

12 JAN 2018

bj

THEN & NOW

- I. MIT (1955-1956)
 - II. STANFORD (1956-1963)
 - III. SLAC (1963-1979)
 - IV. THEN to NOW (1979-2017)
- } THEN
- V. GENERAL RELATIVITY
 - VI. COSMOLOGY
 - VII. DARK ENERGY
- } NOW

MIT (1955-1956)

First encounter

Sid's story

My story

Sid's evening seminars

STANFORD (1956-1963)

The Mass Emigration

Sid

Charlie Schwartz

Fred Zachariasen

Henry Kendall

Burt Richter

by

(Dave Ritson)

Viki Weisskopf & QED

The Thesis

Drell & Schwartz

The Books

SLAC (1963-1979)

Project M

Drell Process

John Bell

Tini Veltman

The Move

Theory Group Ambiance

Naive Drell (\neq Yan)

THEN TO NOW (1979-2017)

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Fermilab (1979-1989)

Back to SLAC (1989-2018)

Sid

Washington

Hoover Institute

SLAC

The Now: "THINK DIFFERENT"

GENERAL RELATIVITY: Choice of language

Riemann

$$g_{\mu\nu}$$

10

"Gauge Gravity"

$$\omega_{\mu}^{ab} \quad e_{\mu}^a \quad O(3,1)$$

$$40 = 24 + 16$$

$$g_{\mu\nu} = e_{\mu}^a \eta_{ab} e_{\nu}^b$$

$$R_{\mu\nu}^{ab} = \partial_{\mu} \omega_{\nu}^{ab} - \partial_{\nu} \omega_{\mu}^{ab} + [\omega_{\mu}, \omega_{\nu}]^{ab}$$

MacDowell-Mansouri Extension

$O(4,1)$

$$S_{MM} \sim 10^{120} \int dx \langle \phi \rangle^5 F_{\Lambda}^{ab} F^{\Lambda cd} \epsilon^{abcd}$$

$$\sim \frac{M_{pl}^2}{\Lambda} \int RR + M_{pl}^2 \int e e R + \Lambda M_{pl}^2 \int e e e e$$

\uparrow GB \uparrow EC \uparrow CC
 -6-

$$A_{\mu}^{AB} \leftrightarrow \omega_{\mu}^{ab}$$

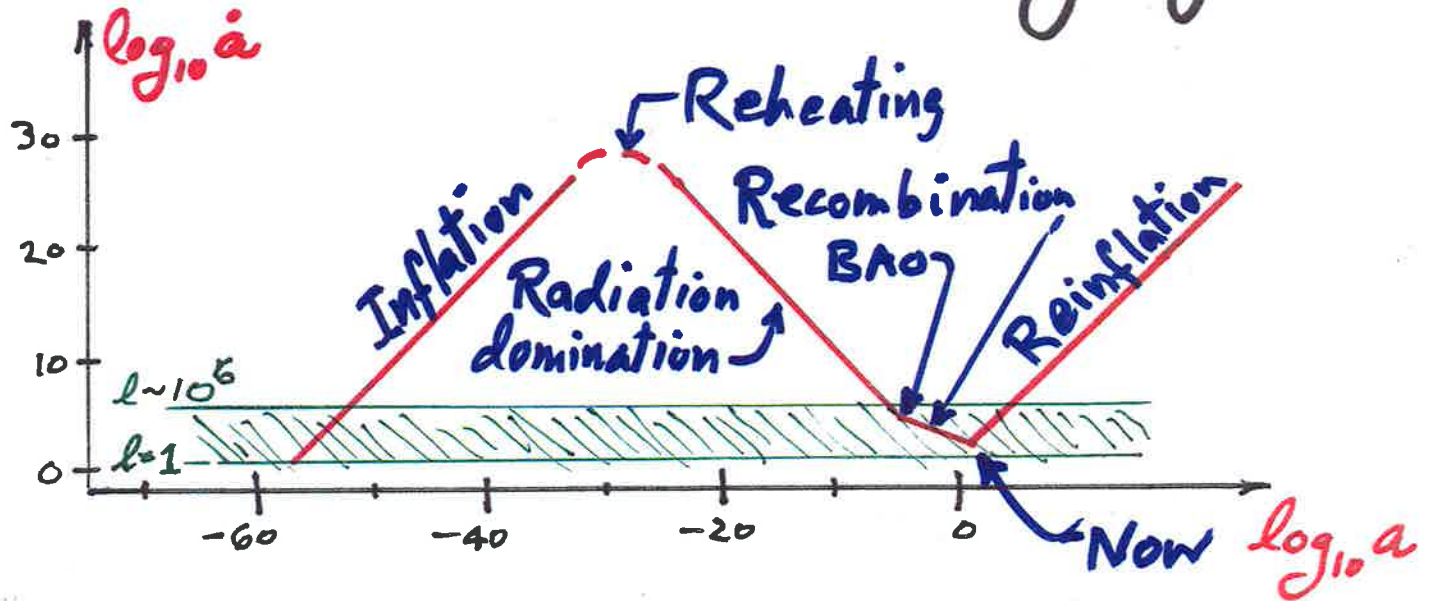
$$\leftrightarrow A_{\mu}^{AS} \leftrightarrow e_{\mu}^a \sqrt{\Delta}$$

$$F_{\mu\nu}^{AB} = \partial_{\mu} A_{\nu}^{AB} - \partial_{\nu} A_{\mu}^{AB} + [A_{\mu}, A_{\nu}]^{AB}$$

COSMOLOGY: Choice of language

History of the Universe

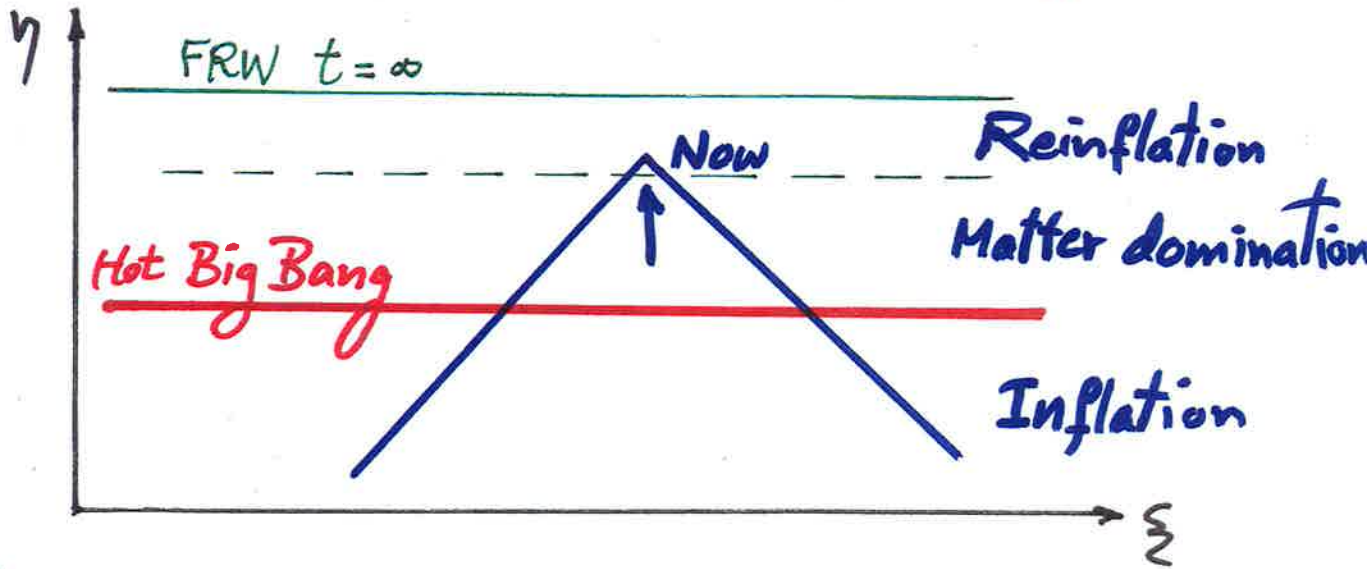
$$ds^2 = dt^2 - a^2(t) d\xi^2$$



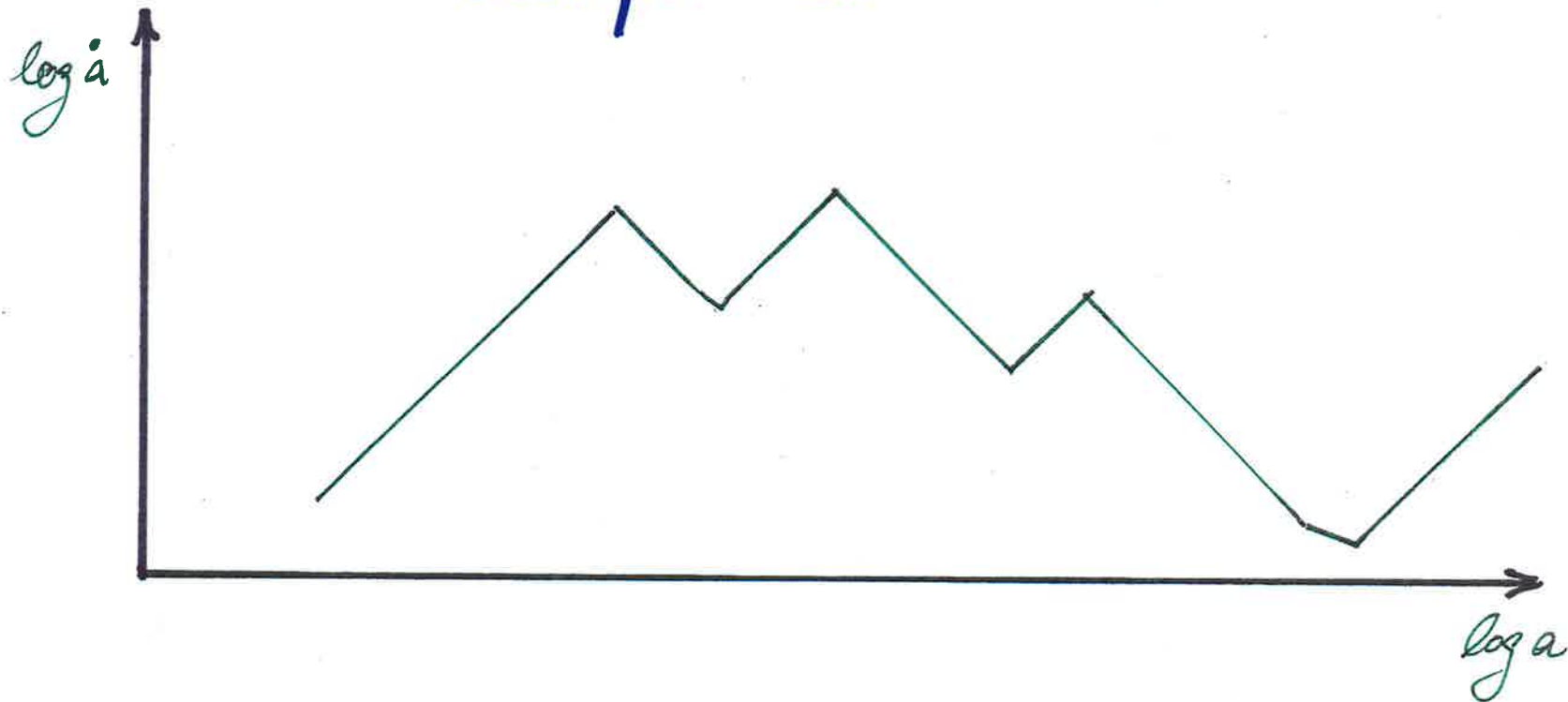
The conformal description

$$ds^2 = a^2(\eta) (d\eta^2 - d\xi^2)$$

$$d\eta = \frac{dt}{a(t)} \Rightarrow \frac{d\eta}{d(\log a)} = e^{-(\log a)}$$



Multiple summits ??



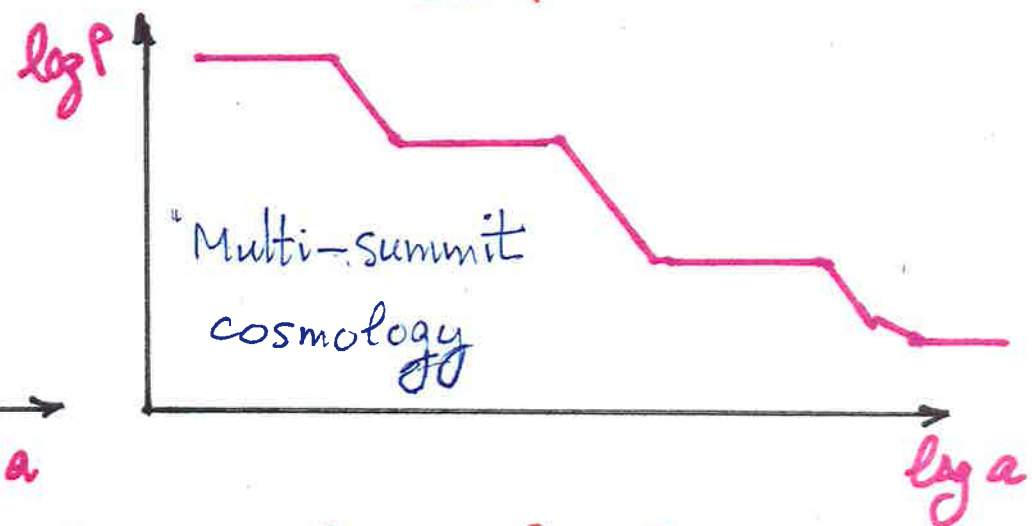
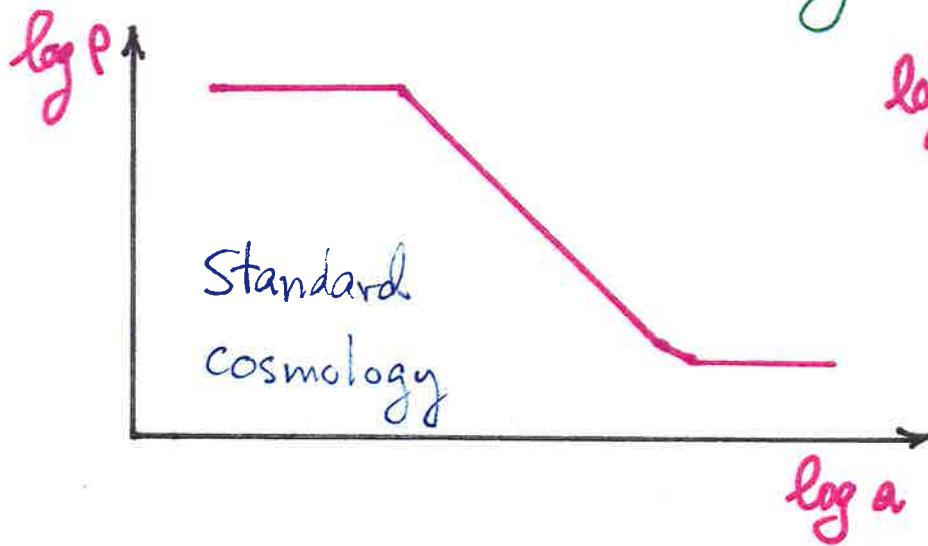
DARK ENERGY: Choice of language?

(MacDowell-Mansouri) "Darkness":

$$S_{GB} = 2\pi \int dt \frac{dN}{dt}$$

"Darkness density" $\rho = \frac{N}{V}$

Darkness density: $\rho = \frac{N}{V} \sim \frac{M_{pl}^2}{\Lambda} \left(\frac{\dot{a}}{a}\right)^3$



Darkness density now $\sim M_{pl}^2 \sqrt{\Lambda} \sim (10^{-20} M_{pl})^3 \sim \Lambda_{QCD}^3$

PEREZ & SUDARSKY (arXiv 1711.05183): Think different!

1. Dark energy is created by spacetime granularity.
2. Reheating converts dark energy into radiation.
3. Dark-energy creation requires matter degrees of freedom.

a) Their "master equation" (hypothetical):

$$\frac{d\Lambda}{d\eta} \sim \frac{R^2}{M_{pl}} \sim \frac{(P-3p)^2}{M_{pl}^5} \quad (R = \text{Ricci scalar})$$

b) The consequence:

Today's dark energy created during the electroweak era:

$$\Lambda \sim M_{pl}^2 \left(\frac{M_{EW}}{M_{pl}} \right)^7 \sim M_{pl}^2 \left(\frac{10^2}{10^{19}} \right)^7 \sim 10^{-119} M_{pl}^2$$