# Gravitational waves through the cosmic web

Garoffolo, A.

# Stellingen

Behorende bij het proefschrift

## Gravitational Waves through the Cosmic Web

1. Fluctuations in the luminosity distance give us access to the large-scale structures of the Universe.
[*Chapter 1*]

2. In scalar-tensor theories with a running Planck's mass, both the luminosity and the angular diameter gravitational wave distances can be explicitly modified.
[*Chapter 4*]

3. The possibility of comparing data from gravitational waves and electromagnetic observations is a significant advancement in cosmology. Over time, models that break degeneracies between these two sectors can be thoroughly tested.
[*Chapter 2, 3 and 4*]

4. The direct detection of a scalar polarization content in a gravitational wave observation does not necessarily imply the existence of additional dynamical mediators of the gravitational force.
[*Chapter 5 and 6*]

5. Since we cannot reproduce the Universe in a laboratory, any new window onto it is extremely valuable. Gravitational waves are an example of this, both when emitted from resolved sources or when they form a stochastic background.
G. Cusin et.al., Phys.Rev. D96(2017) 103019

6. Given the broadness of the gravitational waves' frequency spectrum, it is important to have available descriptions for them that do not rely solely on the high-frequency approximation.
C. Cutler, K. S. Thorne, *An Overview of gravitational wave sources*, arXiv:gr-qc/0204090

7. The Universe is transparent to gravitational waves at all energies below the Planck scale. For this reason, gravitational waves allow us to "see" the Universe much more backward in time compared to the photons of the Cosmic Microwave Background.
L. Valbusa Dall'Armi et. al., Phys. Rev. D103(2021) 023522

8. Although the detection requirements for cosmological purposes seem daunting at present, gaining a better understanding of gravitational waves in cosmology can lead to valuable byproducts for other fields of research in a shorter timeframe.

9. Even in physics, the reader has a consistent share in the successful transmission of a concept. In the words of Philostratus: «...those who look at works of painting and drawing must have the imitative faculty; no one could understand the painted horse or bull unless they knew what such creatures are like.»
Philostratus, *Life of Apollonius of Tyana*

Alice Garoffolo
Leiden, 30th May 2023