Title: Infinite derivative gravity theories: UV completion, inflation and observables

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Series: Quantum Gravity

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Abstract: In my talk I will review motivation for and construction of an infinite derivative gravity. Especially a connection to the string field theory will be highlighted. Then I will demonstrate an exact embedding of the Starobinsky inflation in this construction. In final part I will speak about modifications to observable compared to local models of inflation: spectral indexes, tensor/to scalar ratio, shapes of non-gaussianities and related parameters, gravitational waves production.

Zoom link

Infinite Derivative Gravity

① Where from?

② Why is good?

1850 Ostrogradsky $\partial^{n>2}$

1950 PU: $\mathcal{L} = \frac{1}{2}\varphi\,\Box f(\Box)\varphi$

2016 Rivas Sen $\mathcal{L} = \pm\frac{1}{2}\varphi\,\Box\,\varphi$

ghost

SFT

$$\left(\left|e^{ikX(z)}\right\rangle\right)^3 =$$

$$= e^{\alpha'(k^2+p^2+r^2)}$$

$$\mathcal{L} = \frac{1}{2}\varphi(\Box - m^2)\varphi - \lambda\left(\underbrace{e^{\alpha'\Box}\varphi}_{\psi}\right)^3$$

$$\mathcal{L} = \frac{1}{2}\psi(\Box - m^2)e^{-2\alpha'\Box}\psi - \lambda\psi^3$$

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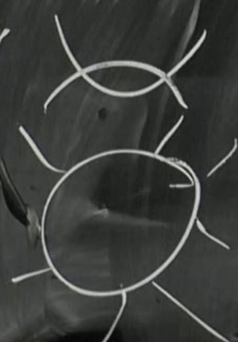
$\left(e^{\sigma(\square)}\varphi\right)^4$



V: $e^{+\sigma}$

Π: $e^{-\sigma}$

$- + + + + + \ldots$

Stelle '77, '78

2016 Biswas, Mazumdar, AK

$$\mathcal{L} = \sqrt{-g}\left[\frac{M_p^2}{2}R + \alpha R^2 + \beta W_{\alpha\mu\nu\beta}^2\right]$$

$$\mathcal{L} = \left[R_{\mu\alpha\nu\beta},\ \nabla_\lambda,\ g_{\alpha\beta}\right]$$

MSS

M, dS, AdS

R^3 $\quad + R_{\mu\nu}^2$

$$\mathcal{L} = \sqrt{-g}\left[\frac{M_p^2}{2}R + R\mathcal{F}(\square)R + W\underbrace{\mathcal{F}_W(\square)}W - \Lambda\right]$$

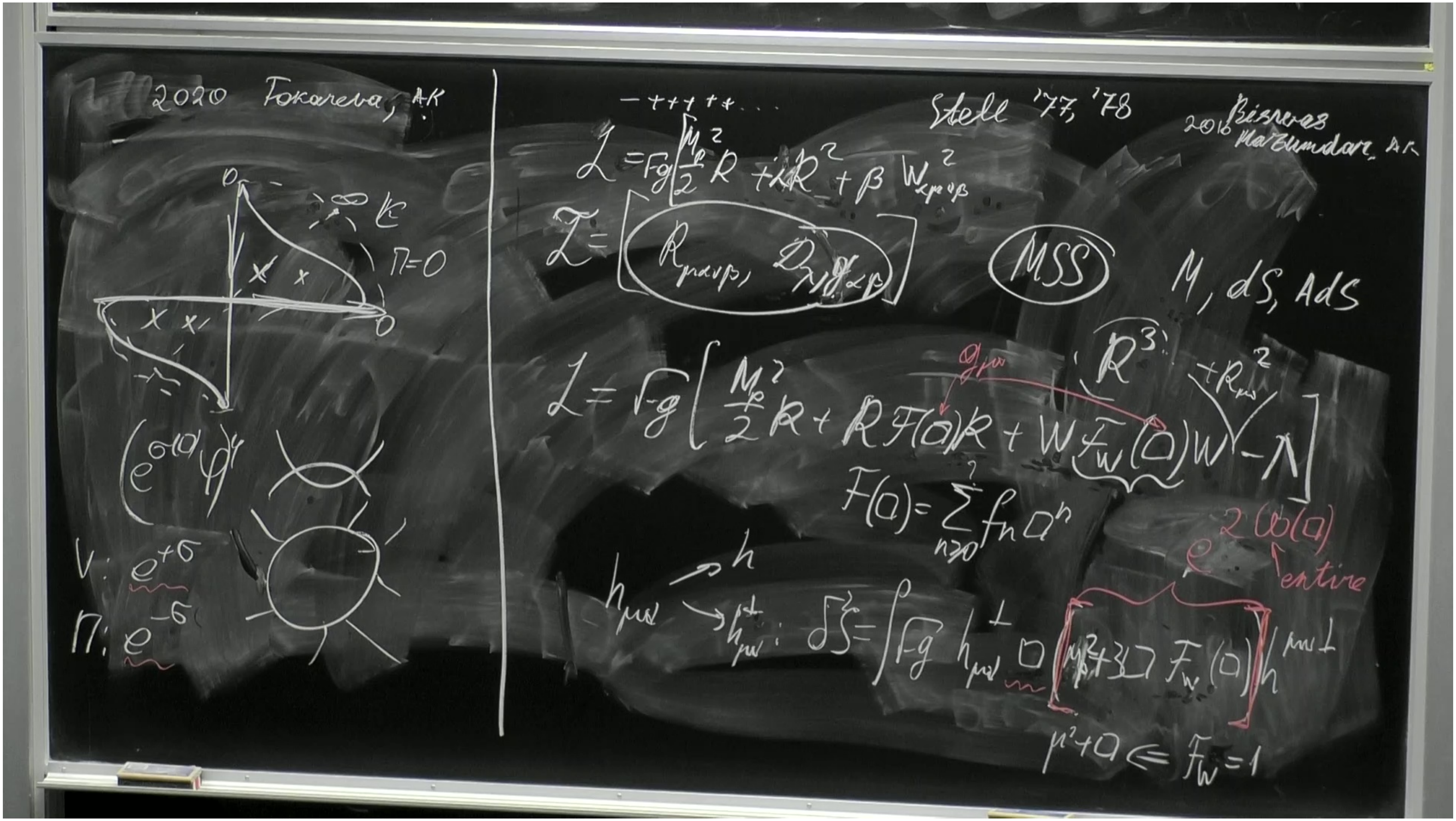
$$\mathcal{F}(\square) = \sum_{n\geq 0} f_n \square^n$$

$e^{2\omega(\square)}$ entire

$h_{\mu\nu} \to h$

$h_{\mu\nu} \to h^\perp_{\mu\nu}$: $\delta^2 S = \int \sqrt{-g}\, h^\perp_{\mu\nu}\, \square \left[M_p^2 + 3\square\, \mathcal{F}_W(\square)\right] h^{\mu\nu\perp}$

$\mu^2 + \square \Leftarrow \mathcal{F}_W = 1$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Π=0
V: e^{+σ}
Π: e^{-σ}
Stelle '77, '78
2016 Biswas, Mazumdar, AK
L = √-g [M_p^2/2 R + αR^2 + β W^2_{αμνβ}]
L = [R_{μανβ}, D_λ g_{αβ}]
MSS
M, dS, AdS
R^3
+R_{μν}^2
g_{μν}
L = √-g [M_p^2/2 R + R F(□) R + W F_W(□) W − Λ]
F(□) = Σ_{n≥0} f_n □^n
e^{2ω(□)}
entire
h_{μν} → h
h_{μν} → h^⊥_{μν} : δ^2 S = ∫ √-g h^⊥_{μν} □ [M_p^2 + 3□ F_W(□)] h^{μν⊥}
μ^2 + □ ⇐ F_W = 1

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$\approx 10^{18}$ GeV

Starobinsky '16

$\mathcal{L} = R + R^2 \Rightarrow \Box R = M^2 R$

$\begin{cases} \text{Conf flat} \\ F'(M^2) = 0 \\ 6M^2 \mathcal{F}(M^2) = M_P^2 \end{cases}$

$P_R = P_{R\,local}$

$P_T = P_{T\,local} \cdot e^{2\omega(R/6)}$

$- + + + + + \ldots$ Stelle '77, '78 2016 Biswas Mazumdar, AK

$\mathcal{L} = \sqrt{-g}\left[\frac{M_P^2}{2} R + \alpha R^2 + \beta W_{\mu\nu\alpha\beta}^2\right]$

$\mathcal{L} = \left[R_{\mu\nu\alpha\beta},\ \nabla_\lambda,\ g_{\alpha\beta} \right]$

MSS

M, dS, AdS

R^3

$\mathcal{L} = \sqrt{-g}\left[\frac{M_P^2}{2} R + R \mathcal{F}(\Box) R + \underbrace{W \mathcal{F}_W(\Box) W}_{\pm R_{\mu\nu}^2} - \Lambda \right]$

$g_{\mu\nu}$

$f_{n} = \frac{1}{2}(1 - n_s) + \text{corr}$

$\mathcal{F}(\Box) \overset{?}{=} \sum_{n \geq 0} f_n \Box^n$

$r = r_{local} \, e^{2\omega(R/6)}$

$\delta^2 S = \int \sqrt{-g}\, h_{\mu\nu}^{\perp}\, \Box \left[M_P^2 + 3\Box \mathcal{F}_W(\Box) \right] h^{\mu\nu\perp}$

$e^{2\omega(\Box)}$ entire

$N = 55$

$\mu^2 + \Box \Leftarrow \mathcal{F}_W = 1$