Into the darkness : forging a stable path through the gravitational landscape

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Stellingen

Behorend bij het proefschrift

"Into the darknes: Forging a stable path through the gravitational landscape".

1. The Effective Field Theory of Dark Energy and Modified Gravity provides the best framework to study the theoretical stability of Scalar-Tensor models in cosmology.

   Chapter 2

2. The inclusion of matter fields should be mandatory when one studies the theoretical stability of cosmological Scalar-Tensor theories over all linear scales. Chapter 3

3. The tachyonic instability in Scalar-Tensor models in cosmology can be seen in terms of a Hamiltonian which is unbounded from below.

   Chapter 3

4. The conditions guaranteeing the absence of the tachyonic instability leave tangible effects on the parameter space of cosmological Scalar-Tensor theories. An example of such an effect is the (μ, Σ) parameter space for the Generalized Brans Dicke models.

   Chapter 5

5. Until recently, the tachyonic instability in cosmological models has been severely neglected.

6. Observations of the Hubble Constant at early and late cosmological times differ by 4σ to 6σ. Verde *et.al.* [arXiv:1907.10625] concluded that the discrepancy is too strong to be solved by a single systematic error in the late time universe data. It is important to note that systematic errors in the Cosmic Microwave Background data cannot explain the discrepancy either.

7. It was shown by E. Gümrükçüoğlu *et.al.* [Phys. Rev. D **94** 064001 (2016)] that ghost instabilities which appear only at long length scales in a cosmological Scalar-Tensor theory, are a manifestation of the Jeans instability. This has ramifications for higher-derivative theories as we encounter in Chapter 3.

8. The detection of gravitational waves with an electromagnetic counterpart has resulted in severe constraints on models of Modified Gravity. This conclusion may be premature as the energy scales observed at LIGO lie very close to the strong coupling scale or cutoff of many models.
   C. de Rham and S. Melville, Phys. Rev. Lett. **121**, 221101 (2018)

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19 September 2019,
Leiden