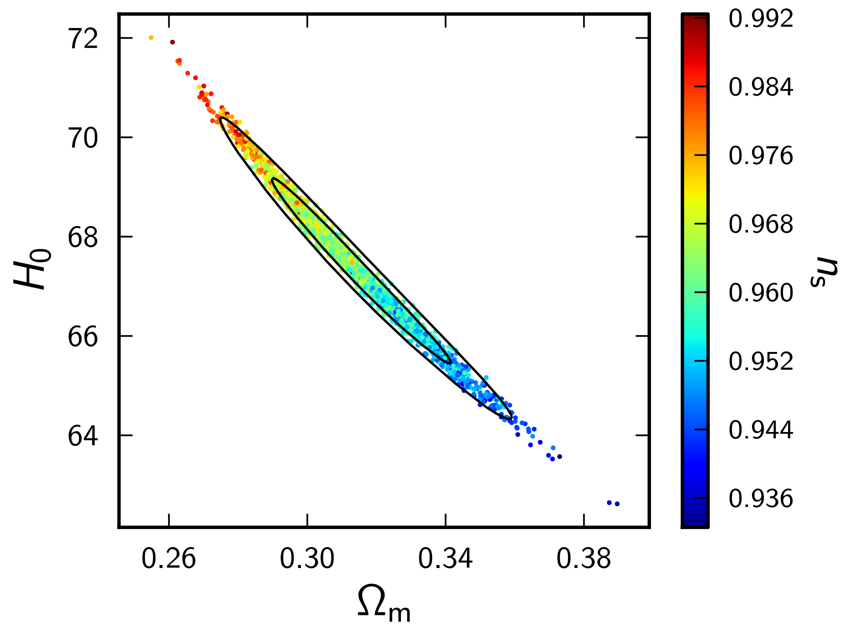
The Hubble constant from Planck



Jo Dunkley (followed by Eiichiro)

KITP, Apr 16

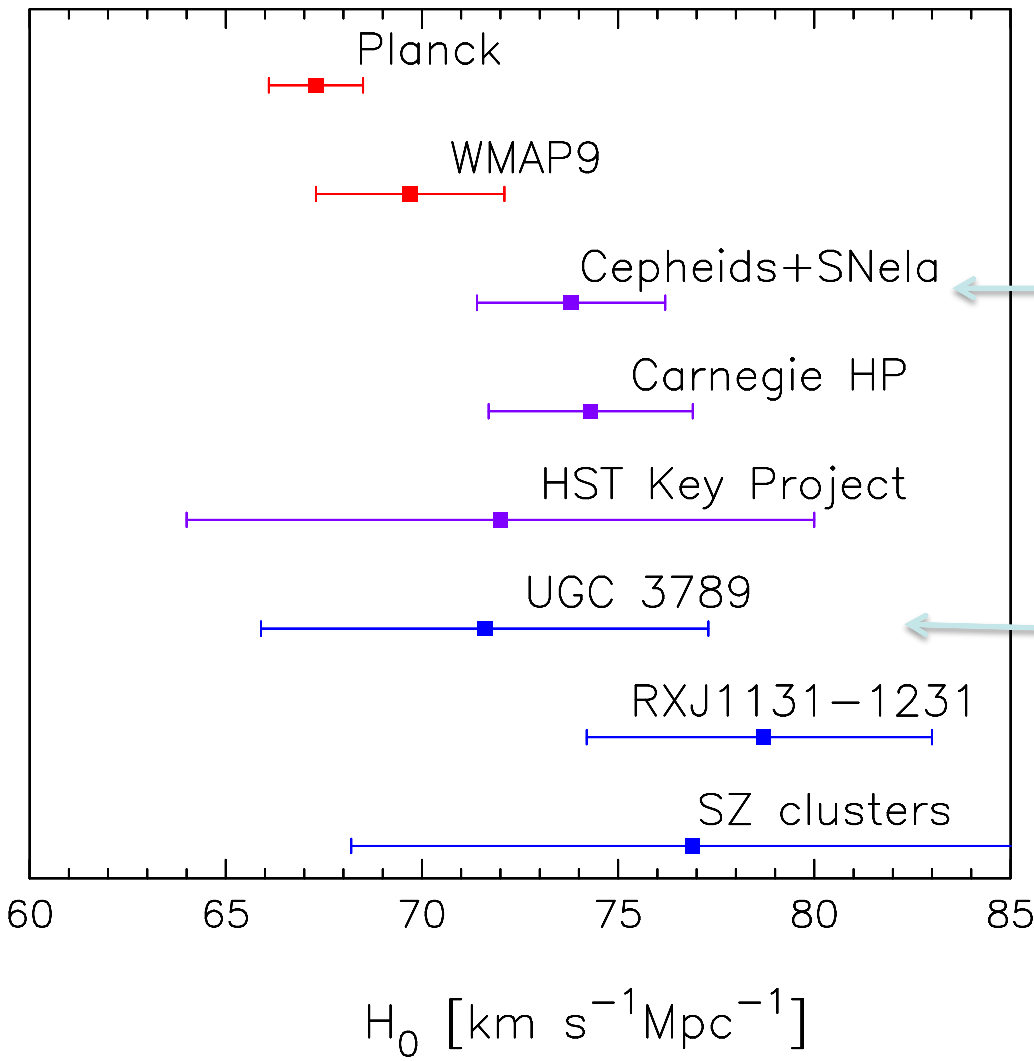
Questions

- Is the Planck-derived Hubble constant now discrepant with direct measurements?

- Is it consistent with WMAP?

- Why is it lower than the WMAP value?

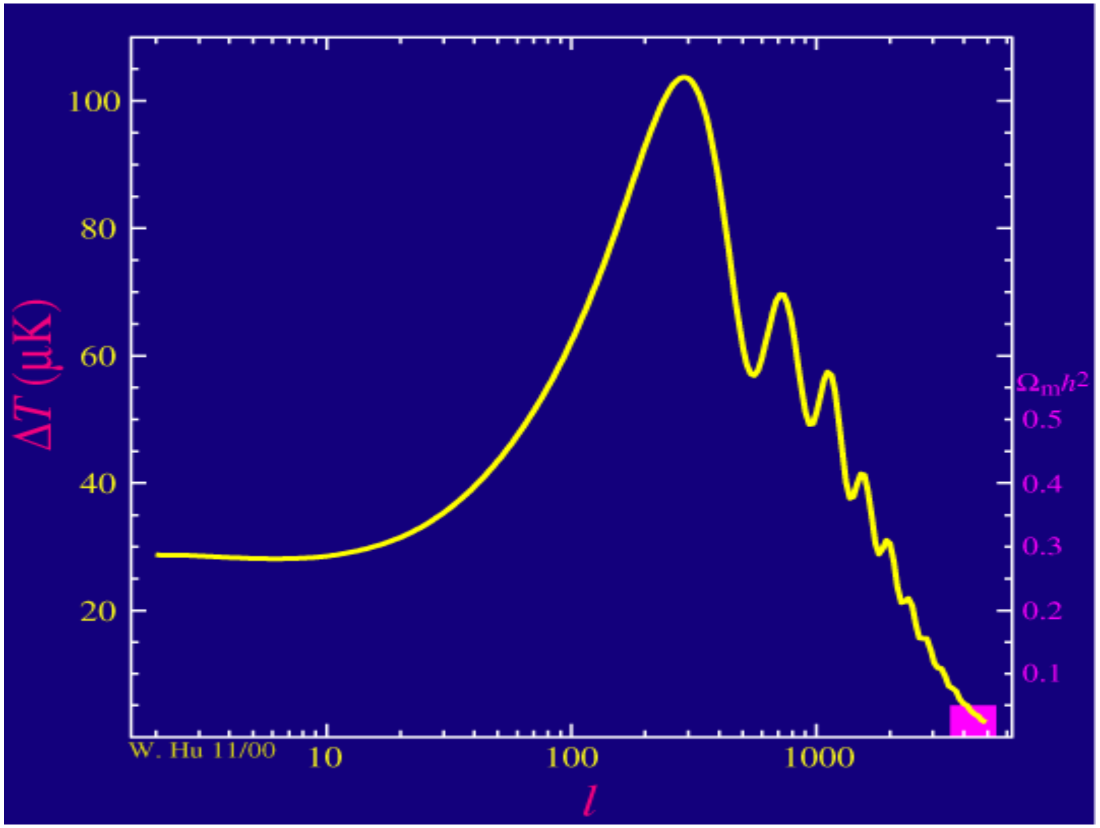
- What 'new physics' could reconcile Planck and local measurements?



Uses three 1st-rung calibrators: 71.3 – 75.7

UGC, at 50 Mpc: now H_0=68.9+-7.1

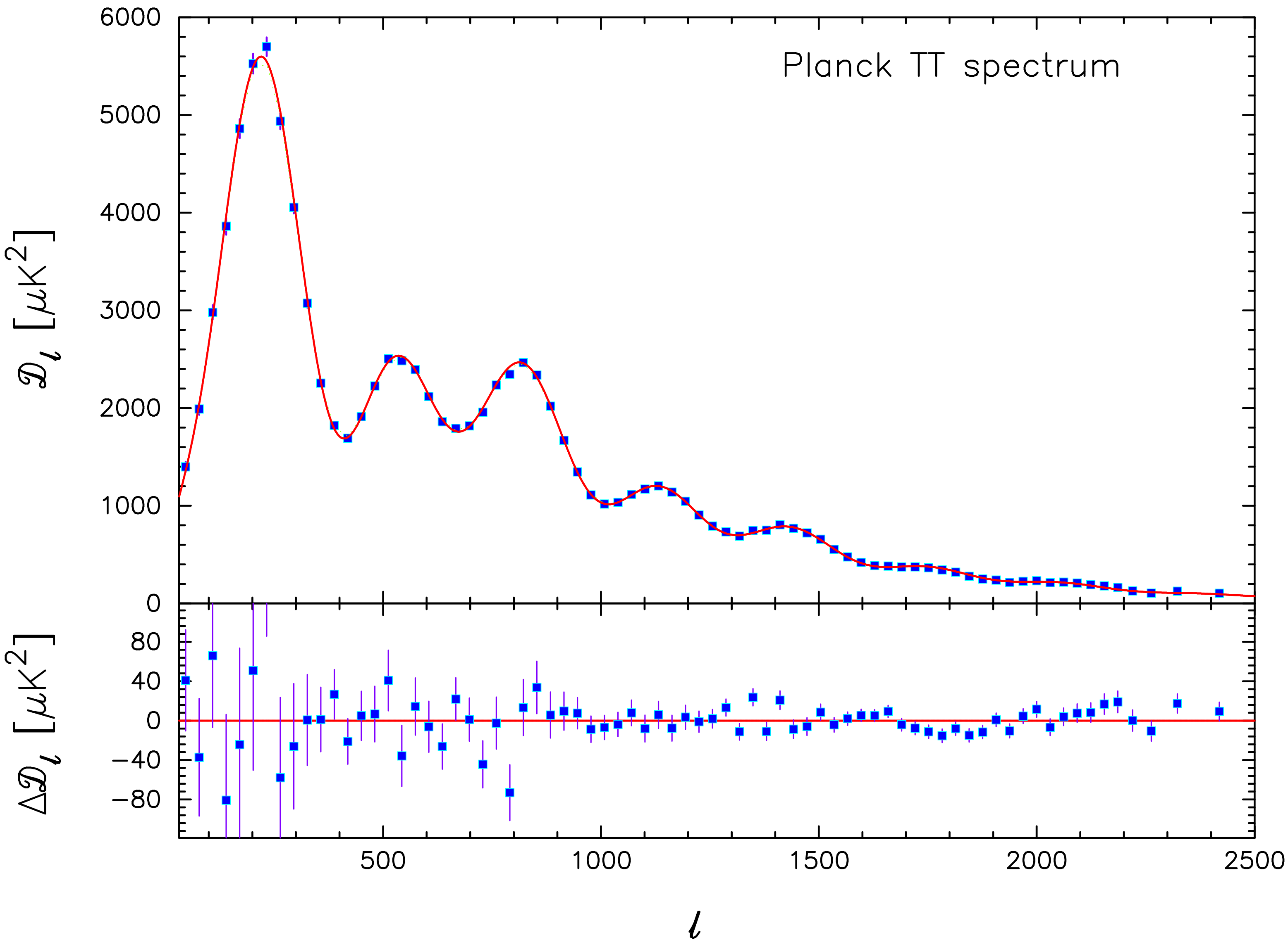
LCDM parameters → H_0



For flat universe:
peak positions ~ $\Omega_m h^3$
2^{nd} peak height ~ $\Omega_b h^2$
1^{st} and $3^{rd}/2^{nd}$ peak height ~ $\Omega_m h^2$

Measures matter-radiation equality
But also: more matter density → more damping. Also more lensing.

From Wayne Hu

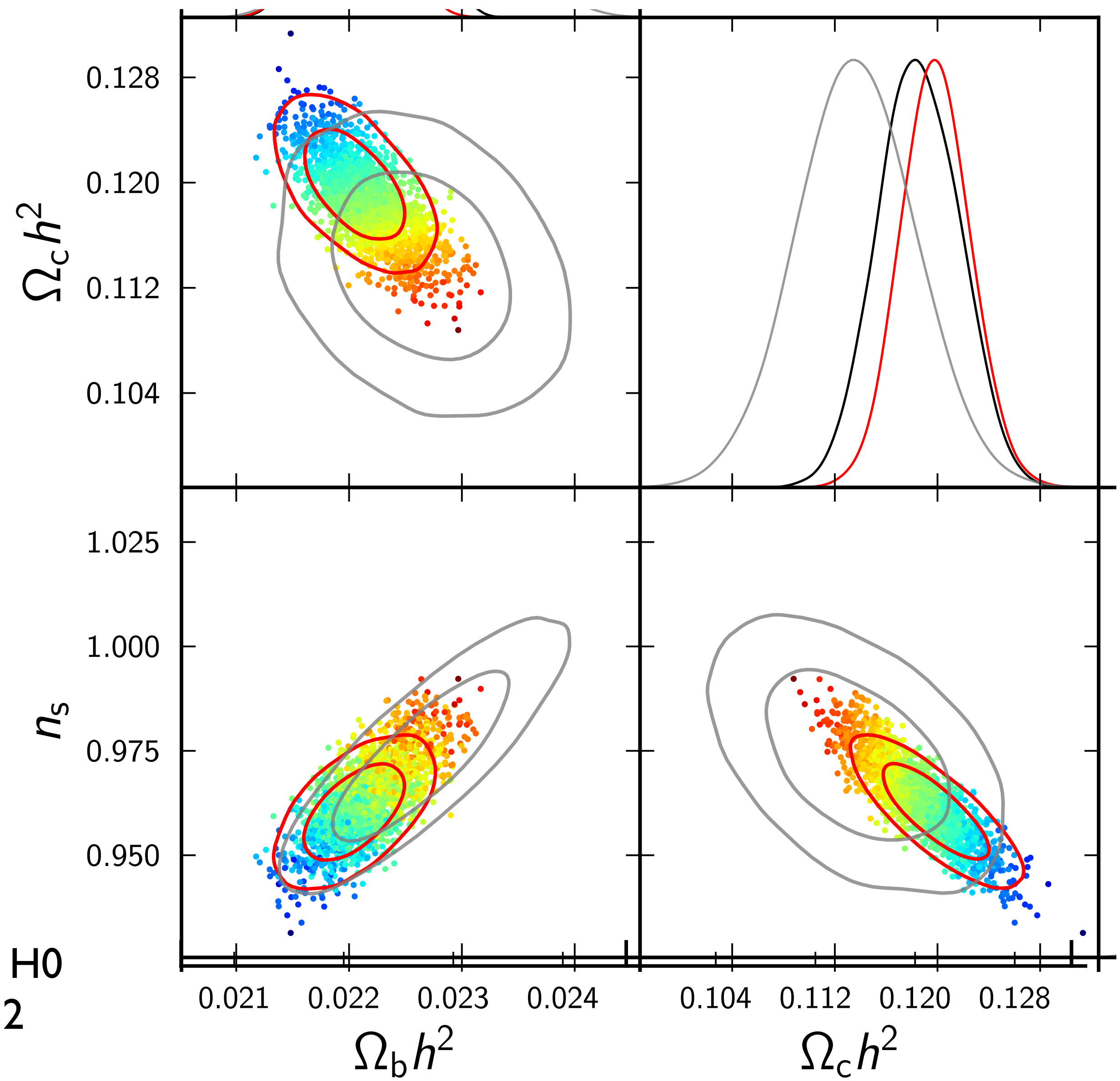


Planck TT spectrum
6000
5000
4000
3000
2000
1000
0
$\mathcal{D}_\ell$ [μK^2]
80
40
0
−40
−80
$\Delta\mathcal{D}_\ell$ [μK^2]
500
1000
1500
2000
2500
ℓ

WMAP v Planck

H_0 = 70.2 ± 2.2
(WMAP9)

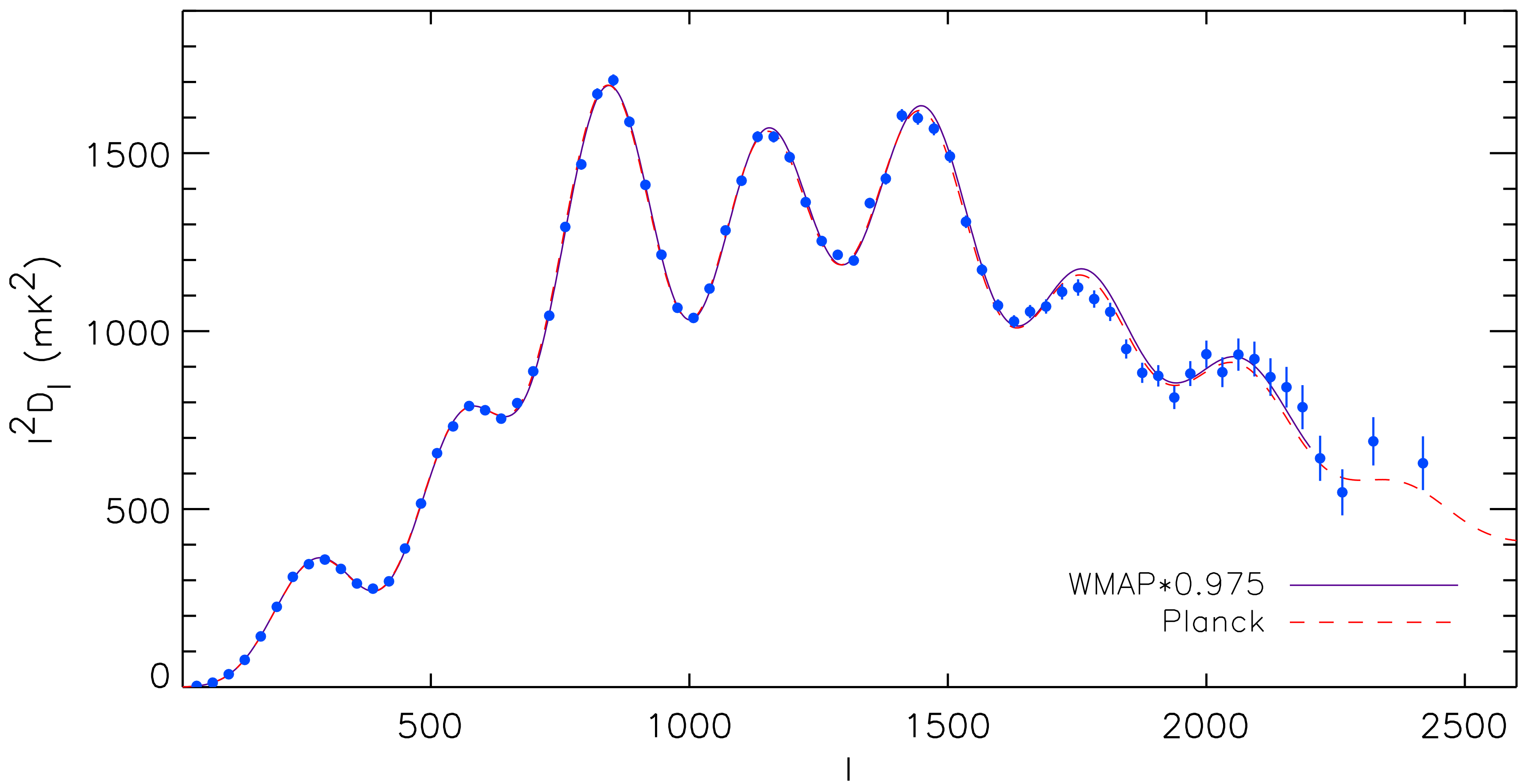
H_0 = 67.3 ± 1.2
(Planck+WP)



Planck: higher och2 → lower H0
Also has lower ns, lower obh2

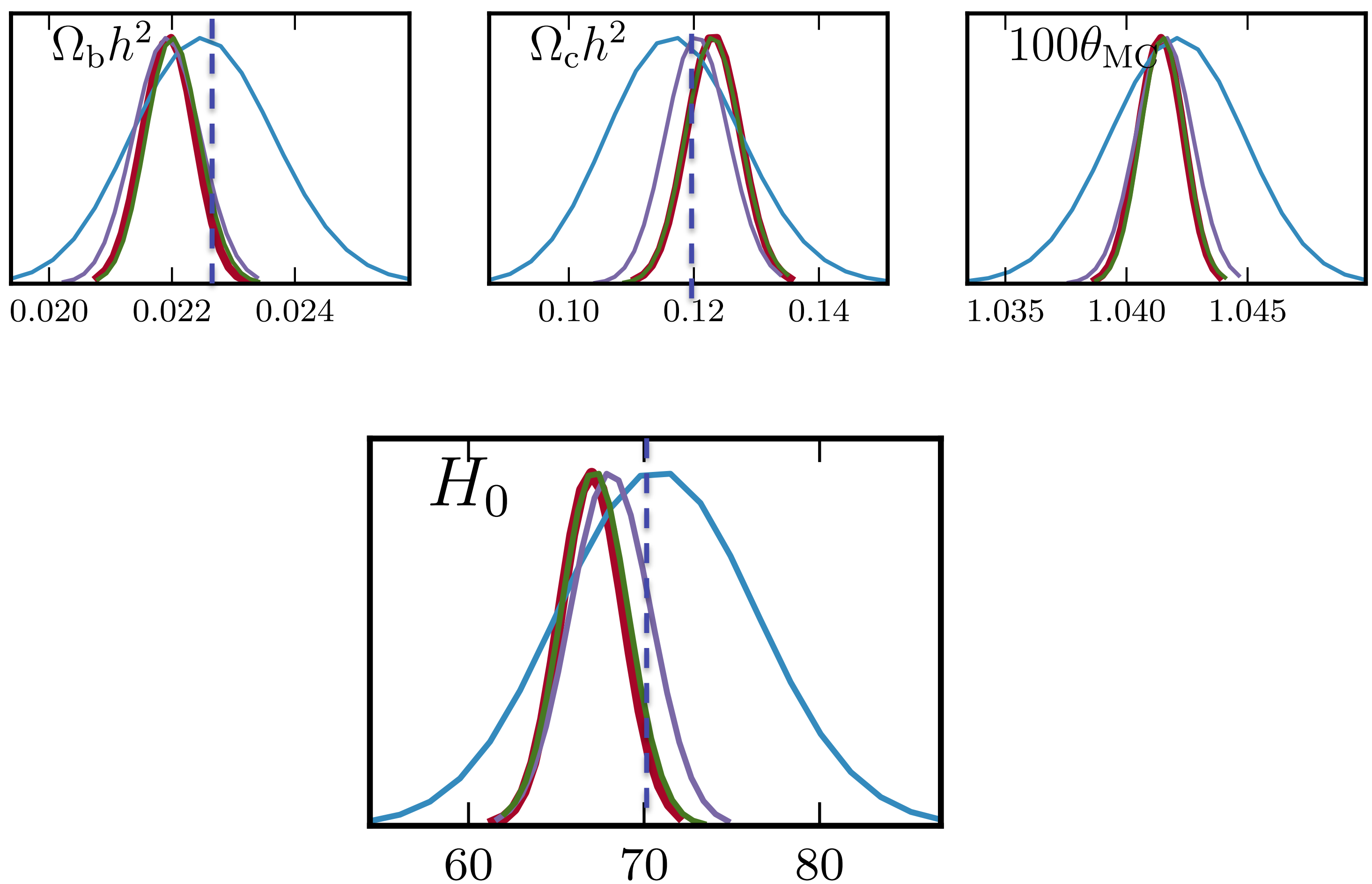
[NB: if we had used mnu=0.06 for WMAP, H0 would be 69.7±2.2]

Where is difference?



Is ell<1000 data consistent?

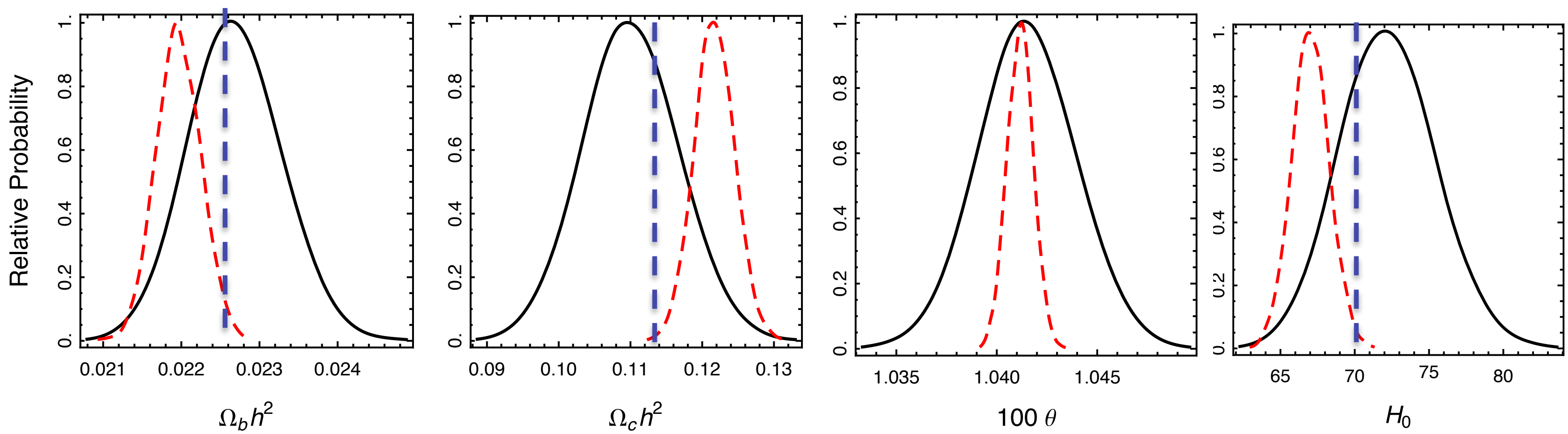
Varying Planck ell range



Lower ell range moves back similar to WMAP ones

Is ell<1000 data consistent?

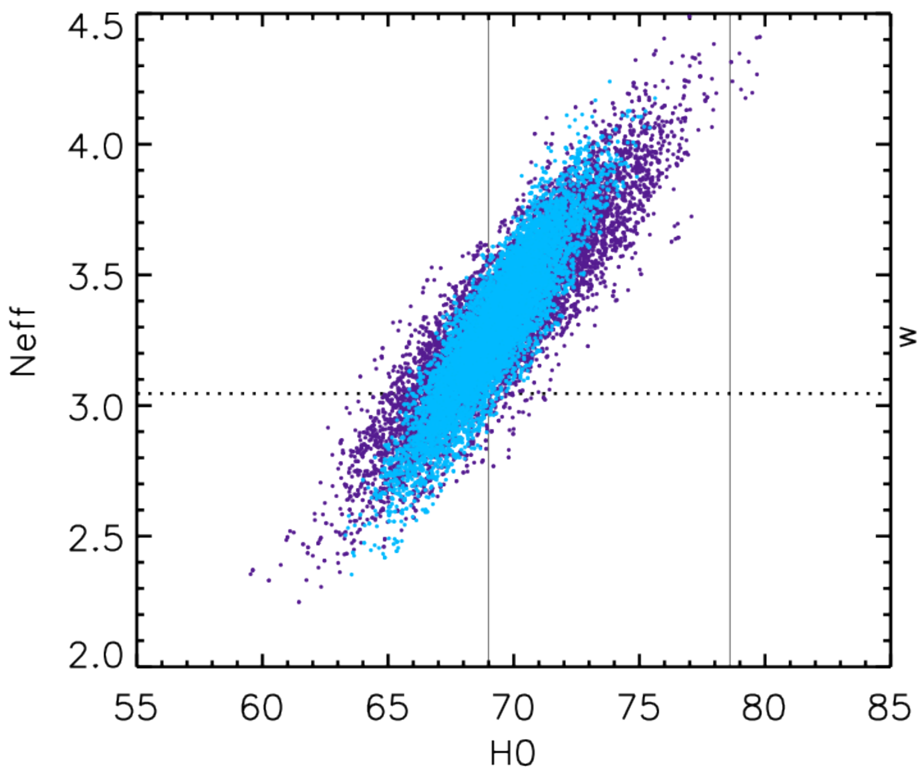
Using just LFI data

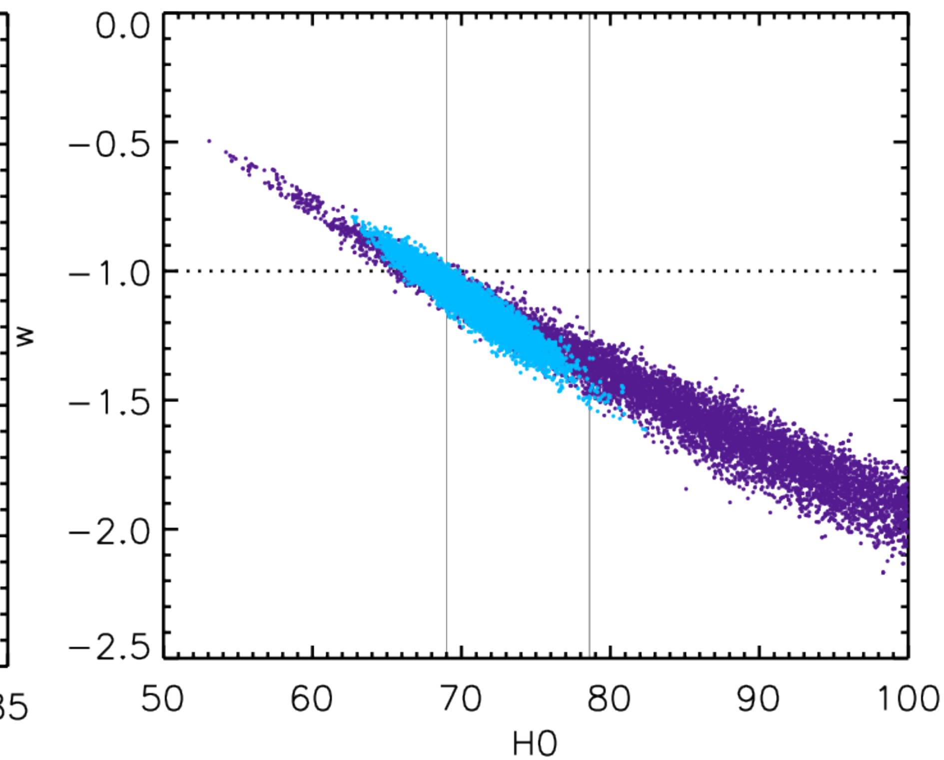


LFI parameters – from 70 GHz - move back similar to WMAP ones (slightly higher H0 and lower och2)

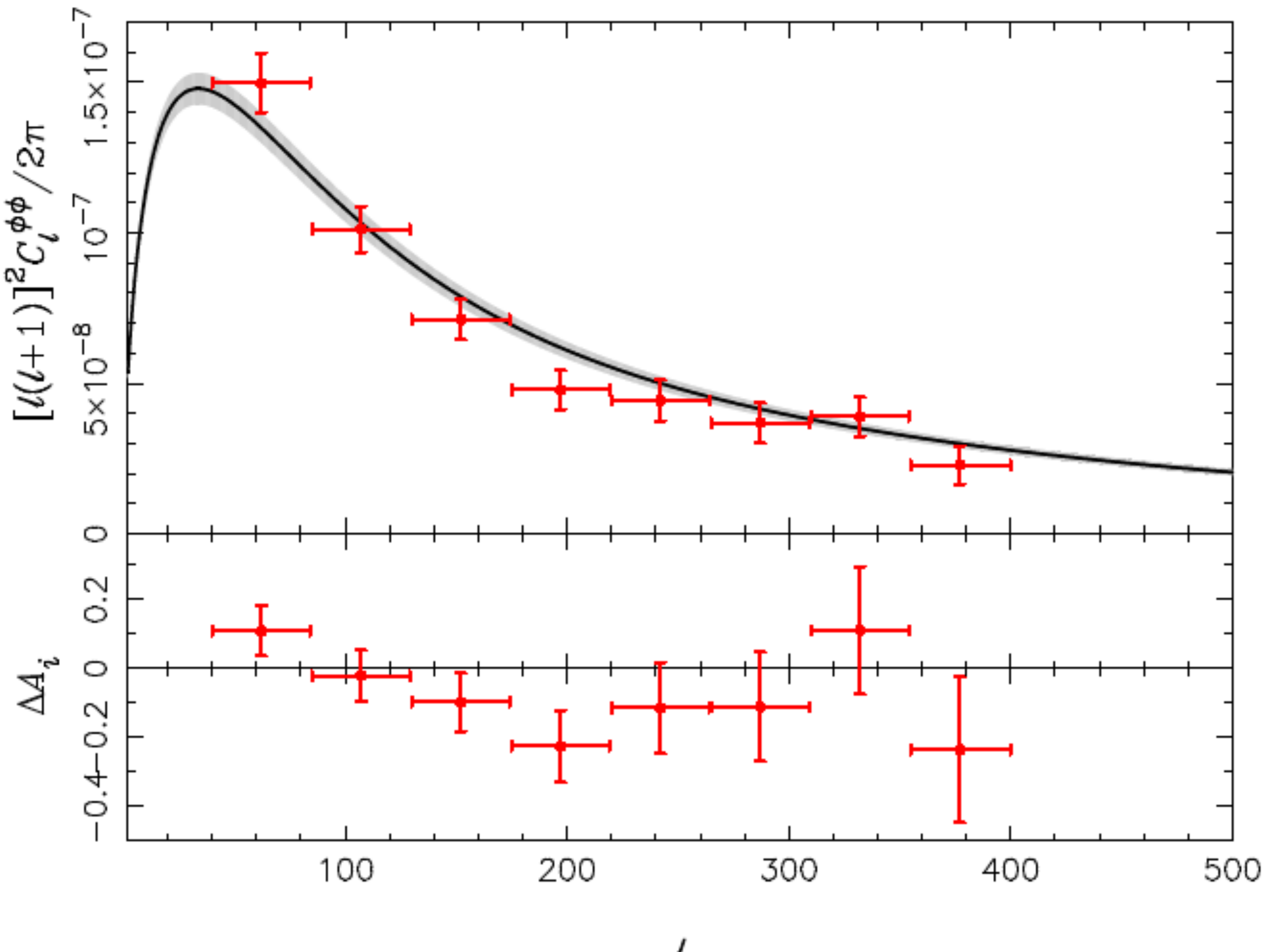
What if difference is real?

Not mnu: anti-correlates with H0
If error is ~halved and mean doesn't change, would need to go beyond LCDM





What does lensing tell us?



Not much yet for LCDM (H_0 = 67.9 ± 1.0) with lensing), but beautifully breaks geometric degeneracy (H_0=64.6 ± 3.3 in curved universe)

Questions

- Is the Planck-derived Hubble constant now discrepant with direct measurements?

    Different at 2.5 sigma from HST measurements.

    Consistent with new water maser measurement

- Is it consistent with WMAP?

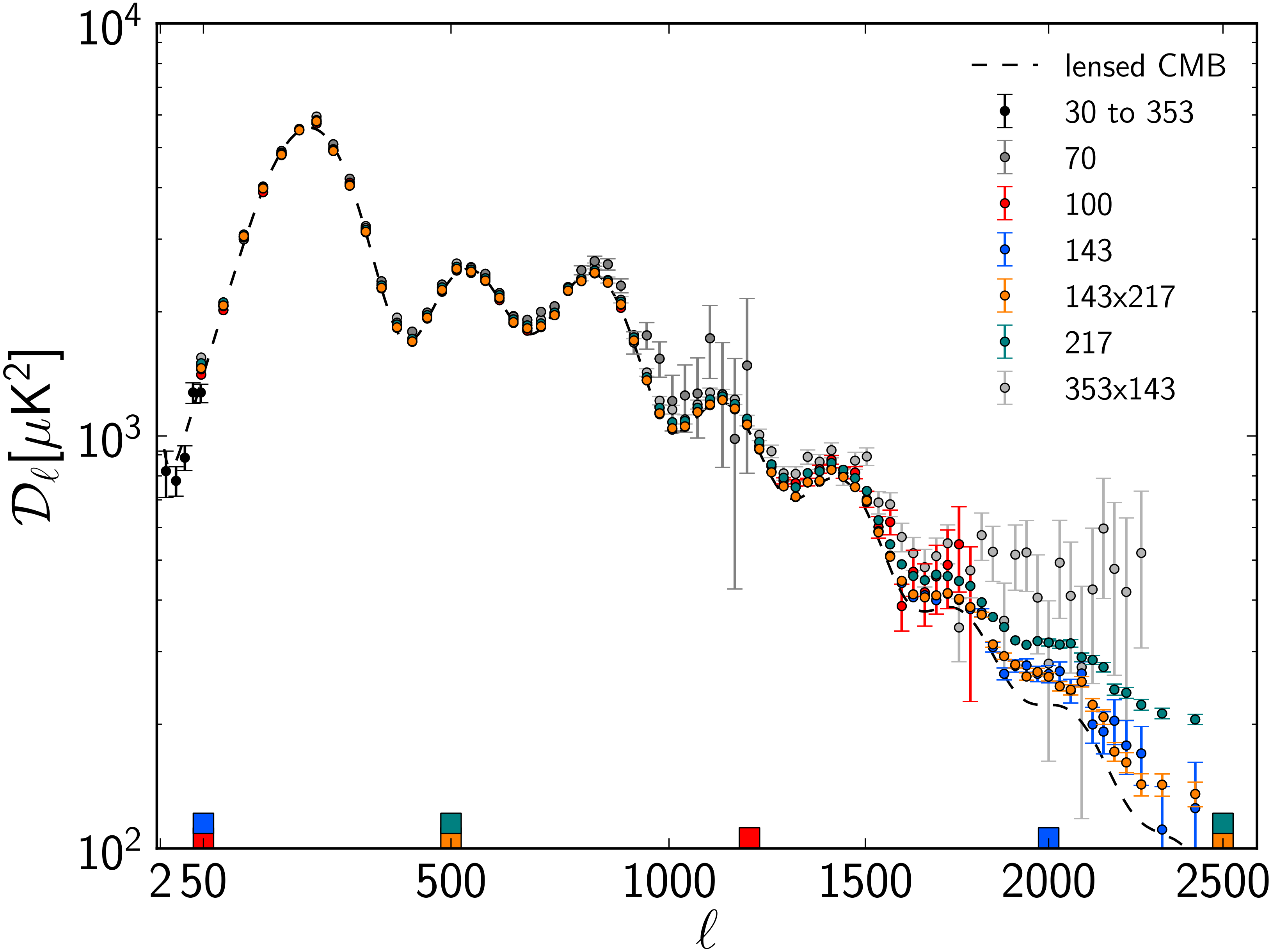
    Best-fit differs by ~1-sigma, but using same ell range see consistent parameters (not driven by amplitude diff)

- Why is it lower than the WMAP value?

    4^{th}-6^{th} peaks are lower than WMAP best-fit model. Need ns<1 and more damping → more och2 and less obh2 → lower H_0.

- What 'new physics' could reconcile Planck and local measurements?

    $3<N_{eff}<3.5$ or $-1.3<w<-1.1$ could fit



lensed CMB
30 to 353
70
100
143
143x217
217
353x143
10^4
10^3
10^2
$\mathcal{D}_\ell [\mu K^2]$
2
50
500
1000
1500
2000
2500
ℓ