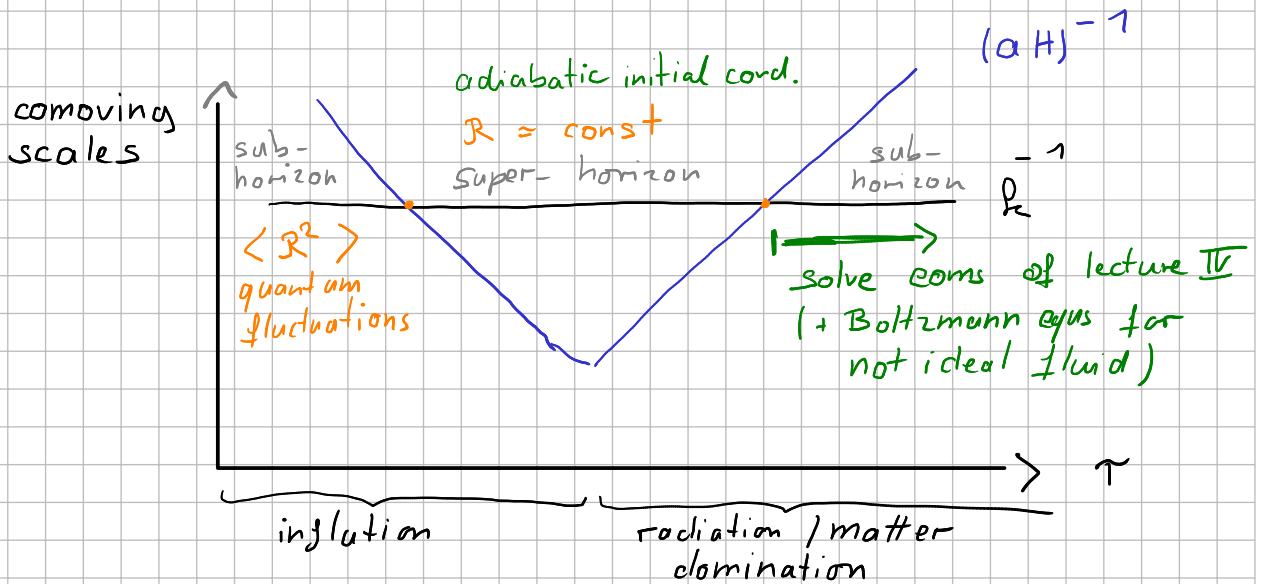


$$\partial_i T^i_0 = (\bar{\rho} + \bar{p}) \partial_i v^i$$

Lecture V Tests of inflation

Recap:



1) phase coherence

density perturbation inside horizon

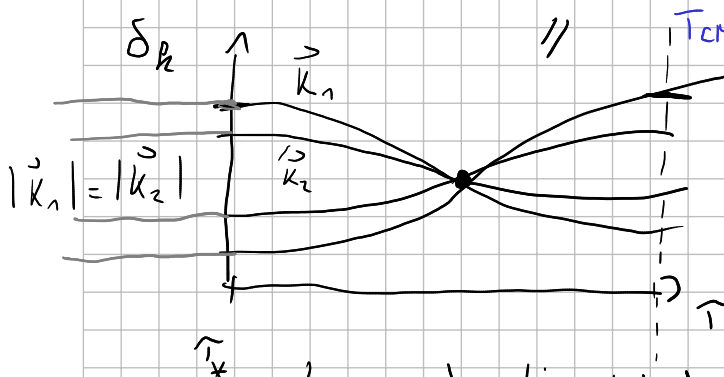
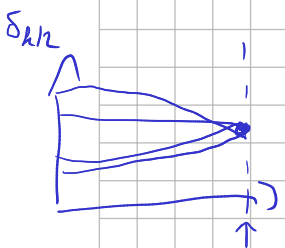
$$\ddot{\delta} - c_s^2 \nabla^2 \delta = F_g[R]$$

→ Fourier expansion: $\delta_{\vec{k}} = A \cos(\vec{k}\vec{x} - \omega t) + B \sin(\vec{k}\vec{x} - \omega t)$

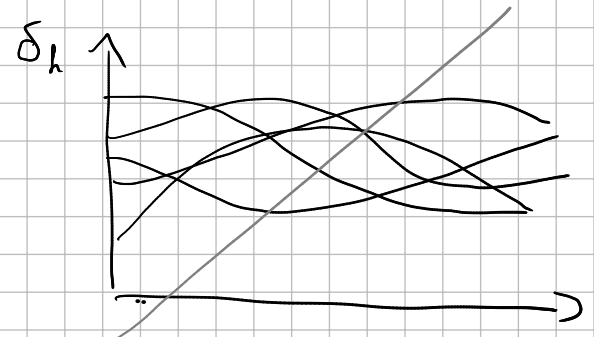
→ initial conditions: $\delta \sim R = \text{const.}$ at horizon re-entry
($\dot{\delta} = 0$)

↳ only cosine mode ($B = 0$)

↳ phase coherence



↳ constructive interference
↳ peaks in CMB T spectrum

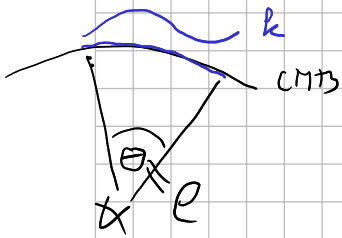


↳ destructive interference

2) CMB

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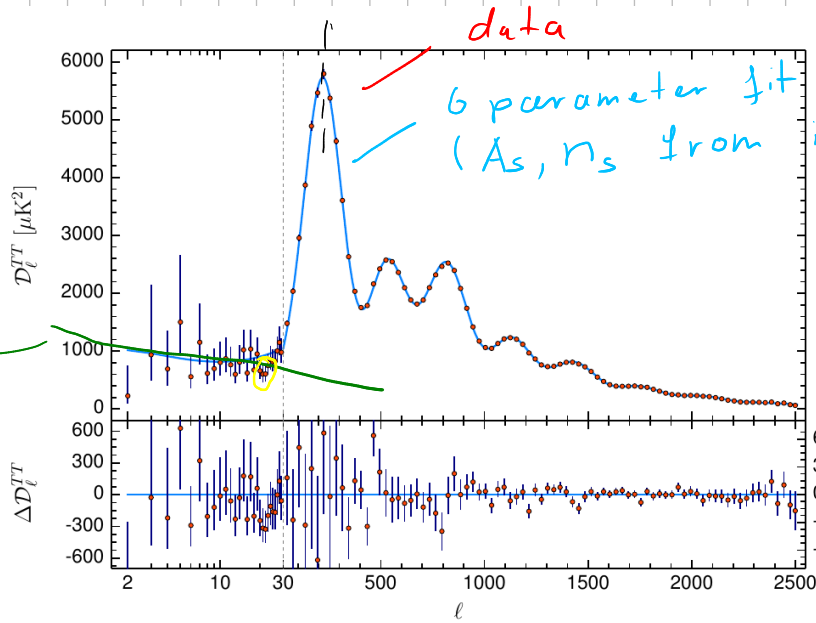
temperature power spectrum



$$A_s = 2 \times 10^{-9}$$

$$n_s \approx 0.987$$

$$\Delta_R^2 \sim \frac{H^4}{\phi^2}$$

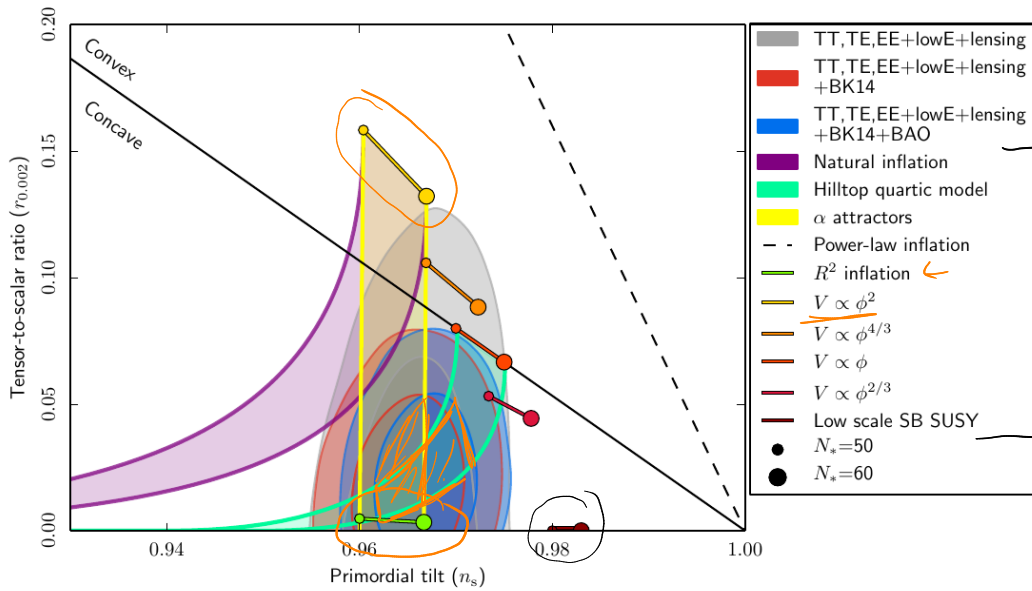


6 parameter fit
(A_s, n_s from inflation)

$$\Delta_R^2 = A_s \left(\frac{k}{k_{ref}} \right)^{2n_s}$$

discriminate between inflation models:

$$r = \frac{\Delta_R^2}{\Delta_s^2}$$

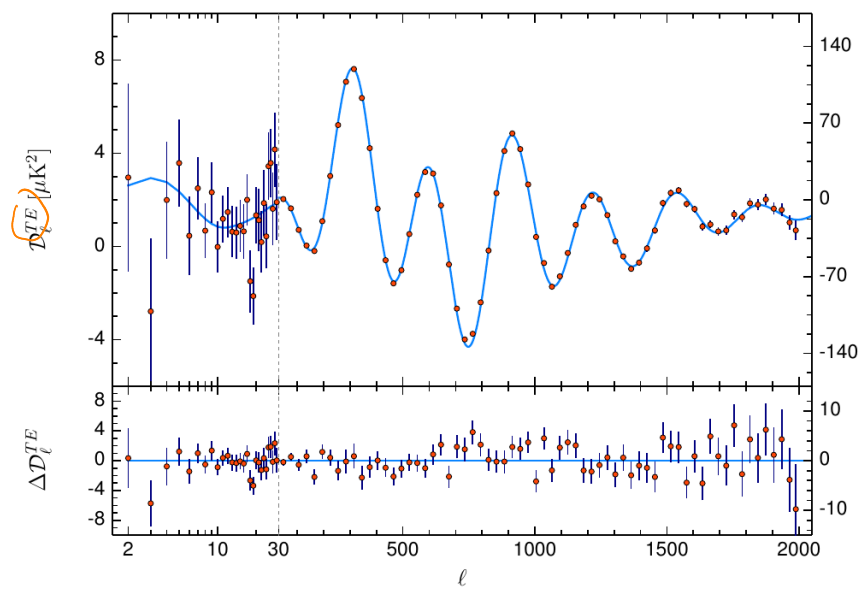
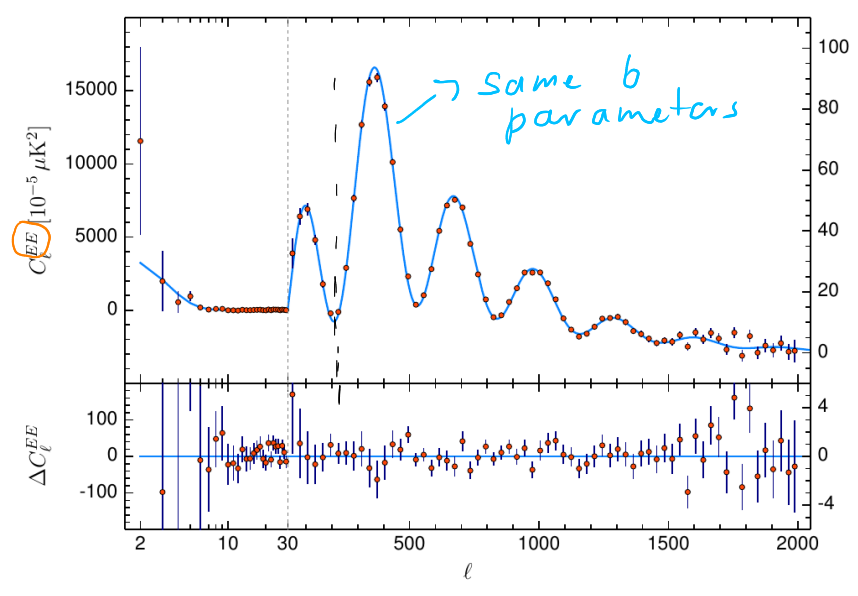


Tensor-to-scalar ratio ($r_{0.002}$)

Primordial tilt (n_s)

- TT, TE, EE+lowE+lensing
- TT, TE, EE+lowE+lensing+BK14
- TT, TE, EE+lowE+lensing+BK14+BAO
- Natural inflation
- Hilltop quartic model
- α attractors
- Power-law inflation
- R^2 inflation
- $V \propto \phi^2$
- $V \propto \phi^{4/3}$
- $V \propto \phi$
- $V \propto \phi^{2/3}$
- Low scale SB SUSY
- $N_s=50$
- $N_s=60$

beyond TT spectrum:



3) (non-) Gaussianity

non-gaussianity:

$$\langle R_{\vec{k}} R_{\vec{k}'} R_{\vec{k}''} \rangle = \delta(\vec{k} + \vec{k}' + \vec{k}'') B(\vec{k}, \vec{k}', \vec{k}'')$$

↳ non-zero iff different \vec{k} -modes are correlated

↳ very small in single field slow-roll inflation

↳ data consistent with single-field slow-roll

4) gravitational waves

$$\Delta_{\text{t}}^2 = \frac{2}{M_{\text{p}}^2} \frac{H_*^2}{\pi^2}$$

$$\Gamma = \frac{\Delta_{\text{t}}^2}{\Delta_{\text{R}}^2} < 0.1$$

$\sim 2 \times 10^{-9}$

≙ upper bound on energy scale of inflation

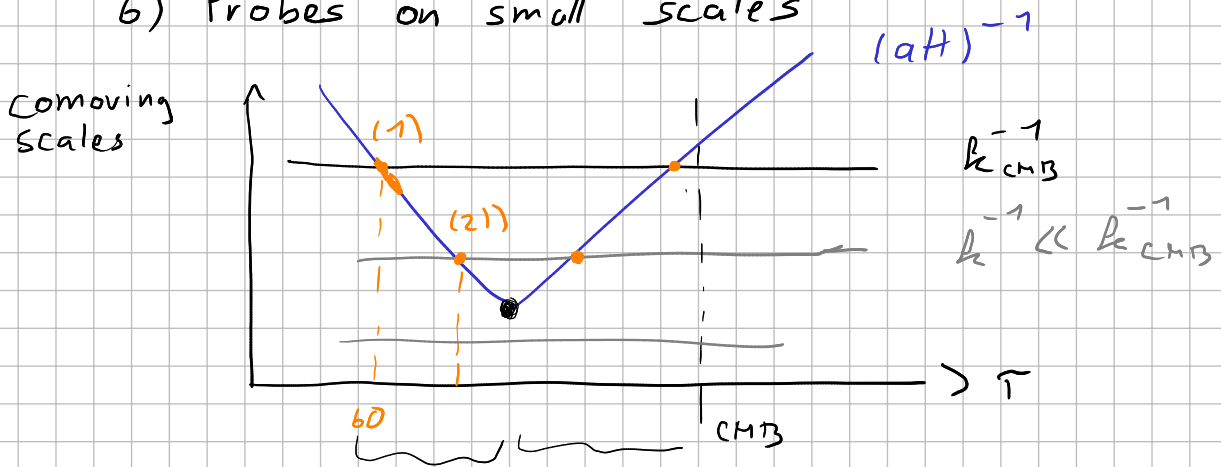
$$n_{\text{t}} = -\Gamma / 8$$

Consistency relation
↳ to be checked

5) adiabatic initial conditions

↳ see lecture IV

6) Probes on small scales



- Scalars

- distortions of CMB blackbody
- PBHs
- LSS

- tensor r

- "
- GW searches, e.g. PTAs, LISA, LIGO
- ↳ Chiara's lecture