

Strings M2-branes

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? Grand Unified Theory ?

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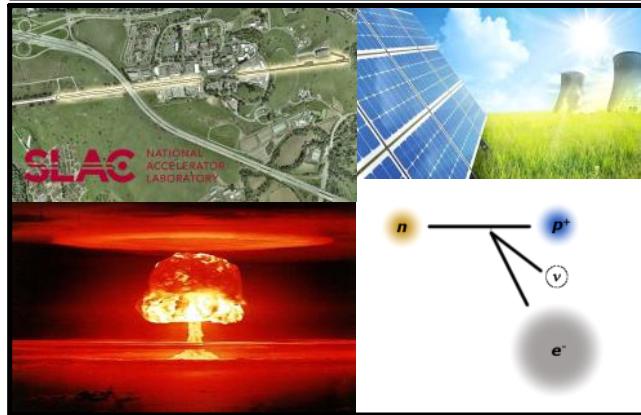
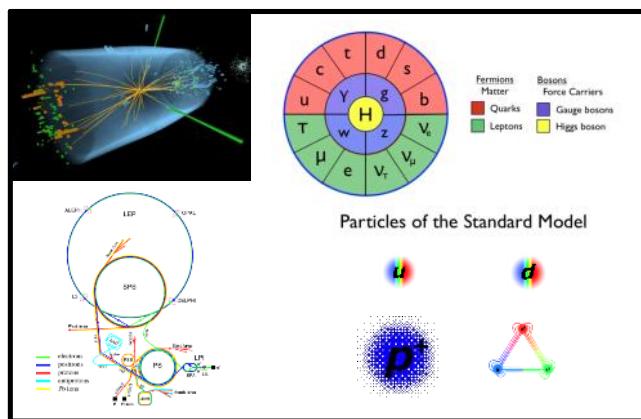
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↑
10⁻³² meters

Stringy Theory

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Grand Unified Theory

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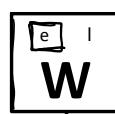
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10⁻²⁸ meters



10⁻¹⁹ meters

The Standard Model

$$\mathcal{L}_{SM} \sim \sum_{S,W,Y} -\frac{1}{4g_i^2} F_i^2 + \sum_{i=1}^3 \sum_{q,\bar{q},d,\bar{d}} (\psi_i^\dagger iD\psi_i + y_i \psi_i^\dagger H \psi_i) + |D_\mu H|^2 - m_H^2 H^2 + \lambda H^4 + h.c.$$

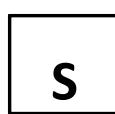
$$e^+ e^- \rightarrow \langle H \rangle \quad W^+ W^- \rightarrow \langle H \rangle$$

$$H \rightarrow \langle H \rangle \sim M_{\text{weak}}$$

$$e^+ \not{\rightarrow} e^- \quad W^+ \not{\rightarrow} W^-$$

$$q\bar{q} \rightarrow \langle q\bar{q} \rangle \sim \Lambda_{\text{QCD}}$$

10⁻¹⁷ meters



10⁻¹⁵ meters

$$a \sim 10^{-15} m$$

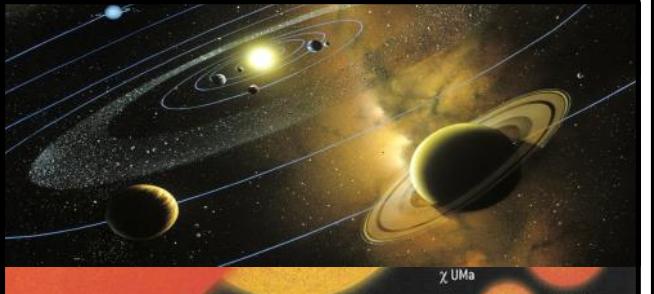
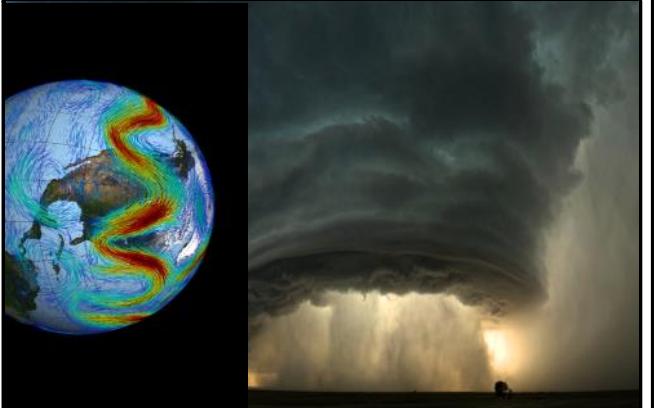
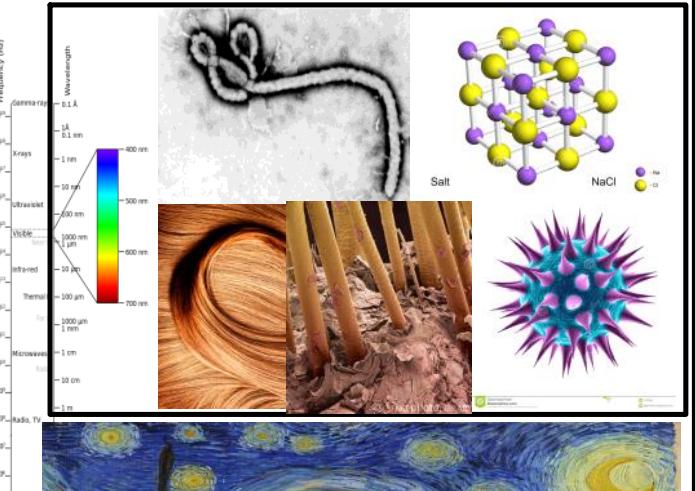
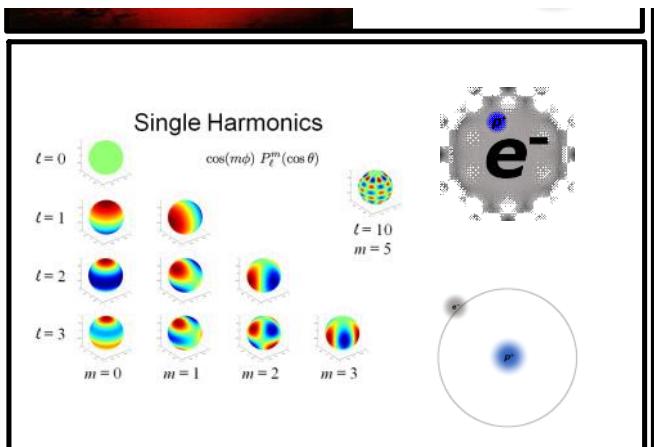
UV ~~~ IR

Electroweak Theory

Quantum Electromagnetism

π^0 K^+ p^+ n^0

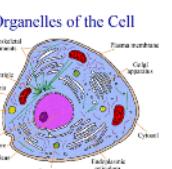
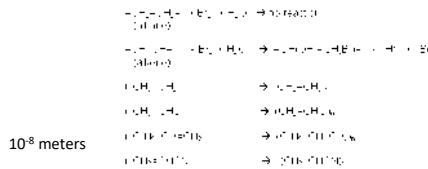
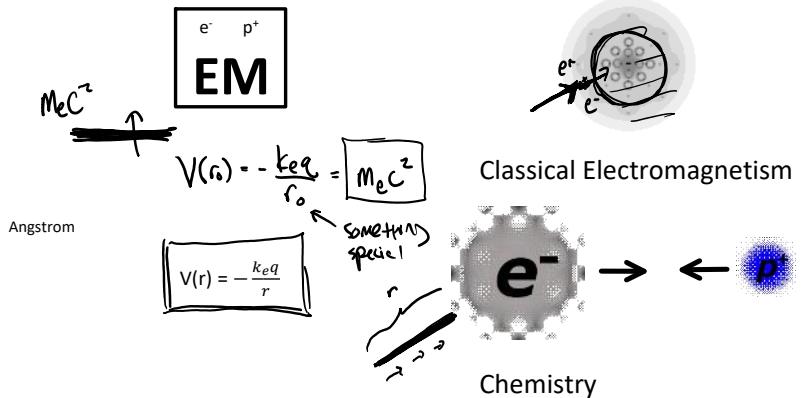
10⁻¹³ meters



1 meter

$$\begin{aligned}\sqrt{\hat{V}} &=? & \cos \hat{V} &=? \\ \frac{d}{dt} \hat{V} &=? & [0, 1] \hat{V} &=? \\ F\{\hat{V}\} &= \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{j\theta k} &=? \\ \text{My normal approach} \\ \text{is useless here.}\end{aligned}$$

Quantum Electromagnetism



Machine Learning?????????



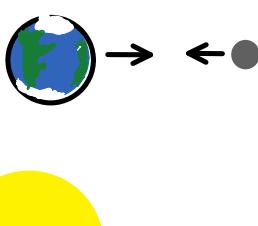
Brute Force?????????????????



Classical Gravity

$$V(r) = -\frac{G_N m}{r}$$

10^8 meters

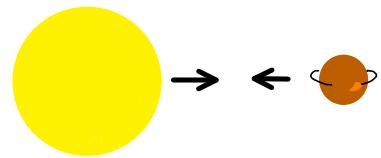




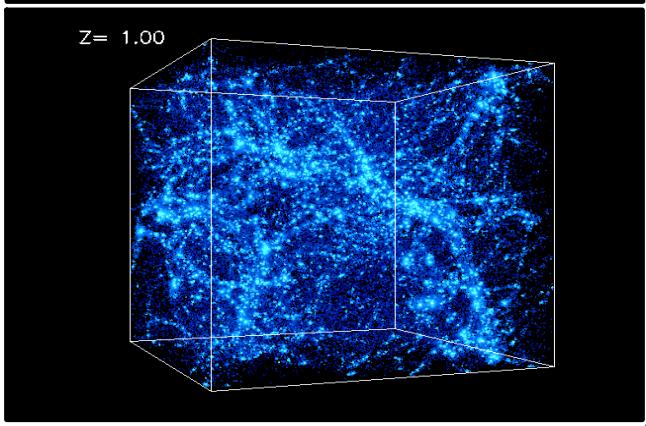
10^8 meters



10^{16} meters



Classical Gravity



10^{24} meters



$$V(r) = \sum_i \frac{G_N m_i}{r - r_i}$$



Classical Gravity

$$V(r) = \sum_i \frac{G_N m_i}{r - r_i}$$

