Physics of Asymptotic Safety?

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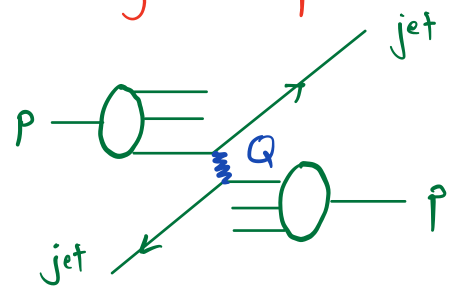
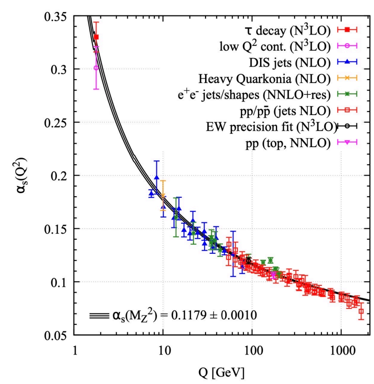
Q1: How is asymptotic safety connected with any physical (observable) behavior of gravity?

E.g. compare QCD





Weinberg (1979): focus on actual reaction rates

$$R = \mu^D f\Big(\frac{E}{\mu}, X, \underbrace{\bar{g}(\mu)}_{\text{scale from physics of process}}\Big)$$

Eg: $\varphi\varphi \to \varphi\varphi$
$hh \to hh$
$\vdots$

$T(s,t)$; $\underbrace{-t}_{q^2} = (\underbrace{s}_{E^2} - 4m^2)\sin^2\frac{\theta}{2}$

$\therefore \quad q \gg M_p \quad \Rightarrow \quad E \gg M_p \,. \quad (q \sim \theta E)$

Does this probe $G_N(q)$?

Apparently not!

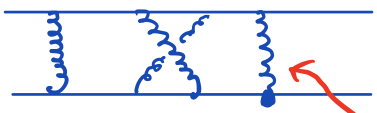
1005.5408 w/ Schmidt-Sommerfeld & Andersen; 1105.2036

see also Dvali, Folkerts, Germani ; Donoghue

Due to physics of gravity.

- First consider $E \gg q \gg M_p$

$E \rightarrow$ $q \uparrow$



Σ ladders = eikonal

$$G_N\left(\frac{q}{N}\right)$$

$$\frac{q}{N} \simeq \frac{1}{R_s(E)}\, \theta^{1/D-3} \sim \frac{1}{b} \quad \text{dominates}$$

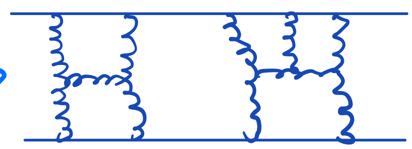
$$R_s \sim (G_N E)^{1/D-3}$$

"Momentum fractionation" 1005.5408

- Now increase q to $\mathcal{O}(E) \leftrightarrow \theta \sim 1$

$$b \sim R_s(E) >> l_p$$

graviton trees $\rightsquigarrow$



$+ \cdots$ $\sim$ Quantum Black Hole

Profound physics!

Size $\sim R_s(E) >> l_p$; $G_N\left(\frac{1}{R_s(E)}\right)$ probed.

$\therefore$ No role for $G_N(q >> M_p)$ in physics?

AS: Formal role in def. of theory?

But assumes field theory description $\int d^4x \, \frac{R}{G_N} + \cdots$

is valid for $\Delta x << l_p$

No a priori reason to believe; speculative ~ others

Q2: Conjecture: Possible reflection of physical

$T(s,t) \downarrow$, $s, -t >> M_p^2$ unitarity, not $G_N(\sqrt{-t})$

$\Gamma \leftrightarrow S$; capture behavior of S?