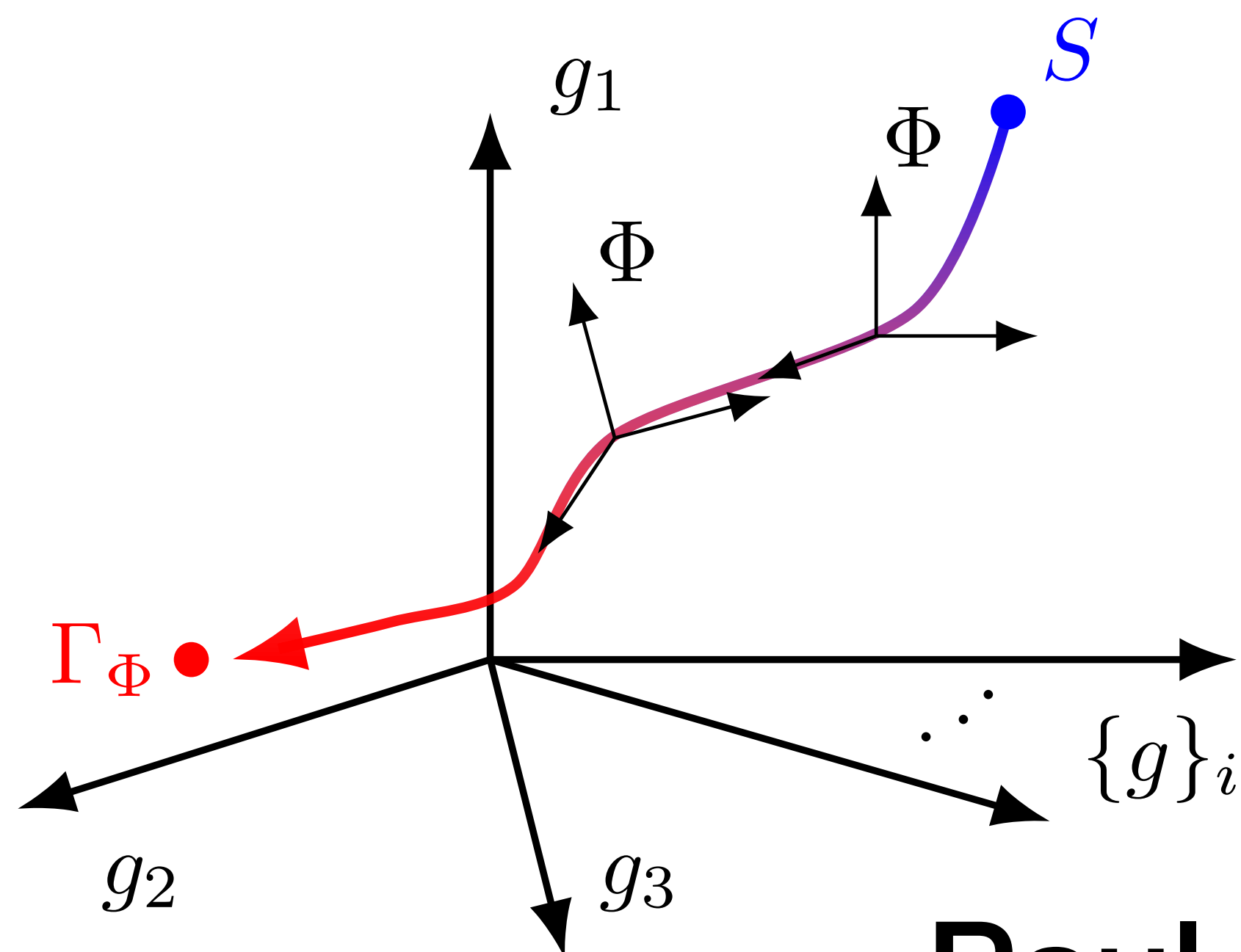


How do you construct a diffeomorphism-invariant flow in quantum gravity?



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Diffeomorphism-Invariant Approach to Asymptotically Safe Quantum Gravity



STRUCTURES
CLUSTER OF
EXCELLENCE

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THE QUESTION

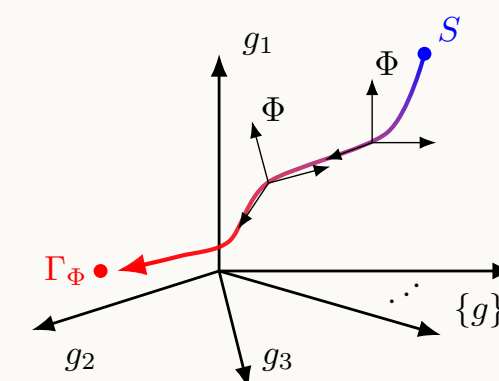
How do you account for diffeomorphism invariance in metric quantum gravity?

01 Motivation

- regulator in the ERGE breaks diffeomorphism symmetry
- how to construct a diffeomorphism-invariant flow?
- preserve the correct relevance counting of operators
- computational accessibility via heat kernel methods [1]

02 Flowing Fields Absorb Breaking

absorb the breaking of the regulator-induced terms with a field reparameterization [2]

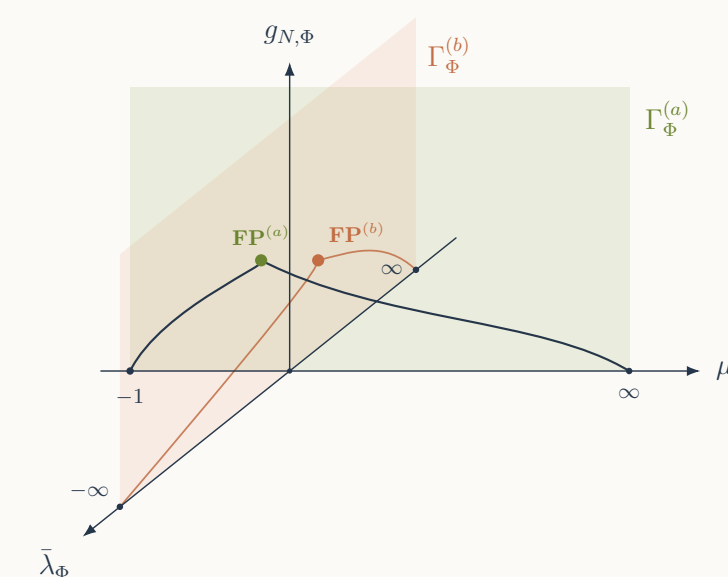


⇒ gauge-invariant flow equation

$$\partial_t \Gamma_\Phi[g] = \frac{1}{2} \text{Tr} \left[\frac{1}{\Gamma_\Phi^{(2)}[g] + R_k[g]} \partial_t R_k[g] \right] + F_\Phi[g].$$

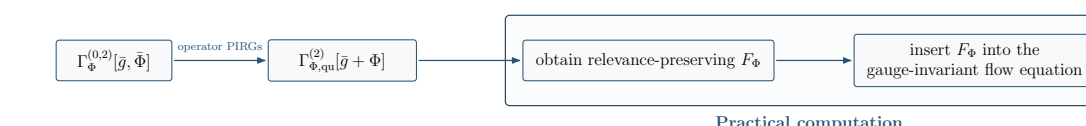
- F_Φ acts as a driving force
- restores the correct relevance of operators
- rectifies the changes from $\sqrt{g} R_k[g] \rightarrow \sqrt{g} R_k[g]$

03 Two Invariant Actions



04 How to Compute the Correction

Workflow

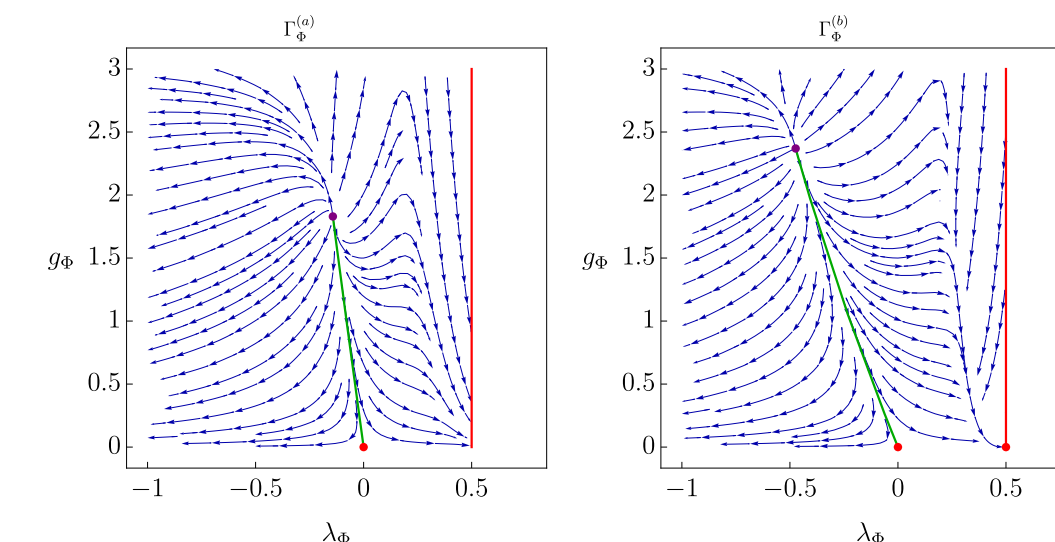


Extracting the diffeomorphism-invariant terms

$$\Rightarrow \partial_t \Gamma_\Phi[g] = -\text{Tr} \left[G \partial_t R_k G \frac{\delta}{\delta g} \left(\Gamma_{\text{qu}}[g] + (S_{\text{gauge}}) \right) \right].$$

05 Results

- rectified breaking terms for the cosmological constant $\Rightarrow \partial_t \lambda_\Phi$



06 Outlook

- rectify terms for $\sqrt{g} R$ to obtain the correct $\partial_t g_{N,\Phi}$
- de Sitter phase possible? (nature of $\lambda_\Phi = 1/2$ singularity)
- stability of gravity-matter systems: minimally coupled scalars and fermions (WIP)
- include all relevant operators: $\sqrt{g} R^2$, $\sqrt{g} C^2$ (?)

07 Ask me about

the different effective actions $\Gamma[g, h]$ vs. $\Gamma_\Phi[g, \phi_i]$ vs. $\Gamma_\Phi[g]$

how to use different strategies to get an error estimate on the results

the role of the $\lambda = 1/2$ singularity

how the (modified) Nielsen and (modified) Slavnov-Taylor identities come into play

TAKE-HOME

We complete the background field approximation and elevate it to a diffeomorphism-invariant flow.