Constraints on the scalar potential from the SDC

Julian Freigang

YSW 2022

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Some general quantum gravity argument with possible experimental implications

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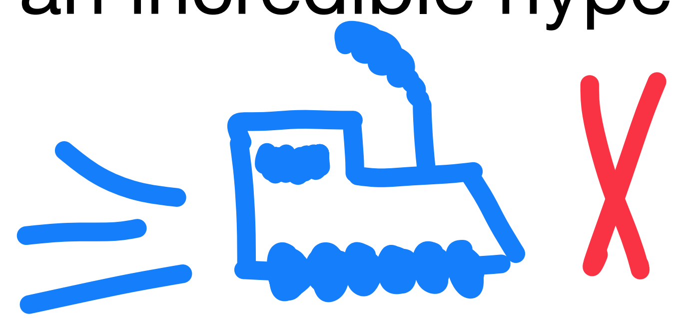

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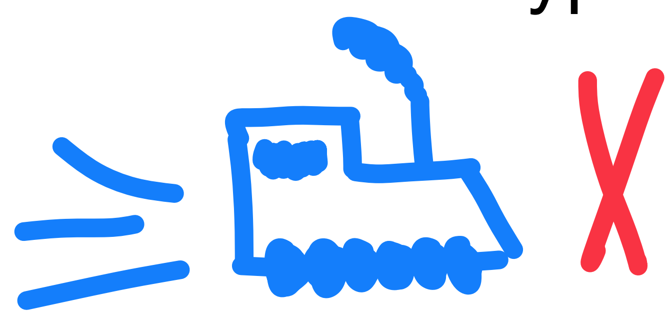

- New point of view: try to take away general lessons from ST as it is a consistent theory of quantum gravity

→ Swampland program

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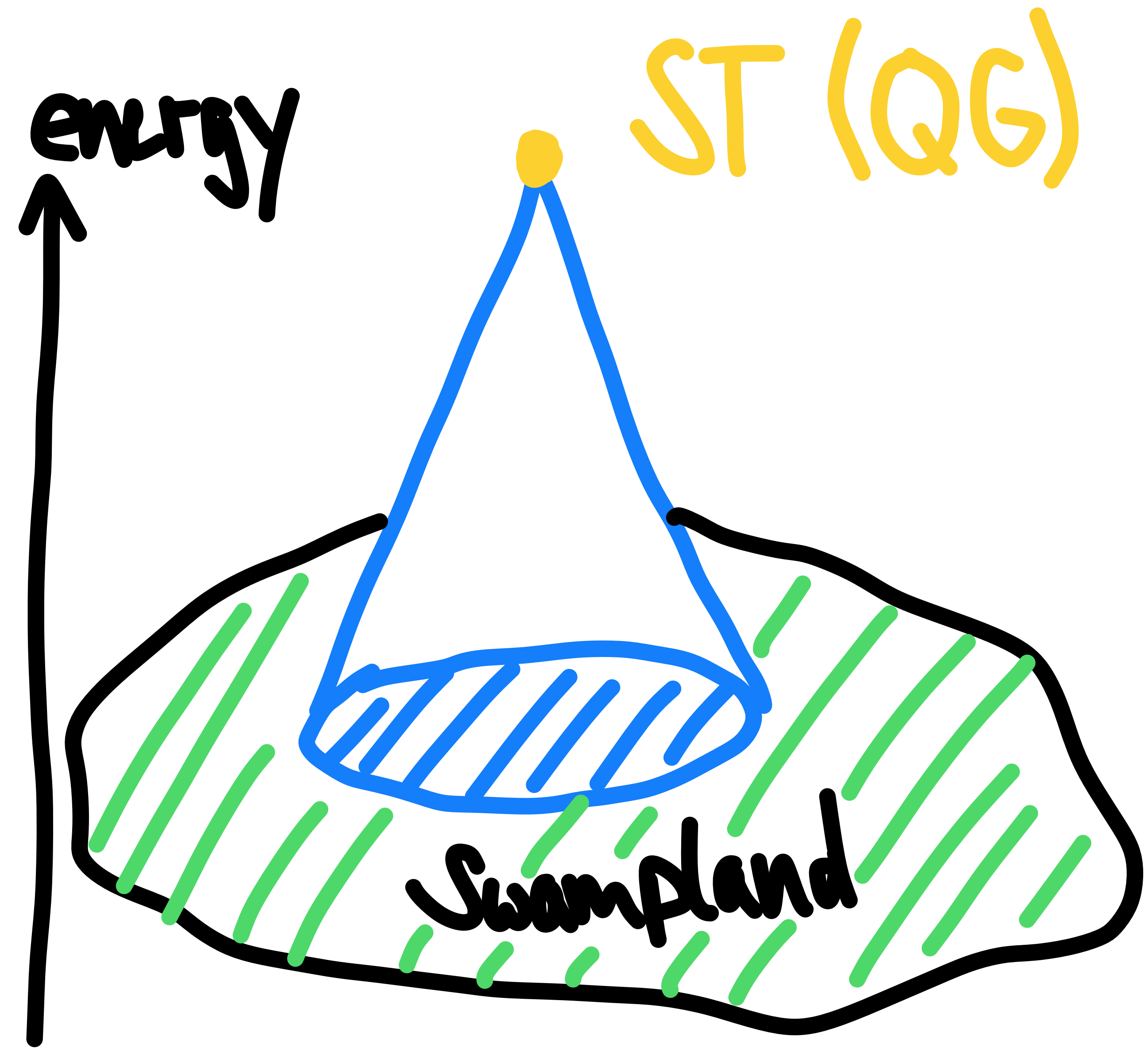

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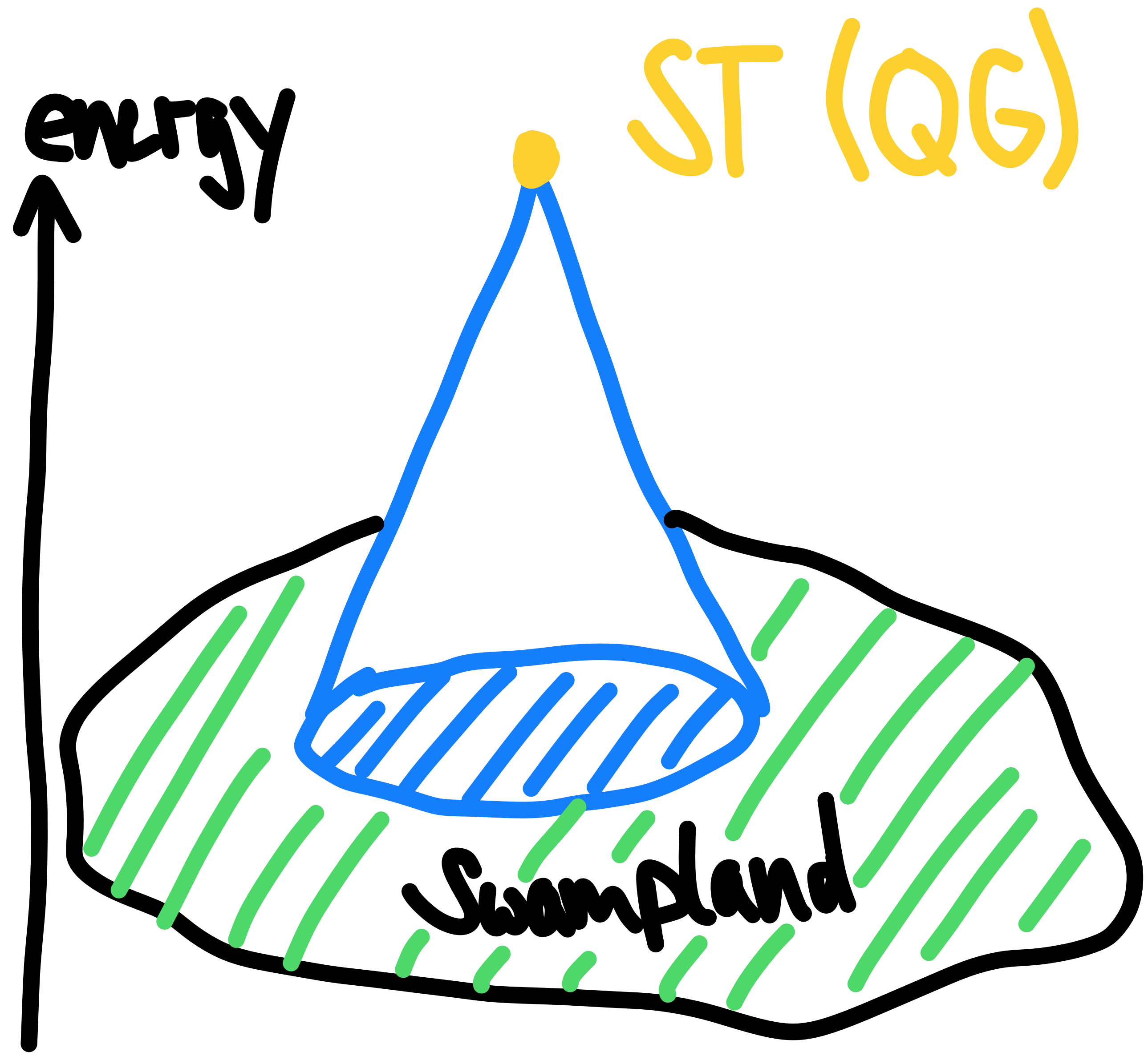
- Distinction between the two via conjectures, e.g. no global symmetries, weak gravity conjecture, SDC …



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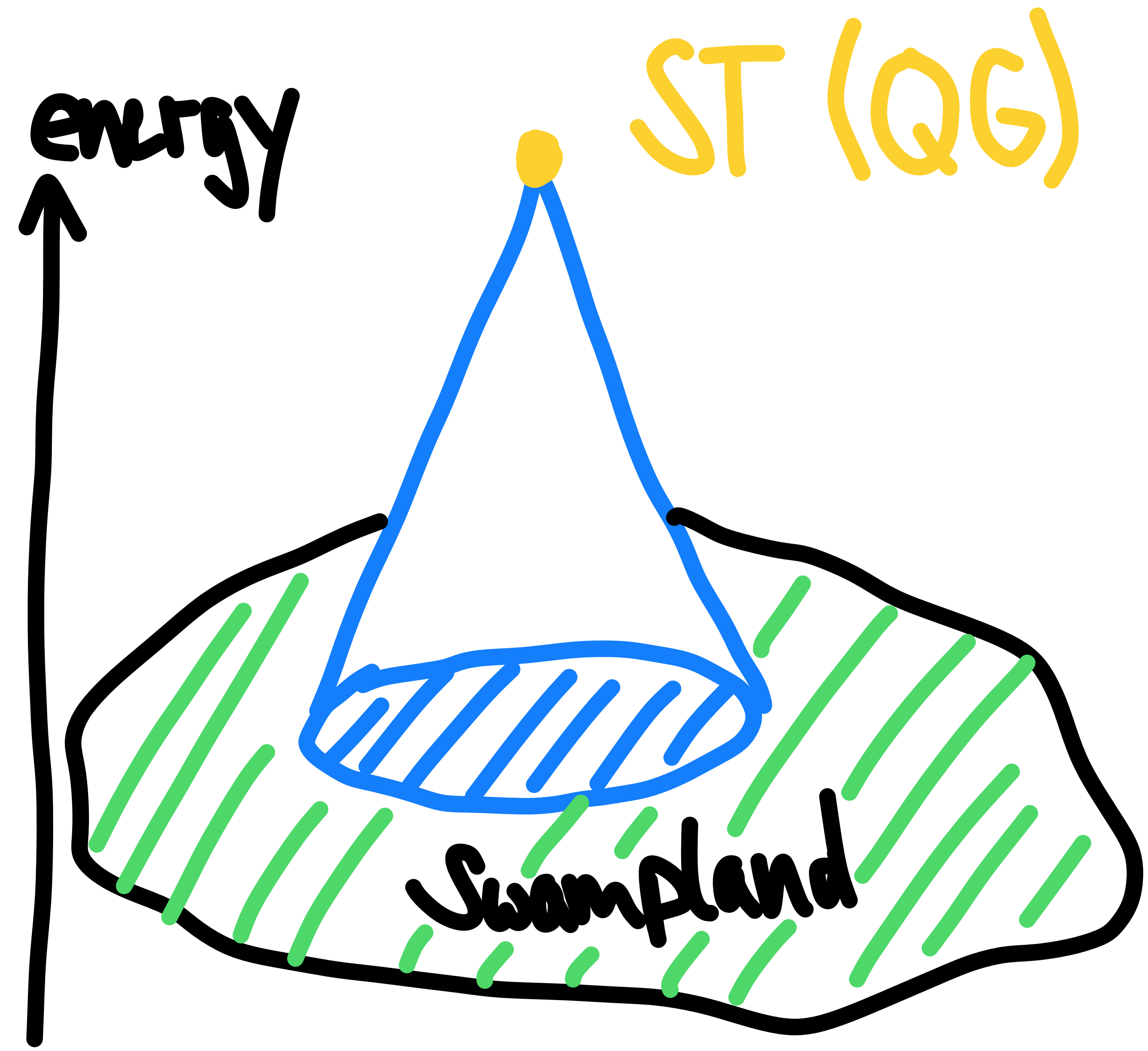
- Usually we have:

  String theory = quantum gravity



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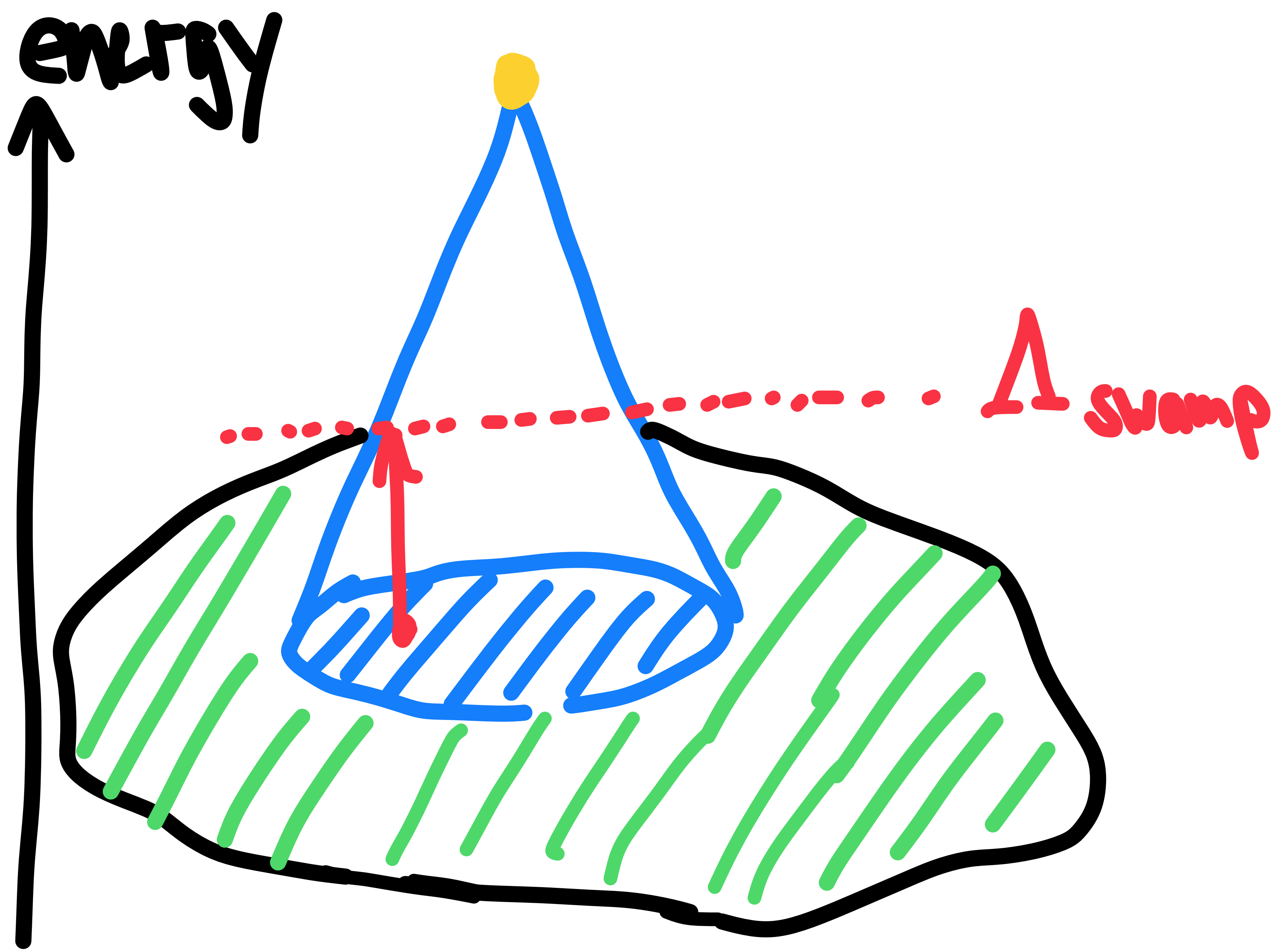

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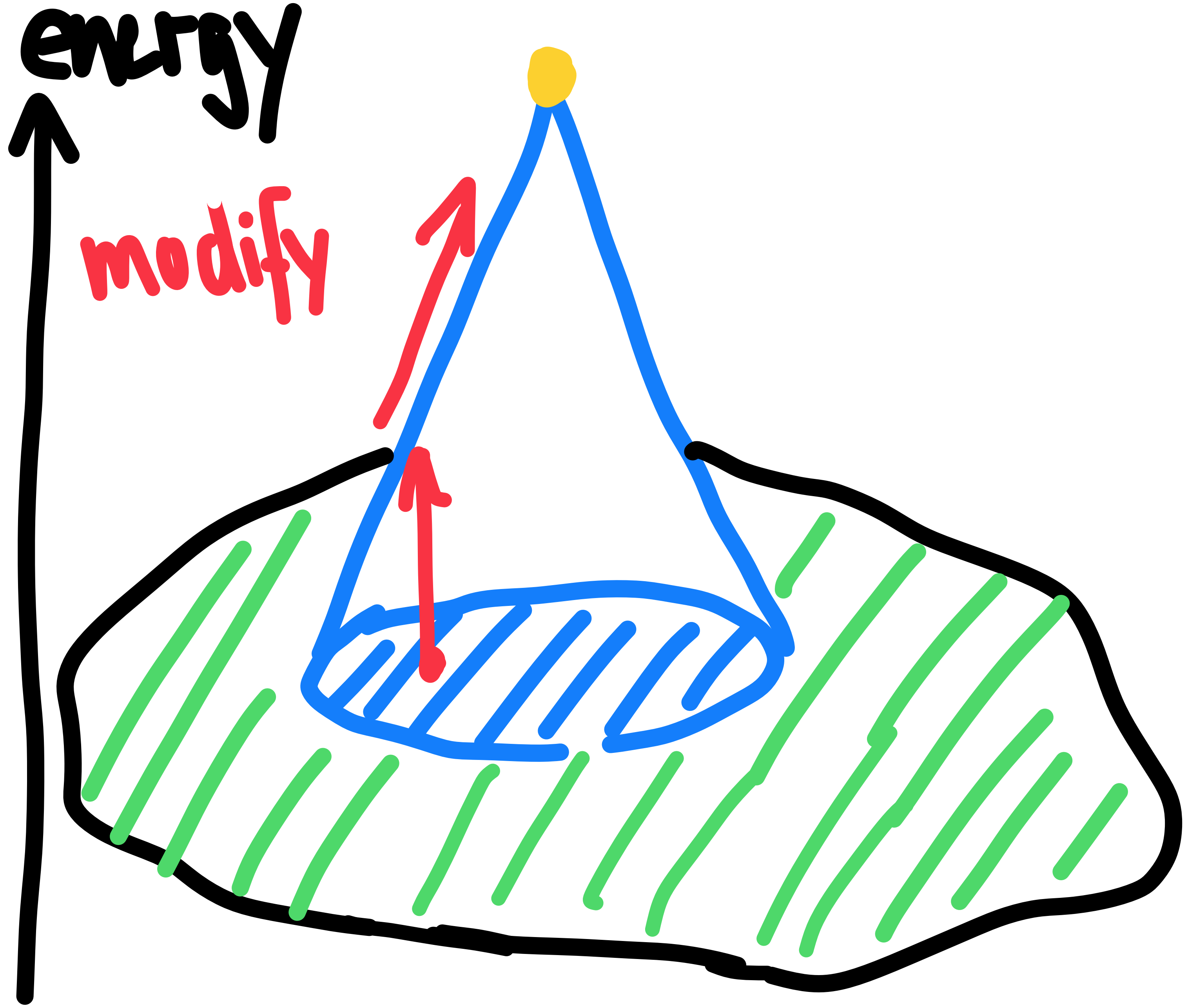

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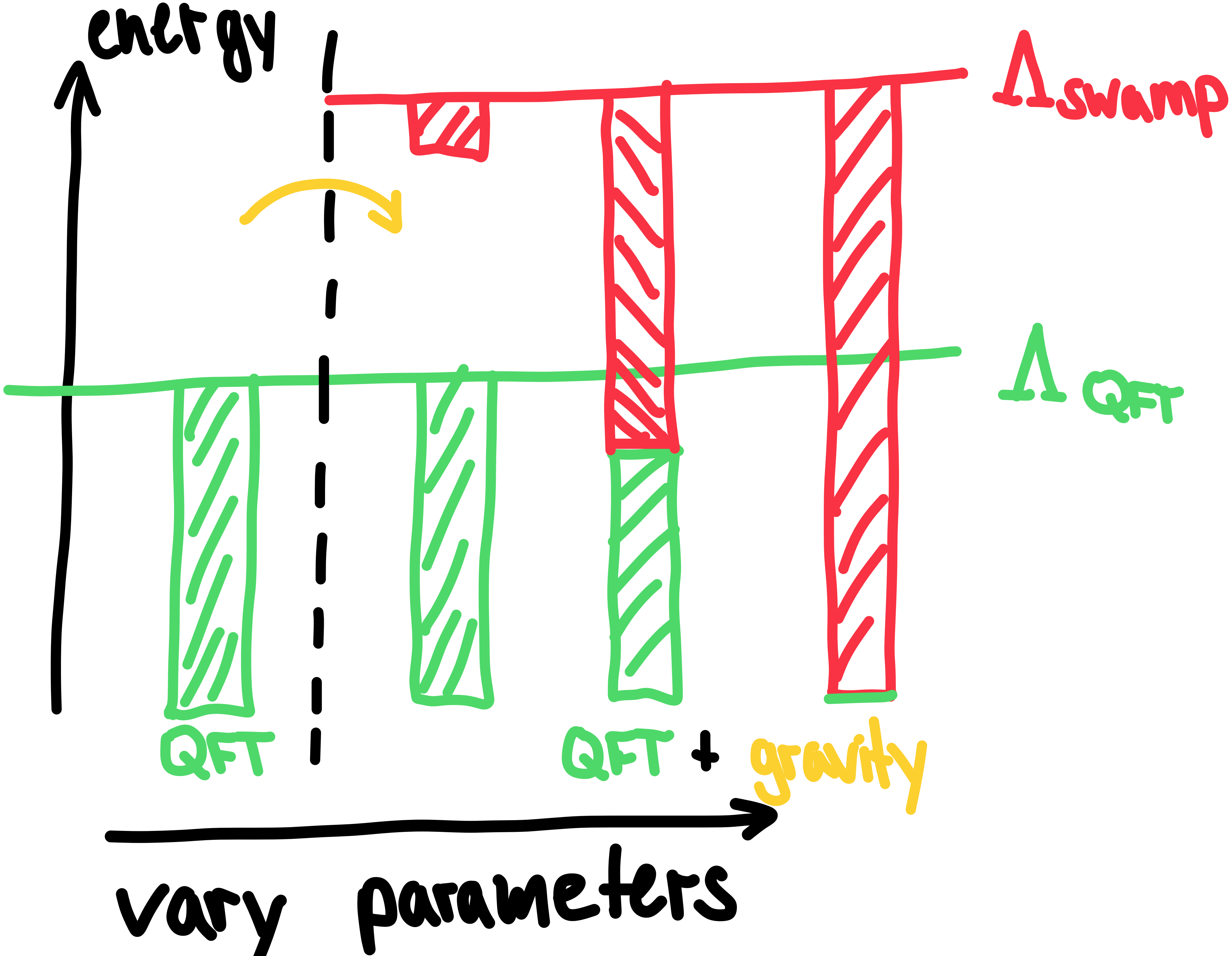

Some general quantum gravity argument:

Scalar Distance Conjecture

- Consider a theory, coupled to gravity, with a moduli space M parametrized by some scalar fields without potential. Starting from any point P in M there exists another point Q in M such that the geodesic distance between P and Q is infinite.

- Then, there exists an infinite tower of states scaling as

$$M(Q) \sim M(P)\, e^{-\alpha\, d(P,Q)}$$

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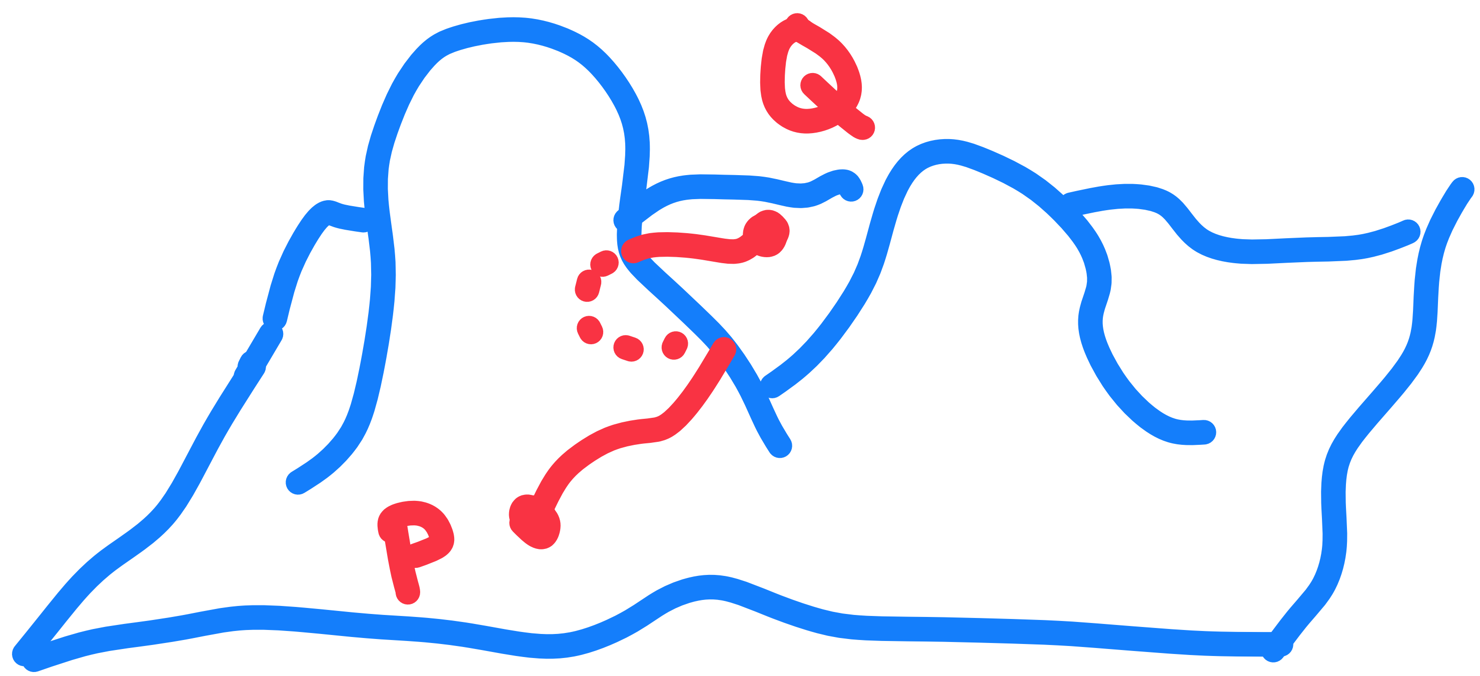
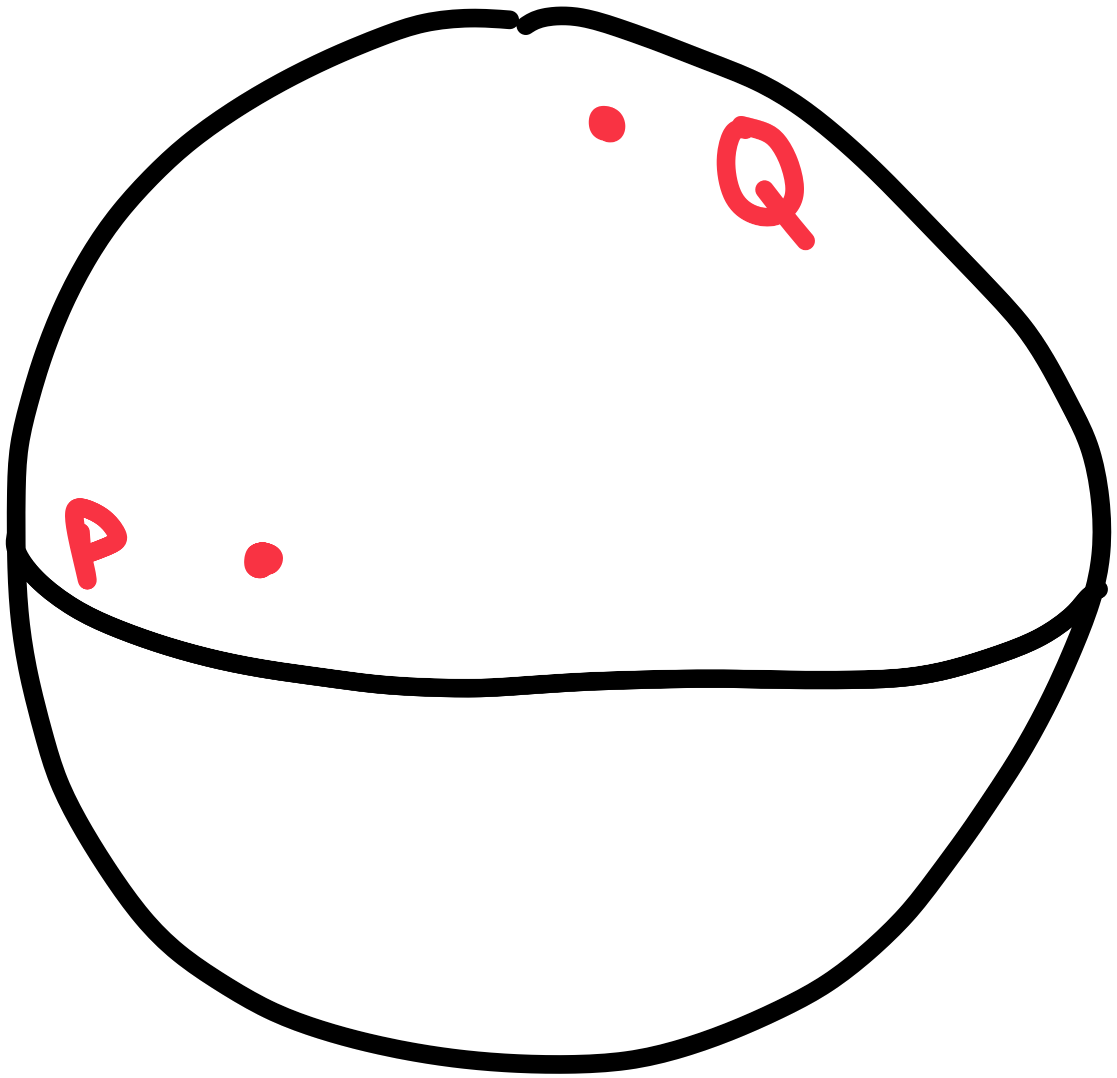
- Geodesic equation: $\ddot{x} + \Gamma \dot{x}^2 = 0$



An example: 2-sphere



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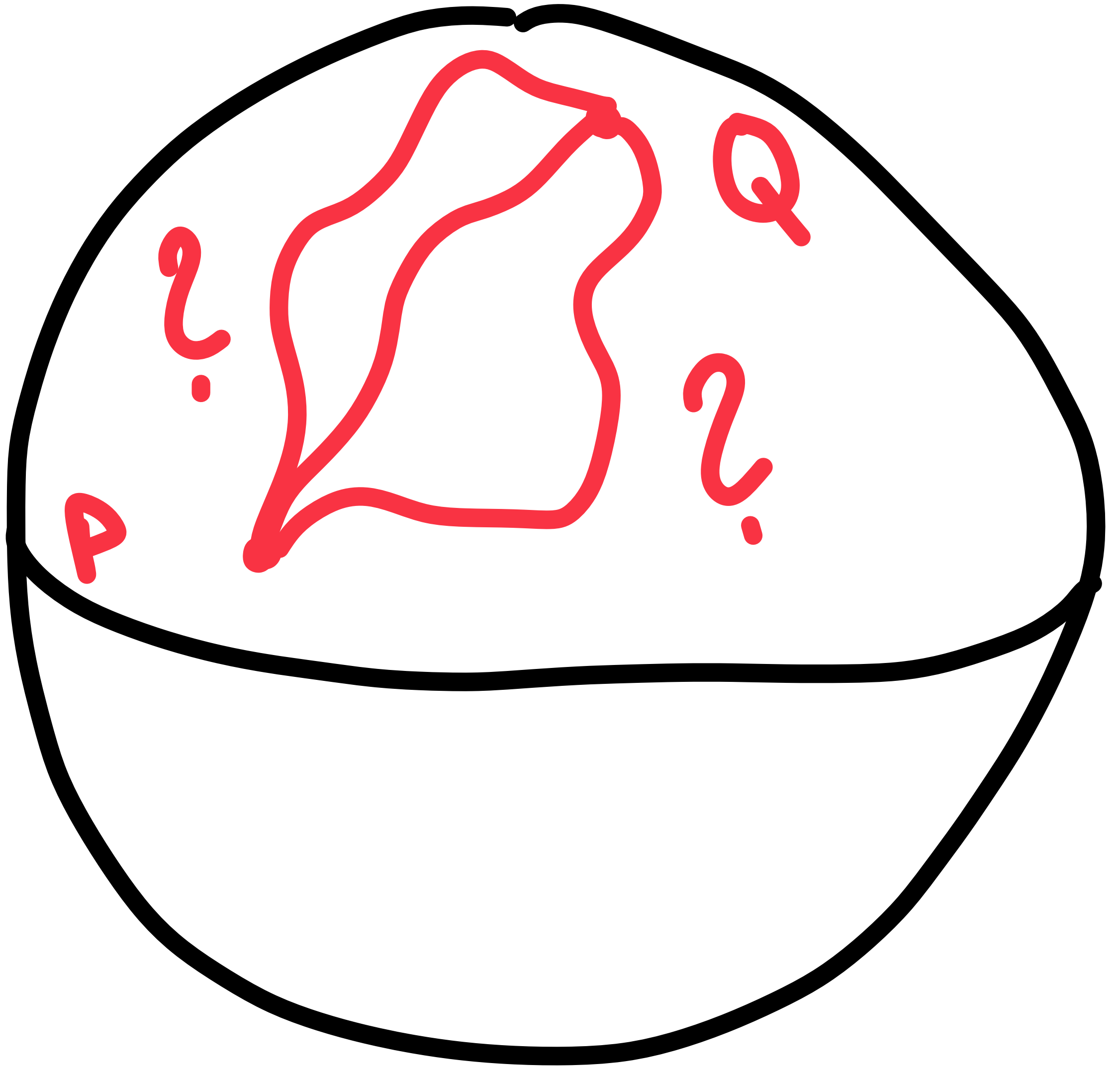

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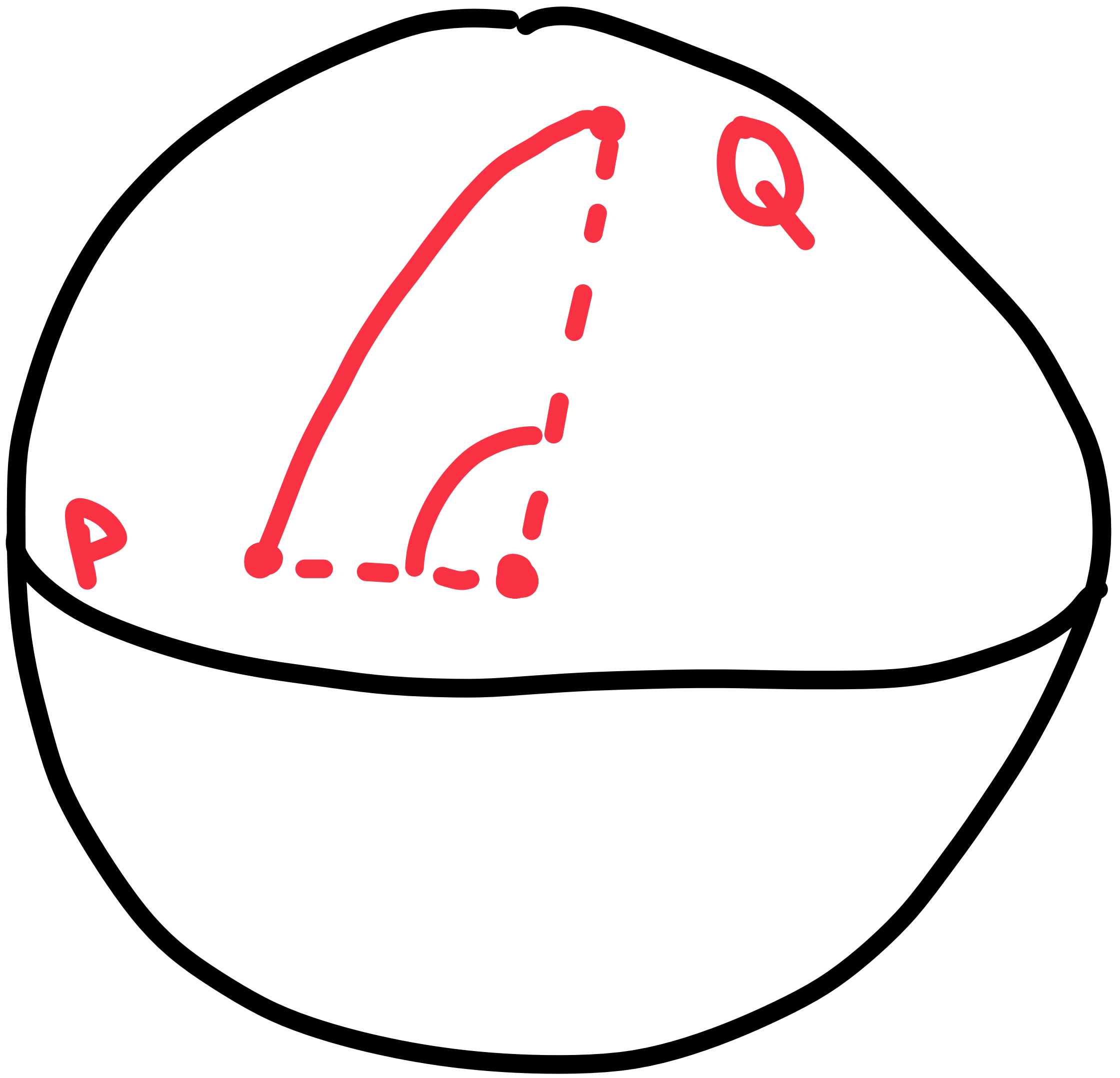

Circle compactification

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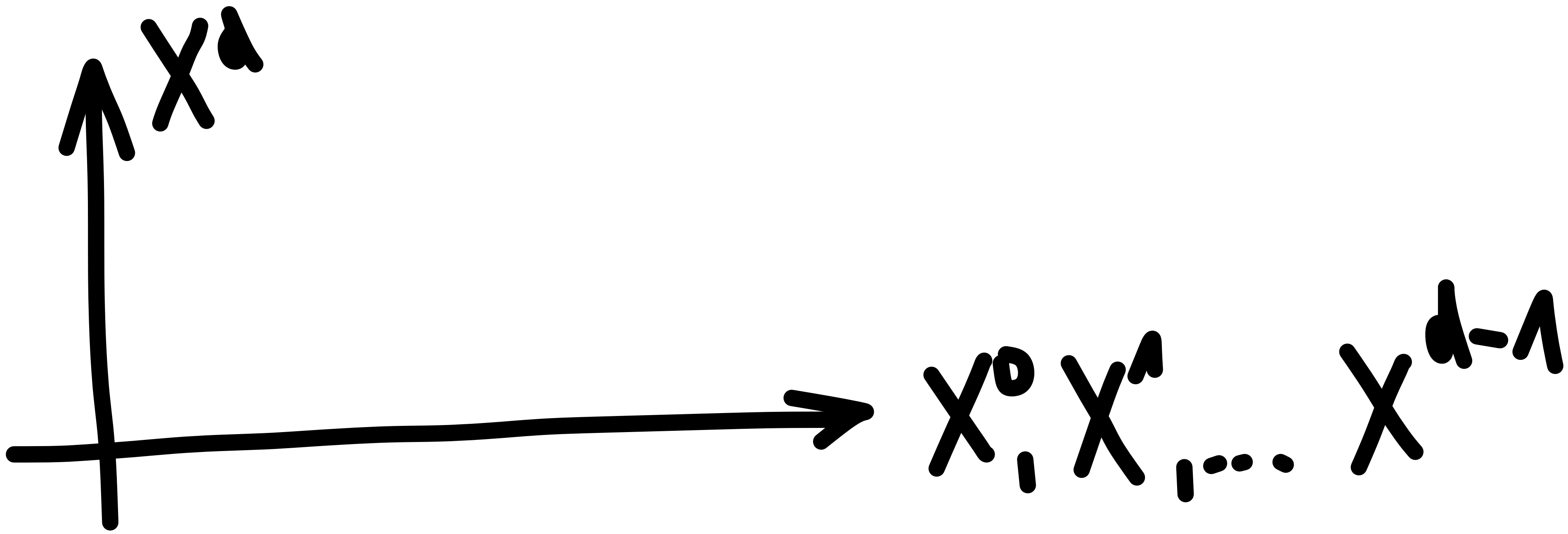

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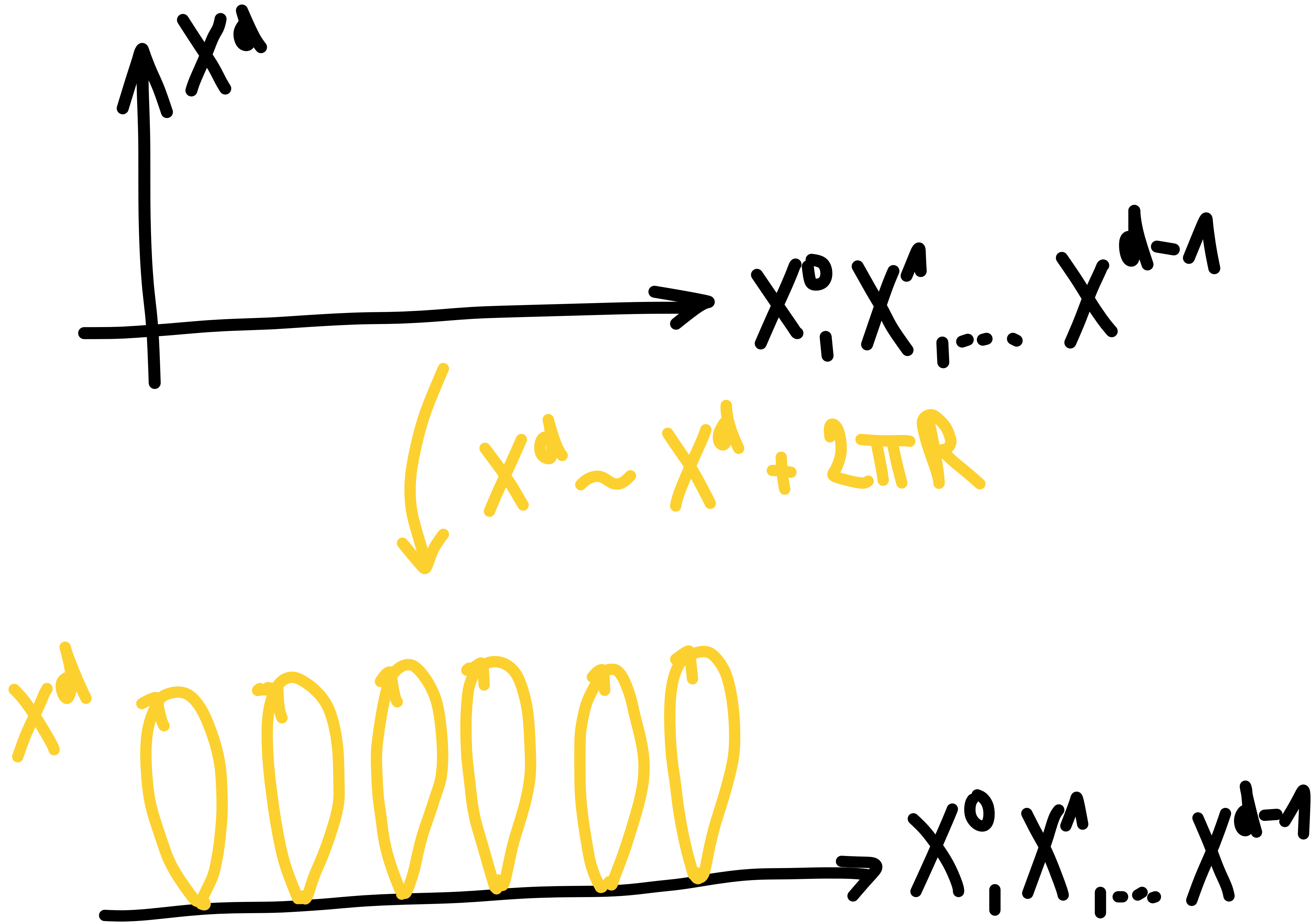

Circle compactification

$$S \sim \int (d+1 \text{ gravity}) \sim \int (d \text{ gravity}) + \frac{1}{R^2}(\partial R)^2$$

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scalar field

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$$\hookrightarrow R \in [0, \infty] \rightsquigarrow \phi \in [-\infty, \infty]$$

moduli space

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$\hookrightarrow \frac{1}{R^2}(\partial R)^2 = \partial(\ln R)^2 \equiv (\partial\phi)^2$ ← scalar field

$\hookrightarrow R \in [0, \infty] \rightsquigarrow \phi \in [-\infty, \infty]$ ← moduli space

$\hookrightarrow$ geodesic distance : $d(P,Q) = \phi_Q - \phi_P$

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$$\hookrightarrow \Box_{d+1} \Psi \sim \sum_{n=-\infty}^{\infty} \Big(\Box_d + \underbrace{\frac{n^2}{R^2}}_{m_n^2}\Big) \psi_n$$

$$m_n^2 \sim e^{-\phi} \sim e^{-d(P,Q)}$$

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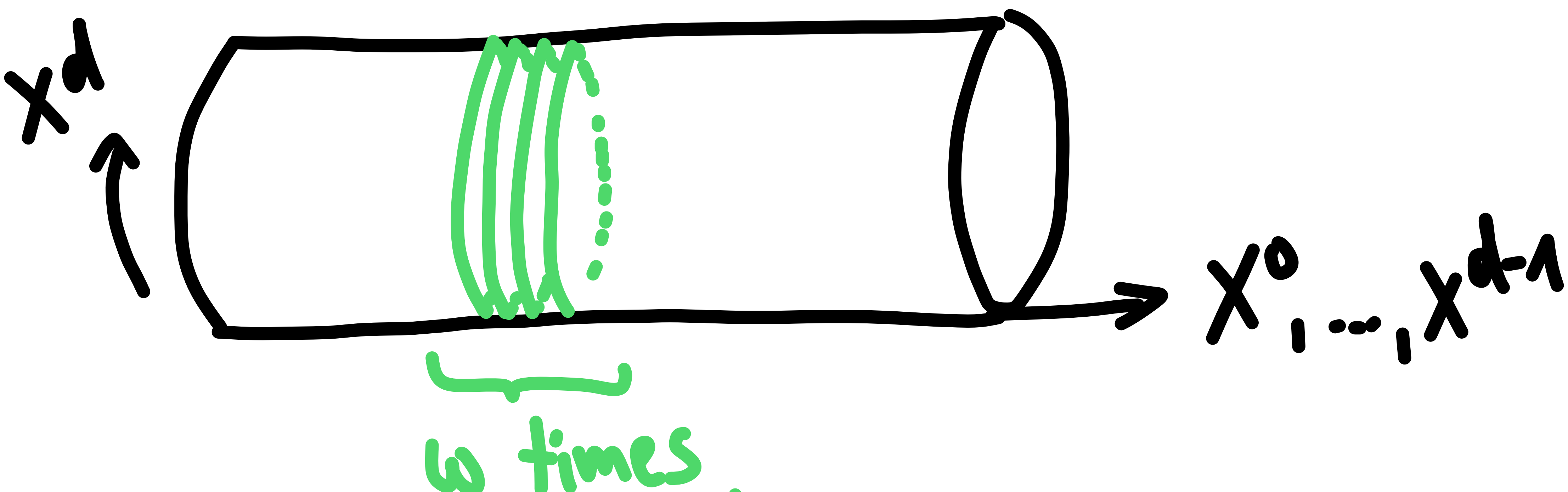

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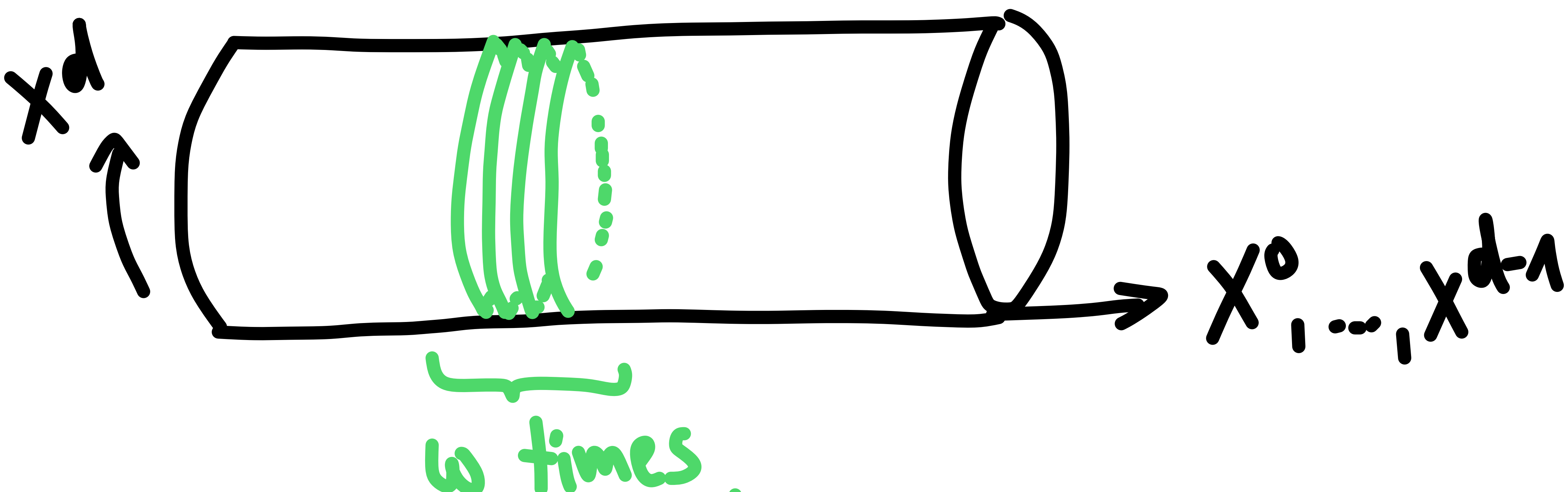

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- This is inherently stringy (or inherent to QG)

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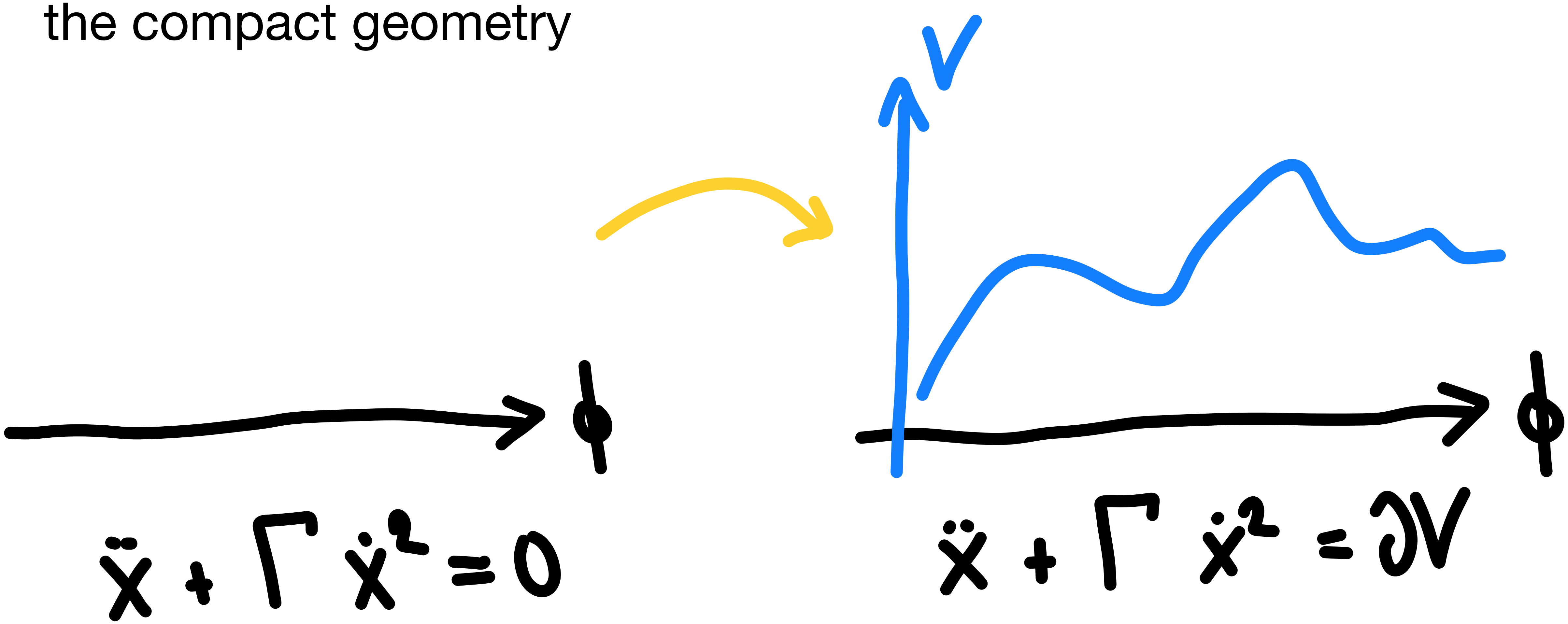

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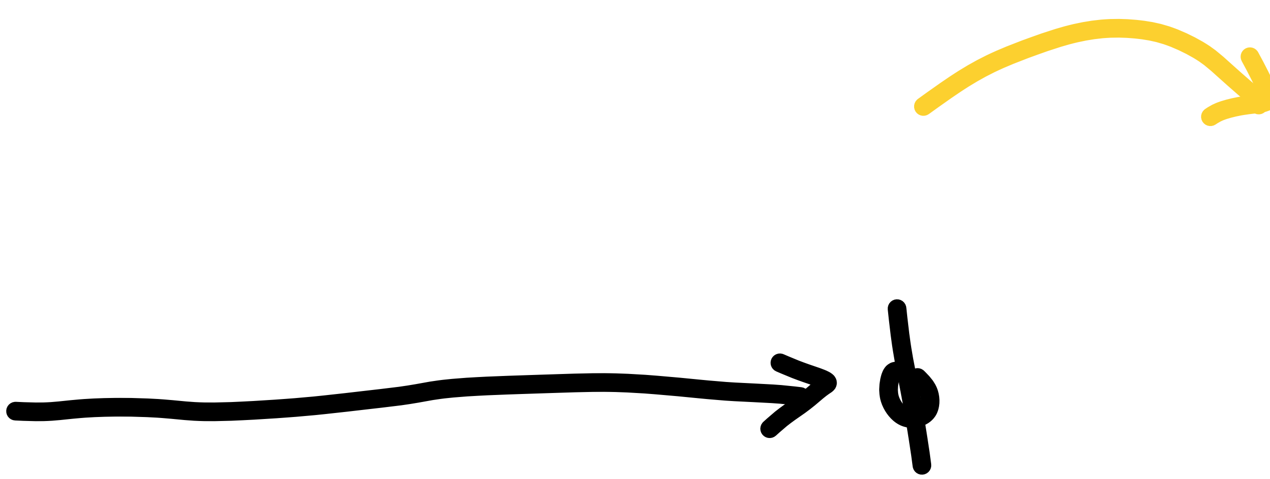

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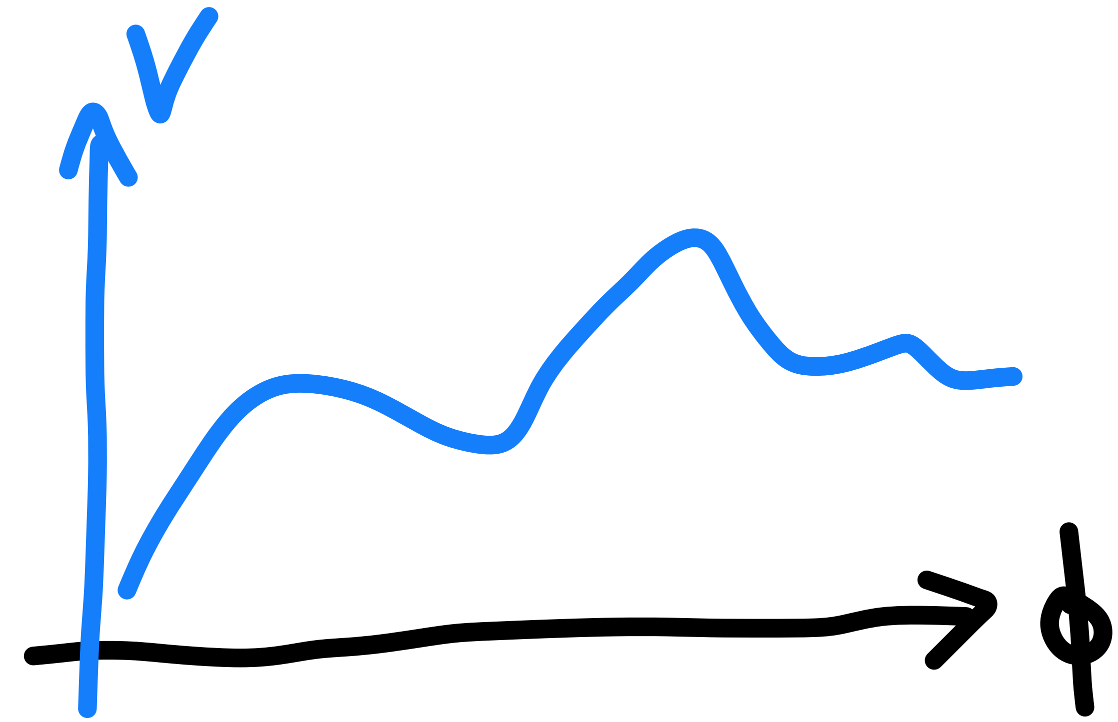

$$\ddot{x} + \Gamma \dot{x}^2 = \partial V$$

- There is an effective scalar theory with a potential:

→ Inflation


Thank you!