Title: Landscape Attractors

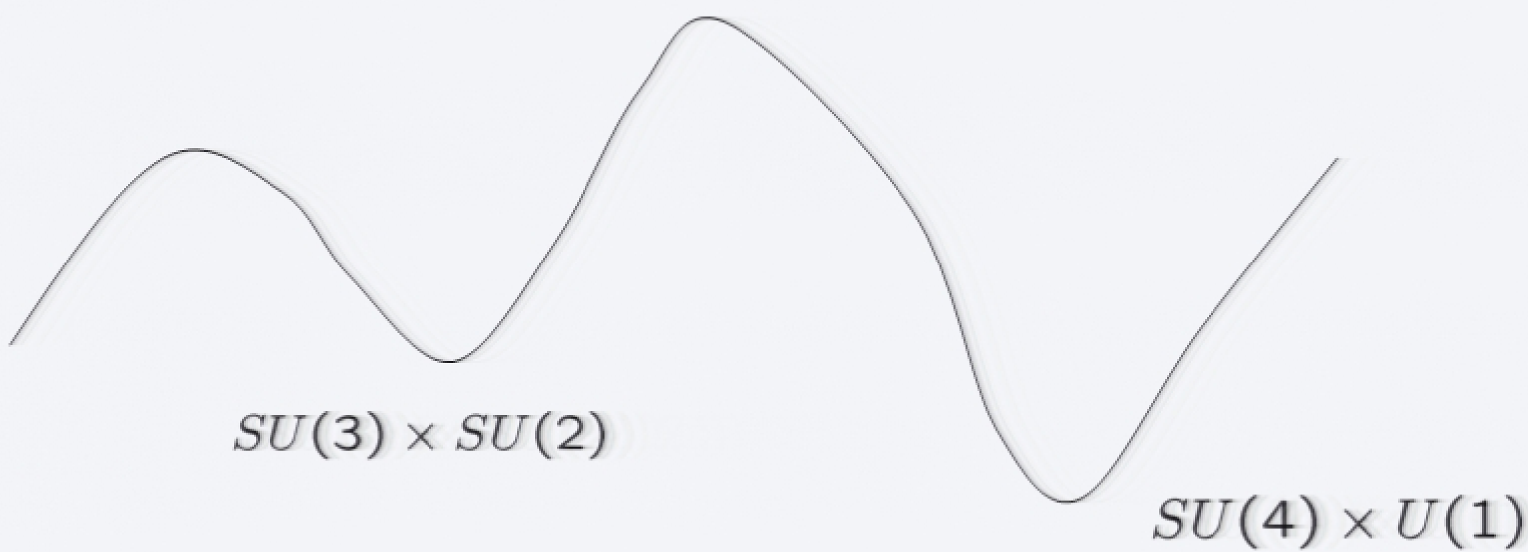
Date: Mar 31, 2005 12:15 PM

URL: http://pirsa.org/05030152

Abstract:

Landscape days in Practical Cosmology

After Years of Self-reproducing Inflationary Universe in Cosmology



L. Kofman
CITA

Fluctuations in the Universe with Compact Extra Dimensions

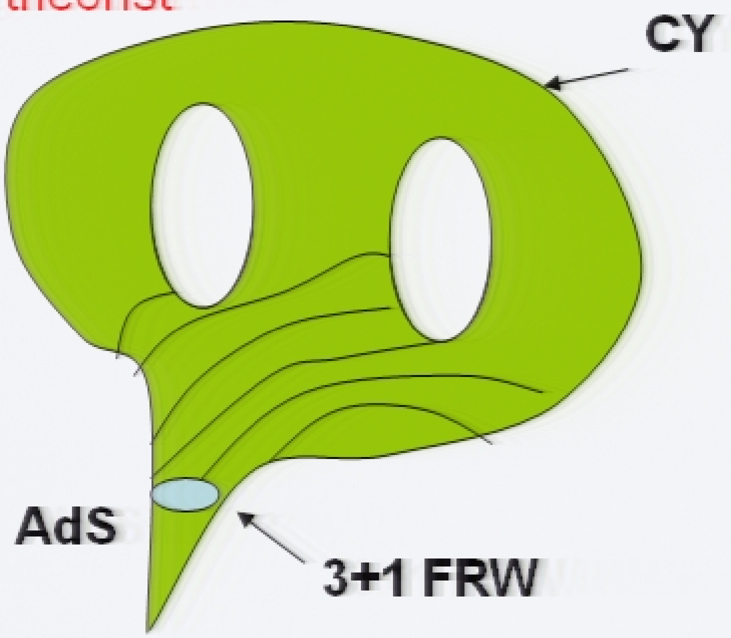
Scanning Inflation

Modulated Fluctuations

Perimeter, March 2005

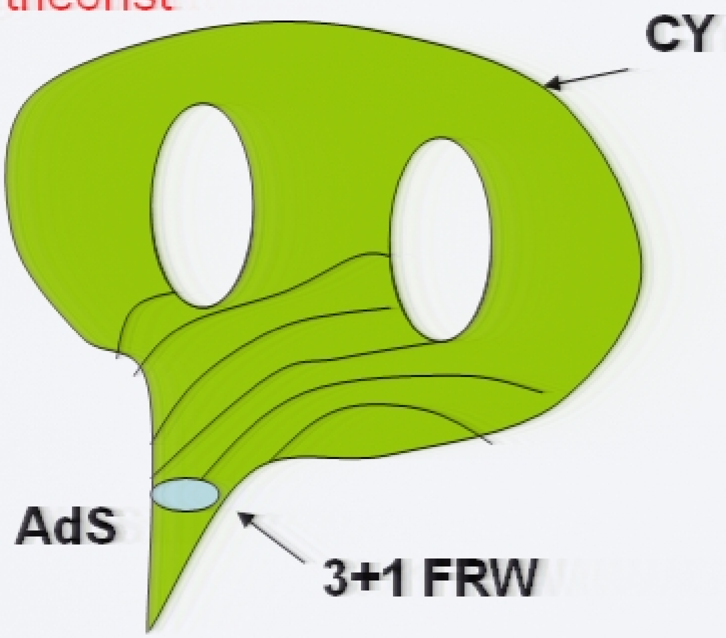
Fluctuations in Cosmology with Compactification

string theorist

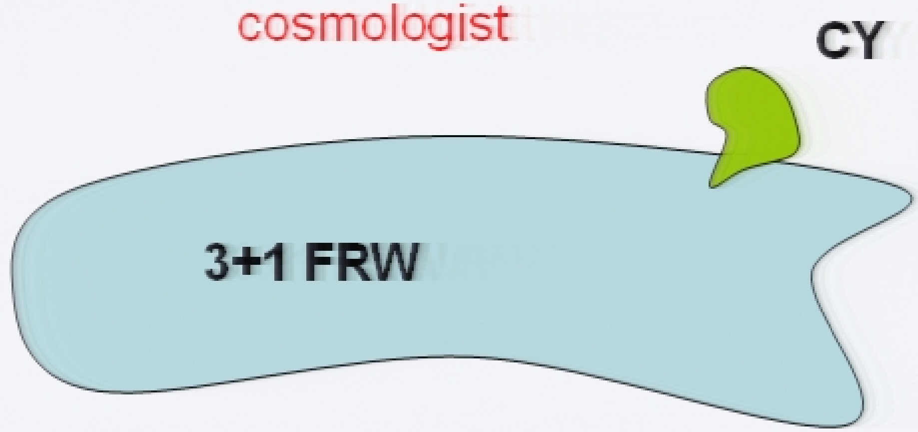


Fluctuations in Cosmology with Compactification

string theorist

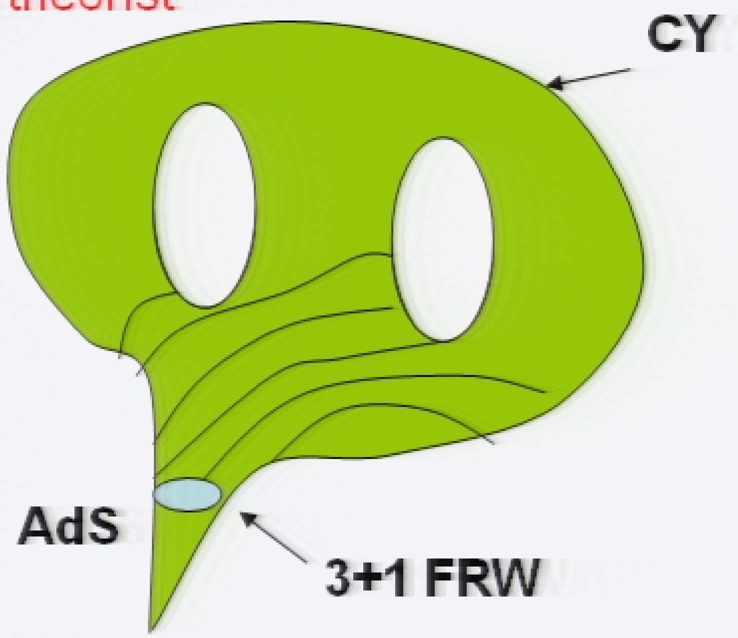


cosmologist

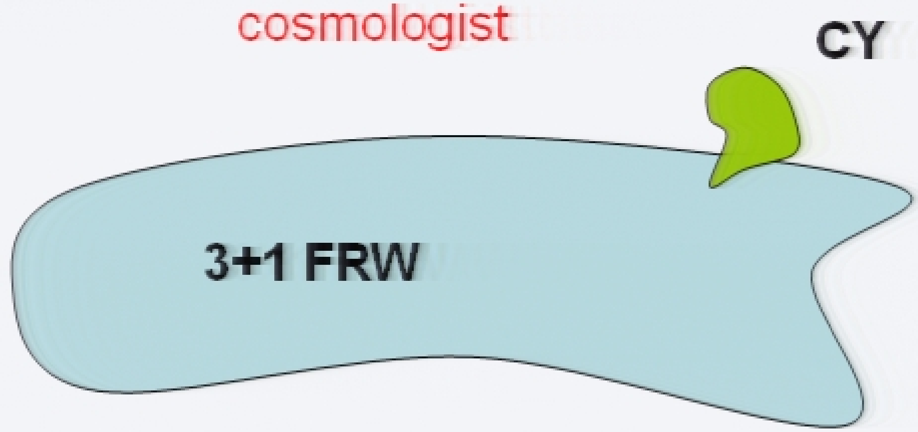


Fluctuations in Cosmology with Compactification

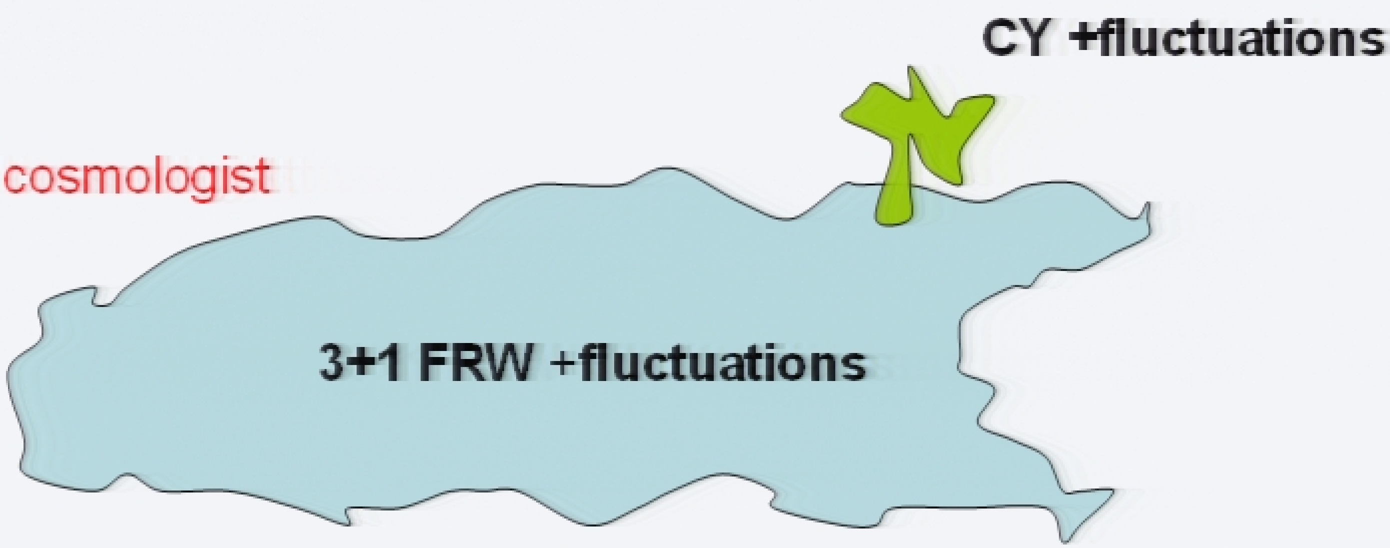
string theorist



cosmologist



Practical cosmologist



background

$$ds^2 = A(y)^2[g_{\mu\nu}dx^\mu dx^\nu + g_{ab}dy^a dy^b]$$

$$G^A_B = 8\pi\kappa_{10}T^A_B$$

fluctuations

$$ds^2 = [(1+2\Psi)g_{\mu\nu}+2E_{;\mu\nu}+2F_{(\mu;\nu)}+h_{\mu\nu}]dx^\mu dx^\nu + (\delta^c_b + 2 + 2\Phi^c_b)g_{ac}dy^a dy^b] - 2A_{a\mu}dy^a dx^\mu$$

$$\delta G^A_B = 8\pi\kappa_{10}\delta T^A_B$$

$$ds^2 = A^2[(1+2\Psi)ds_4^2 + (1+2\Phi)g_{ab}dy^a dy^b]$$

$$\delta G^A_B = 8\pi\kappa_{10}\delta T^A_B$$

$\Phi = -\frac{2}{d}\Psi$

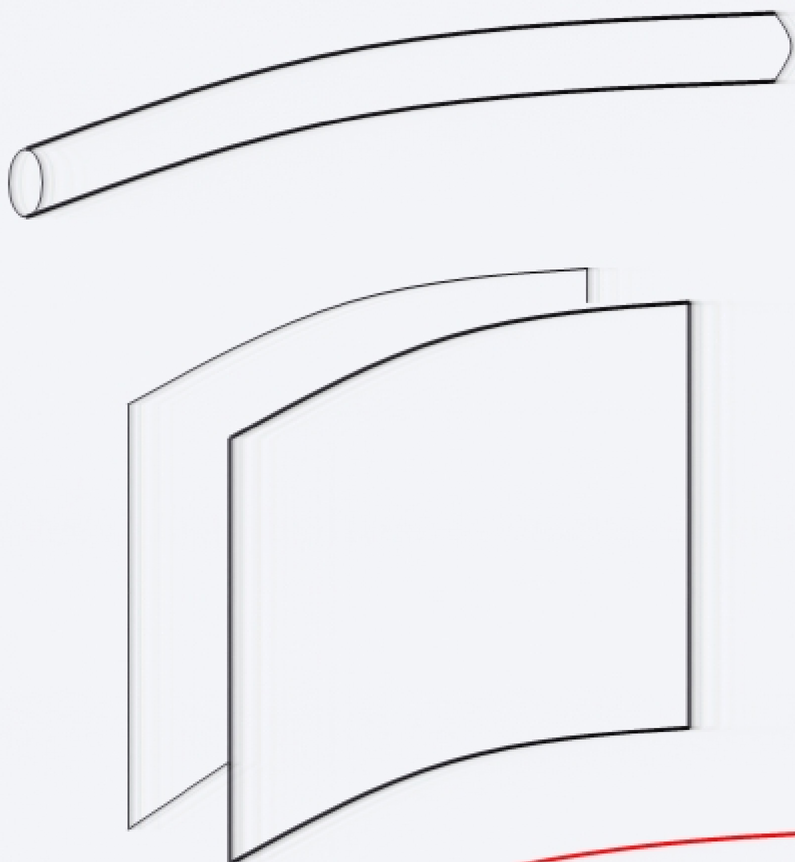
$$\Psi(x,y) = \sum_n \tilde{\Psi}_n(y) Q_n(x)$$

$$(\nabla_\mu \nabla^\mu + m_n^2) Q_n(x) = 0$$

$$(\nabla_a \nabla^a + \tilde{m}_n^2) \tilde{\Psi}_n(y) = 0$$

$$m_n^2 = -\frac{12d}{2+d} H^2 + \tilde{m}_n^2$$

Fluctuations in Cosmology with Compactification

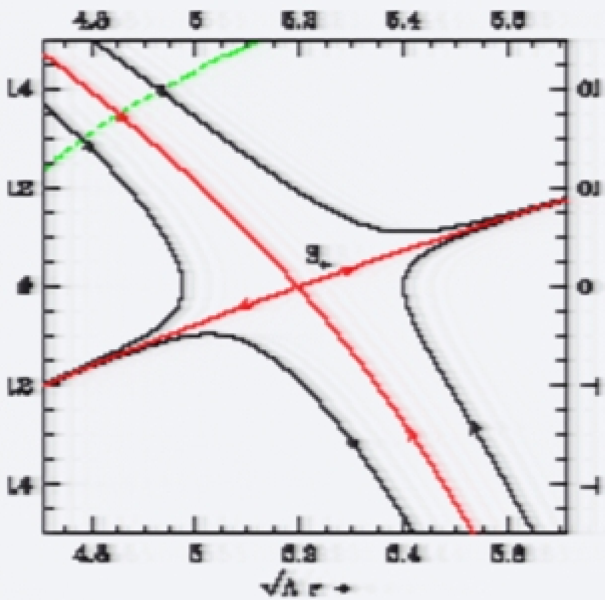


$$\mathbf{dS_4} \times \mathcal{M}$$

$$ds^2 = A^2(y)[(-\,dt^2 + e^{2Ht}d\vec{x}^2) + g_{ab}dy^a dy^b]$$

$m_n^2 = -\frac{12\,H^2}{1+2/d} + \mu_n^2(R) + \mu_n^2(A)$ example $dS_4 \times S^d$, $T_B^A = \Lambda \delta_B^A$

$$ds^2 = -dt^2 + a^2(t)\, d^3\mathbf{x} + r^2(t) \left[d\theta_1^2 + \sin^2\theta_1 \, \left(d\theta_2^2 + \ldots \right) \right]$$



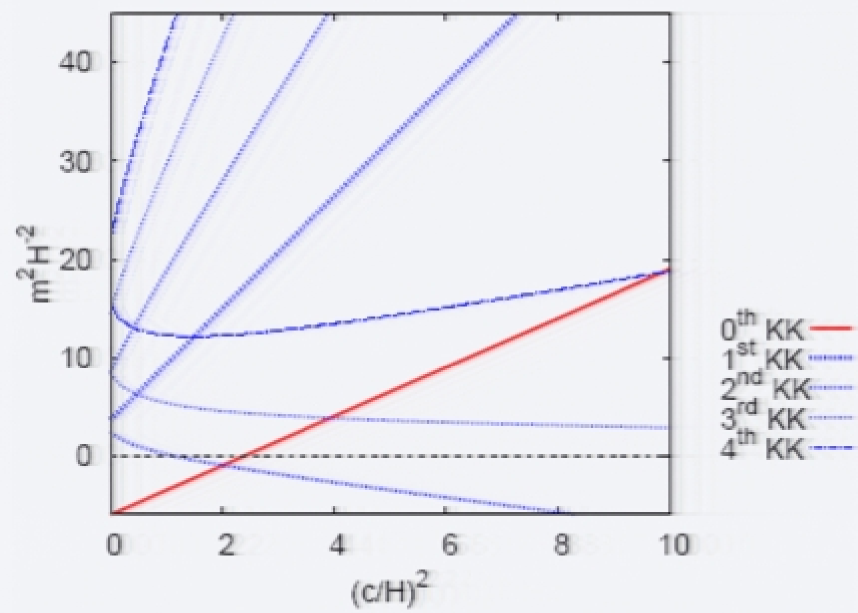
saddle point $a(t) = e^{Ht}, r(t) = 1$

Gravitational instability of anysotropoc geometry

generalization to FRW: KK masses are time-dependent $m^2(t) = -\gamma H^2(t) + \tilde{m}^2$

$$dS_4 \times S^6$$

plus Flux ⇒



Too strong fluxes lead to new instability

Summary

Theory of cosmological fluctuations in models with extra dimensions

Generic properties of fluctuations in 3+1+d dim

Instabilities exclude regions of landscape

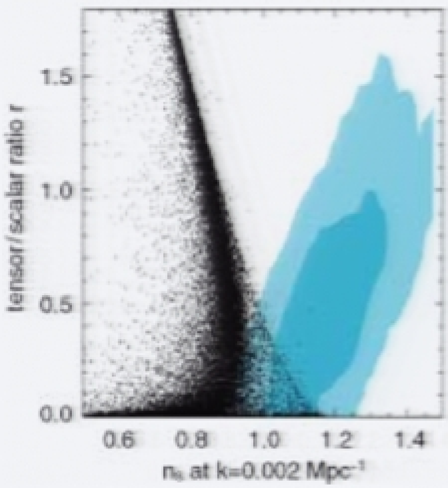
Constraints on working stabilization

Potential observables: varying couplings/masses, Primordial fluctuations

Bottom-up

Scanning Inflation

R.Bond, C.Contaldi,
A.Frolov, L.Kofman
T.Souradeep
P.Vandrevange



$P_s(k) = A_s k^{n_s - 1}$, $r = P_{GW}/P_s$

RG flow method

Small slow roll parameters

$\epsilon = \frac{M_p^2}{4\pi}\frac{H'^2}{H^2}$, $\eta = \frac{M_p^2}{4\pi}\frac{H''}{H^2}$, $\xi \sim H'''$ etc.

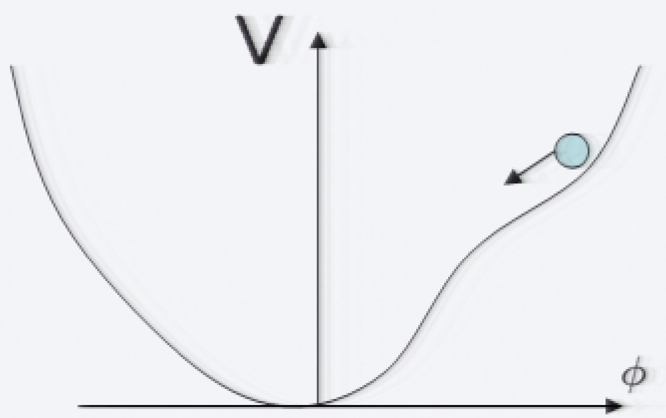
Flow eqs.

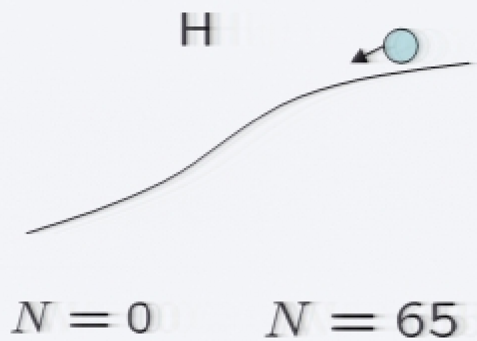
$\frac{d\epsilon}{dN} = \epsilon(\sigma + 2\epsilon)$

$\frac{d\sigma}{dN} = -5\sigma\epsilon - 12\epsilon^2 + 2\xi$

$\frac{d\xi}{dN} \sim$ cubic in $\epsilon, \sigma, \xi + \lambda$

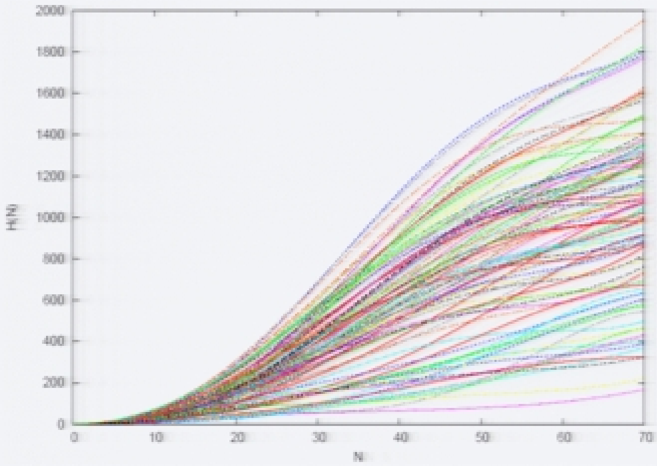
etc






Inflaton Landscape @ Mont Tremblant
scanning acceleration histories

Ensemble of Inflationary trajectories



Chebyshev decomposition

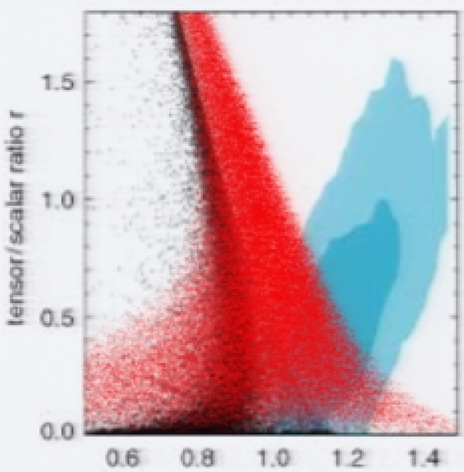
$$H(x) = \sum c_n T_n(x)\ ,\ x = \frac{2N - N_{\max}}{N_{\max}}\ .$$

$$\|H(x) - \sum^{M} c_n T_n(x)\| = min\ .$$

$0 < \frac{dH}{dN} < H$ $\qquad$ $\frac{dH}{dN} = H$ at $N = 65$

Related methods of trajectory generation

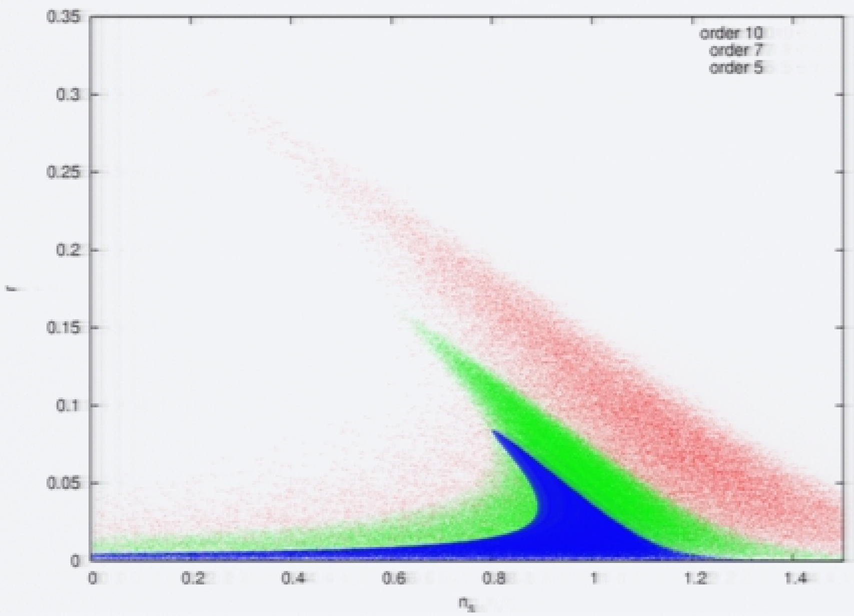
speed 10^3 up vs RGF



From trajectory $H(N)$ to observables

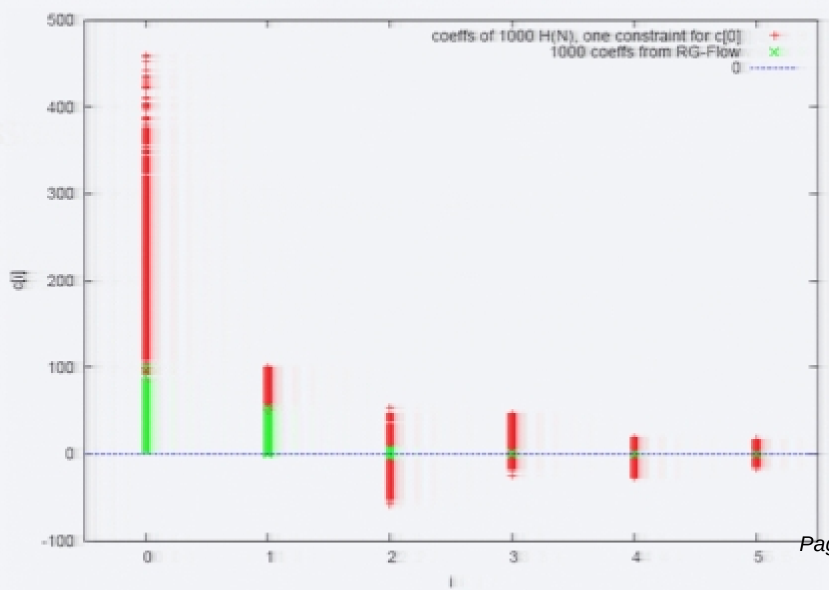
$P_s = \frac{8\pi H^4}{M_p^4 H_{,\phi}^2}$, $P_{GW} = \frac{8H^2}{\pi M_p^2}$ at $k = aH$

Space of models opens wide

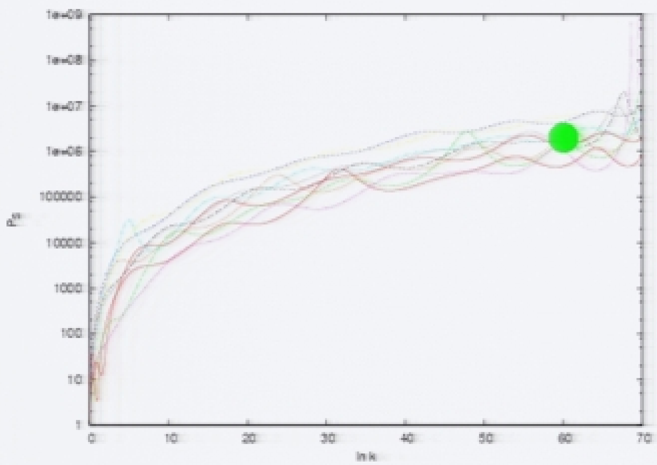


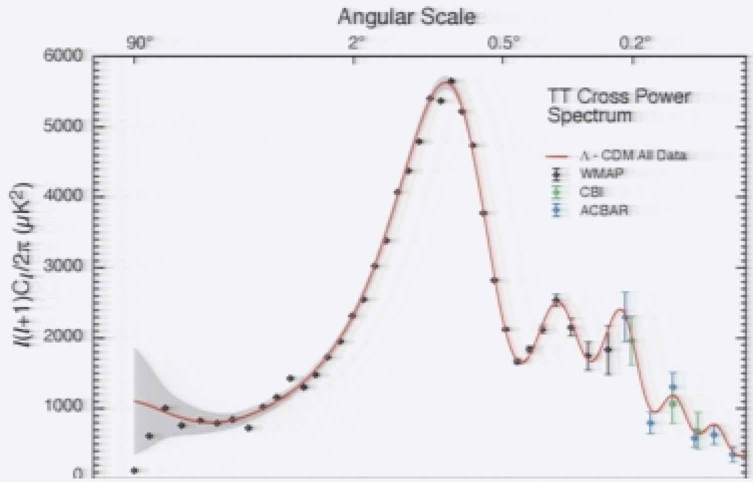
space opens more with higher order polynoms

Comparison of c_n (red) in our method vs c_n (green) of Chebyshev transform of trajectories generated with RG flow
Same truncation

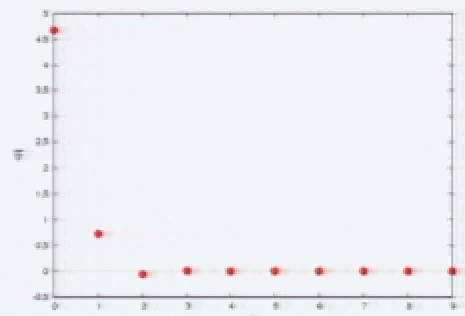


Observational constraints on trajectories

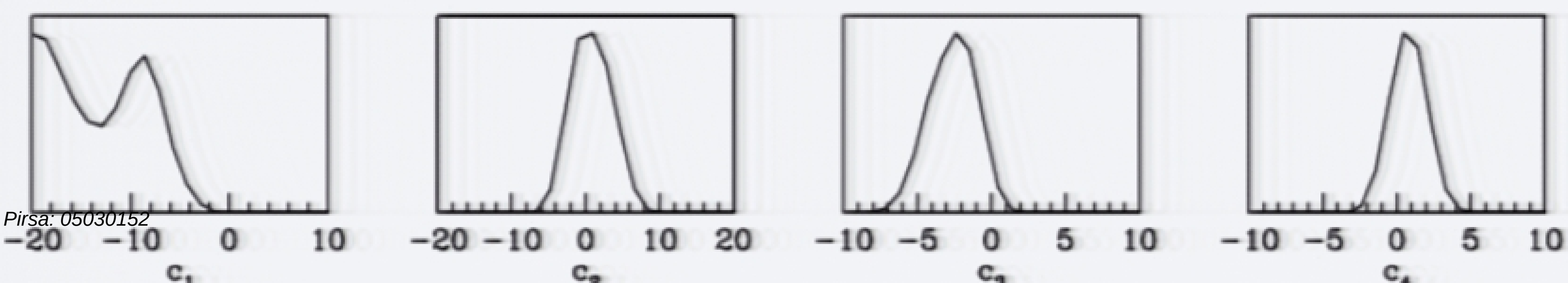




Markov Chain Monte Carlo



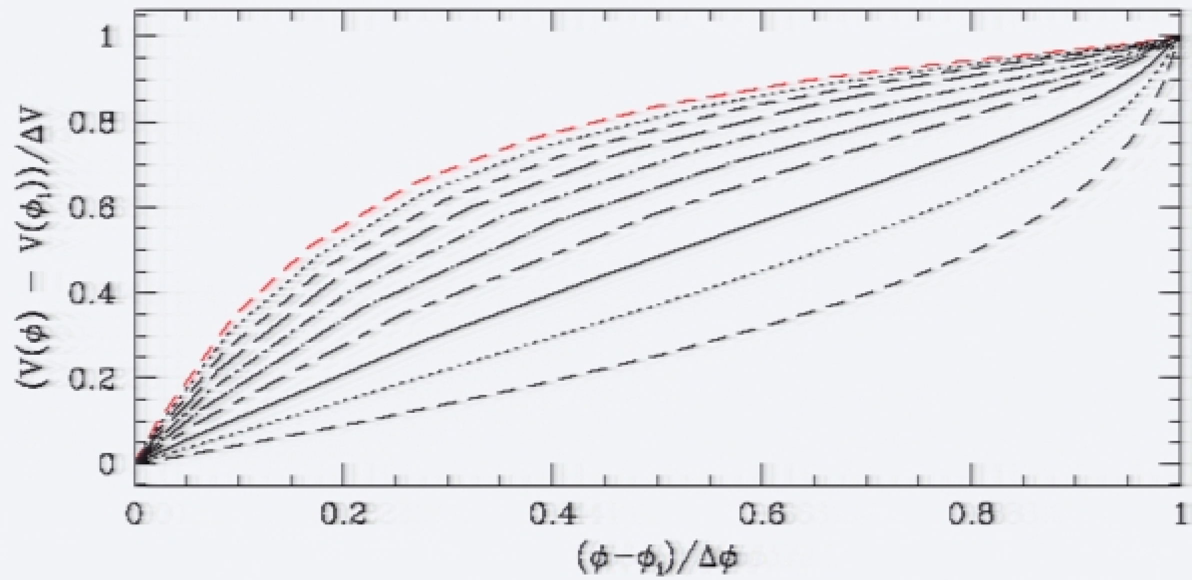
Example of c_n for $V = \frac{1}{2}m^2\phi^2$



Degeneracy of the Potential Reconstruction

known $P_s(k) \rightarrow$ reconstruct $V(\phi)$

$$P_s(k) = \frac{8\pi H^4}{M_p^4 H'^2}$$



$$V(\phi) = \frac{M_p^4}{32\pi^2}\left(\frac{12\pi}{M_p^2}H^2 - H'^2\right)$$

$$\frac{dH}{d\log k} = \frac{H^3}{H^2 - \pi M_p^2 P_s(k)}$$

$$\phi - \phi_0 = \frac{M_p^2}{2}\int_{\ln k_0}^{\ln k} d\ln k' \frac{\sqrt{P_s(k')}}{H^2(k')}\frac{dH}{d\ln k'}$$

Degeneracy is lifted by fixing $P_{GW} = \frac{H^2}{M_p^2}$

Example $P_s(k) = k^{n_s - 1}$

$n_s = 0.98$