Quoniam

# Matter Fields in Asymptotically Safe Quantum Field Theories of Gravity

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## Abstract – Dissertation

In this doctoral thesis we present the research of Refs. [1–4] concerning the asymptotic safety scenario in quantum gravity. We motivate the theoretical and conceptual need for the existence of a theory of quantum gravity, and explain how such a theory might be realised through the construction of an ultraviolet complete quantum eld theory dened via a high-energy interacting xed point. In particular, we give a pedagogical introduction to the functional renormalisation group, as well as xed points and critical phenomena. Thereafter we investigate the issue of background independence, which is introduced when constructing a scale-dependent eective action of a gauge theory using the background eld formalism through the introduction of an infrared cuto operator and the gauge xing procedure. To this end we study simultaneous solutions of the ow equation combined with so-called modied split Ward identities in a conformally truncated theory in the derivative expansion. In the main part of this thesis we study the dynamics of a gravitational system coupled to a number of scalar elds. In doing so, we nd scaling solutions in a fully functional truncation using the derivative expansion and background eld approximation on a d-dimensional sphere. We then study a similar system using the vertex expansion in a fully dynamical uctuation eld calculation. This is done in the exponential as well as the linear parametrisation of the metric, using dierent gauge xing procedures. We nd that the overall behaviour is very similar in both cases. We furthermore nd however that the contribution of the scalar elds to the gravitational coupling diers in its sign compared to older results obtained in a background eld approximation. To correct this behaviour, we supplement the background eld equations with modied split Ward identities, with the aim to obtain the uctuation eld behaviour from a background approximation. This seems to give satisfactory results in the case of the cosmological constant, whilst the running of Newton's constant still diers signicantly.

**PDF:** https://iris.sissa.it/retrieve/handle/20.500.11767/57085/43623/thesis.pdf

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