First cosmology results from Planck

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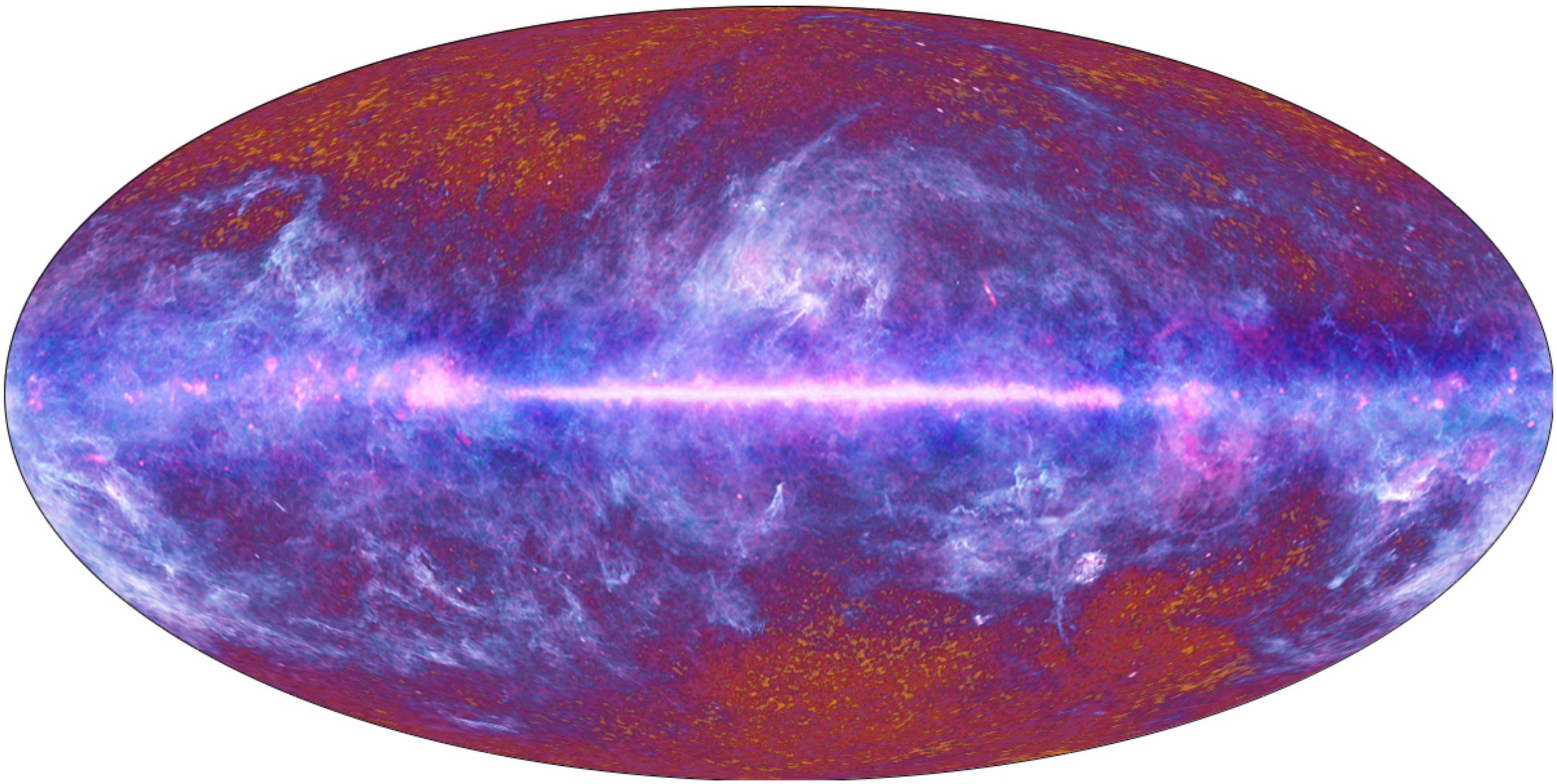
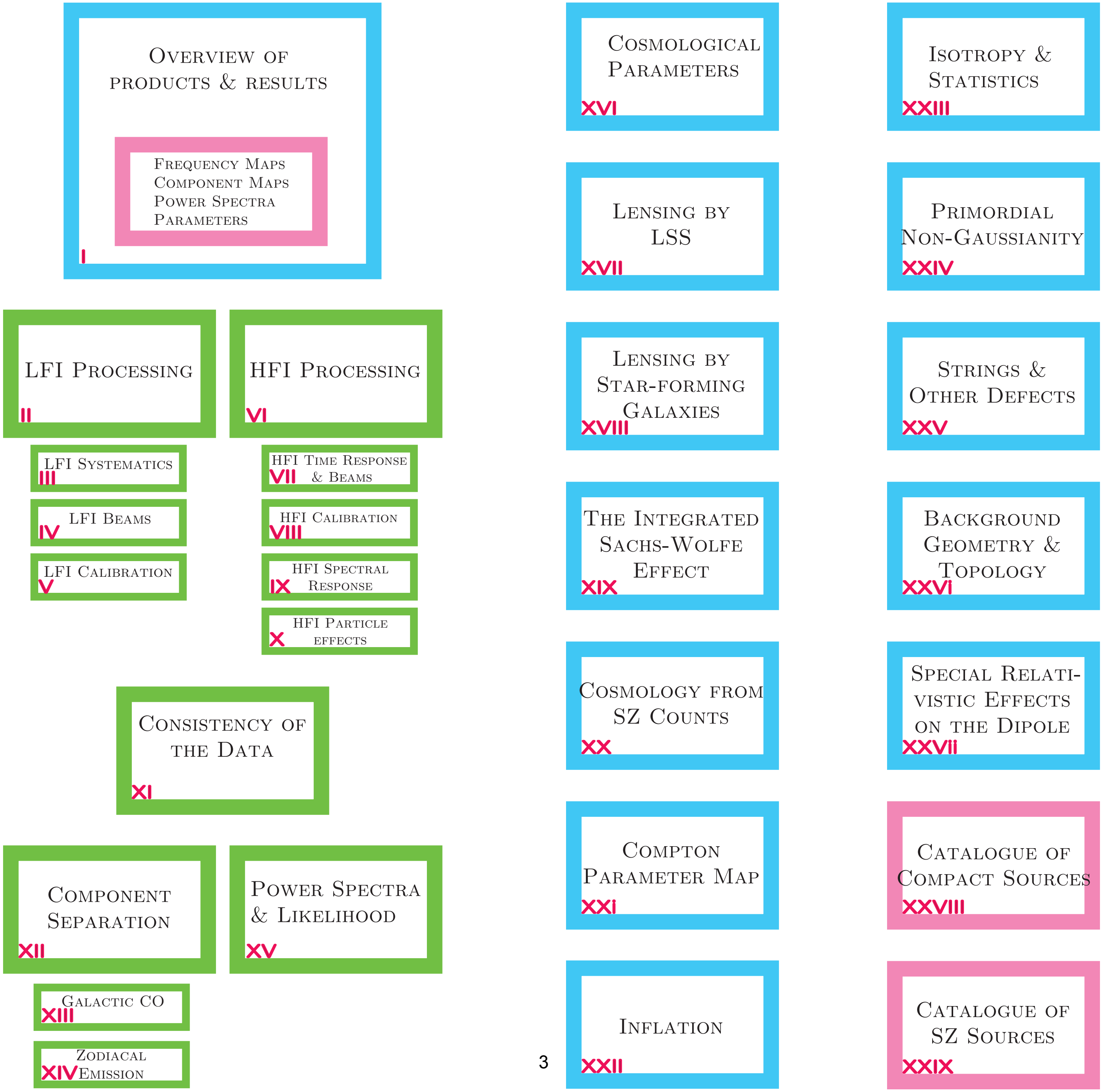
for the Planck team



Planck mission

- Planck is a 3rd generation space mission (COBE, WMAP)
  - Like WMAP, Planck observes at "L_2".
- It is part of ESA's "Cosmic Visions" program.
  - Launched in May 2009 along with the Herschel satellite.
  - Stably and continuously mapping the sky since 13 August 2009.
- In a nutshell:
  - 74 detectors covering 25GHz-1000GHz, resolution 30'-5'.
  - Sensitivity is ~25x better than WMAP and resolution ~3x better.
  - Expect 6x more modes and 12x lower noise per arcmin^2.
- Planck measures temperature anisotropy with accuracy set by fundamental astrophysical limits.

Close on 1000 pages . . .



Current data release

- Temperature anisotropies during the nominal mission (12 Aug 2009 – 27 Nov 2010).
  - Products all available from Planck Legacy Archive (PLA).
- There will be two more data releases, one/year.
- These will cover additional sky and polarization.

Access to PLA

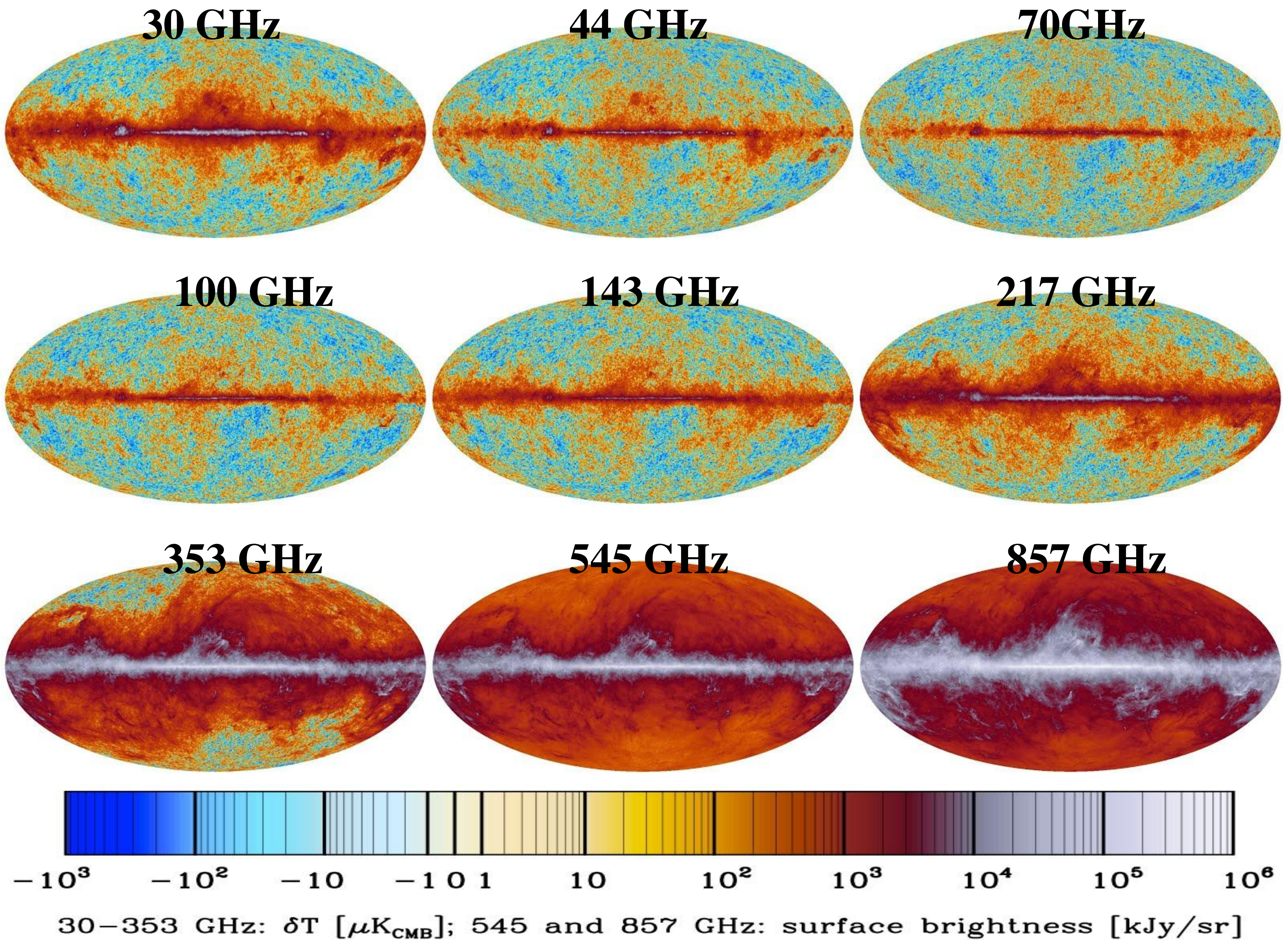
The PLA is freely accessible via the URL:

http://pla.esac.esa.int/pla/pla.jnlp

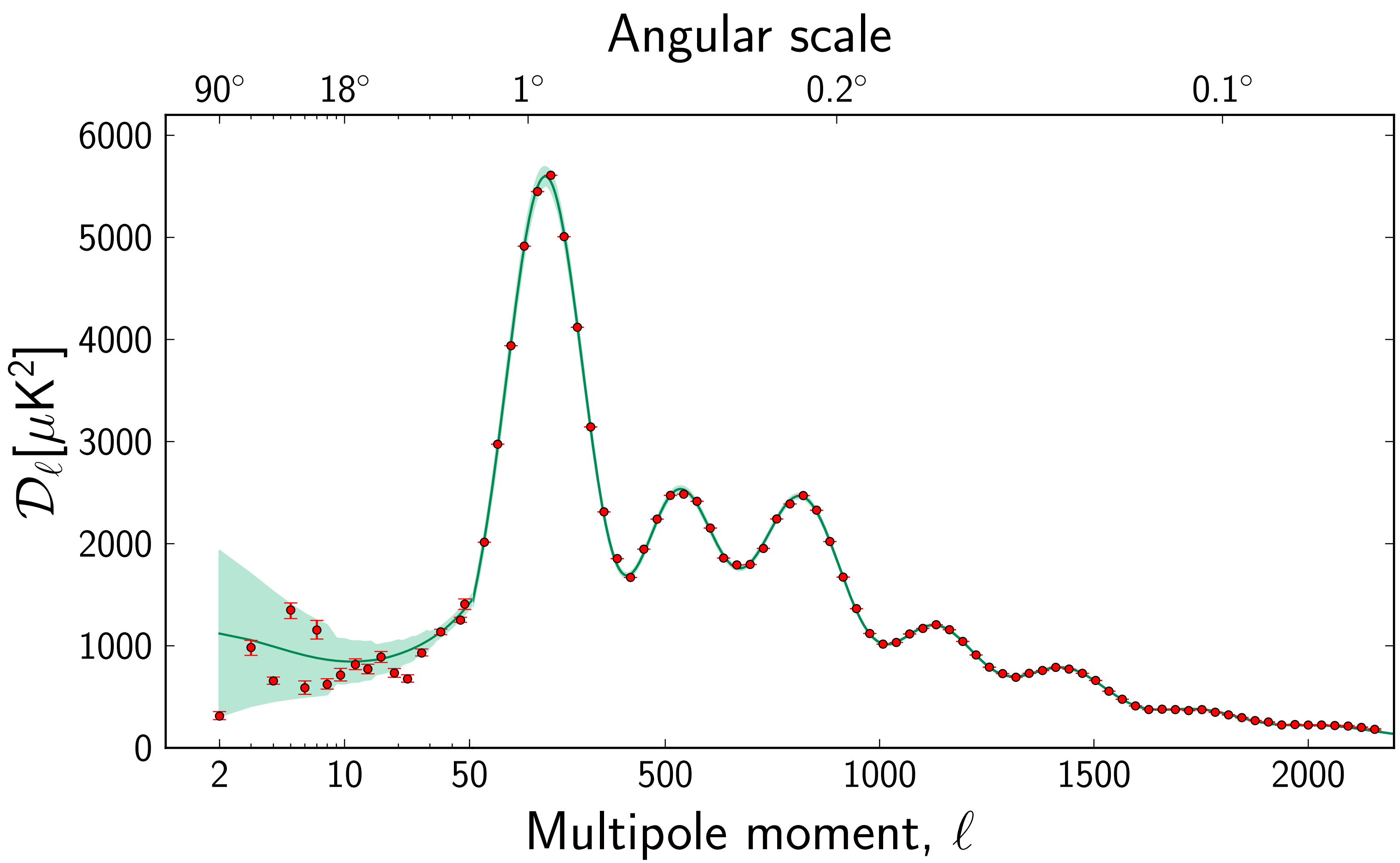
Frequently requested products | **Explanatory supplement** | **Planck publications**

Planck science team home | **Use of Planck data**

The PLA interface also inter-operates with the astronomical catalogues served by the Centre de Donnees de Strasbourg (CDS), via the interactive software Aladin. Data can be transferred seamlessly from the PLA to Aladin. Additional tabular data manipulation functionality is available via the Topcat tool. Please note that users do not need to install Aladin and Topcat a-priori in order to use them; they will be called up automatically by the PLA interface when invoked.

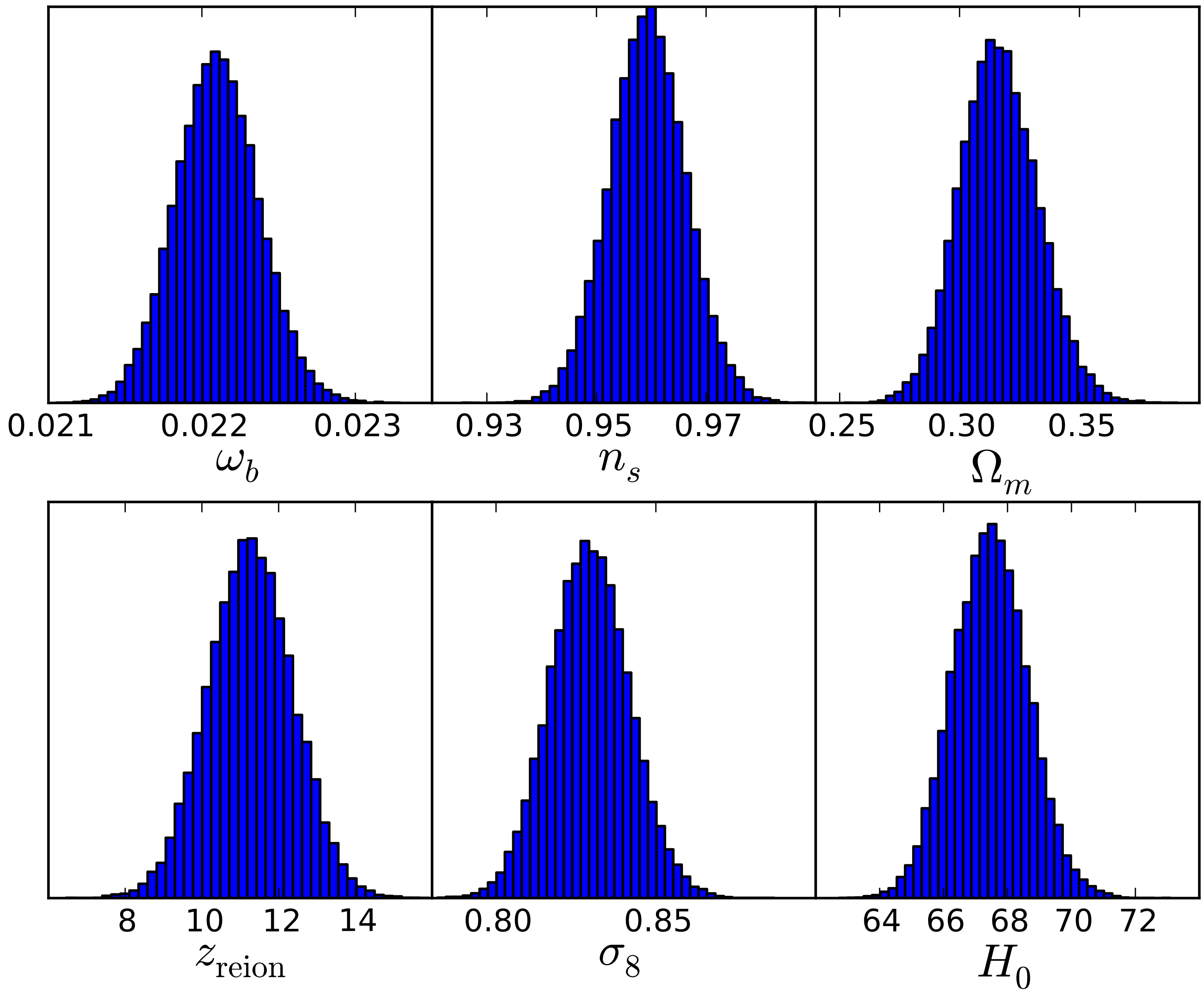

30 GHz
44 GHz
70GHz
100 GHz
143 GHz
217 GHz
353 GHz
545 GHz
857 GHz
-10^3 -10^2 -10 -1 0 1 10 10^2 10^3 10^4 10^5 10^6
30−353 GHz: δT [μK_{CMB}]; 545 and 857 GHz: surface brightness [kJy/sr]

The angular power spectrum



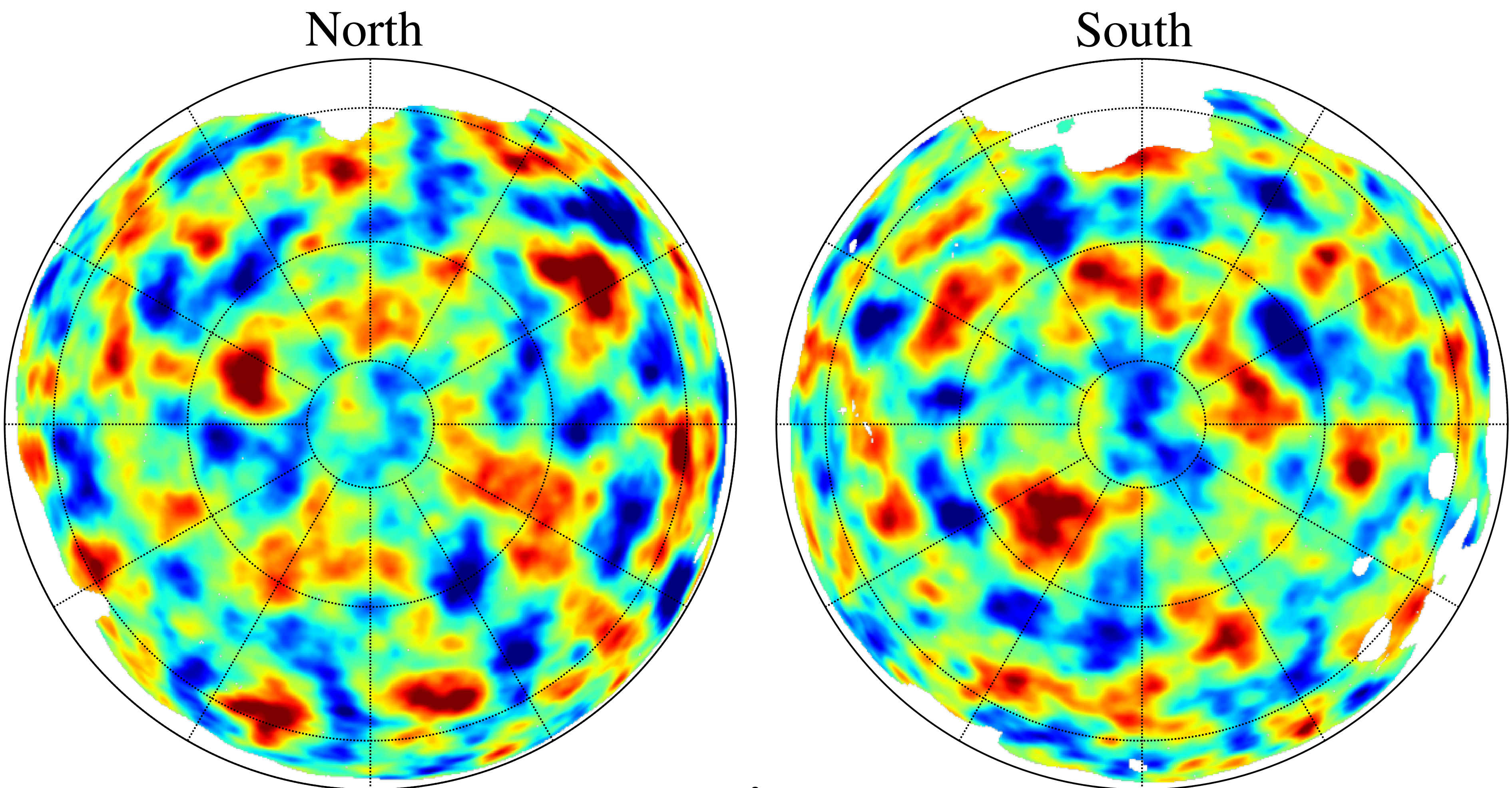
Parameter constraints

The Planck data provide tight constraints on the six parameters describing the ΛCDM model, and thus on derived parameters.



Projected gravitational potential

Planck has made the highest S/N detection of lensing of the CMB ever: our noisiest channel is more significant than all previous measurements combined!



Inflation

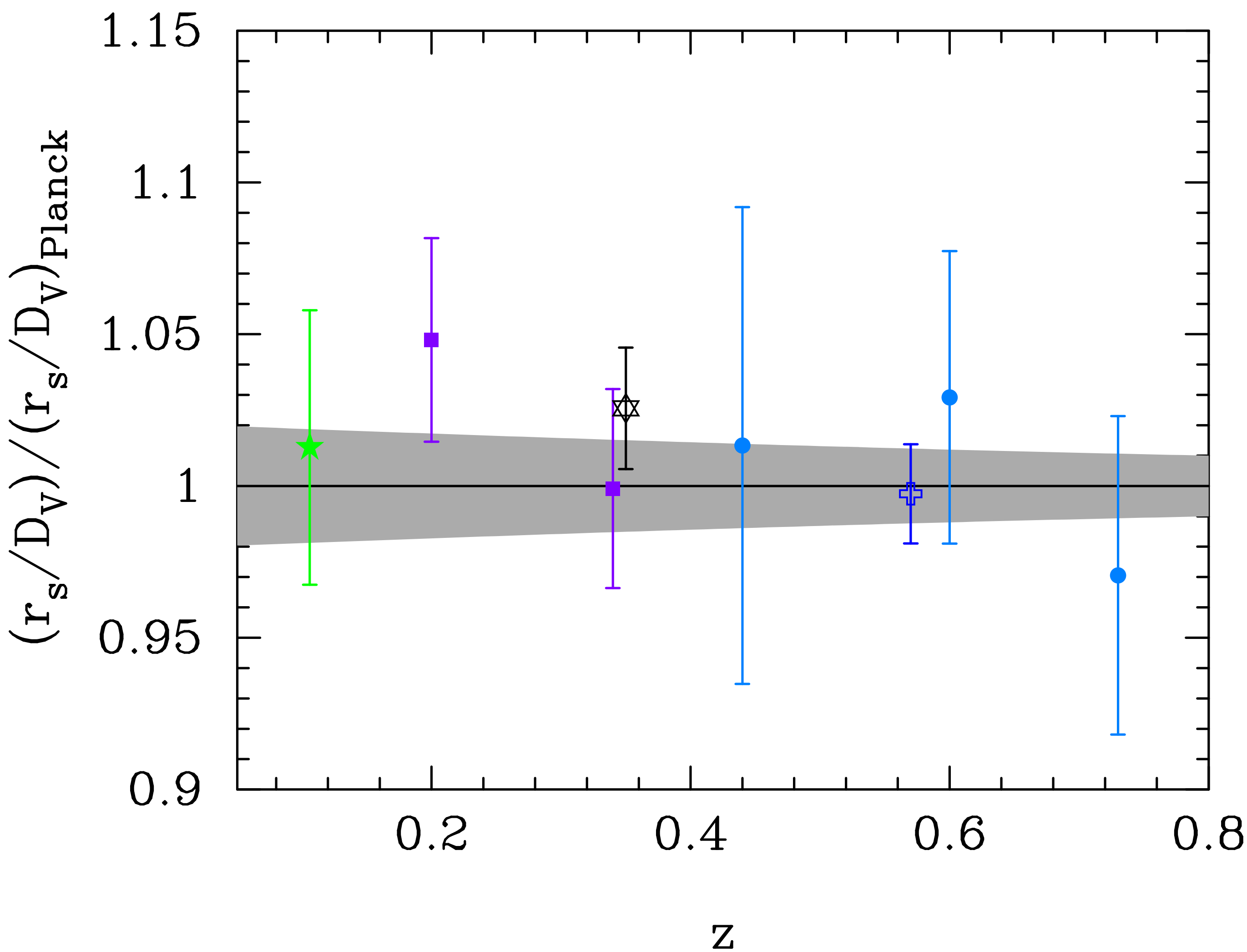
- Planck prefers the simplest inflationary models.
  - These models are (in some sense) the hardest to understand theoretically, because they are so minimal!
- No detectable:
  - Tensor modes.
  - Running (of the spectral index).
  - Isocurvature modes.
  - Non-Gaussianity.

Interesting models with modified couplings to gravity …

Consistency with other data

- The Planck data are consistent with the predictions of the simplest ΛCDM models.
- Within the framework of such models we can compare to a wide variety of other astrophysical/cosmological datasets.
  - Large-scale structure (shape of power spectrum). ✓
  - Baryon Acoustic Oscillations (distance scale). ✓
  - Type Ia SNe (distance scale). ✓✗
  - Direct measures of distance ladder (local distance scale). ✗
  - Gravitational lensing/cosmic shear. ✗
  - Abundance of rich clusters of galaxies. ✗✓

Distance scale comparison: BAO



Acoustic oscillations at z~1100 and z<1 tell the same story about the distance scale: ΛCDM!

Highlights

- Overall good agreement with previous experiments.
  - But differences are non-trivial given the errors.
- ΛCDM model provides a stunningly good fit.
  - Tens of millions of pixels ➔ millions of multipoles ➔ thousands of C_ls ➔ just 6 numbers
  - But the numbers are different than we thought before.
  - No evidence for running spectral index, m_ν, N_{eff}, f_{NL}, …
- Lots of valuable information about inflation.
- Highly significant lensing detection.
- Fantastic agreement with BBN
  - Involves all the known laws of physics!
- In good agreement with large-scale structure and BAO distance scale, not in as good agreement with other astrophysical probes …

Conclusions

- The Planck mission has been stunningly successful.
- Impressive confirmation of the standard cosmological model – but with non-trivial revisions.
- More data to be analyzed and released!

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The End