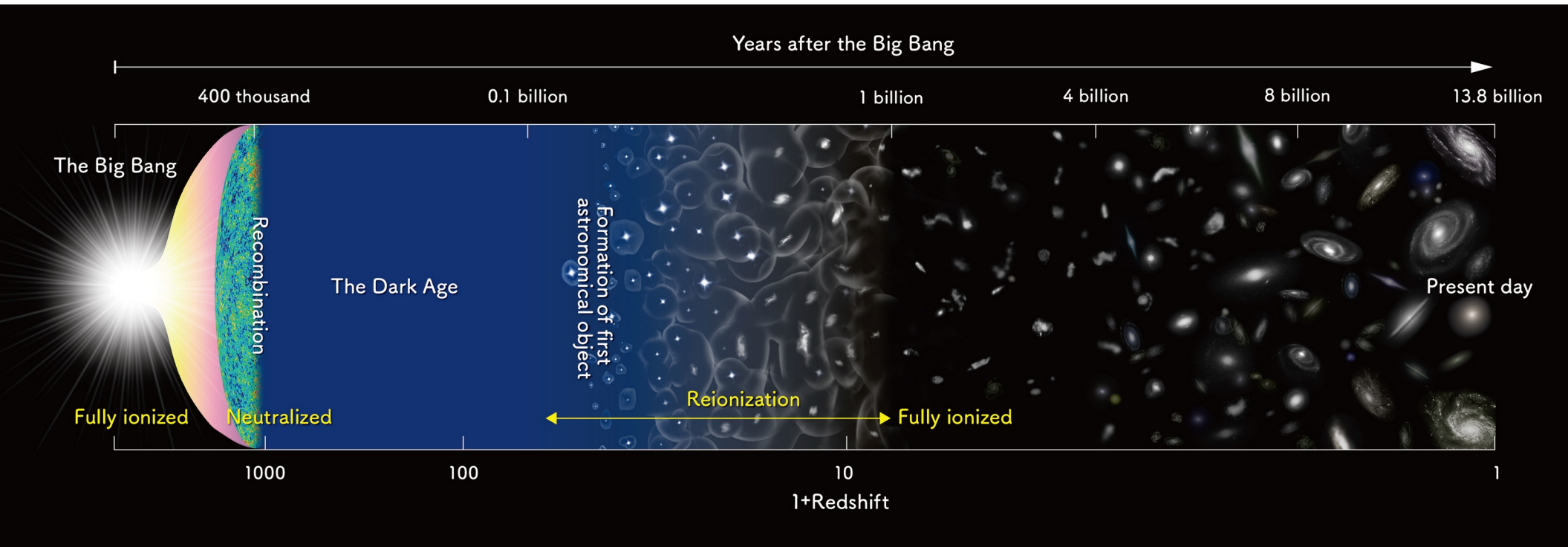


ACT DR6: Cosmology from the CMB with Ground-Based Experiments

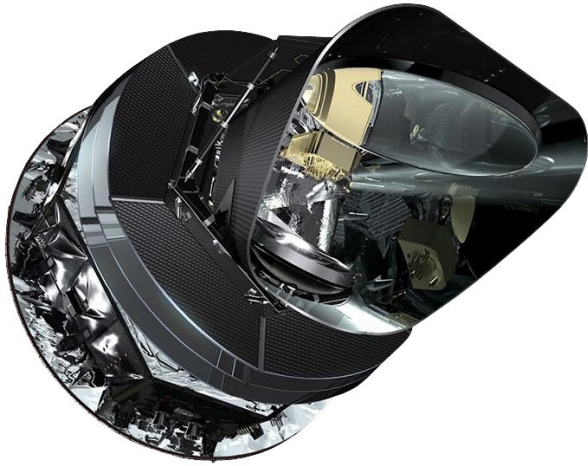
Hidde Jense
Leiden, 2026



Cosmic History of the Universe

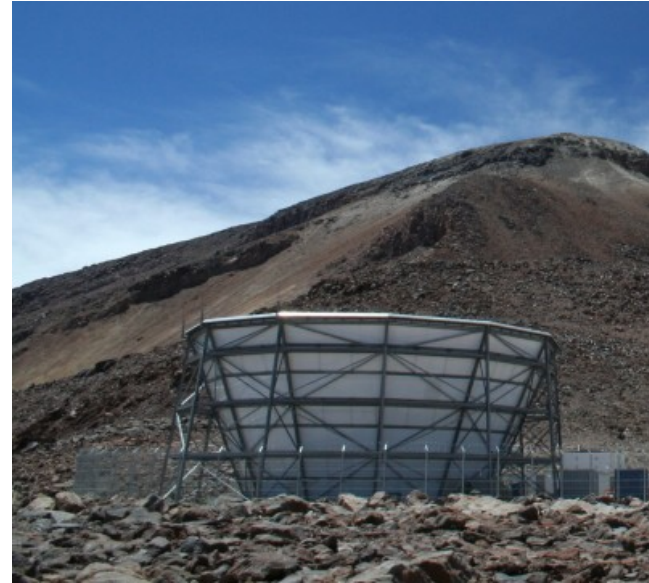


Past, Present, and Future Experiments



Planck

Last release 2018
70% sky coverage for science
5-10 arcmin resolution
9 bands 30-850 GHz



Atacama Cosmology Telescope

Observations 2008-2022
30% sky coverage for science
1-2 arcmin resolution
5 bands 30-220 GHz
Noise 3-6x lower than Planck

The Atacama Cosmology Telescope

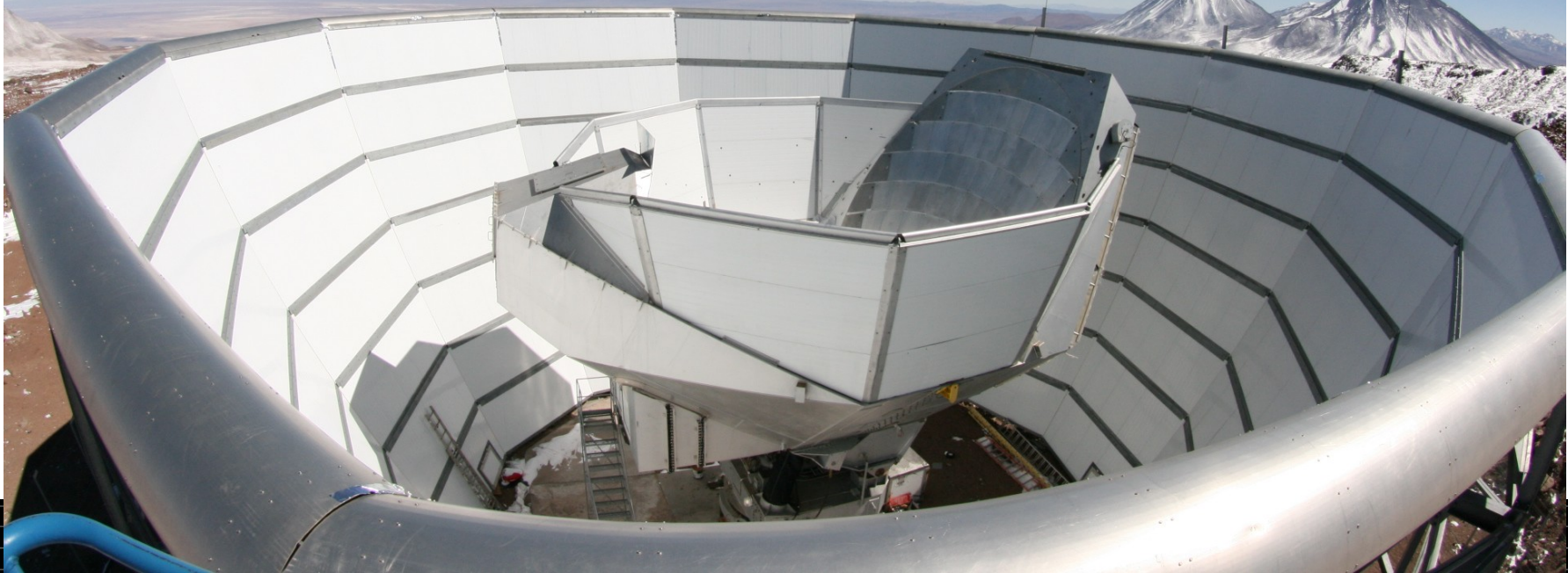
Cerro Toco Plateau in Chile



Credit: Debra Kellner, 2019

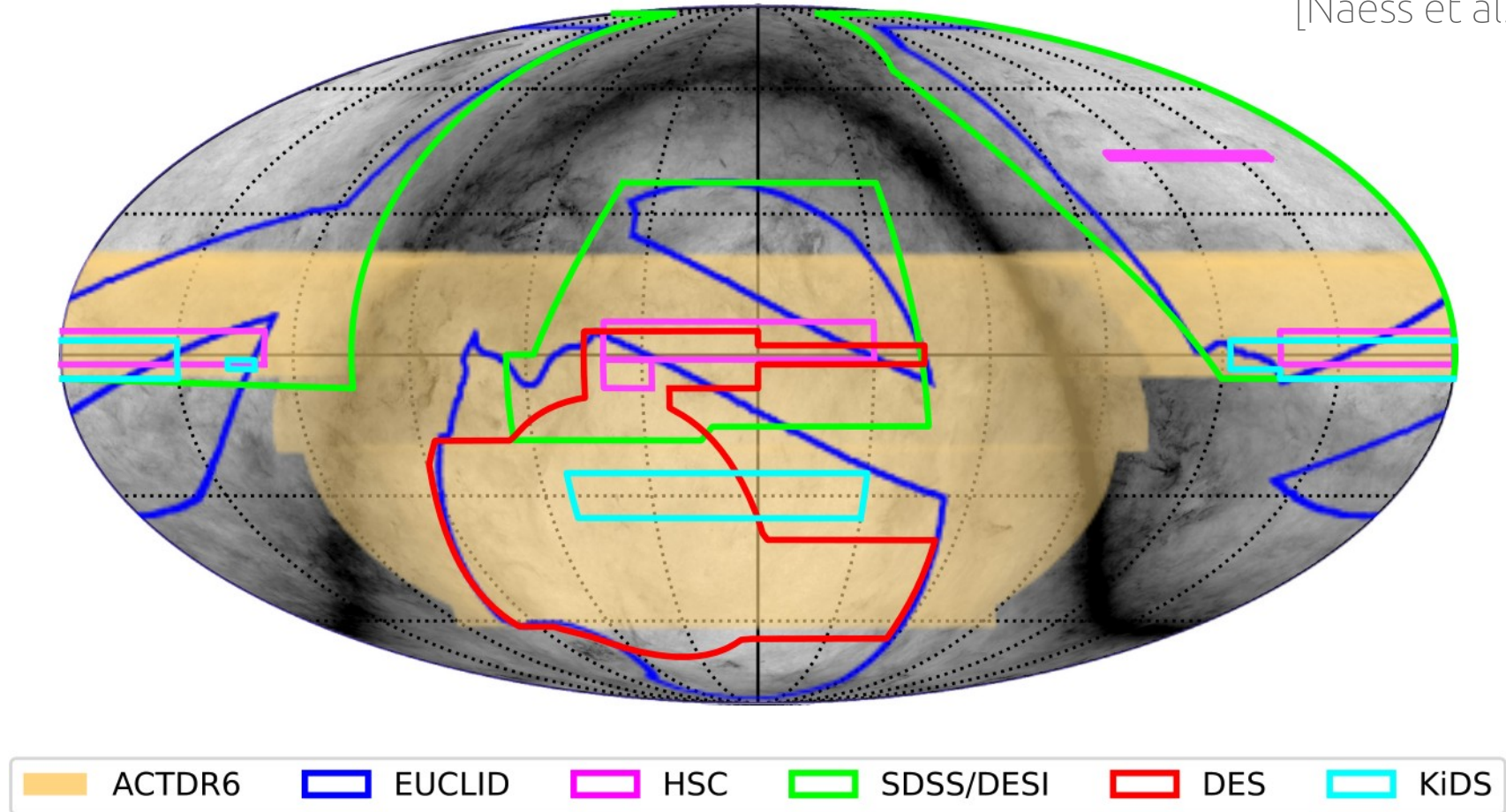
ACT Data Release 6

- Data Release 6 (DR6):
 - Maps and Power Spectra from 3 bands (90/150/220 GHz);
 - 5x resolution, 3x polarization depth compared to *Planck*;
 - 10x data volume of previous release (DR4).
- Cosmological constraints competitive with *Planck*.
 - First test of CMB cosmology independent from *Planck*.

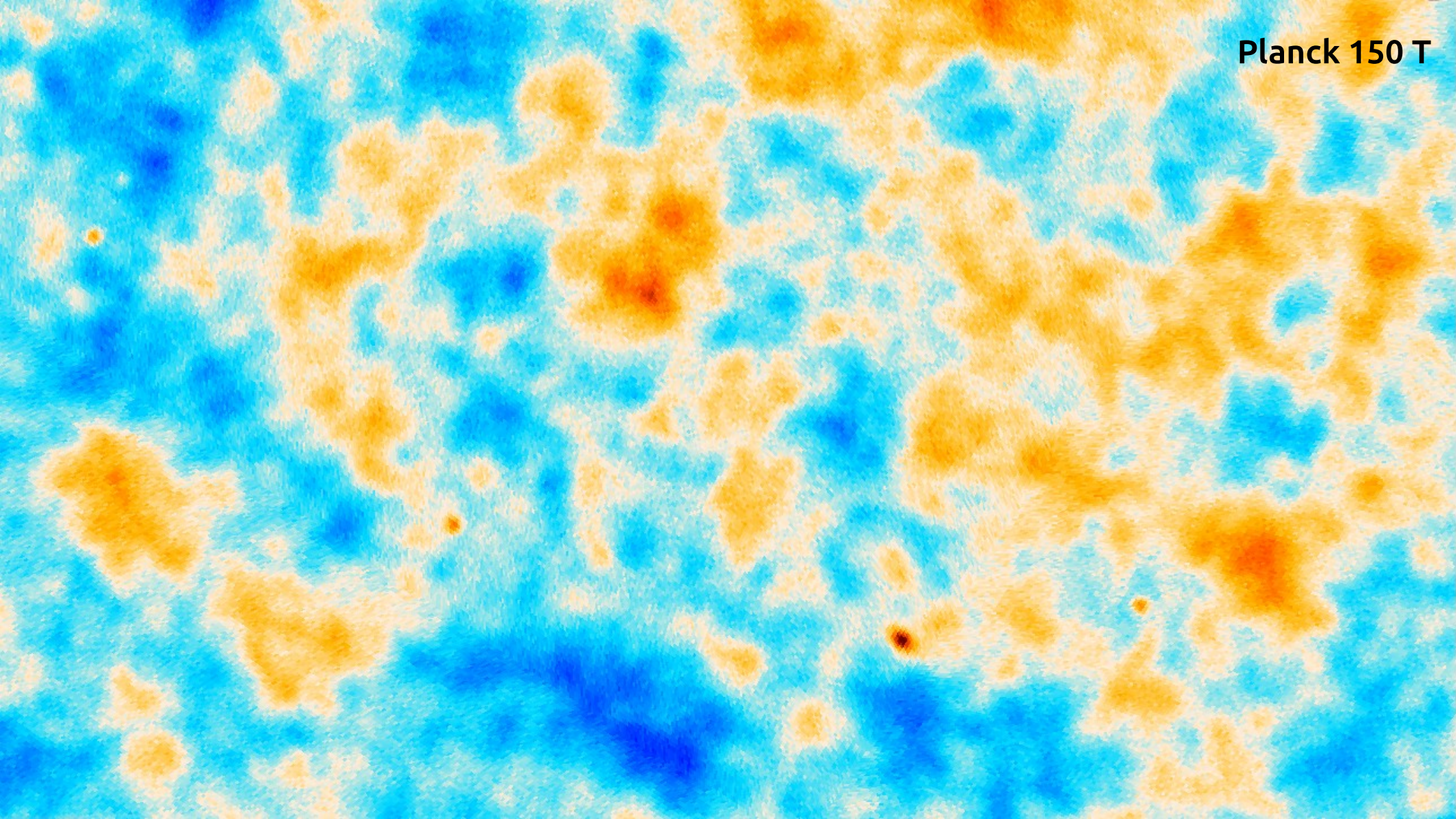


ACT DR6

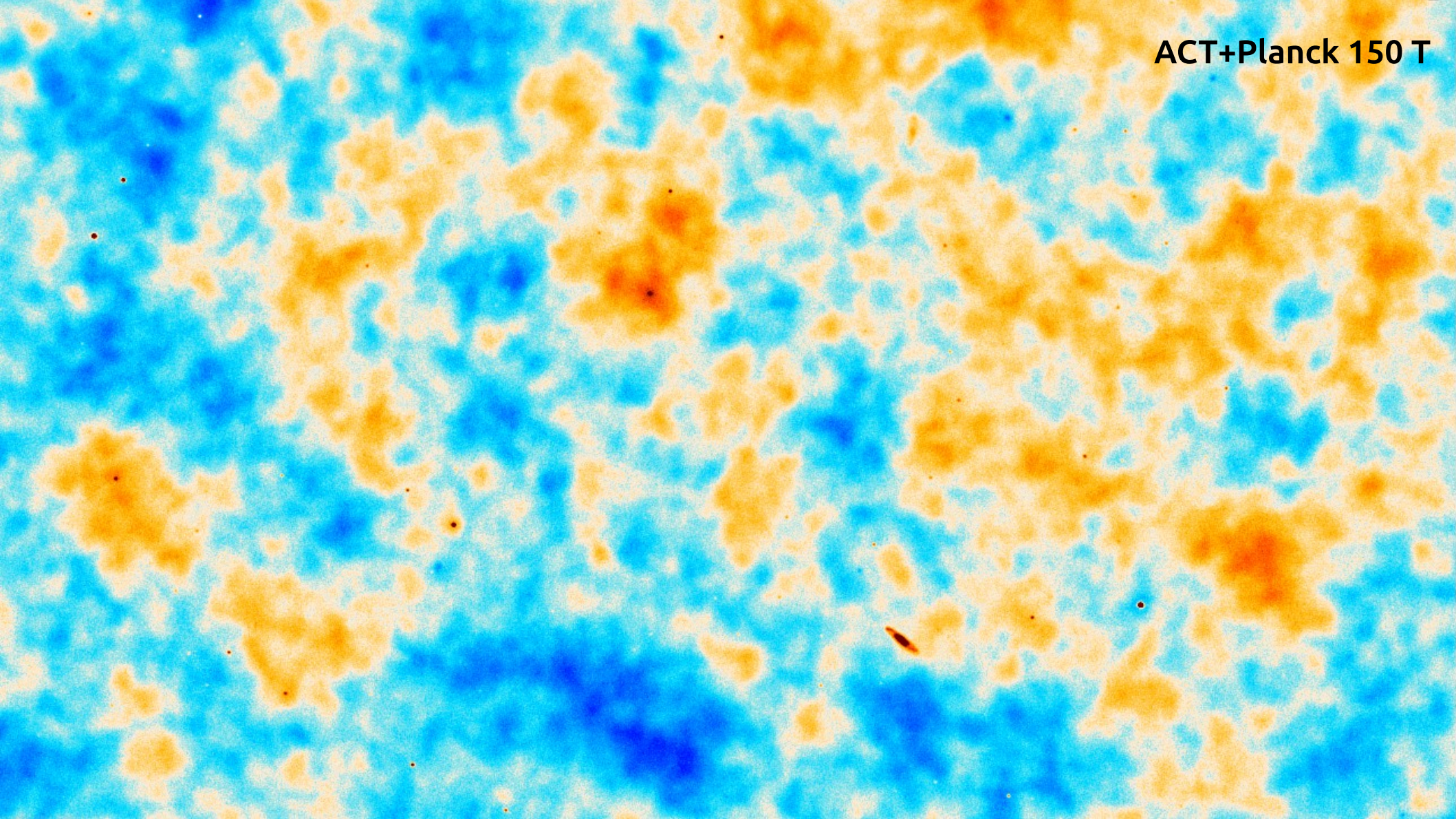
[Naess et al., 2025]



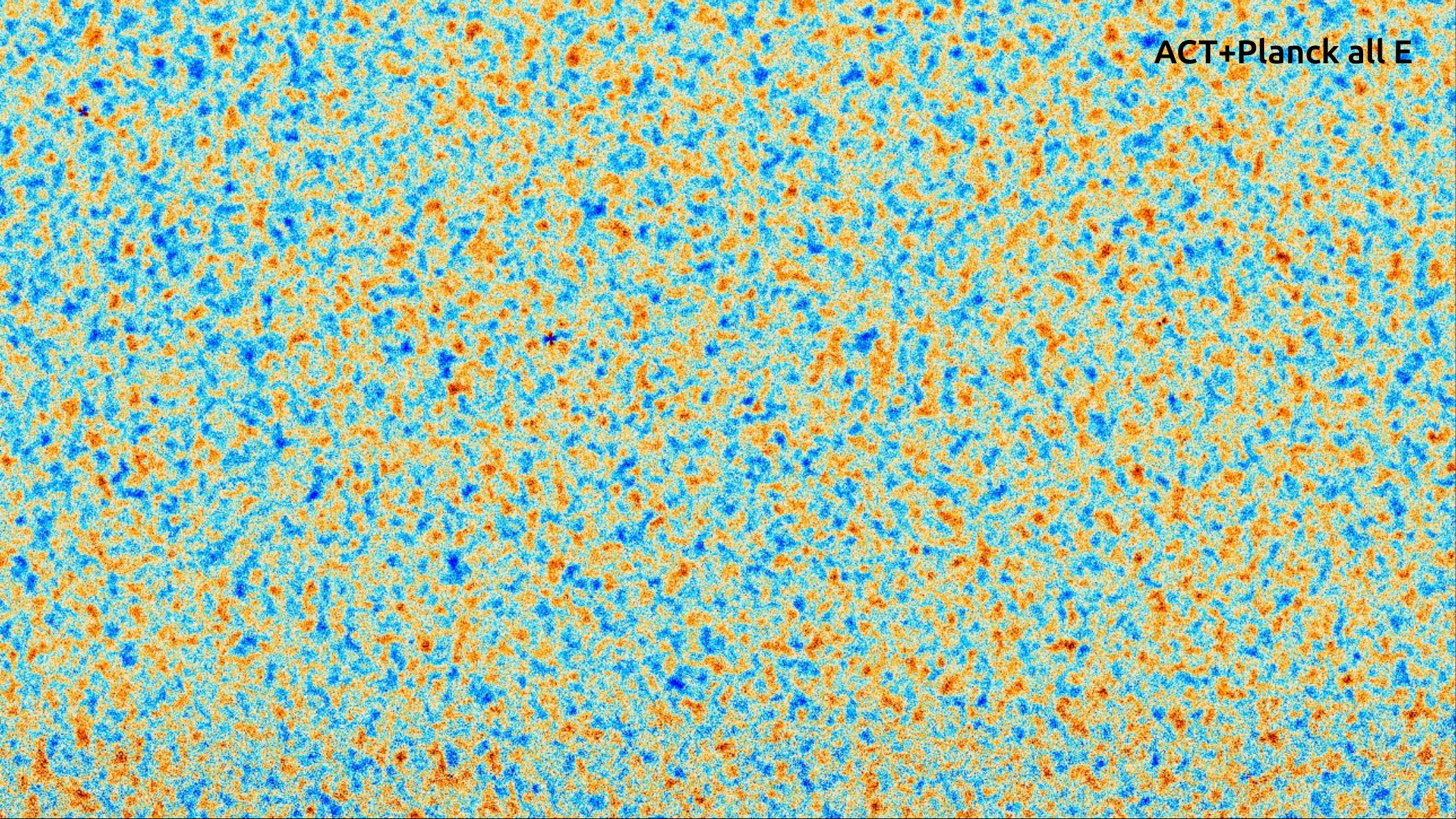
Planck 150 T



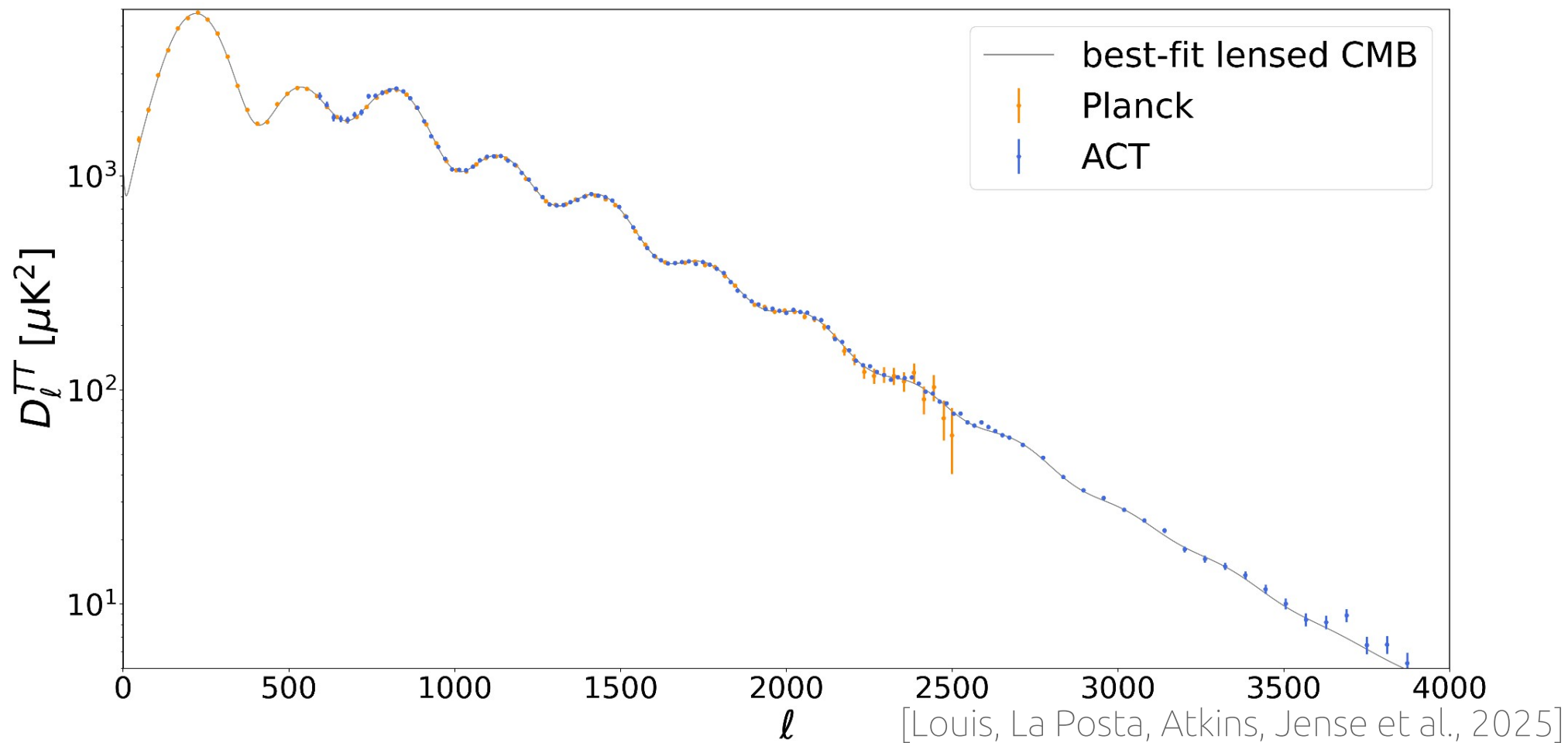
ACT+Planck 150 T



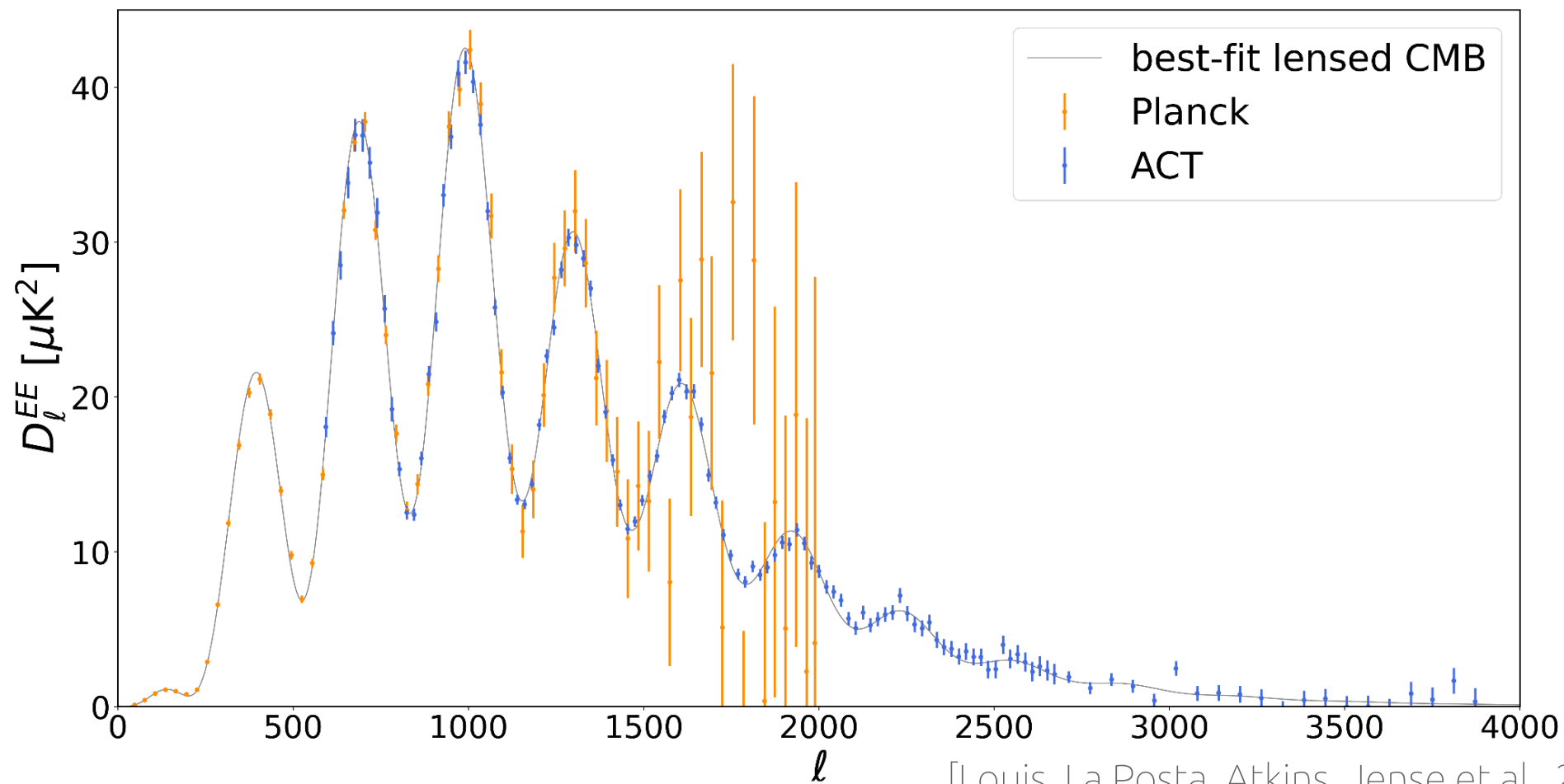
ACT+Planck all E



DR6 Power Spectra



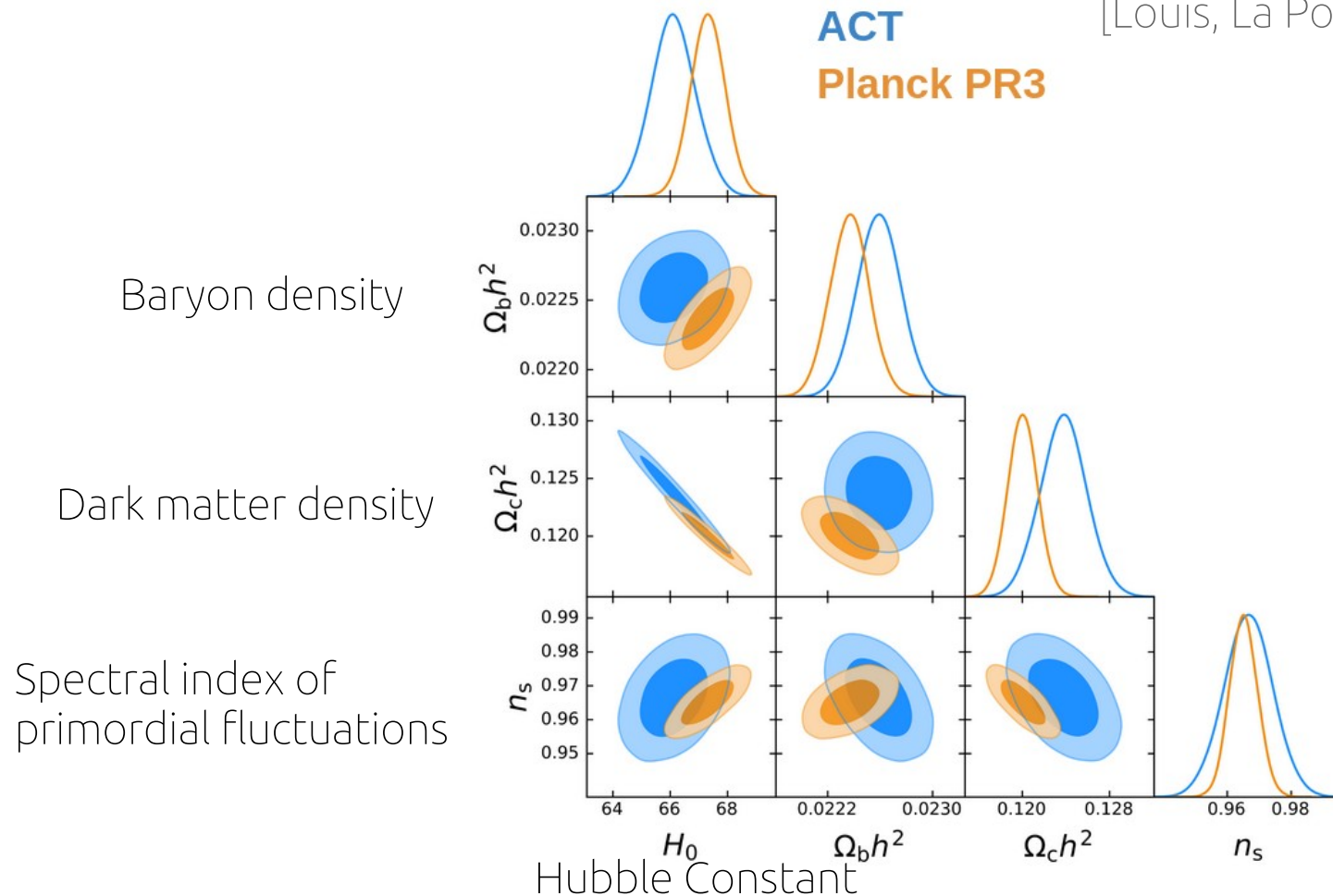
DR6 Power Spectra



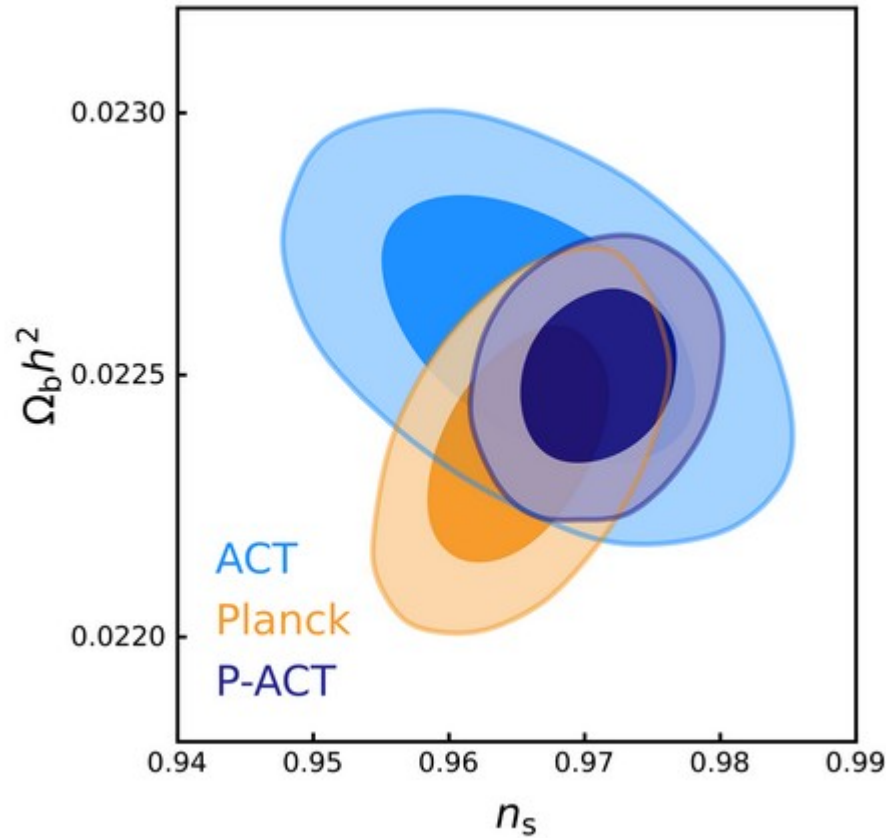
[Louis, La Posta, Atkins, Jense et al., 2025]

Cosmological Concordance

[Louis, La Posta, Atkins, Jense et al., 2025]



Cosmological Concordance

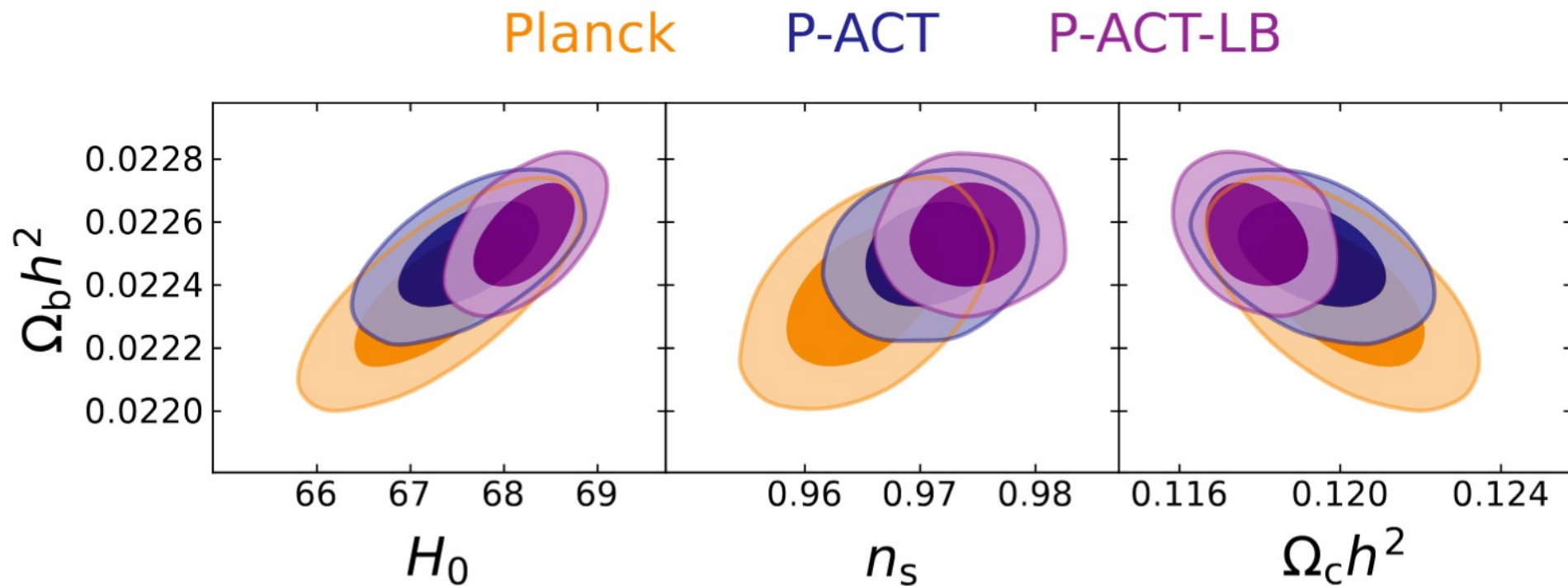


ACT and Planck operate at different scales, so parameters can be degenerate in different ways.

This means the combination of them can be very efficient in breaking these degeneracies.

[Louis, La Posta, Atkins, Jense et al., 2025]

DR6 Λ CDM Cosmology



Combining P-ACT with lensing and BAO measurements from DESI gives the state-of-the-art constraints on cosmological parameters. We measure $H_0 = 68.22 \pm 0.36$ km/s/Mpc.

[Louis, La Posta, Atkins, Jense et al., 2025]

DR6 Beyond- Λ CDM Cosmology

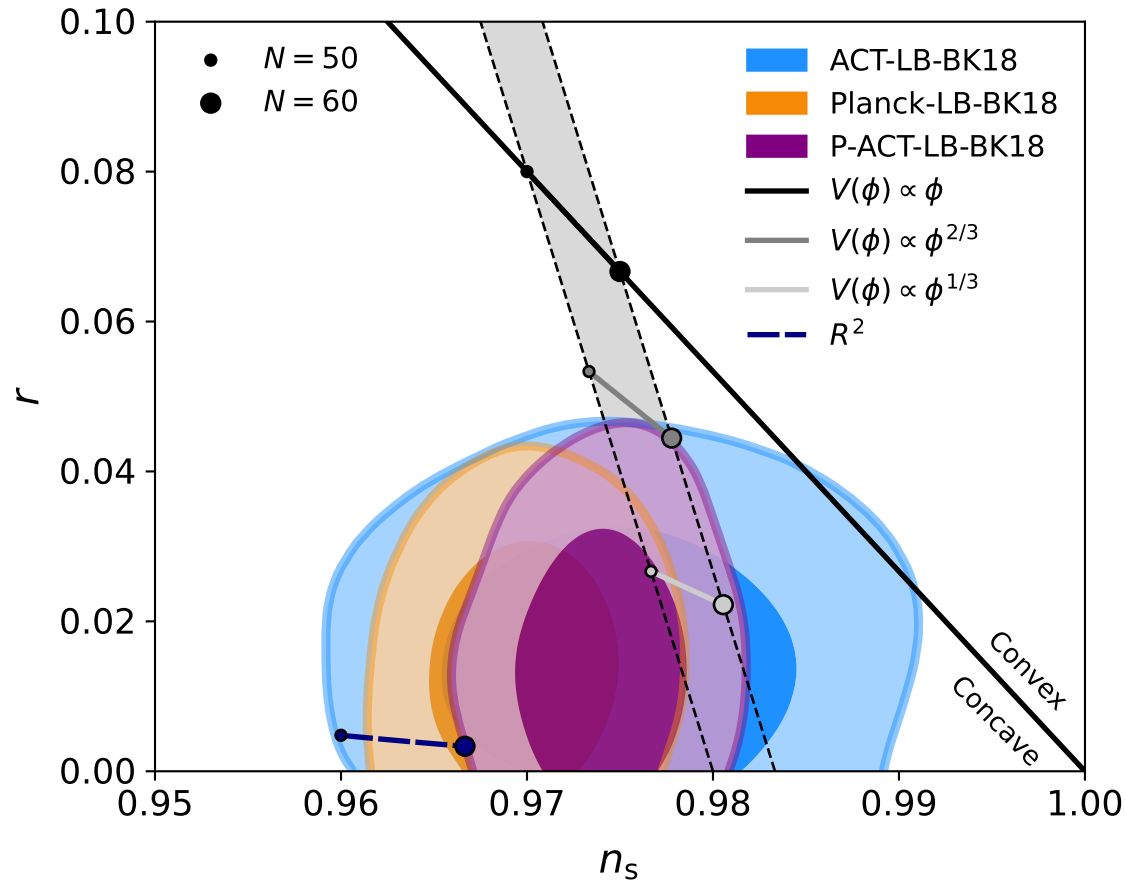
At this point, we tested a wide range of extensions to the Λ CDM model, looking for:

- Improvements thanks to ACT DR6;
- Models that are of interest (“tensions”).

We can measure a lot of different types of models with ACT DR6:

- Inflation physics
- Particle astrophysics
- Recombination physics
- Tests of Gravity and late-time physics

Inflation Physics



Tightened constraints on
primordial perturbation power
spectrum.

Planck: $n_s = 0.9651 \pm 0.0044$

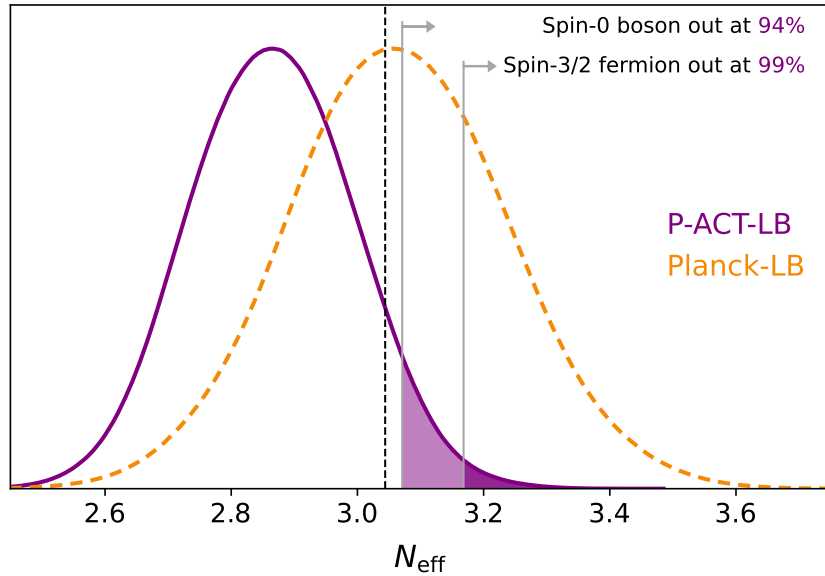
P-ACT-LB: $n_s = 0.9743 \pm 0.0034$

No evidence of a departure
from a simple power law.

No deviation from adiabaticity
detected.

[Calabrese, Hill, Jense, La Posta et al., 2025]

Particle Physics

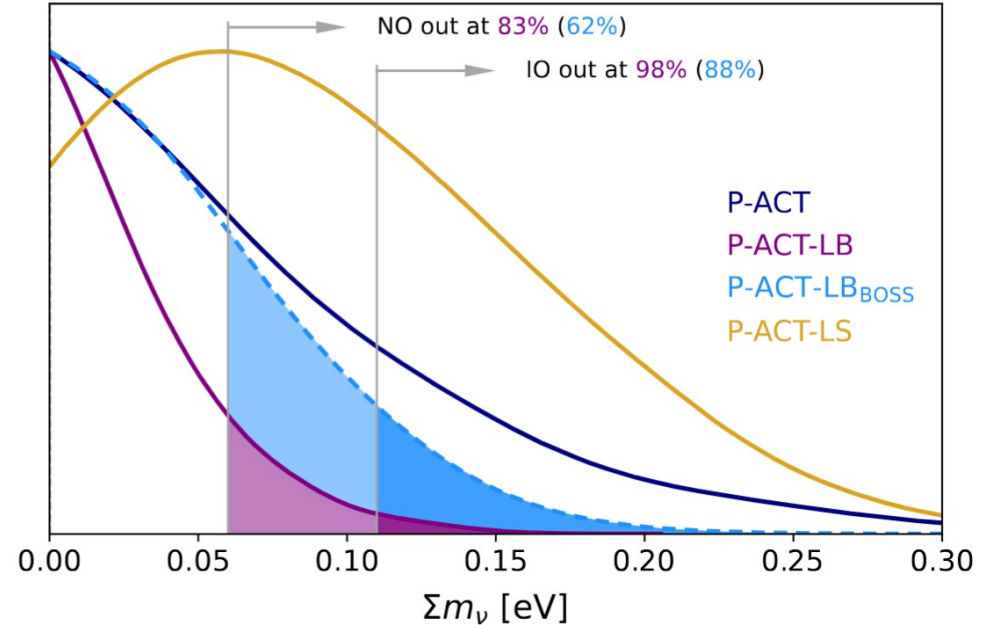


Tight constraints on the existence of beyond-standard model relativistic particles.

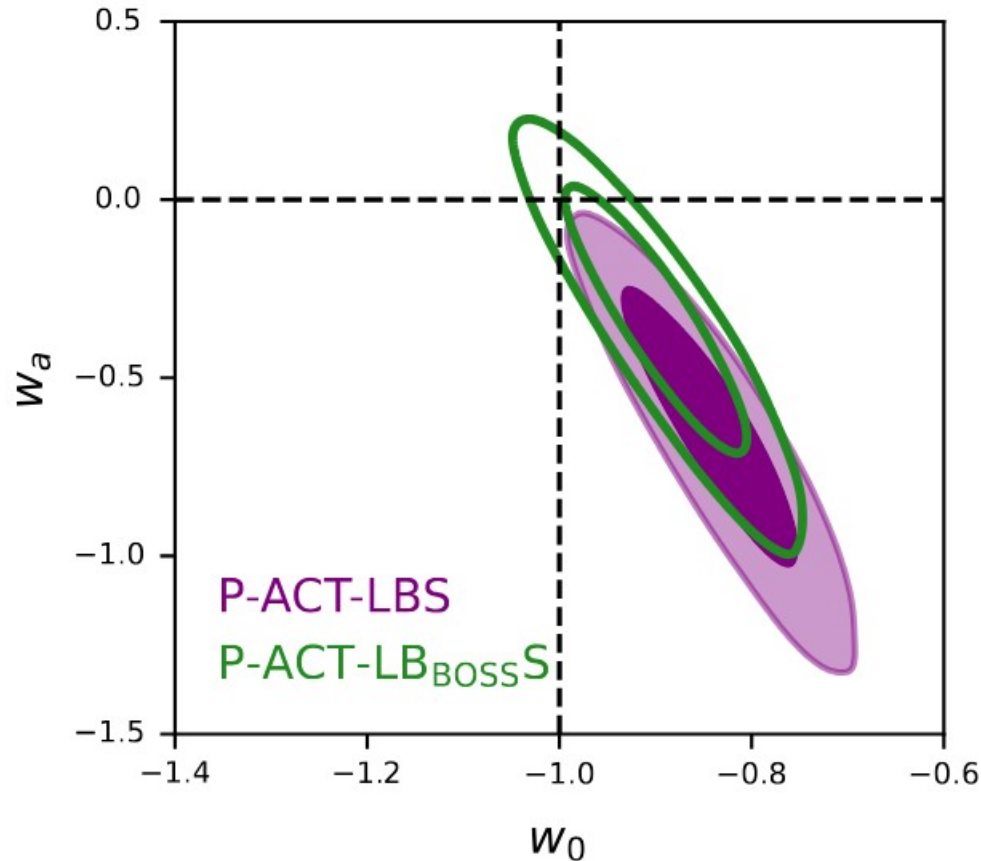
No evidence for non-zero neutrino mass.

$$\Sigma m_\nu < 0.082 \text{ eV (95\%, P-ACT-LB)}$$

[Calabrese, Hill, Jense, La Posta et al., 2025]



Dark Energy

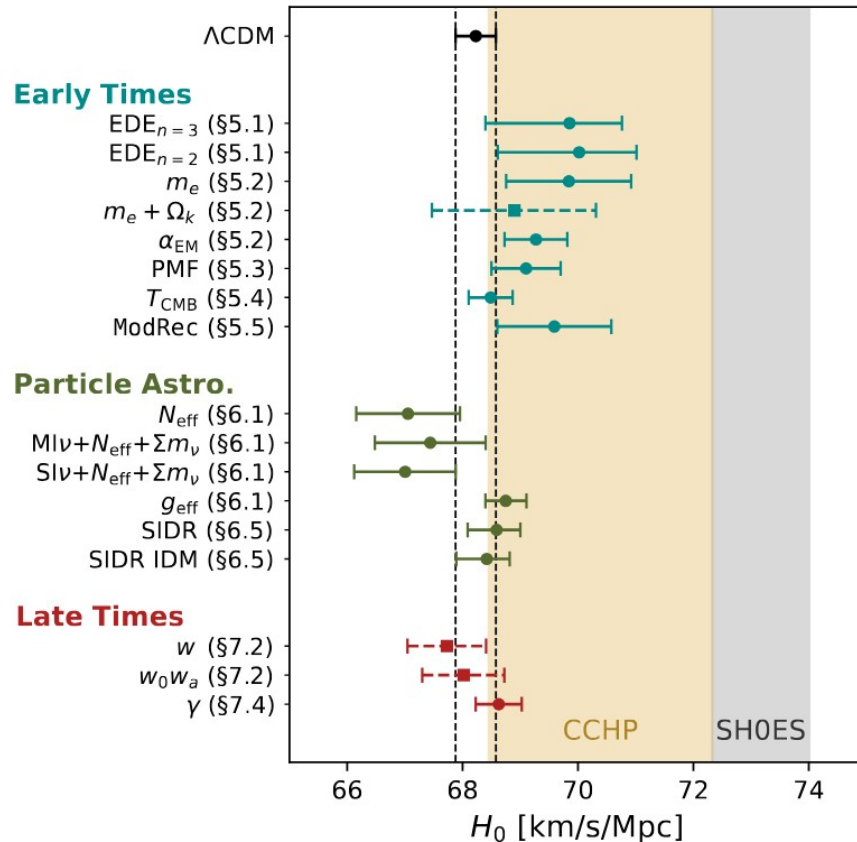


From P-ACT CMB data, we find no evidence for evolving dark energy.

Any hints of evolving dark energy beyond Λ are driven by BAO and SNIa data.

[Calabrese, Hill, Jense, La Posta et al., 2025]

Hubble Tension



CMB: $H_0 = 68.22 \pm 0.36$ km/s/Mpc
Local: $H_0 = 73.17 \pm 0.86$ km/s/Mpc

None of the extensions we investigated (including models specifically targeting this tension) provide space to resolve this.

Data Availability



LAMBDA legacy archive (lambda.gsfc.nasa.gov)

- Maps (frequency, coadd, ILC, null tests)
- MCMC chains, power spectra



PSpipe repository (Simons Observatory)
(<https://github.com/simonsobs/PSpipe>)

- Code to reproduce spectra and likelihood



NERSC (/global/cfs/cdirs/cmb/data/act_dr6/dr6.02)

In addition to all products on LAMBDA:

- Single-pass maps for time-domain studies
- Noise models and simulations
- Products to reproduce spectra and likelihood

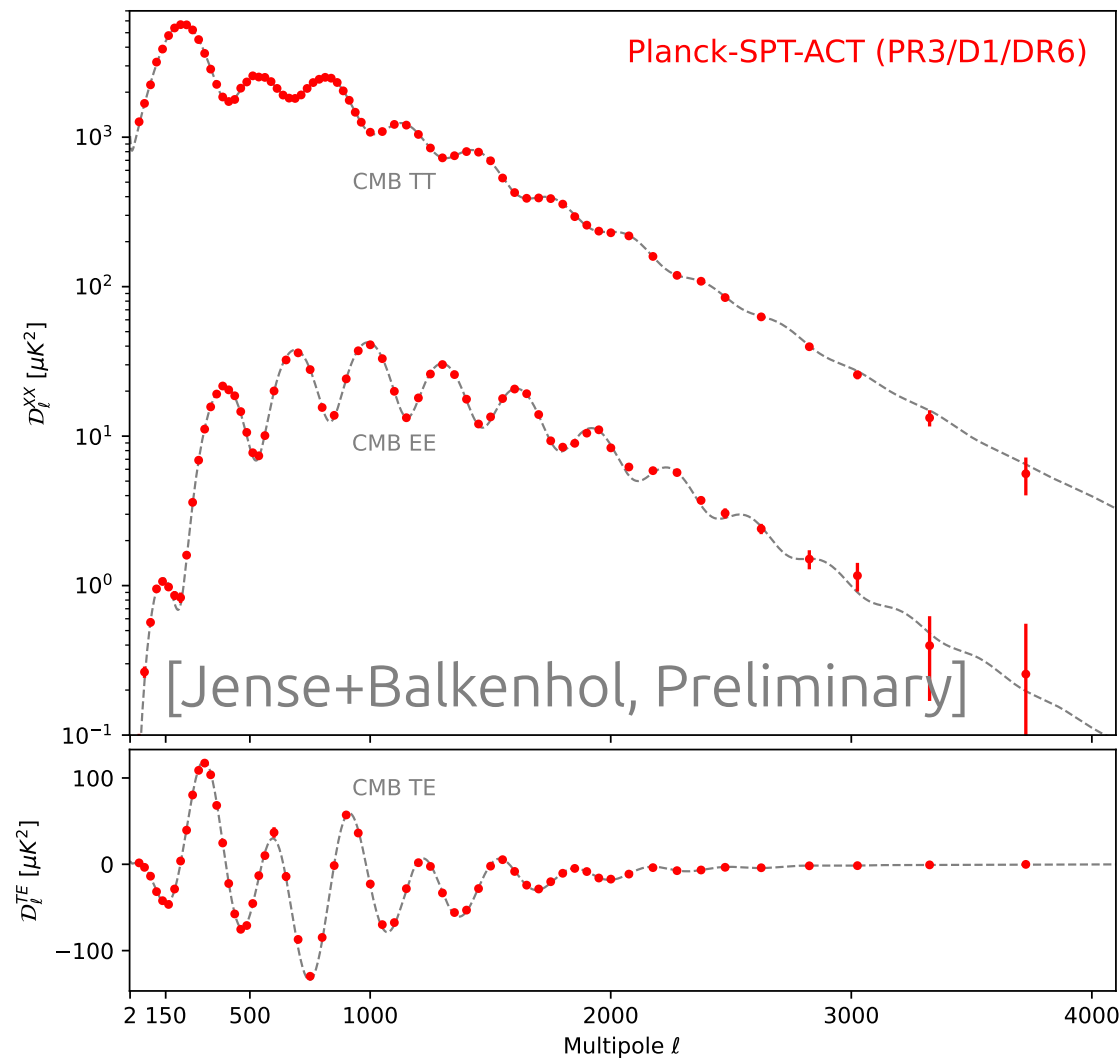


DR6_Notebooks

ACT DR6 Jupyter Notebooks
(https://github.com/ACTCollaboration/DR6_Notebooks)

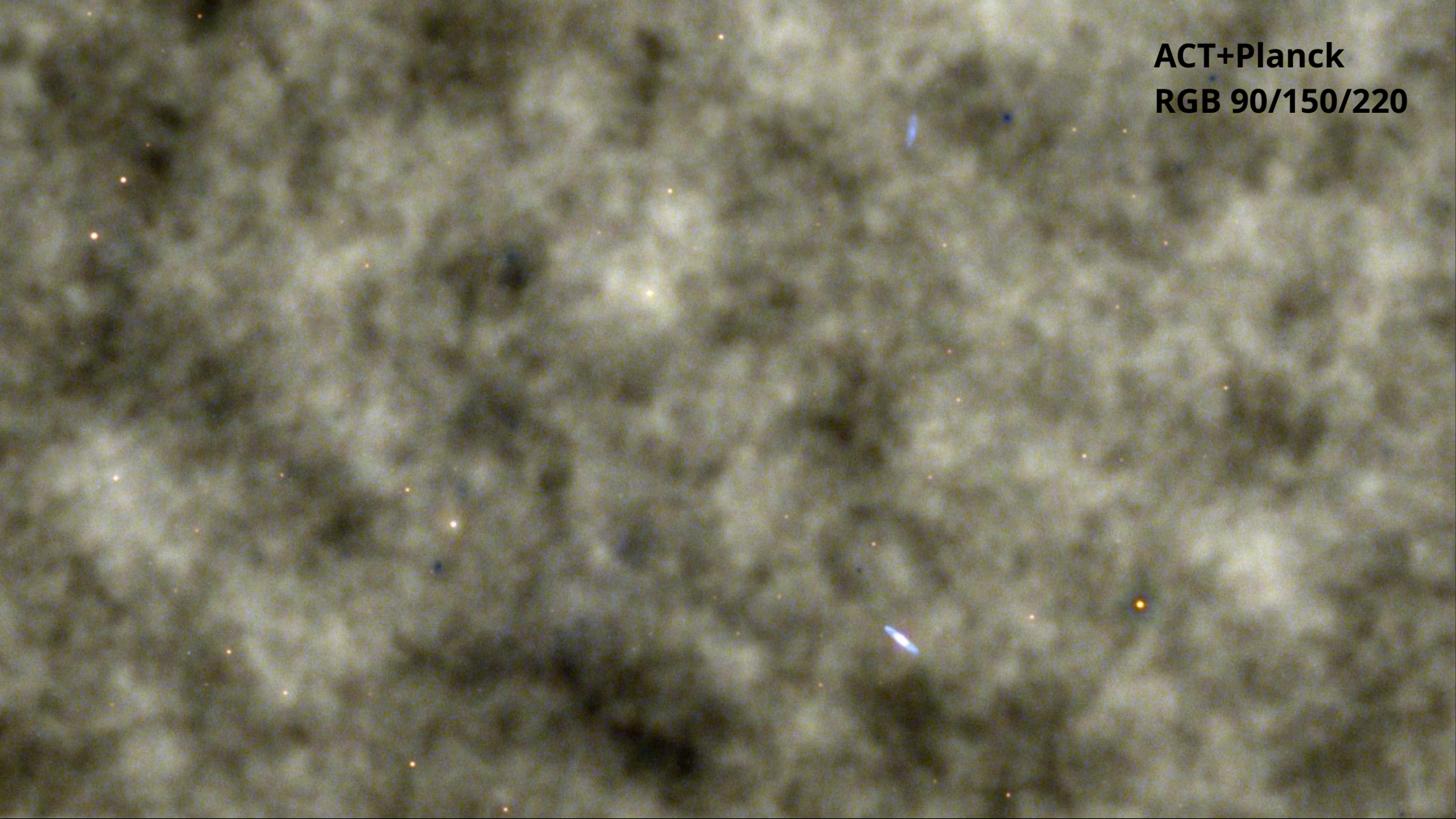
- Explanatory tutorials for DR6 data products

Concordance Power Spectra

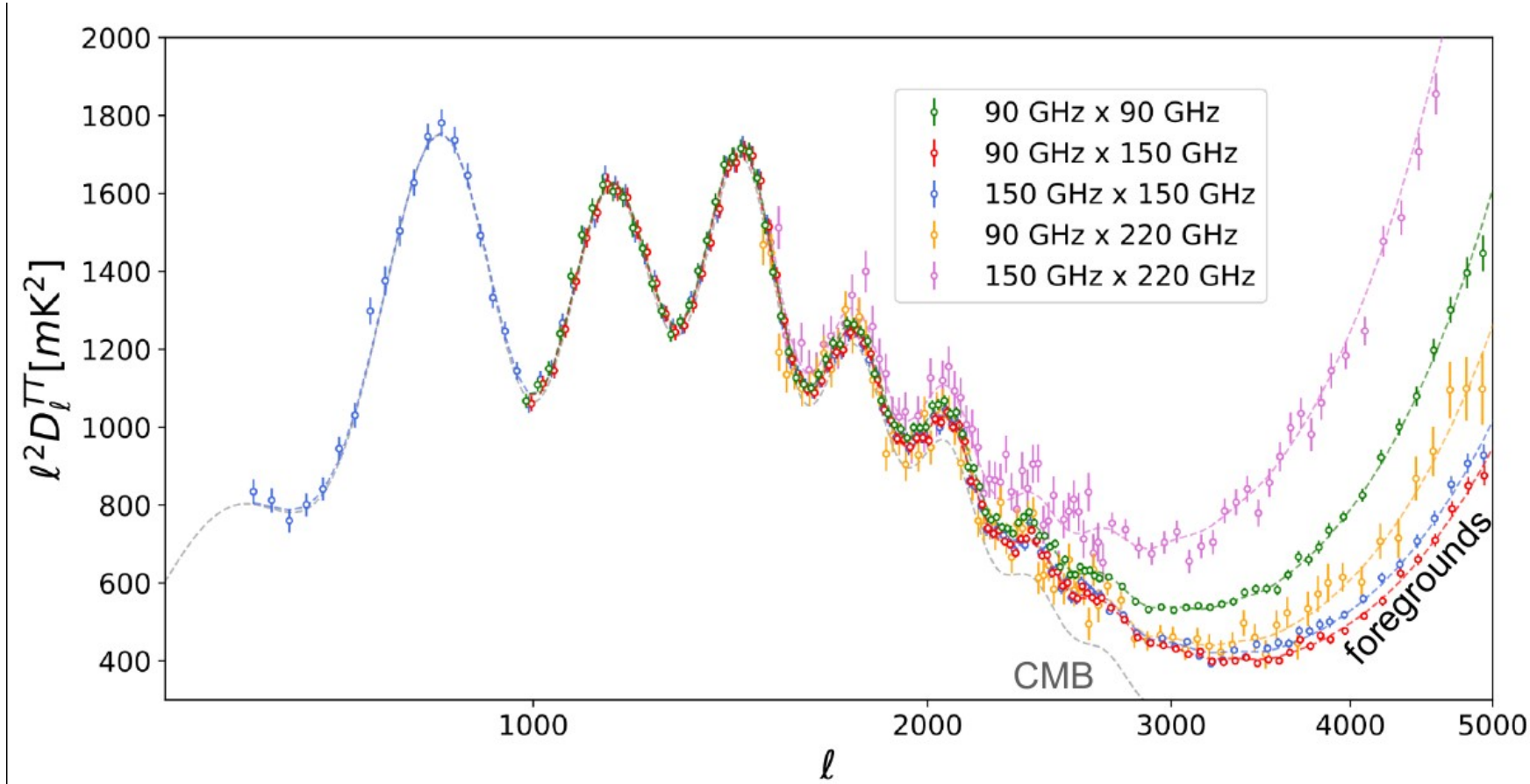


- Concordance between different experimental setups (Planck/ACT/SPT, see Lennart's talk after this).
- Tight constraints on cosmology from ground-based observations.
- The CMB remains an **important probe** for (beyond)-standard model physics.

ACT+Planck
RGB 90/150/220



DR6 Power Spectra



DR6 Power Spectra

