

What $\left\{ \begin{array}{l} \text{shape dynamics} \\ \text{asymptotic safety} \end{array} \right\}$ can do for $\left\{ \begin{array}{l} \text{asymptotic safety} \\ \text{shape dynamics} \end{array} \right\}$

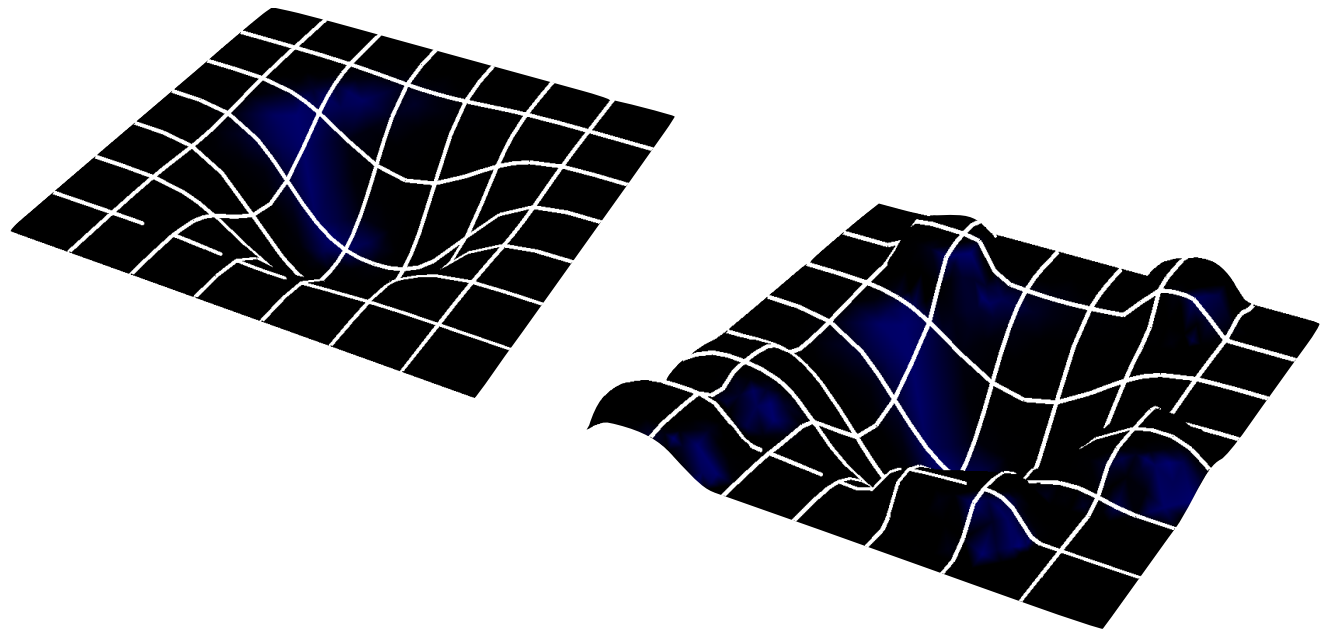
Mini- workshop on shape dynamics

Perimeter Institute, June 25, 2015

Challenge in quantum gravity

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$$\int \mathcal{D}_{\text{field configurations}} e^{iS} \quad ?$$

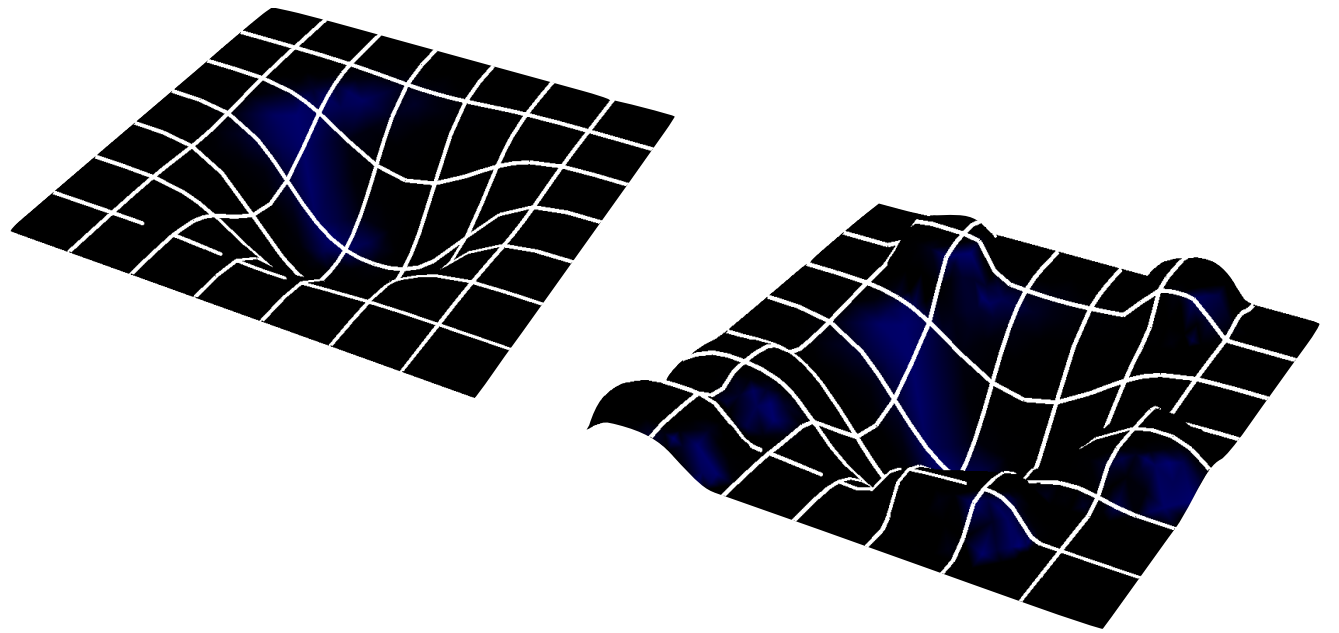


Control quantum fluctuations on all scales

-> Renormalization Group flow $\int \mathcal{D}_{\text{high-momentum modes}} e^{i\Gamma_k}$

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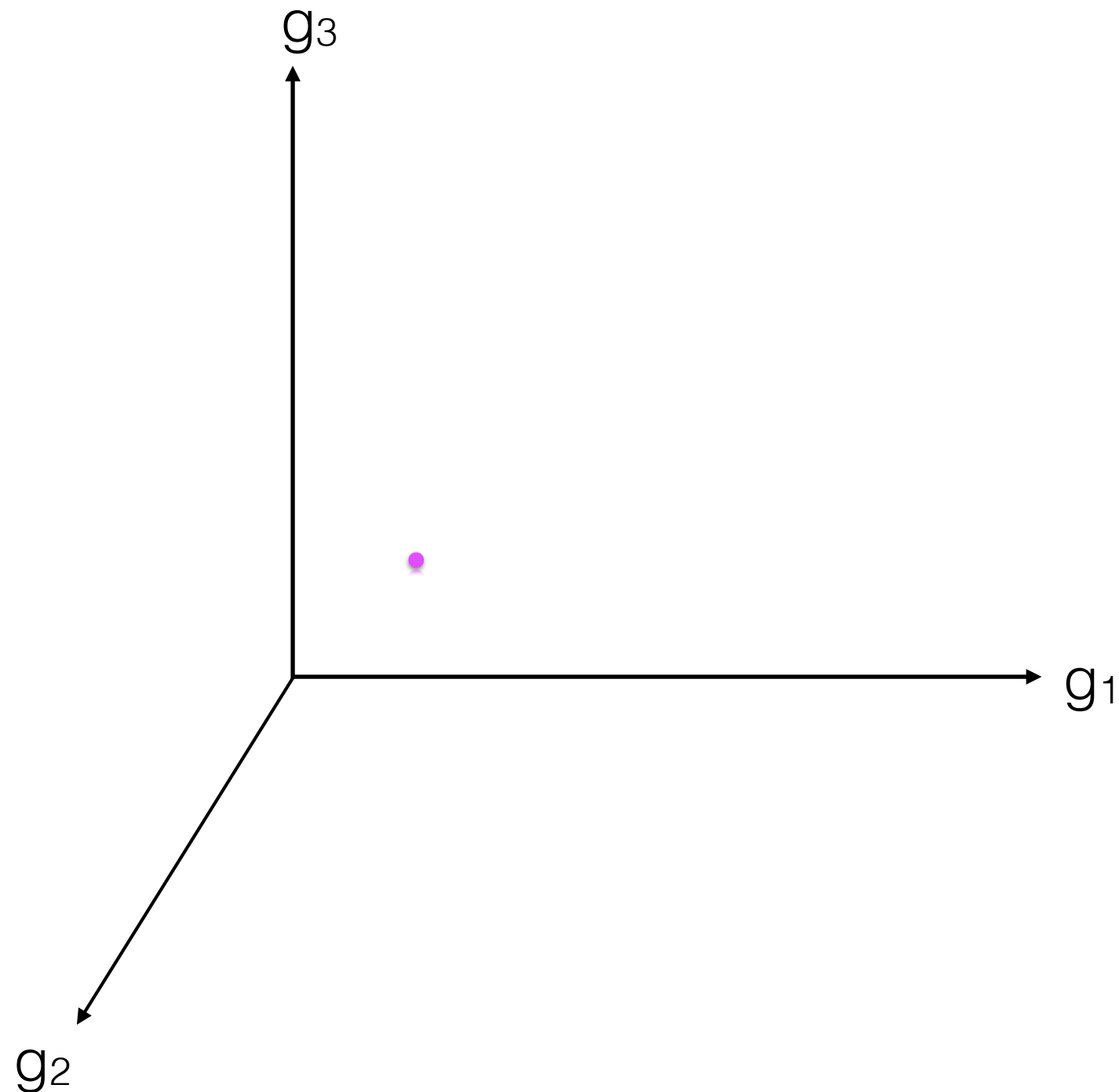
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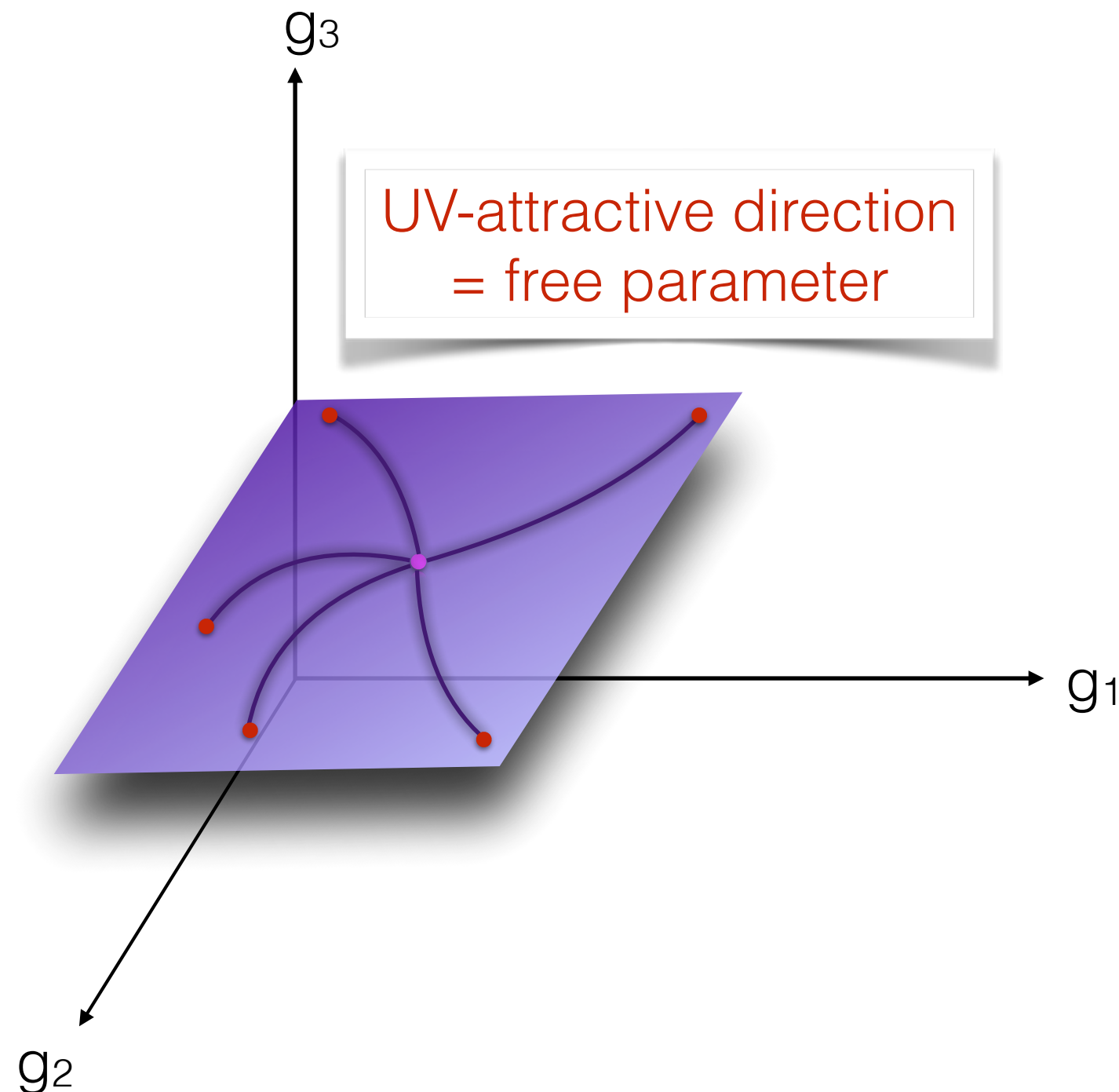
effective theory:
running couplings diverge
at “scale of new physics”

fundamental theory:
running couplings reach
finite ultraviolet limit

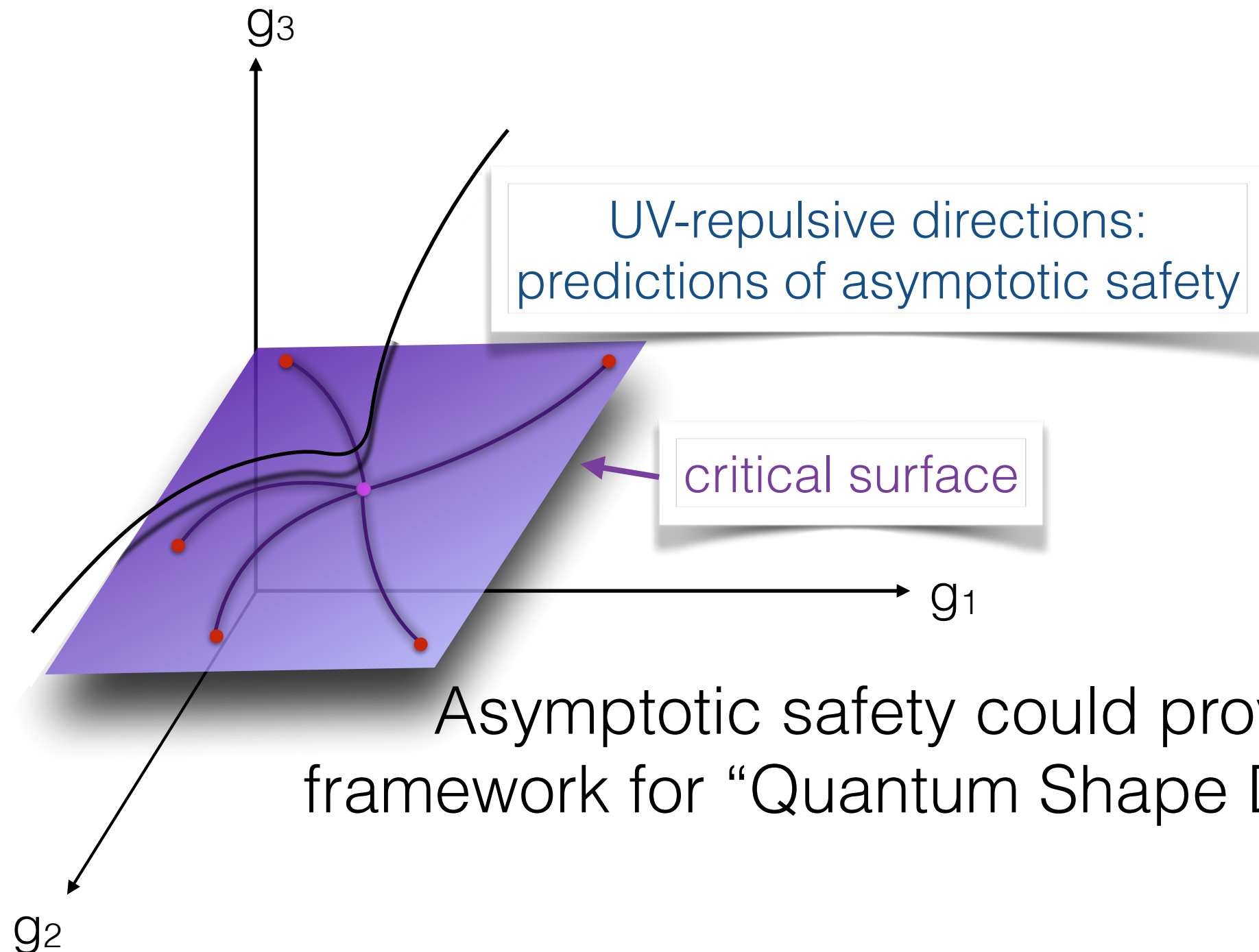
Asymptotic safety



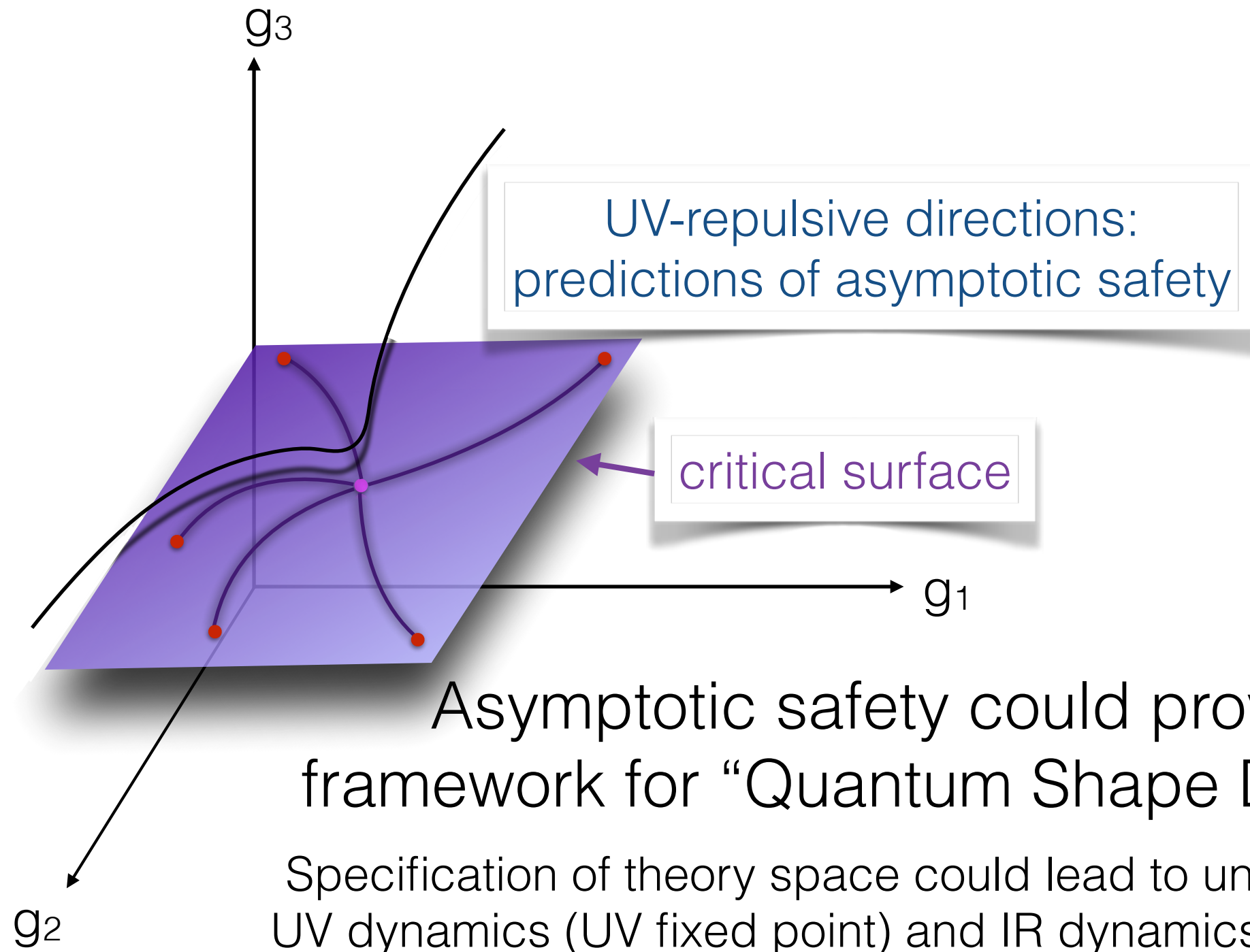
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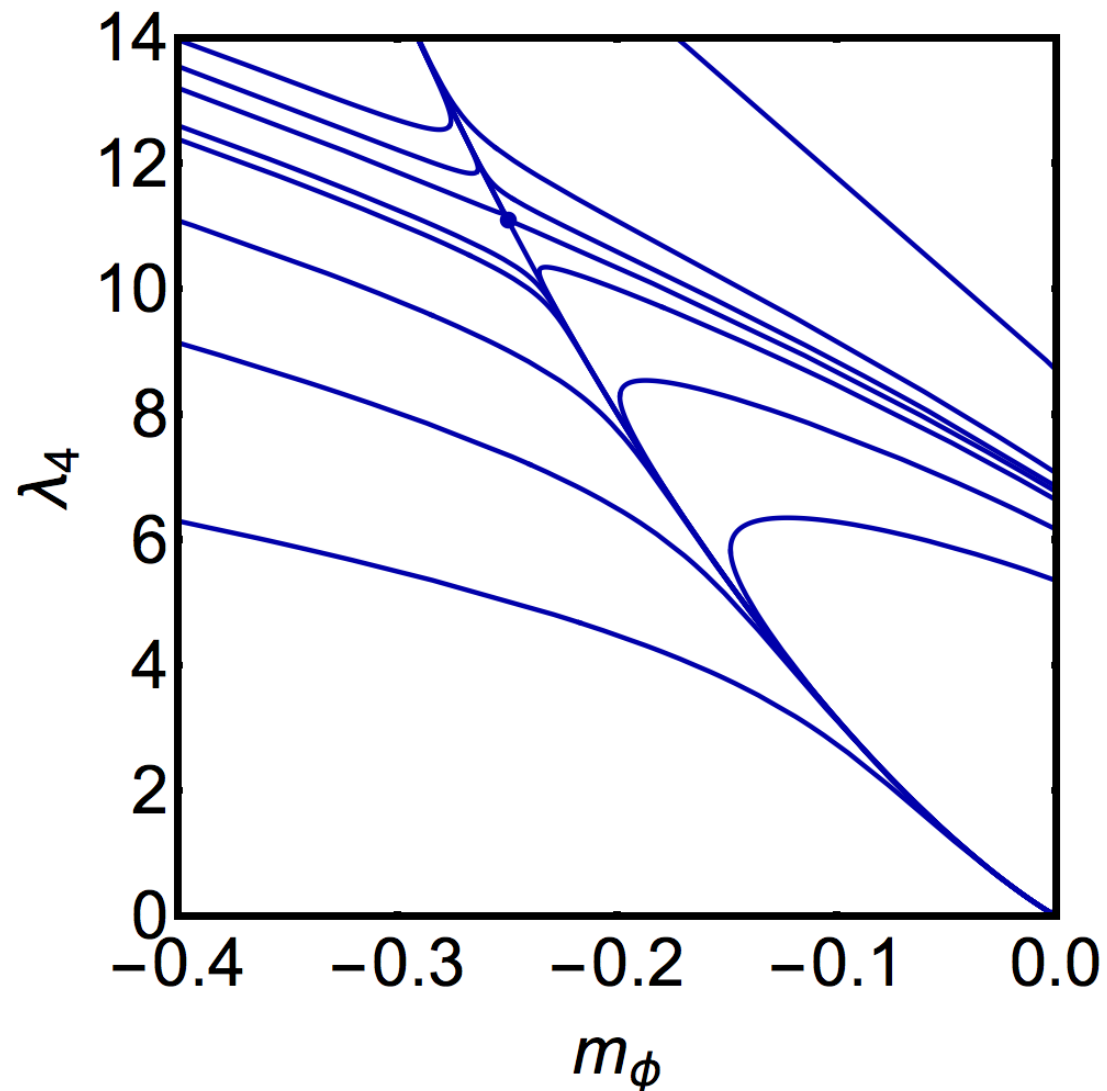


Interacting fixed points & universality classes

Wilson-Fisher fixed point: $S = \int d^3x \left(\frac{1}{2} \partial_\mu \phi_i \partial^\mu \phi_i + \frac{m_\phi^2}{2} \phi_i^2 + \frac{\lambda_4}{4} \phi_i^4 \right)$

$i = 1, \dots, N$

$O(N)$ symmetry



characterized by:

N	$\nu = 1/\theta_1$	$\omega = -\theta_2$
1	0.630	0.799
2	0.670	0.789
3	0.707	0.782

universality class depends on degrees of freedom & symmetry

Observational distinction of different universality classes for gravity?

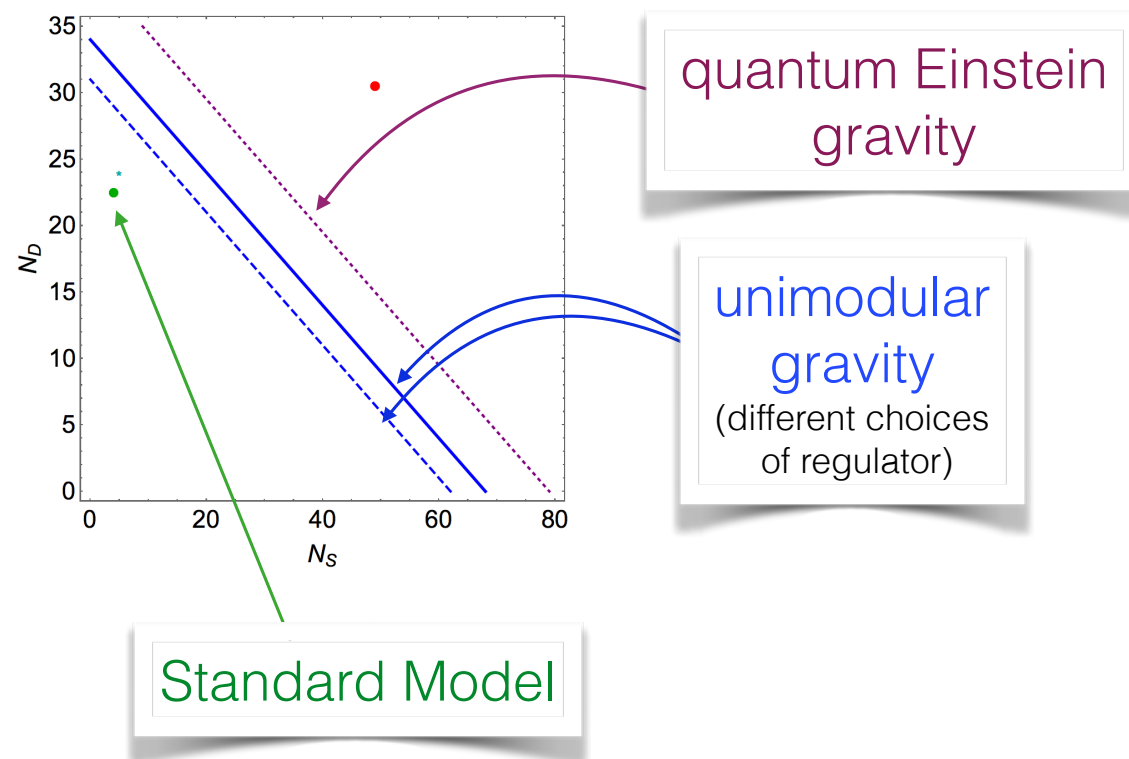
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- irrelevant directions \leftrightarrow predictions
- low-energy tests: compatibility with matter

perturbative analysis:

$$\beta_G = 2G + \frac{G^2}{6\pi} (-20(46) + N_S + 2N_D - 4N_V - N_{RS})$$

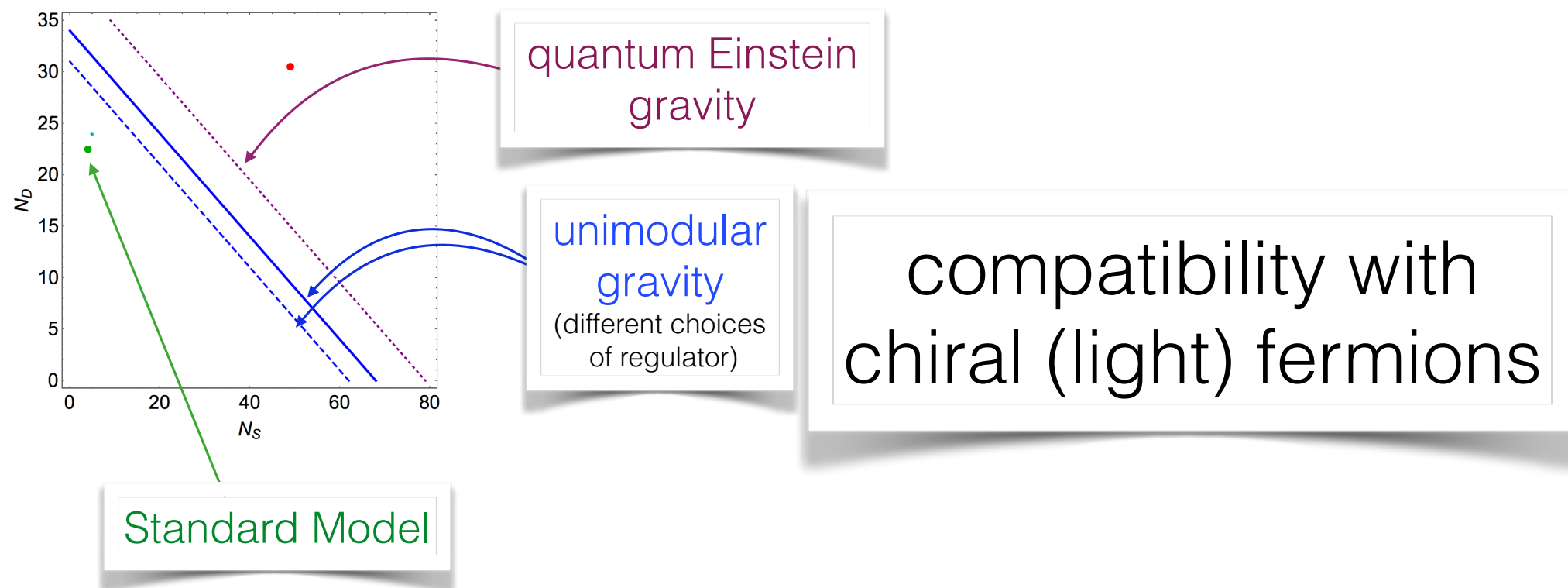


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- Technical challenge: Adapt functional Renormalization Group tools to the shape dynamics theory space!