

Title: Cosmology Theory: Inflation

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URL: <http://pirsa.org/15070030>

Abstract:

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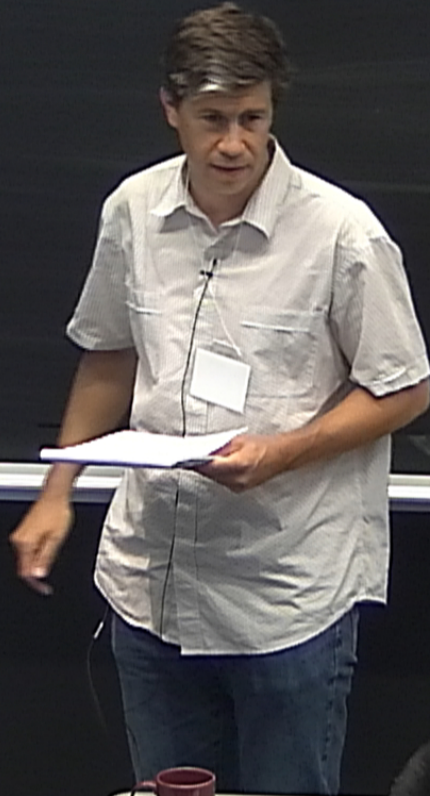
1303.5226

FRW $H(t)$

① $\int_R d^4x \sqrt{g}$

② $f(t) R$

③ g^{00}



FRW $H(t)$

1) $\frac{\sqrt{g} d^4x}{R}$

2) $f(t) R$

3) g^{00}

$$g^{\mu\nu} \partial_\mu \phi \partial_\nu \phi - V(\phi)$$

$$\phi = \bar{\phi}(t) + \delta\phi(t, x)$$

$$g^{00} \dot{\phi}^2$$

FRW

$$\boxed{H(t)}$$

1) $\frac{\sqrt{g} d^4x}{R}$

2) $f(t) R$

3) g^{00}

$$S = \int d^4x \sqrt{g} \left[\frac{1}{2} M_{pl}^2 R - c(t) g^{00} - \Lambda(t) \right]$$

$$+ \frac{1}{2} M(t)^4 (g^{00} + 1)^2 + \frac{1}{3!} M^4 (g^{00} + 1)^3$$

+ Extensiv $\vec{c}(t)$

$$g^{00} = g^{00}_{FRW} + \delta g^{00}$$

$$c(t) = -M_{pl}^2 \dot{H}$$

$$\Lambda(t) = M_{pl}^2 (3H^2 + \dot{H})$$

$$\epsilon = -\dot{H}/H^2$$

$$ds^2 = -N^2 dt^2 + h_{ij} (dx^i + N^i dt) (dx^j + N^j dt)$$

$z^{\zeta}(y, t)$

$$h_{ij} = \delta_{ij} a^2(t) e$$

$$\downarrow + \delta N \rightarrow \delta N = \dot{\zeta} / H$$

$$N_i = \partial_i \psi$$

$$\nabla^2 \psi = \left[-\frac{\delta^2 S}{\delta \psi} + a^2 \epsilon \dot{\zeta} \right]$$

$$g^{\infty} - \Lambda(t)$$

$$+ \frac{1}{3!} M^4 (g^{\infty} + \lambda^2)$$

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CAUTION

CAUTION

FRW

$H(t)$

1) $\frac{\sqrt{g} d^4x}{R}$

2) $f(t) R$

3) g^{00}

$$S = \int d^4x \sqrt{g} \left[\frac{1}{2} M_{Pl}^2 R - c(t) g^{00} - \Lambda(t) \right. \\ \left. + \frac{1}{2} M(t)^4 (g^{00} + 1)^2 + \frac{1}{3!} M^4 (g^{00} + 1)^3 \right]$$

+ Extensiv \vec{w}_{fluid}

$$g^{00} = g^{00}|_{FRW} + \delta g^{00}$$

$$c(t) = -M_{Pl}^2 \dot{H}$$

$$\Lambda(t) = M_{Pl}^2 (3H^2 + \dot{H})$$

$$\epsilon = -\dot{H}/H^2$$

$ds^2 =$

$h_{ij} =$

$\downarrow + \delta N$

$$R = c(t) g^{\infty} - \Lambda(t)$$

$$t)^4 / (g^{\infty} + 1)^2 + \frac{1}{3} M^4 (g^{\infty} + 1)^2$$

extensiv \vec{w}

$$\epsilon = \dot{H} / H^2$$

$$ds^2 = -N^2 dt^2 + h_{ij} (dx^i + N^i dt) (dx^j + N^j dt)$$

$$h_{ij} = \delta_{ij} a^2(t) e^{2\zeta(x,t)}$$

$$\downarrow + \delta N \rightarrow \delta N = \dot{\zeta} / H$$

$$N_i = \partial_i \psi \quad \nabla^2 \psi = \left[-\frac{\delta^2 \zeta}{H} + a^2 \epsilon \zeta \right]$$

$$S = M_{pl}^2 \int d^3x dt \epsilon a^3(t) \left[\dot{\zeta}^2 - a^2 (\partial_i \zeta)^2 \right] +$$

$$\phi = M_{pl} \sqrt{\epsilon} \zeta$$

9.6318
9.3557

$$ds = -N dt + \dots$$

$$h_{ij} = \delta_{ij} a^2(t) e^{2\zeta(\mathbf{x}, t)}$$

$$\Delta + \delta N \rightarrow \delta N = \dot{\zeta} / H$$

$$N_i = \partial_i \psi \quad \nabla^2 \psi = \left[-\frac{\delta^2 \zeta}{H} + a^2 \epsilon \zeta \right]$$

$$S = M_{pl}^2 \int d^3x dt \epsilon a^3(t) \left[\dot{\zeta}^2 - a^2 (\partial_i \zeta)^2 \right] + \phi = M_{pl}^2 \epsilon \zeta$$

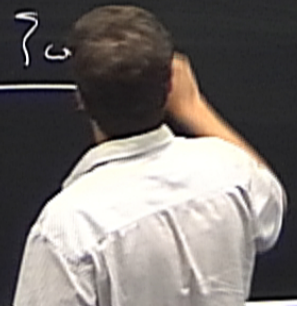
$$R = c(t) g^{\infty} - \Lambda(t)$$

$$t)^4 (g^{\infty} + 1)^2 + \frac{1}{3} M^4 (g^{\infty} + 1)^2$$

transic wroot

$$\zeta_{ce} \propto (1 - ik\eta) e^{ik\eta} \quad a d\eta = dt$$

$$k\eta \rightarrow 0 \quad \zeta_c$$



$$S = M_{pl}^2 \int d^3x dt \epsilon a^3(t) [\dot{\zeta}^2 - a^2(\partial \zeta)^2] + \phi = M_{pl}^2 \epsilon \zeta$$

$$\zeta_{ce} \propto (1 - ik\eta) e^{ik\eta} \quad \text{with } \eta d\eta = dt$$

$$k\eta \rightarrow 0 \quad \zeta_{const} \quad \langle \zeta^2 \rangle \quad \lambda$$

$$M_{pl}^2 \epsilon \lambda^3 T \omega^2 \zeta^2 \sim 1$$

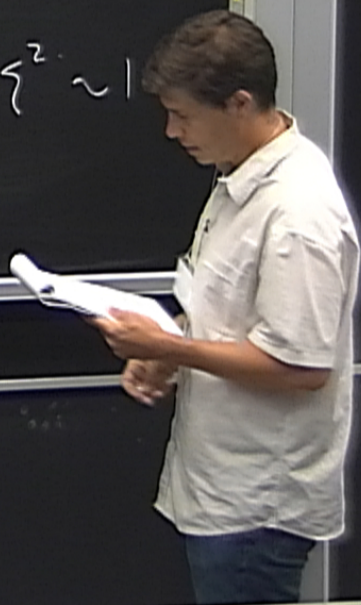
$$R = c(t) g^{\infty} - \Lambda(t)$$

$$\frac{t^4}{(g^{\infty} + 1)^2} + \frac{1}{3} M^4 (g^{\infty} + 1)^2$$

extensiv \vec{c} \vec{w}

$$\epsilon = -\dot{H} / H^2$$

CAUTION



$$M_{pe} \in \Lambda \quad \omega \in \mathbb{R}$$

$$\xi^2 \propto \frac{H^2}{M_{pe}^2}$$

$$ds^2 = -N^2 dt^2 + h_{ij} (dx^i + N^i dt) (dx^j + N^j dt)$$

$$h_{ij} = \delta_{ij} a^2(t) e^{2\zeta(x,t)}$$

$$\Delta + \delta N \rightarrow \delta N = \dot{\zeta} / H$$

$$N_i = \partial_i \psi \quad \nabla^2 \psi = \left[-\frac{\delta^2 \zeta}{H} + a^2 \epsilon \dot{\zeta} \right]$$

$$S = M_{pe}^2 \int d^3x dt \epsilon a^3(t) \left[\dot{\zeta}^2 - a^{-2} (\partial_i \zeta)^2 \right] +$$

$$\phi = M_{pe} \sqrt{\epsilon} \zeta$$

$$R = c(t) g^{\infty} - \Lambda(t)$$

$$t^4 / (g^{\infty} + 1)^2 + \frac{1}{3} M^4 (g^{\infty} + 1)^2$$

extensiv \vec{w}

$$\epsilon = -\dot{H} / H^2$$

$$M_{pe} \in \Lambda \mid \omega \in \mathbb{C}$$

$$\xi^2 \propto \frac{H^2}{M_{pe}}$$

$$+ h_{ij} (dx^i + N^i dt) (dx^j + N^j dt)$$

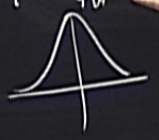
$$\delta N = \dot{\xi} / H \Rightarrow \delta g^{\alpha\beta}$$

$$N_i = a \cdot \dot{\chi} \quad \nabla^2 \chi = \left[-\frac{\dot{\chi} \dot{\xi}}{H} + a^2 \epsilon \dot{\xi} \right]$$

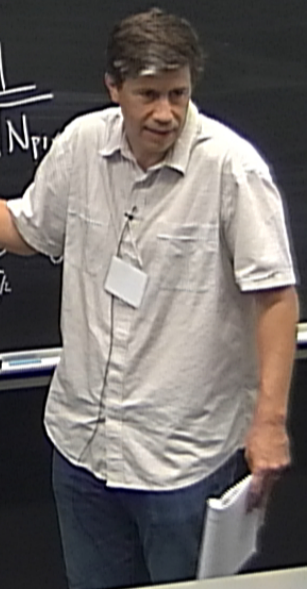
$$\frac{d^3 x dt}{\sqrt{\epsilon}} \in \frac{a^3(t)}{c^3} \left[\dot{\xi}^2 - (a^{-2} \partial_i \dot{\xi})^2 \right] +$$

$$L_3 \subset \frac{a^3 \epsilon}{c^3} \left[\frac{1}{c^2} (\epsilon - 3(1 - c^2) / \dot{\xi}^2) \right]$$

$$\frac{\langle \xi \xi \xi \rangle}{\langle \xi^2 \rangle^{3/2}} \propto \frac{1}{\sqrt{N_{pe}}}$$



$$\frac{\Delta X}{\langle X \rangle^{3/2}}$$



$$M_{pe} \in \lambda | \omega | \leq \dots$$

$$\xi^2 \propto \frac{H^2}{M_{pe}}$$

$$+ h_{ij} (dx^i + N^i dt) (dx^j + N^j dt)$$

$z \xi(x, t)$

$$\delta N = \dot{\xi} / H \Rightarrow \delta g^{\infty}$$

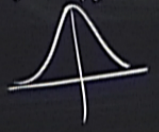
$$N_i = 2:4 \quad \nabla^2 \psi = [- + a^2 \in \xi]$$

$$d^3x dt \in \frac{a^3(t)}{c^3} [\xi^2 - (a^2 \partial_i \xi)^2]$$

$\sqrt{\in} \xi$

$$L_3 \subset \frac{a^3 \in}{c^3} \left[\frac{1}{c^3} (\in - 3(1 - c^2) / \gamma^2) \right]$$

$$\frac{\langle \xi \xi \xi \rangle}{\langle \xi^2 \rangle^{3/2}} \propto \frac{1}{\sqrt{N_{pix}}}$$

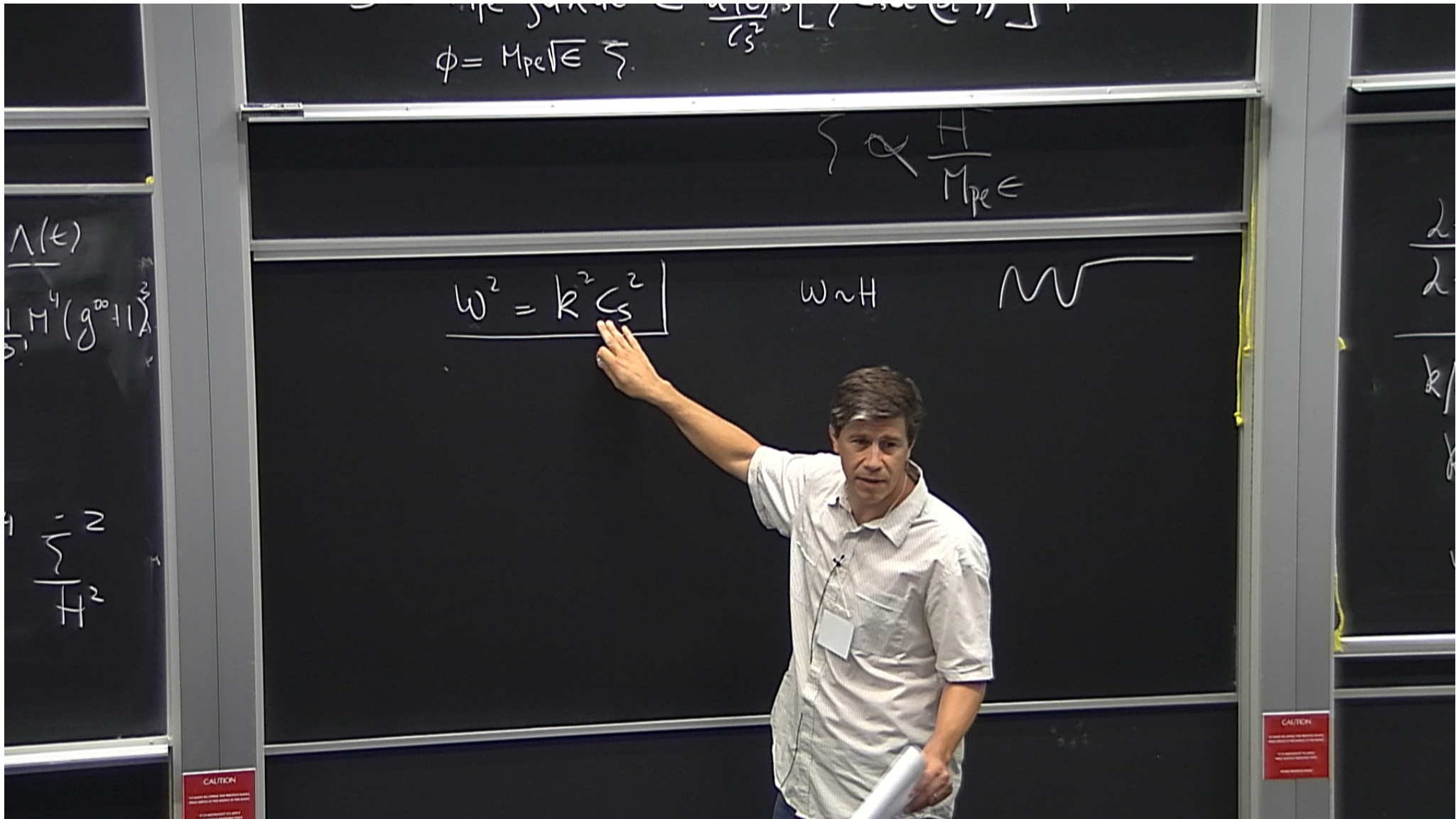


$$\frac{\langle X^3 \rangle}{\langle X^2 \rangle^{3/2}} \propto \frac{1}{\sqrt{N_{\text{samples}}}}$$

$(dx^i + N^i dt) (dx^j + N^j dt)$
 $N = \dot{\xi} / H \Rightarrow \delta g^{\omega}$
 $N_i = \partial_i \psi \quad \nabla^2 \psi = \left[-\frac{\partial^2 \xi}{H} + a^2 \epsilon \dot{\xi} \right]$
 $\epsilon \frac{a^3(t)}{c_s^2} \left[\dot{\xi}^2 - (a^2 \partial_i \xi)^2 \right] +$

$\frac{\lambda_3}{\lambda_2} \Big| \text{---} \left. \begin{array}{l} \epsilon \xi \\ \frac{1}{c_s^2} \xi \end{array} \right\}$
 $\frac{k/a = w = H}{k \eta \sim 1}$

CAUTION



$$\phi = M_{pe} \sqrt{\epsilon} \xi$$

$$\int \propto \frac{H}{M_{pe} \epsilon}$$

$$\omega^2 = k^2 c_s^2$$

$$\omega \sim H$$



$$\Lambda(k)$$
$$\frac{1}{5} M^4 (g^{00} + 1) \lambda^3$$

$$\frac{\dot{\xi}^2}{H^2}$$

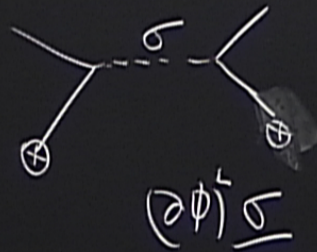
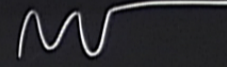
$$S = M_{\text{pl}}^2 \int d^3x dt \epsilon \frac{a^3(t)}{c^3} [\dot{\zeta}^2 - c^2 (\partial_i \zeta)^2] +$$

$$\phi = M_{\text{pl}} \sqrt{\epsilon} \zeta$$

$$\zeta \propto \frac{H}{M_{\text{pl}}} \epsilon$$

$$w^2 = k^2 c_s^2$$

$$w \sim H$$



$$\bar{\phi} + \delta\phi$$

$$(\partial\phi)^4$$

$$(\partial\phi)^2 (\partial\phi)^2$$

$$(\bar{\phi} \delta\phi)^2$$



$$\frac{\lambda_3}{\lambda_2}$$

$$k/a = w = H$$

$$k \eta \sim 1$$

$$w \sim H$$

$$R = c(t) g^{\infty} - \Lambda(t)$$

$$\frac{1}{3} M^4 (g^{\infty} + 1)^2 + \frac{1}{3} M^4 (g^{\infty} + 1)^3$$

tensor curvature

$$M_{\text{pl}}^2 \frac{1}{c^2} \dot{\zeta}^2 = M^4 \frac{\dot{\zeta}^2}{H^2}$$

$$\epsilon = -\dot{H}/H^2$$

$$\zeta_{ce} \propto (1 - \text{CRM}) e$$

$$\text{CRM} \rightarrow 0 \quad \zeta \quad \sqrt{\langle \zeta^2 \rangle} \quad \lambda$$

$$\langle \zeta(k_1) \zeta(k_2) \zeta(k_3) \rangle = \delta^D(\vec{k}_1 + \vec{k}_2 + \vec{k}_3) \underline{F(k_1, k_2, k_3)}$$

$$\propto k^{(n_s-1)}$$

$$F = (n_s - 1) \left[\text{Local} \right] + \epsilon \left[\text{epulater} \right]$$



$$R = c(k) g^{\infty} - \Lambda(k)$$

$$\frac{1}{\zeta^2} (g^{\infty} + 1)^2 + \frac{1}{3} M^4 (g^{\infty} + 1)^3$$

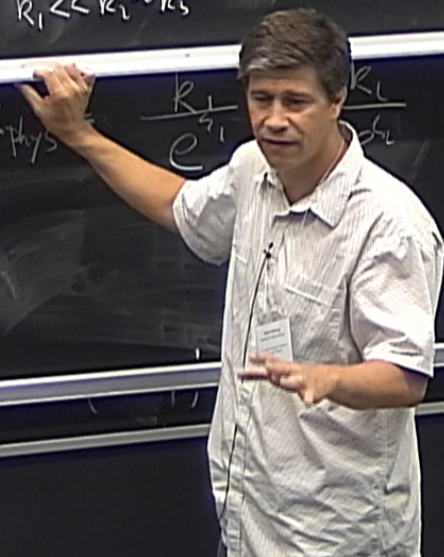
intensity curve \rightarrow

$$\frac{1}{\zeta^2} \zeta^2 = M^4 \frac{\zeta^2}{H^2}$$

$$\epsilon = -\dot{H}/H^2$$

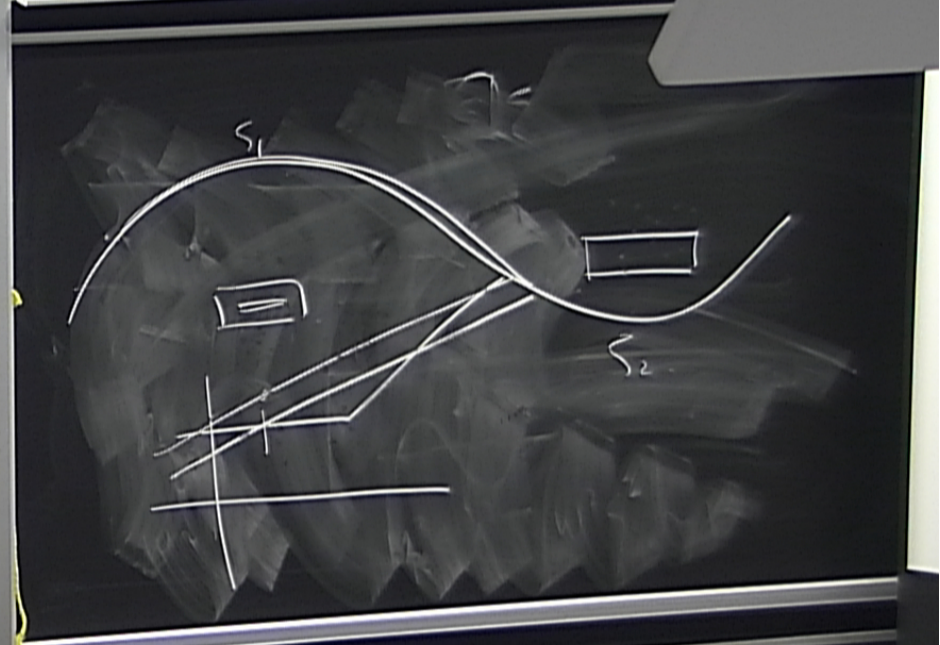
$$\langle \psi(k_1) \psi(k_2) \psi(k_3) \rangle = \delta^D(k_1 + k_2 + k_3) F(k_1, k_2, k_3)$$

$$F = \underbrace{(n_s - 1)}_{\substack{\text{Local} \\ \nearrow \\ k_1 \ll k_2 \sim k_3}} [Local] + \underbrace{\left(\epsilon + \frac{1}{\epsilon^2} - 1 \right)}_{\substack{\text{epulabed} \\ \nearrow \\ \text{triangle diagram}}} [epulabed]$$



PW

$$\frac{\langle X^3 \rangle}{\langle X^2 \rangle^{3/2}} \propto \frac{1}{N_{\text{samples}}}$$



$\zeta(k_1) \zeta(k_2) \zeta(k_3) \approx \delta^D(\bar{k}_1 + \bar{k}_2 + \bar{k}_3) F(\bar{k}_1, \bar{k}_2, \bar{k}_3)$

$F = \frac{(n_s - 1)}{e} [Local] + \left(\epsilon + \frac{1}{e_s^2} - 1 \right) [epulational]$

$k_1 \ll k_2$

$n_{st} - 1$
 k_{phy}

$\langle X^3 \rangle \propto \frac{1}{N_{samps}^{3/2}}$

$\langle X^2 \rangle^{3/2}$

PW

S_1
 S_2