Scanning Inflation

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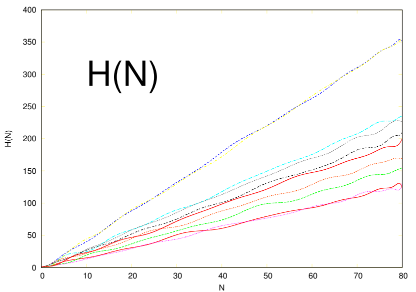
Outline

1. Overview
2. Trajectories
3. Observables
   - Classical Observables
   - Powerspectra
   - Outlook
4. Conclusions

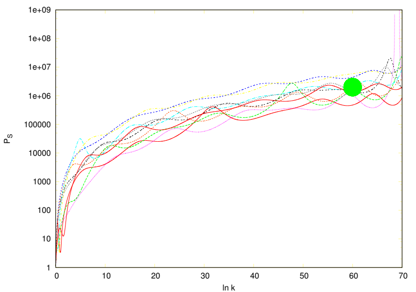
The Eye Of The Needle

reconstruction $\longleftarrow$

Acceleration



Powerspectrum



trajectory $H(N)$ $\xrightarrow{\text{map}}$ $P_R \propto \frac{H^2}{\epsilon}$

(natural object from Hamilton-Jacobi formalism)

(mildly broken scale invariance)

Slow-Roll Parameters

- Equations of Motion

$$\begin{aligned} \ddot{\phi} + 3H\dot{\phi} + V' &= 0 \\ \frac{8\pi}{3m_p^2}\left(\frac{1}{2}\dot{\phi}^2 + V\right) &= H^2 \end{aligned}$$

- Slow roll parameters

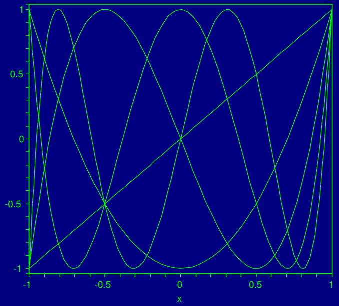
$$\epsilon = -\frac{\dot{H}}{H^2}, \quad \eta = \frac{m_p^2}{4\pi}\frac{H''}{H}, \quad \zeta^2 = \left(\frac{m_p^2}{4\pi}\right)^2 \frac{H'''H'}{H^2}, \sigma = 2\eta - 4\epsilon$$

- Powerspectra

$$P_R \equiv A_S \left(\frac{k}{k_{\mathrm{pivot}}}\right)^{n_s - 1} \propto \frac{H^2}{\epsilon}, \quad P_G \equiv A_t \left(\frac{k}{k_{\mathrm{pivot}}}\right)^{n_t} \propto H^2$$

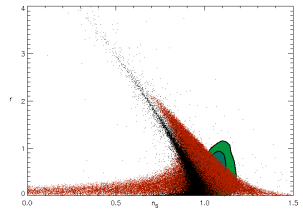
Trajectories

- N: # of efolds $dN = -Hdt$
- Constraints during inflation
  - $0 \leq \epsilon \leq 1$
  - $H > 0$
- at the end of inflation $\epsilon = 1$
- Expansion to arbitrary order
  - $H(N) = \sum_i c_i T_i(x)$
  - with $x = \frac{2N - N_{\max}}{N_{\max}}$, Chebyshev polynomials $T_i(x)$ (uniformly best approximation to “true” function)



$$T_n(\cos(x)) = \cos(nx)$$

Classical Observables
the basic picture

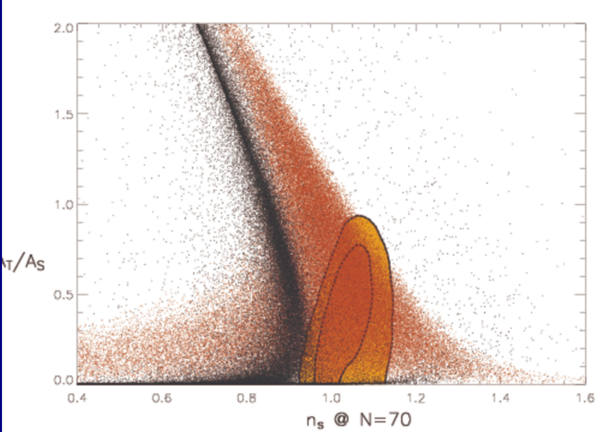


- Classical Observables

$$
\begin{aligned}
n_s - 1 &= \sigma - (5 - 3C)\epsilon^2 - \frac{1}{4}(3 - 5C)\sigma\epsilon + \frac{1}{2}(3 - C)\zeta^2 \\
r \equiv \frac{A_T}{A_S} &= \epsilon(1 - C(\sigma + 2\epsilon)) \\
\frac{dn_s}{d\ln k} &= -2\zeta^2 + 5\sigma\epsilon + 12\epsilon^2
\end{aligned}
$$

Classical Observables

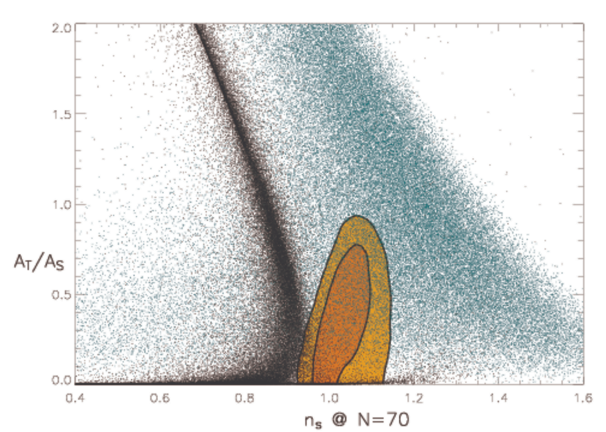
opening the space of observables - order 7



Chebyshev method is fast

Classical Observables

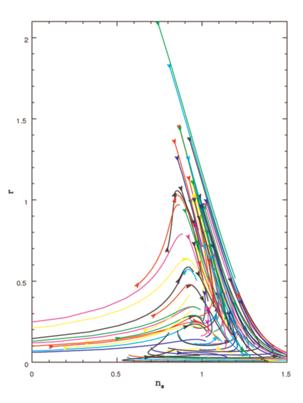
opening the space of observables - order 10



increasing the order opens the space of observables

Classical Observables

moving points

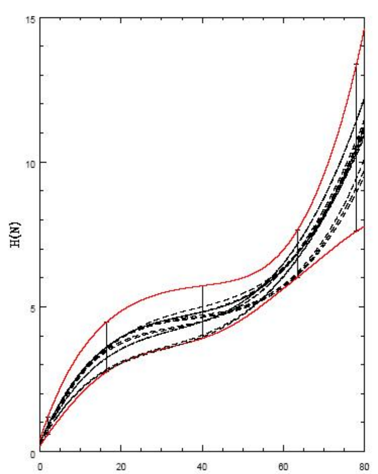


varying N moves the points in observable space around

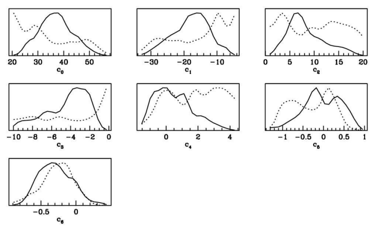
Alternatives?

- Classical Observables:
  - sensitive to choice of point in time
  - no measure on the space
  - no interpretation of densities as likelihoods
- Alternative:
  - use the powerspectra:
    - Chebyshevization of $H, P_R, \ln(P_R), \epsilon$
    - time variable $N \leftrightarrow \ln(k)$
    - full powerspectra $\leftrightarrow$ expansion around pivot point

COSMOMC
H

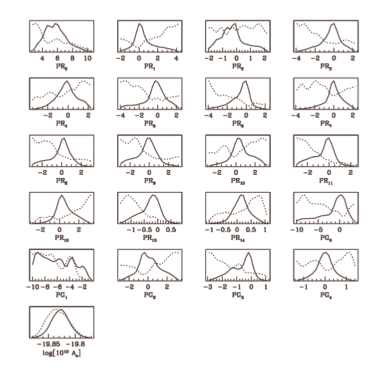


- $H(N)$ expanded to order 5
- Datasets used: WMAP only



COSMOMC

P_R



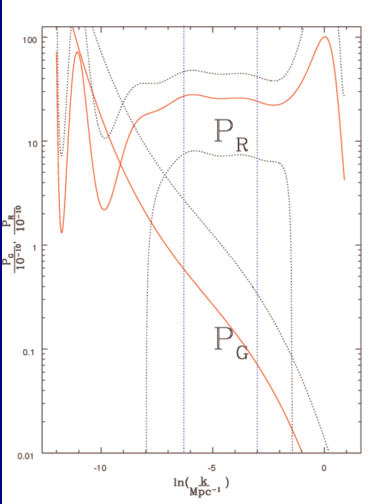
- Expansion of $\ln(P_R(\ln k)$ to order 15
- Datasets used:
  - ACBAR
  - BOOMERanG
  - CBI
  - DASI
  - MAXIMA
  - VSA
  - WMAP
  - 2dF
  - SDSS

Powerspectra

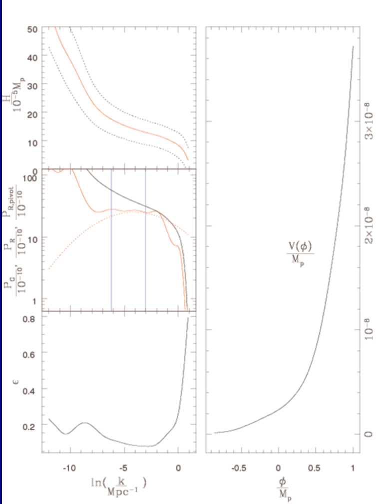
- Powerspectra

$$P_R \propto \frac{H^2}{\epsilon}$$
$$P_G \propto H^2$$

- consistency relation not used



To Do



TODO:

- full reconstruction of higher order Chebyshev $H(\ln k)$
- reconstruction of the potential $V(\phi)$

Conclusions

- Increasing the order of Chebyshevization opens the space of classical observables
- Classical Observables $\leftrightarrow$ power spectra
- Reconstruction of inflationary trajectories