

Title: Debate on RG flow and SD

Date: Jun 25, 2015 04:00 PM

URL: <http://pirsa.org/15060029>

Abstract:



What  $\begin{Bmatrix} \text{shape dynamics} \\ \text{asymptotic safety} \end{Bmatrix}$  can do for  $\begin{Bmatrix} \text{asymptotic safety} \\ \text{shape dynamics} \end{Bmatrix}$

Mini- workshop on shape dynamics

Perimeter Institute, June 25, 2015

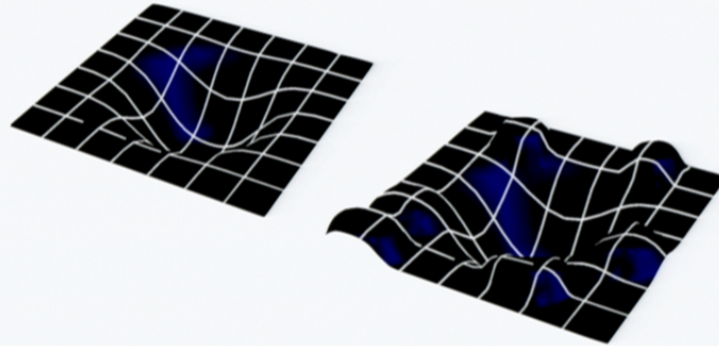


# Challenge in quantum gravity



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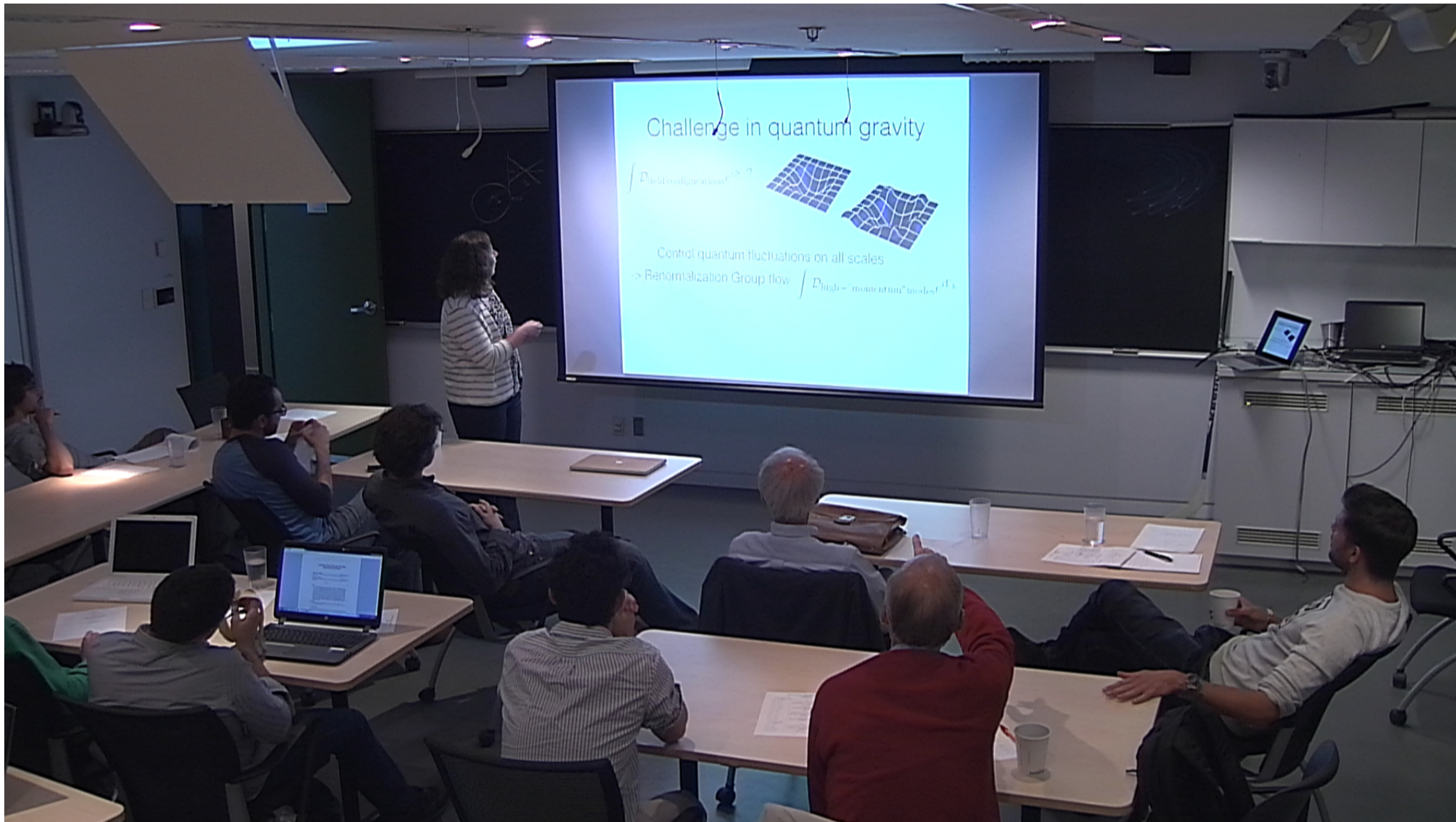
$$\int \mathcal{D}_{\text{field configurations}} e^{iS} ?$$



Control quantum fluctuations on all scales

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

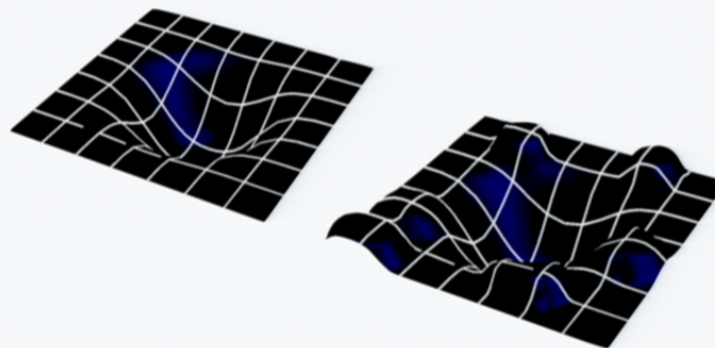






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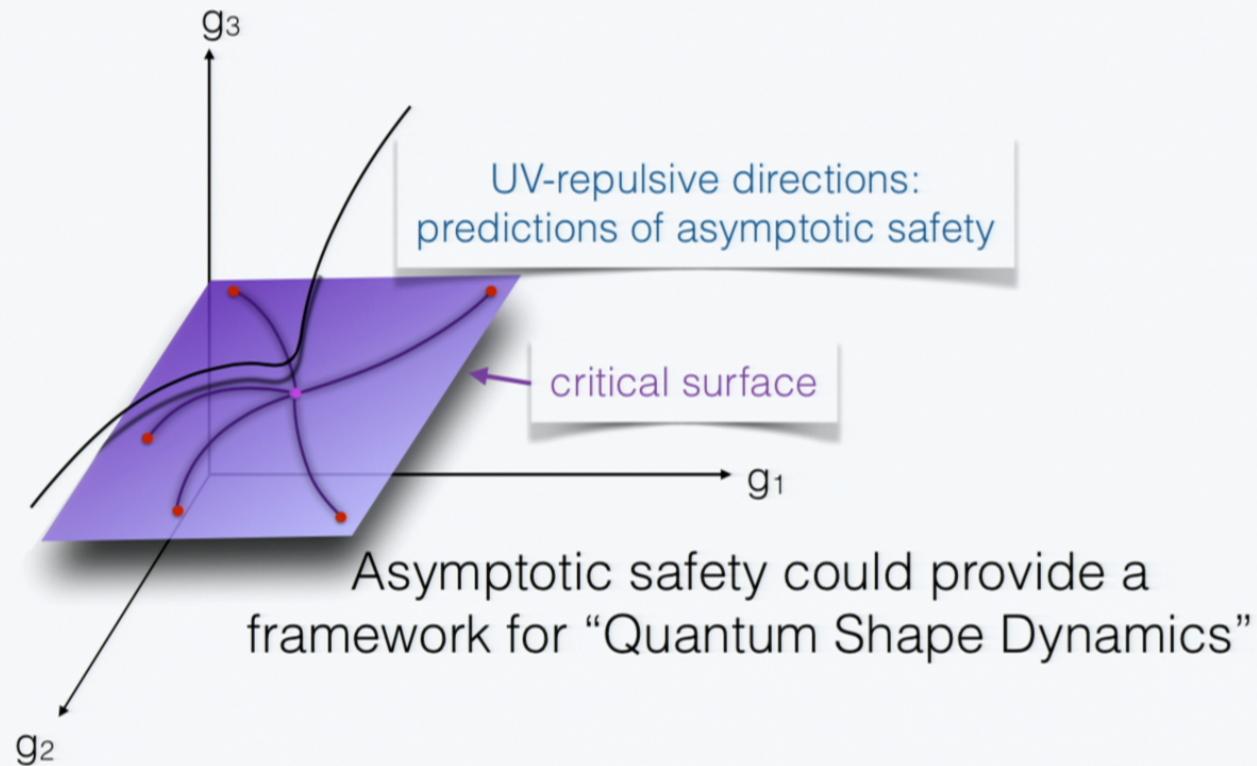
effective theory:  
running couplings diverge  
at "scale of new physics"

fundamental theory:  
running couplings reach  
finite ultraviolet limit

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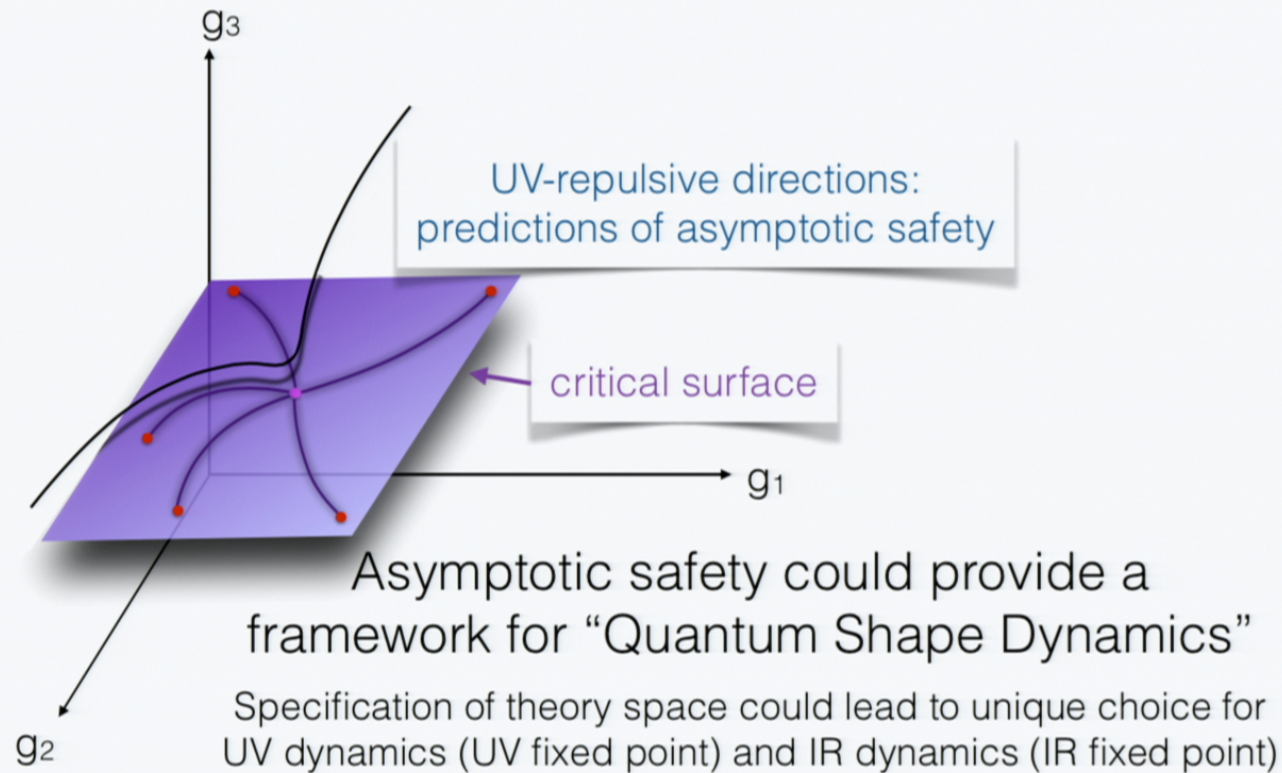


# Asymptotic safety



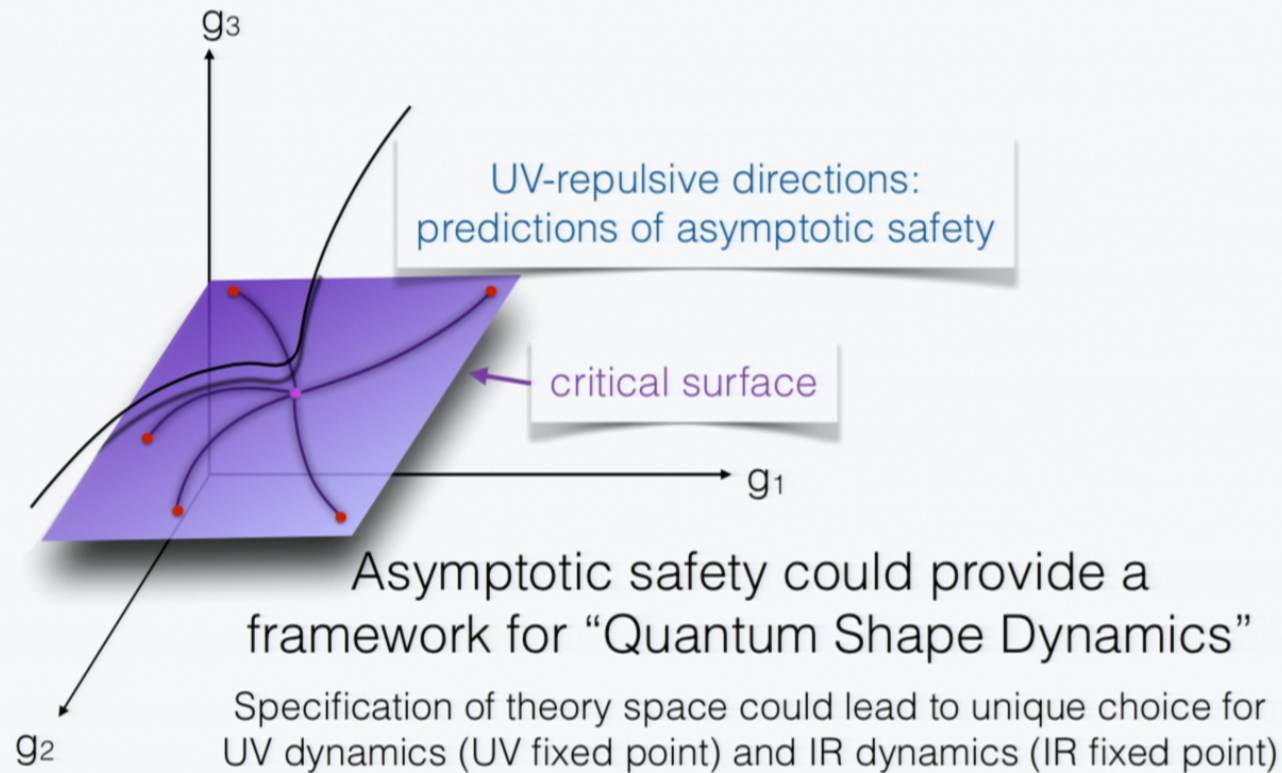


# Asymptotic safety





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# Interacting fixed points & universality classes

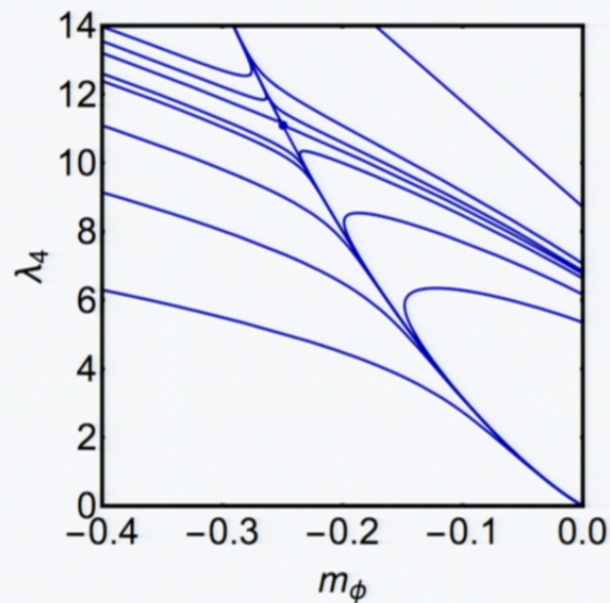
Wilson-Fisher fixed point:  $S = \int d^3x \left( \frac{1}{2} \partial_\mu \phi_i \partial^\mu \phi_i + \frac{m_\phi^2}{2} \phi_i^2 + \frac{\lambda_4}{4} \phi_i^4 \right)$

$i = 1, \dots, N$

$O(N)$  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?

- irrelevant directions  $\leftrightarrow$  predictions

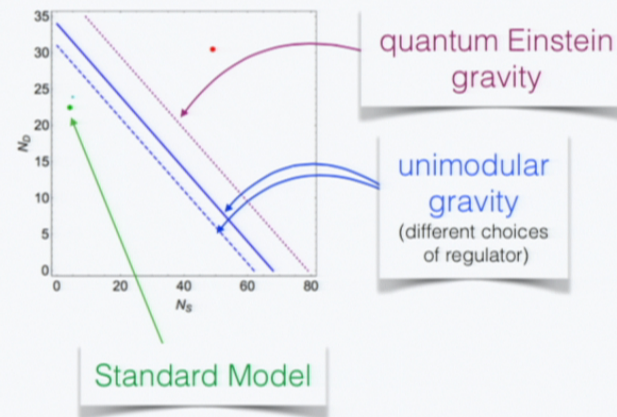


## Observational distinction of different universality classes for gravity?

- 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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- Is asymptotically safe shape dynamics unitary (i.e. no ghost-like poles of the propagator)?



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- Is shape dynamics asymptotically safe? How can we find out?
- Is it compatible with the observed matter & all its properties?
- Does asymptotically safe shape dynamics feature less relevant directions (higher degree of predictivity?)
- Is asymptotically safe shape dynamics unitary (i.e. no ghost-like poles of the propagator)?
- Technical challenge: Adapt functional Renormalization Group tools to the shape dynamics theory space!



