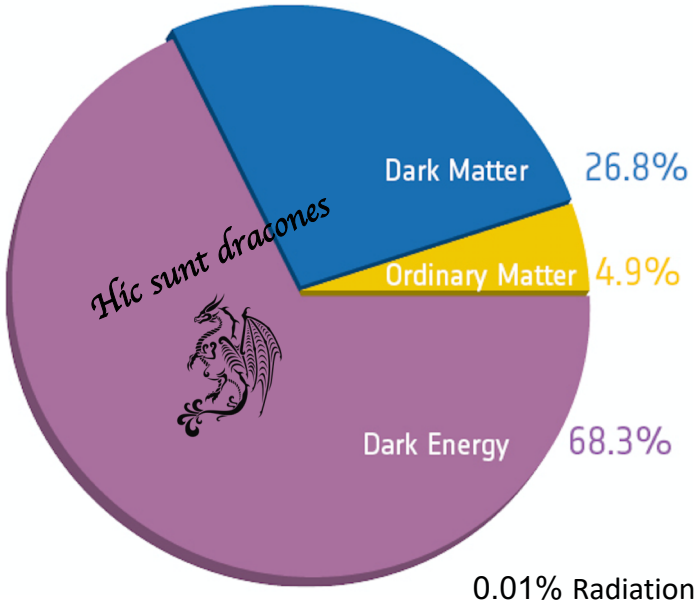
Planck 2018 results. VI. Cosmological parameters, Submitted to A&A

Planck 2018 results. V. Legacy Power Spectra and Likelihoods, soon to be submitted

BICEP2/Keck & Planck Collaborations: "A Joint Analysis of BICEP2/Keck Array and *Planck* Data", 2015 Phys. Rev. Lett. 114, 101301

2018 Gruber Prize in Cosmology

"Planck measured, with unprecedented precision, the matter ***content and geometry of the universe****, the imprint on the CMB of hot gas in galaxy clusters and of* ***gravitational lensing by large-scale structure****, constrained a hypothetical* ***`inflationary' phase****, pinned down* ***when the first stars formed****, and provided unique information about interstellar dust and magnetic fields in our Galaxy"*



0.01% Radiation

We provided the most stringent tests yet of the Cosmological Model.

Fully described by 6 parameters:

- Determined with high precision (< 1% level)
- and accuracy (lots of internal consistency checks)
- Improving on previous constraints by factor 1.5 – 2
- Very powerful in constraining extensions to the base model
  (Curvature, Helium Abundance, Running of the Spectral Index, Dark Energy equation of state, Sum of neutrino masses, Number of relativistic species)

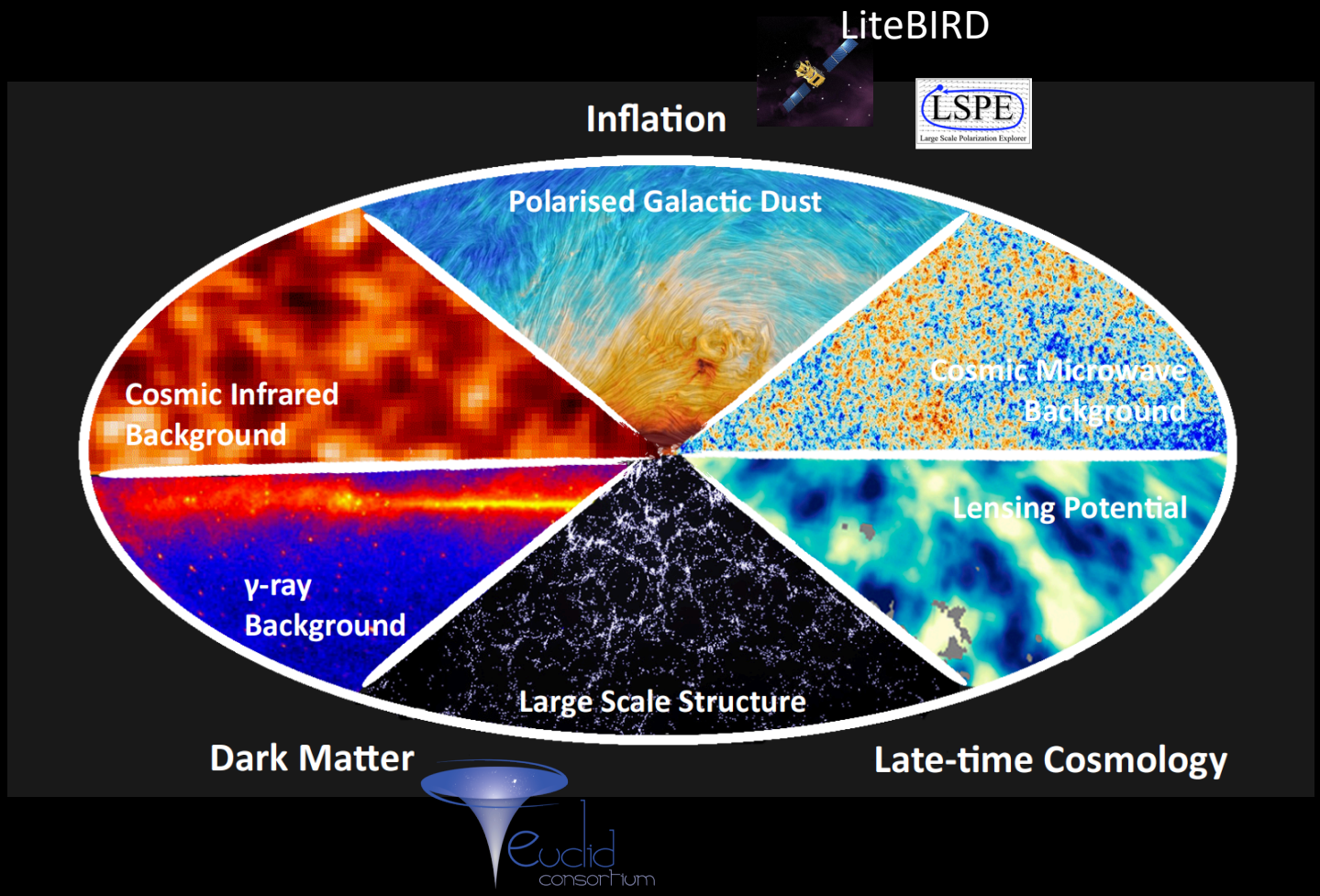
No compelling evidence for new physics beyond the base inflationary ΛCDM model of Cosmology. However, some tensions with astrophysical measurements, may or may not hint at new physics.

CMB data to test non-standard Physics

- **Searches for Cosmic Strings**
  Novel method to search for cosmic strings in CMB maps using steerable wavelets, that are directional filters on the sphere.
  "Planck 2013 results. XXV. Searches for cosmic strings and other topological defects", 2014 A&A 571, A25
- **In-vacuo birefringence**
  A novel method to constrain an anisotropic rotation of the CMB linear polarization.
  Gubitosi, G., Migliaccio, M., Pagano, L. et al, *"Using CMB data to constrain non-isotropic Planck-scale modifications to Electrodynamics"*, JCAP, Issue 11, pag.3 (2011)
- **Dark Matter Equation of State**
  Investigate the impact of a non-standard time evolution of the dark matter component.
  Calabrese, E., Migliaccio, M., Pagano, L. et al., "Cosmological constraints on the matter equation of state", Physical Review D, Volume 80, Issue 6, id. 063539 (2009)
- **Primordial Non-Gaussianity**
  Tightest constraints on CMB non-Gaussianity from suborbital experiments.
  Natoli, P., De Troia, G., Hikage, C., Komatsu, E., Migliaccio, M. et al., "BOOMERanG Constraints on Primordial Non-Gaussianity from Analytical Minkowski Functionals", MNRAS, Vol. 408, Issue 3, (2010)

  Migliaccio, M. et al., "Probing primordial non Gaussianity in the BOOMERanG CMB maps: an analysis based on analytical Minkowski functionals", Nuclear Physics B, (2009)

A Bright Future



"Putting the concordance model on the test bench:
fundamental physics from the cross-correlation of cosmological probes"