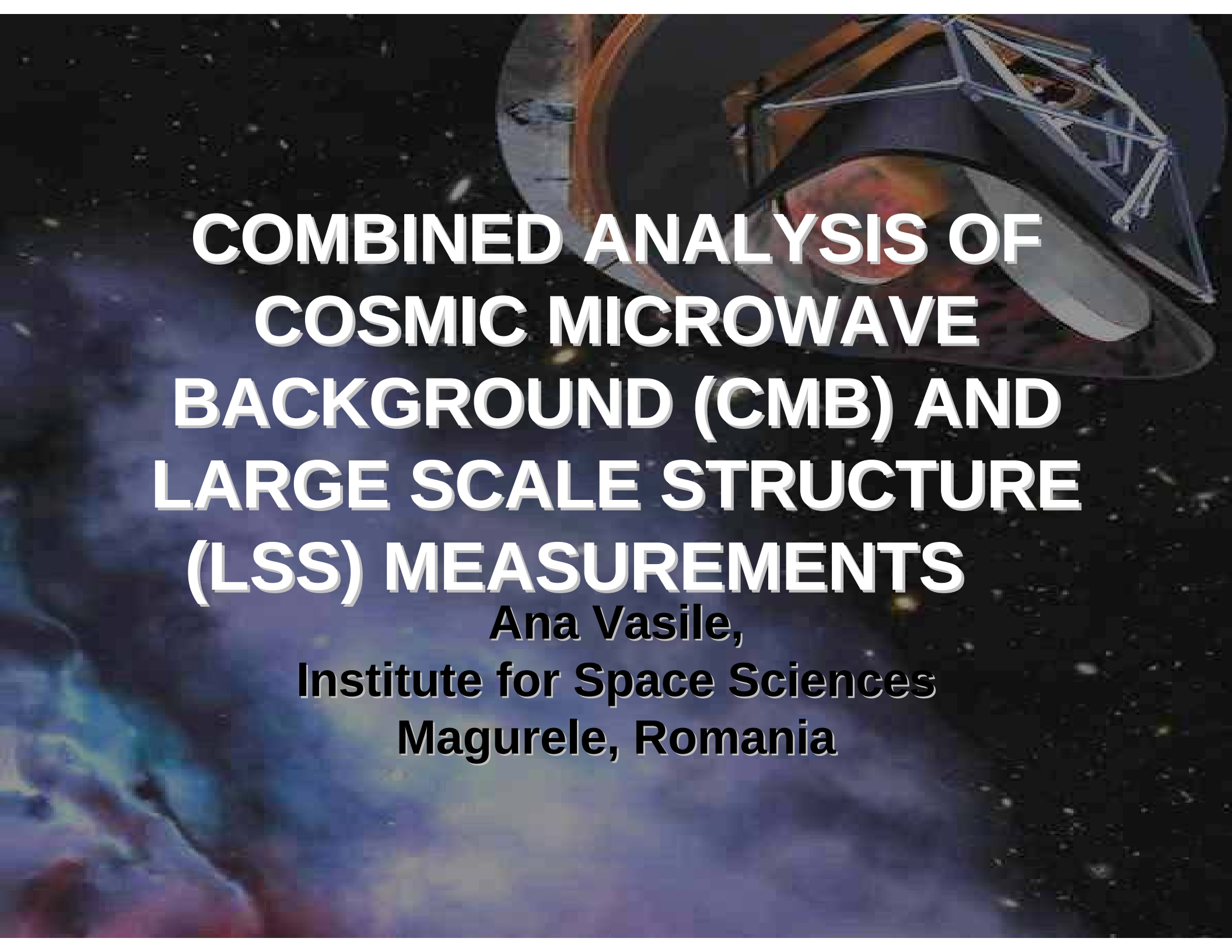
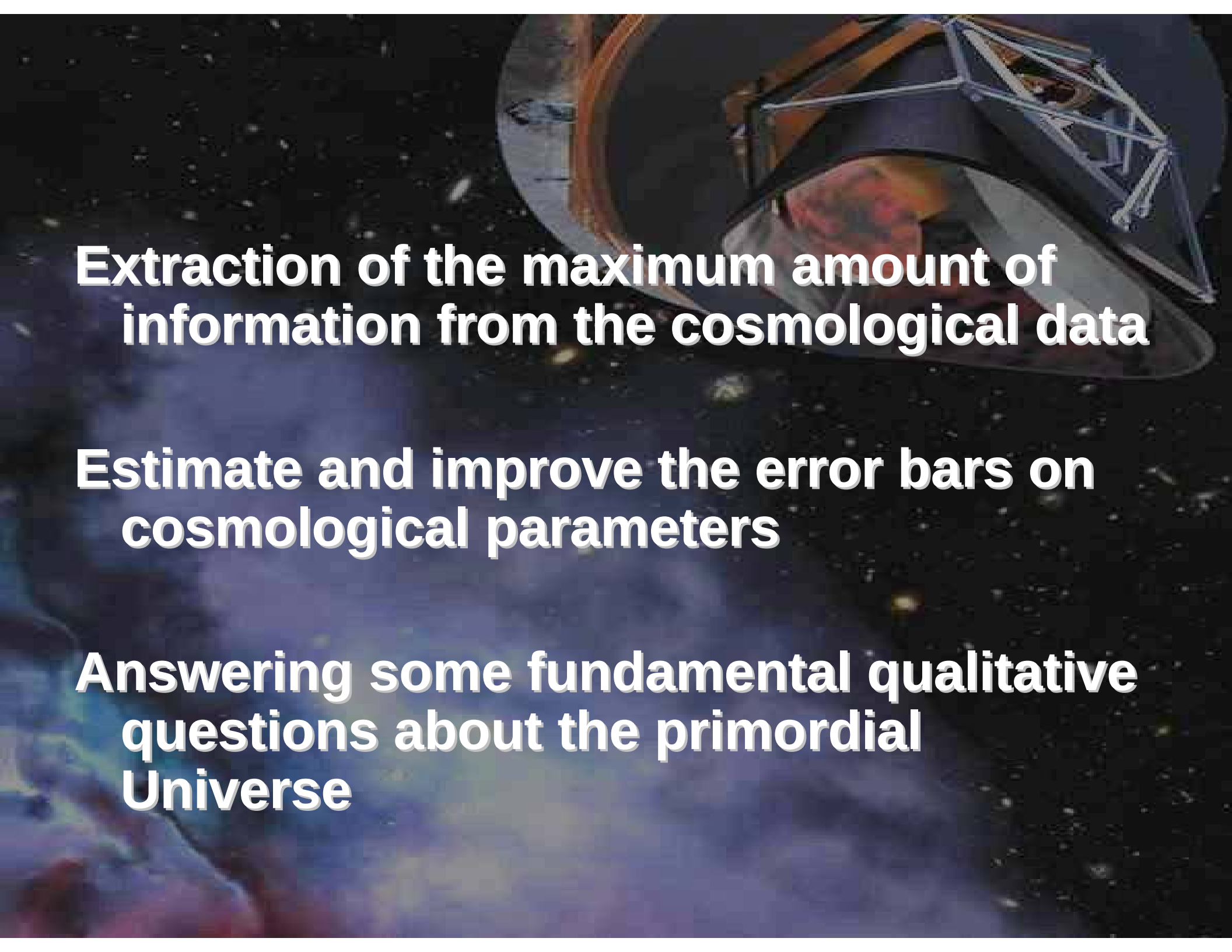


COMBINED ANALYSIS OF COSMIC MICROWAVE BACKGROUND (CMB) AND LARGE SCALE STRUCTURE (LSS) MEASUREMENTS

Ana Vasile,
Institute for Space Sciences
Magurele, Romania


What do cosmologists want?



Extraction of the maximum amount of information from the cosmological data

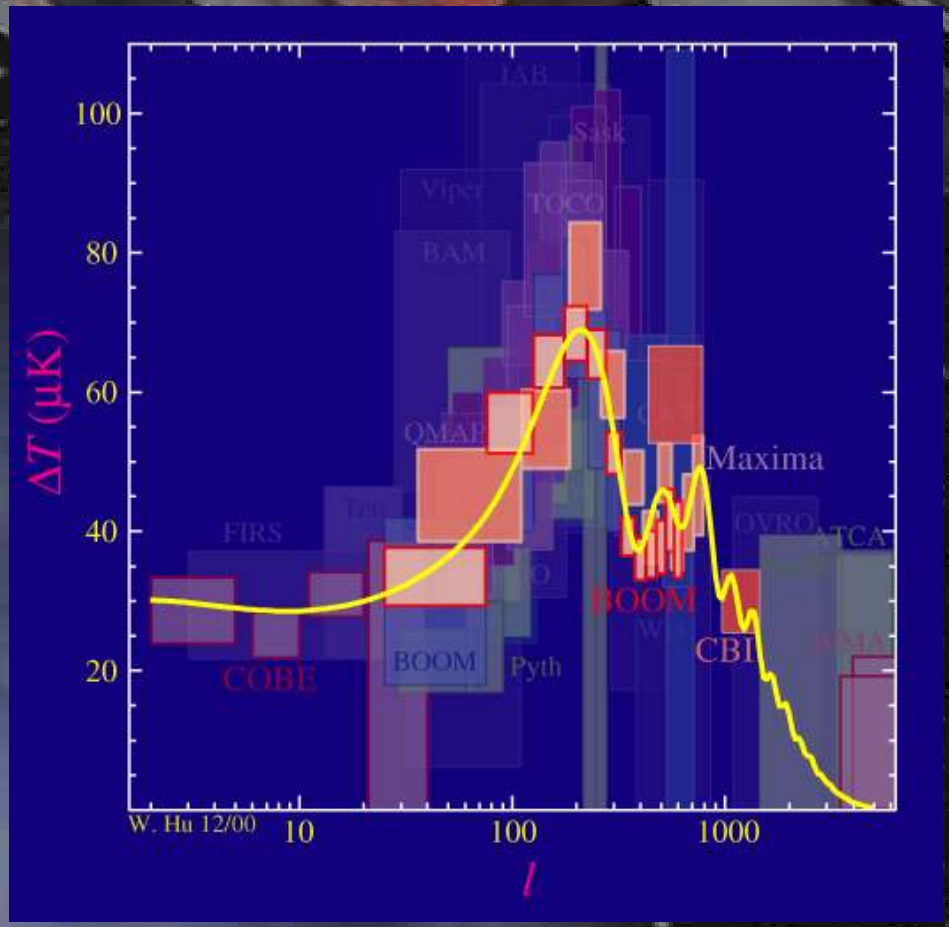
Estimate and improve the error bars on cosmological parameters

Answering some fundamental qualitative questions about the primordial Universe

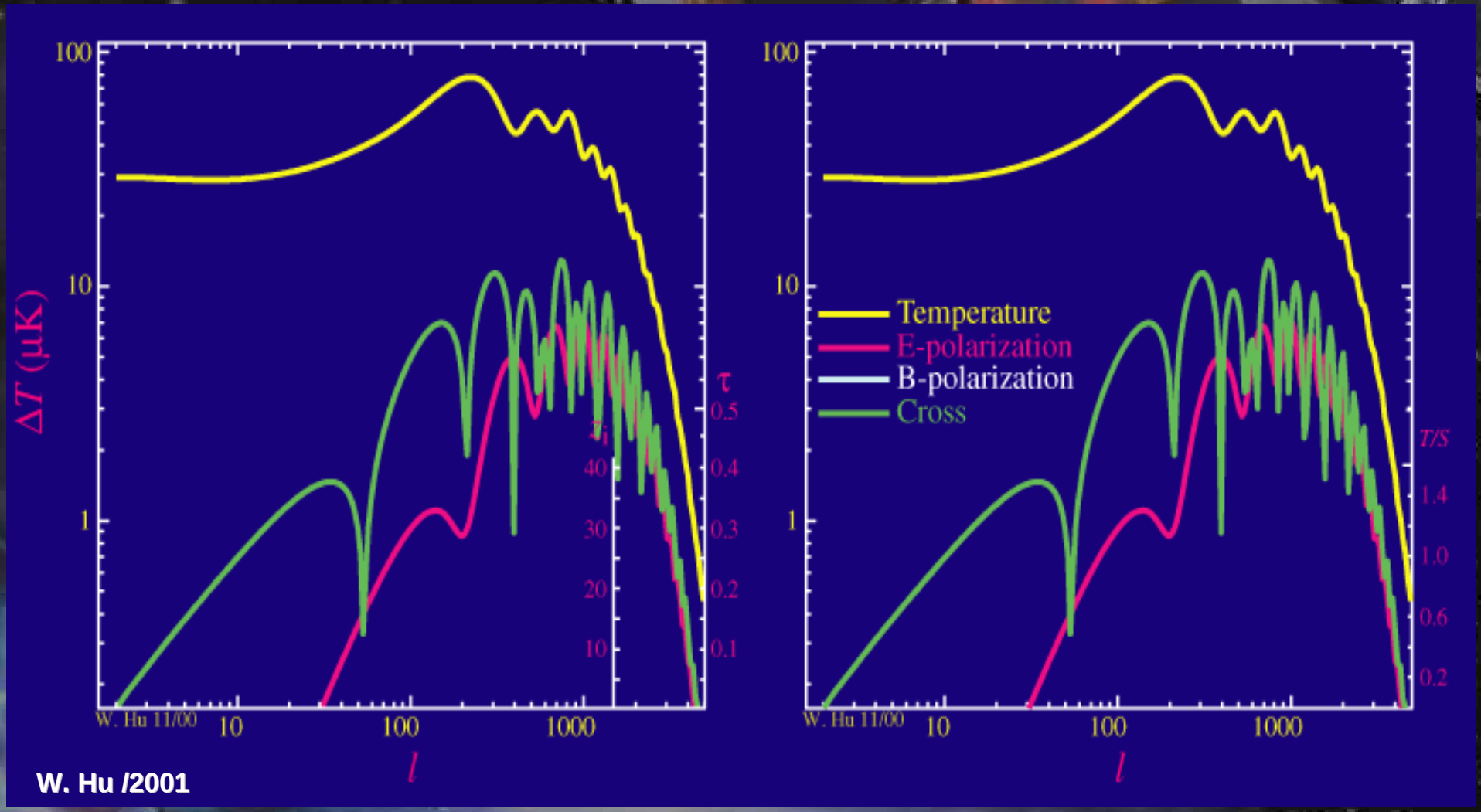
What do cosmologists get?

CMB POWER SPECTRUM

- The CMB power spectrum contains a wealth of cosmological information
- Nevertheless not enough to get the complete cosmological picture



DEGENERACY – MAJOR PROBLEM



W. Hu /2001

Left: the reionization of the universe parameterized by both the optical depth (or fraction of the CMB rescattered during reionziatoion) and the redshift of reionzation. Right: the gravitational waves parameterized by their contribution relative to density fluctuations at the quadrupole (*l*=2).

SOLUTION

- Combining CMB and LSS data can obtain complementary constraints and eliminate the degeneracies
- Degenerate directions of one data set can be well constraint directions of another
- Can make a consitency check between different sets of data and a certain cosmological model

TOOLS:
COSMOLOGICAL MONTE CARLO

A “random-walk” in the parameter space, where the probability to be anywhere in the space is proportional with the aposteriori probability

Advantage: It scales approximately linearly with the number of parameters so that many parameters can be included for only small additional computation costs

MCMC IN PRACTICE

1. Start with a set of cosmological parameters $\{\alpha_1\}$, compute C^1_l and the likelihood L_1
2. Take a random step in the parameter space → new set of cosmological parameters $\{\alpha_2\}$.

The probability distribution of the step → Gaussian in each direction *i* with r.m.s $\sigma_i \equiv$ "step size"

MCMC IN PRACTICE II

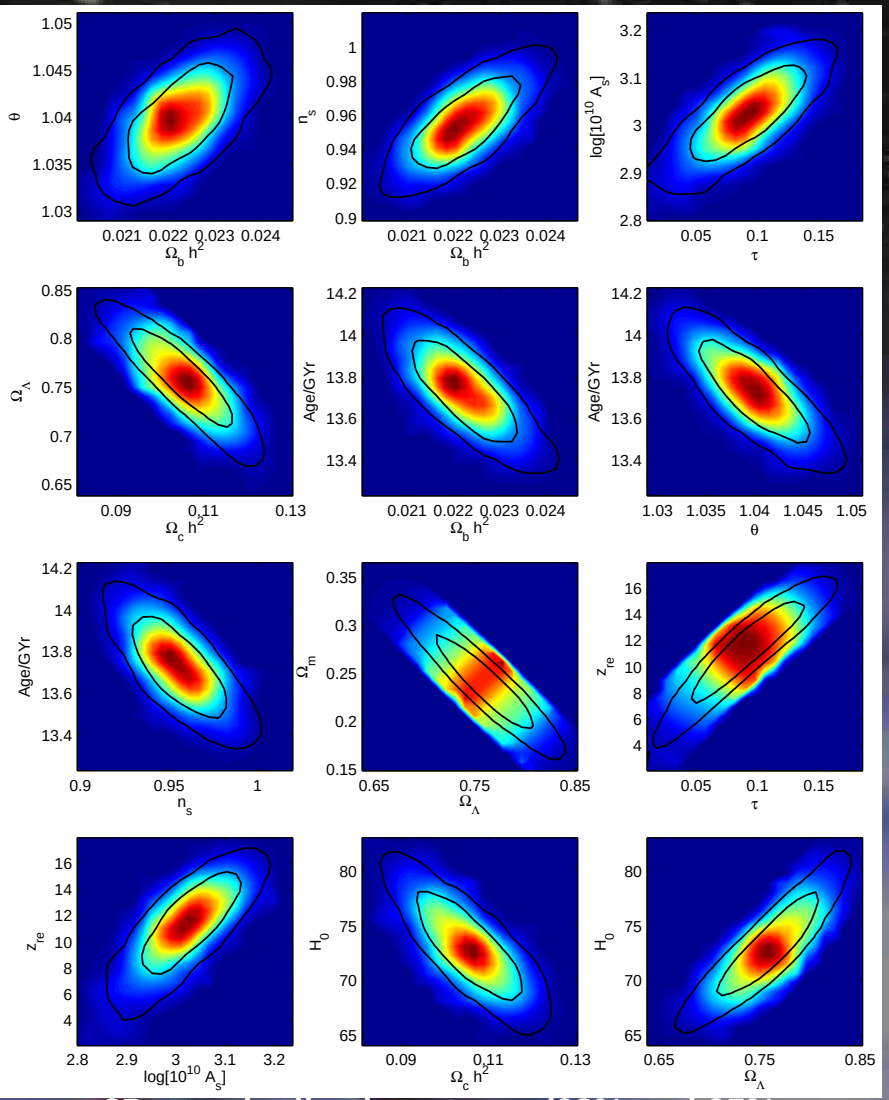
3. Compute again C^2_l and L_2

4a. If $L_2/L_1 \geq 1$ take the step. New set $\{\alpha_2\}$

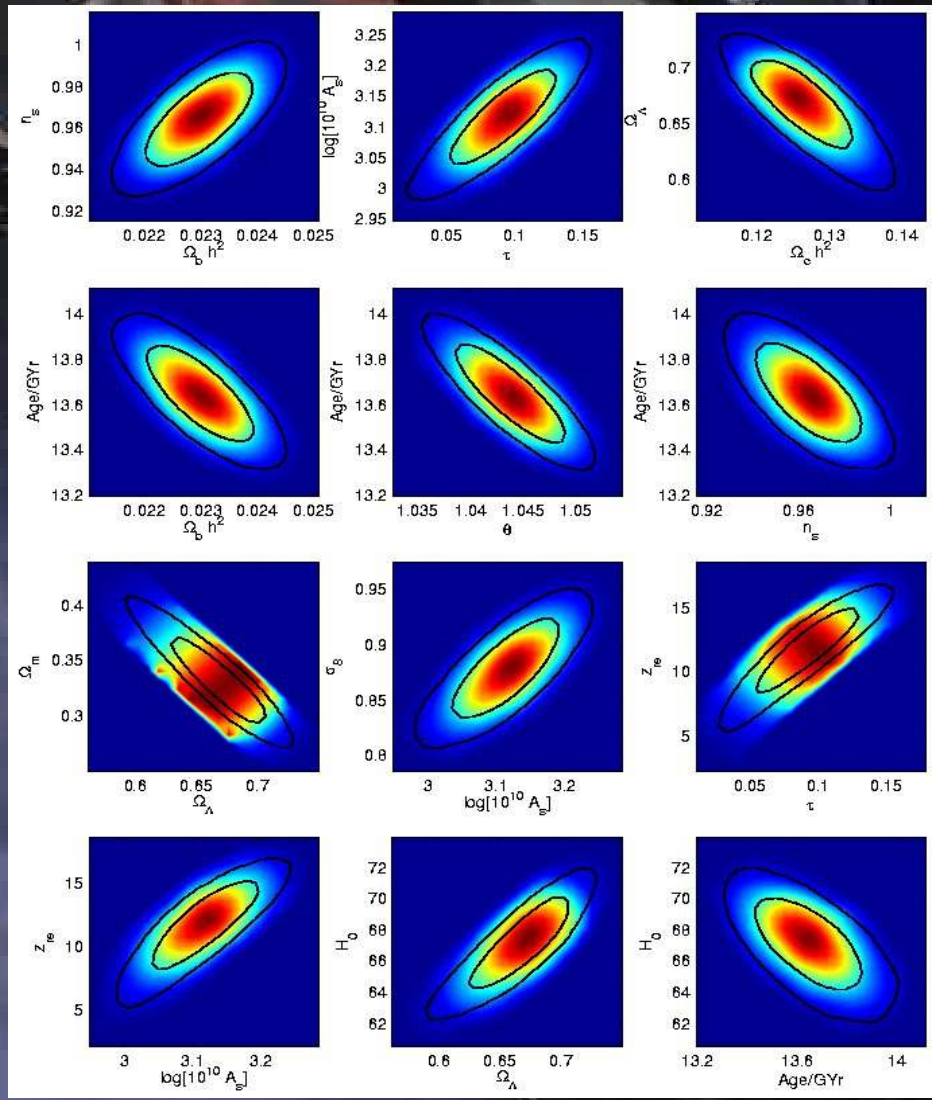
4b. Else draw a random number x from a uniform distribution from 0 to 1. If $x \geq L_2/L_1$ do not take the step but return to step 2. Else, take the step and return to 4a

5. Run separate chains randomly chosen and stop when a certain convergence criterion is reached

Advantages of the combined analysis

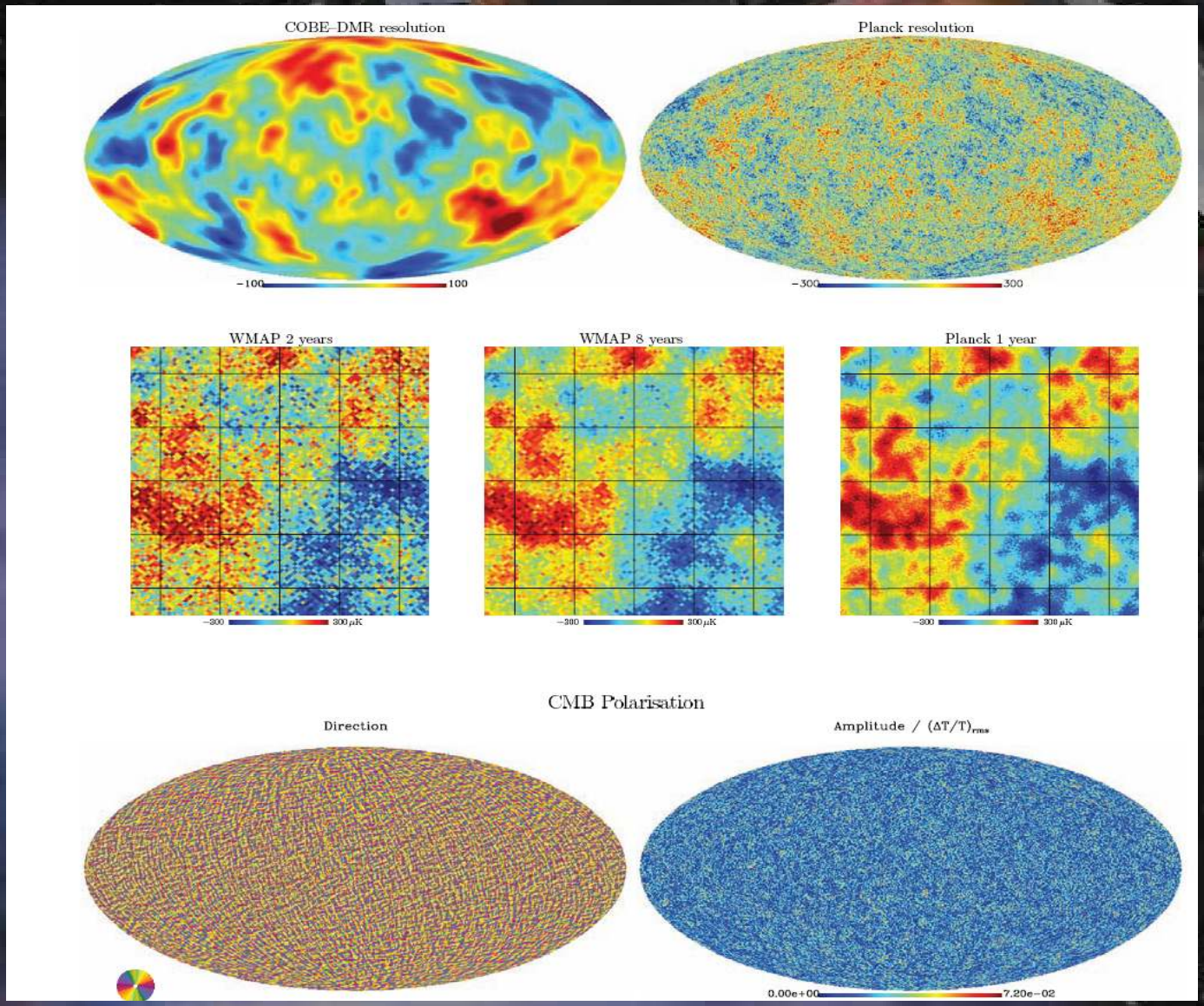


2D marginalized contours (68% and 95% confidence levels) for some combinations of parameters for WMAP only



Same as left panel for WMAP+2dFGRD+SDSS+CBI

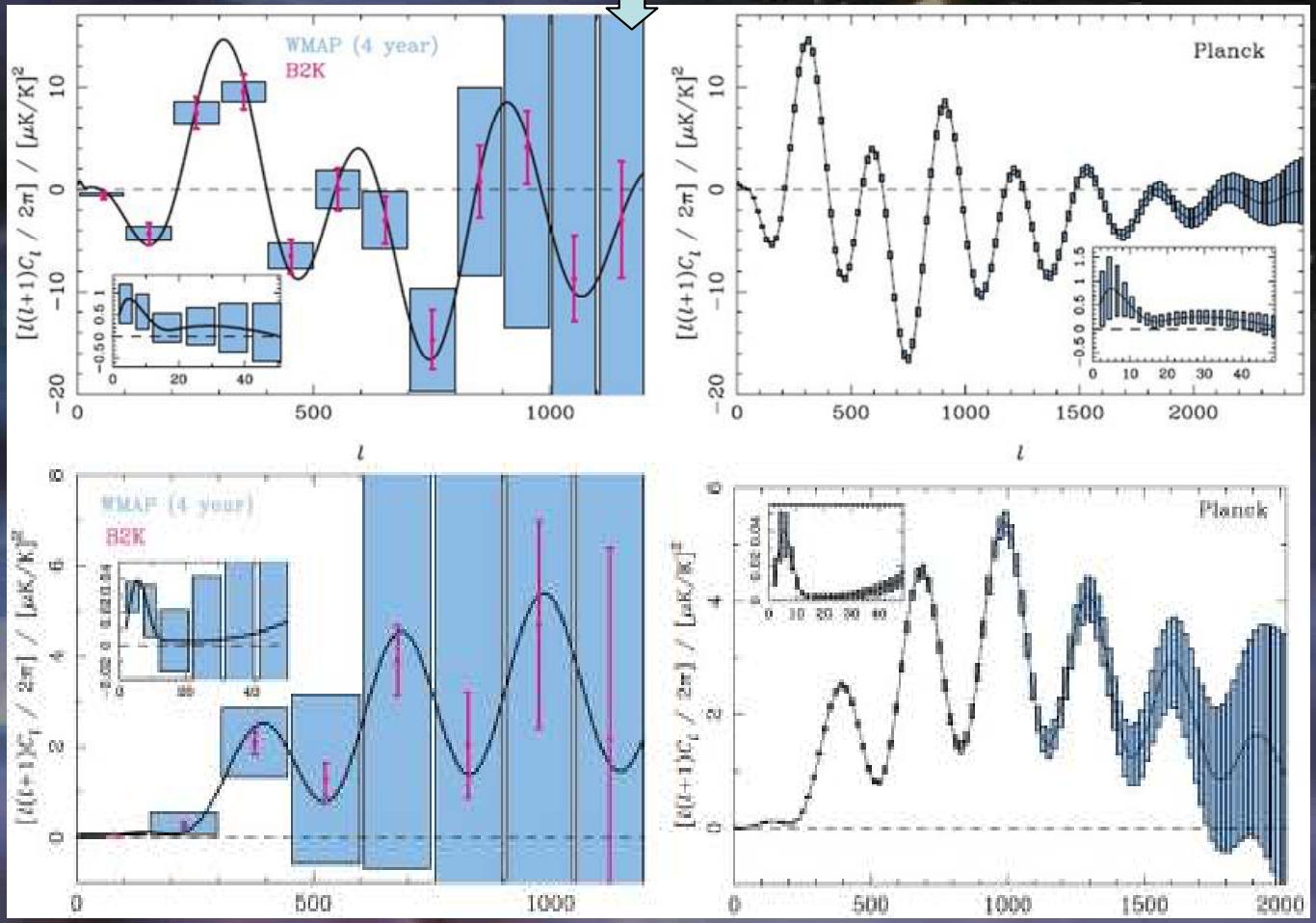
NEW DATA ≡ IMPROVED TOOLS

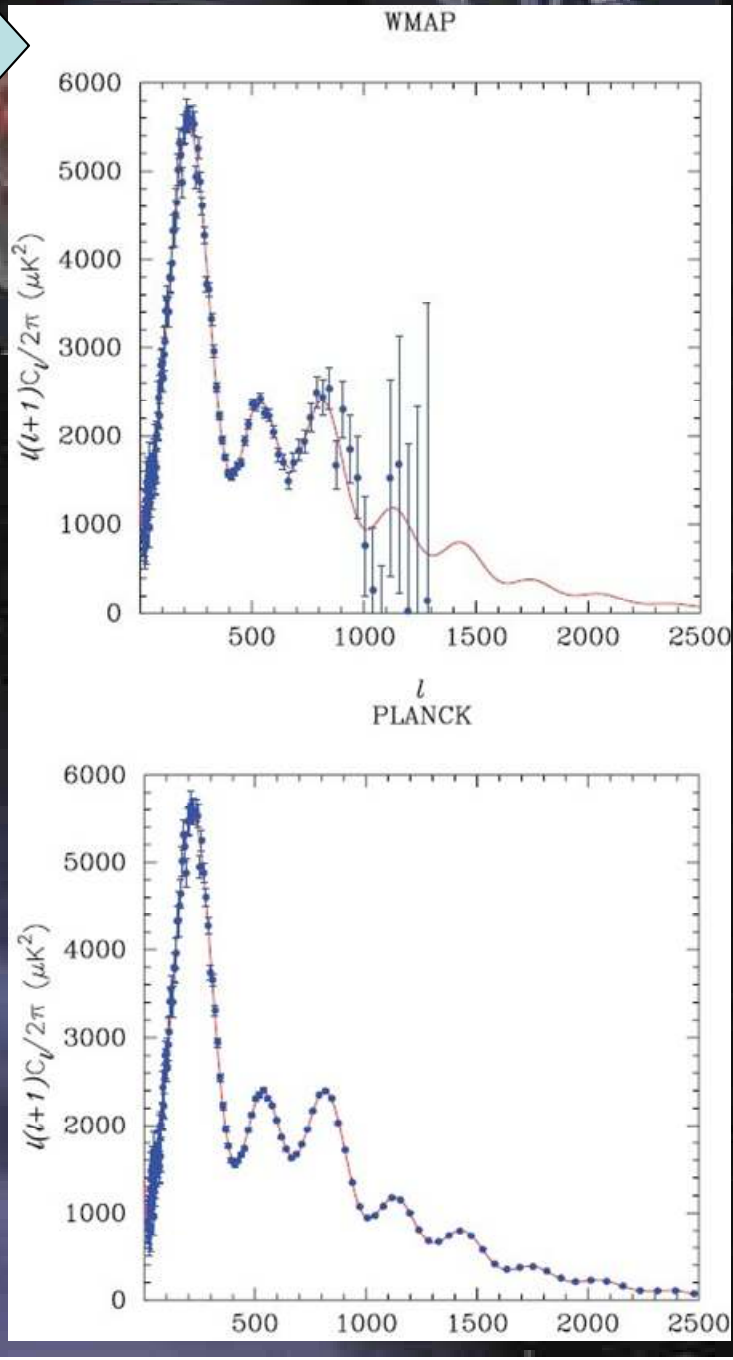


Simulated maps of the CMB sky in inflationary CDM models

The realisation of the CMB power spectrum of the ΛCDM model (red line) after 4 years of WMAP observations versus the same with the sensitivity and angular resolution of Planck

Forecasts for the ±1σ errors on the temperature-polarization cross correlation power spectrum in a ΛCDM model





From Planck Bluebook