Schrödinger scholars exhibition - 2022

Probing gravitational waves with a network of ground-based detectors

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Background

- 2016-2019: BSc. Physics, University of Padua, Italy
- 2019-2021: MSc. Physics, University of Padua, Italy
- 2021-present: PhD Physics, Imperial College of London

PhD thesis title: *Gravitational wave polarisations measurements using detector networks*

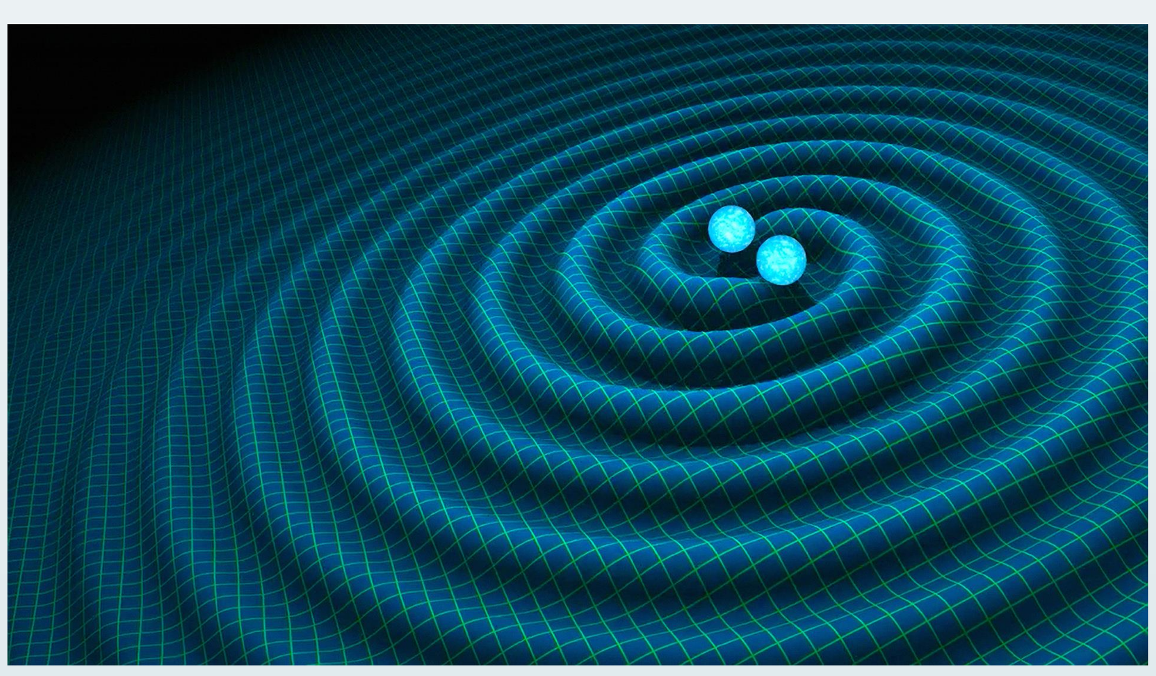
Supervisor: Prof. Carlo R. Contaldi

Introduction

My PhD program is aimed to understand in detail which are the properties of some **astrophysical** and **cosmological** models which can be probed with next generation **gravitational wave** experiments, producing forecasts on the observative power of present and planned missions, with a focus on ground-based **interferometers**, very powerful instruments which can make very accurate measurements of gravitational wave properties.

What are gravitational waves?

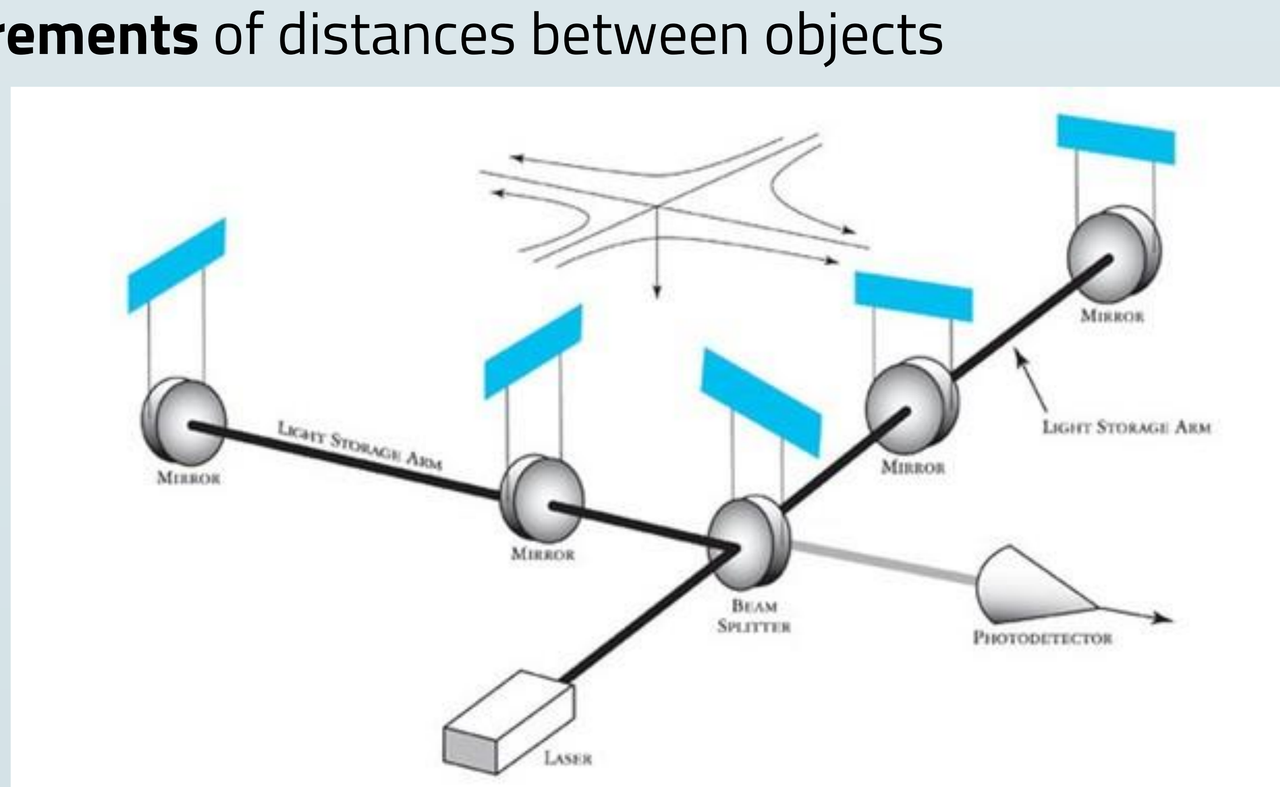
Gravitational waves are perturbations of the **spacetime** due to strong gravitational interactions in the framework of general relativity.



For instance, during **compact objects mergers**, as the one represented in the picture above[1] a production of gravitational waves has been observed. **Black holes** and **neutron stars** are the most common examples of compact objects

Interferometers and gravitational waves

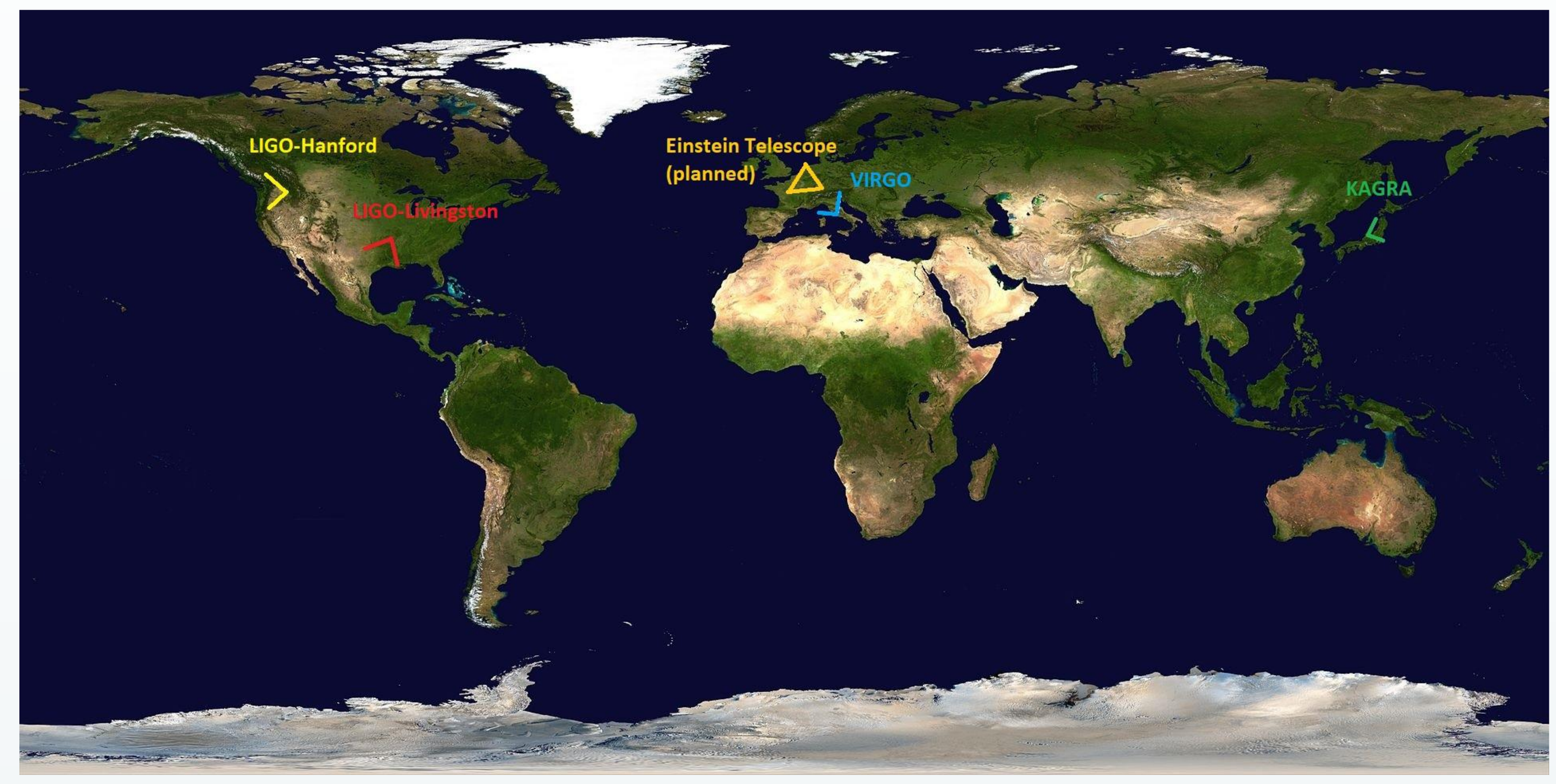
Interferometers are instruments capable of making extremely **precise measurements** of distances between objects



When the interferometer is crossed by a gravitational wave, the **length** of its **arms** changes. This can be observed by looking at the Interference pattern produced by **a laser beam** that travels the arms of the interferometer [2]

A network of interferometers

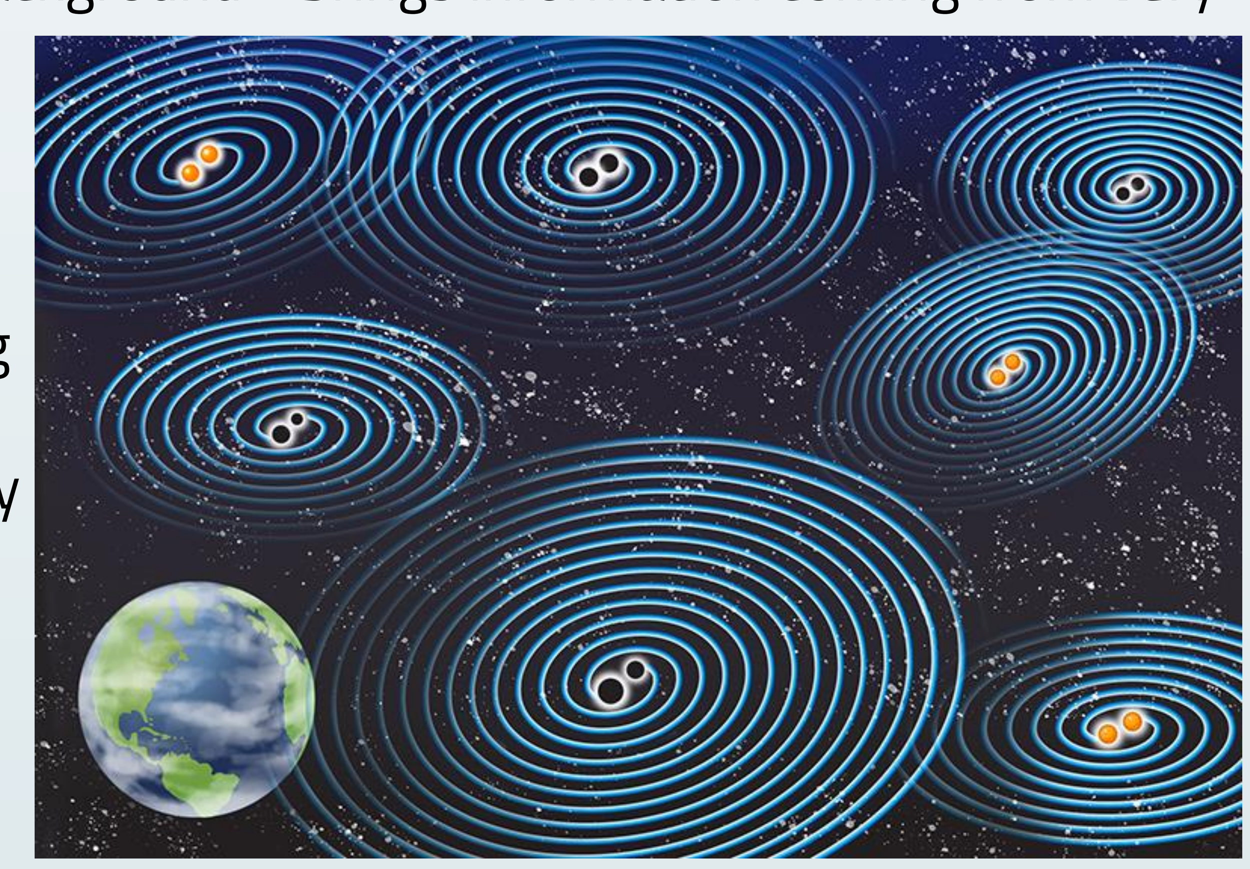
Using a **network** of interferometers allows a better characterization of many features of the observed gravitational wave (such as its **direction** of propagation and the **polarization**) [3]



These are the existing (and near future-planned) gravitational wave interferometers we use to study gravitational waves

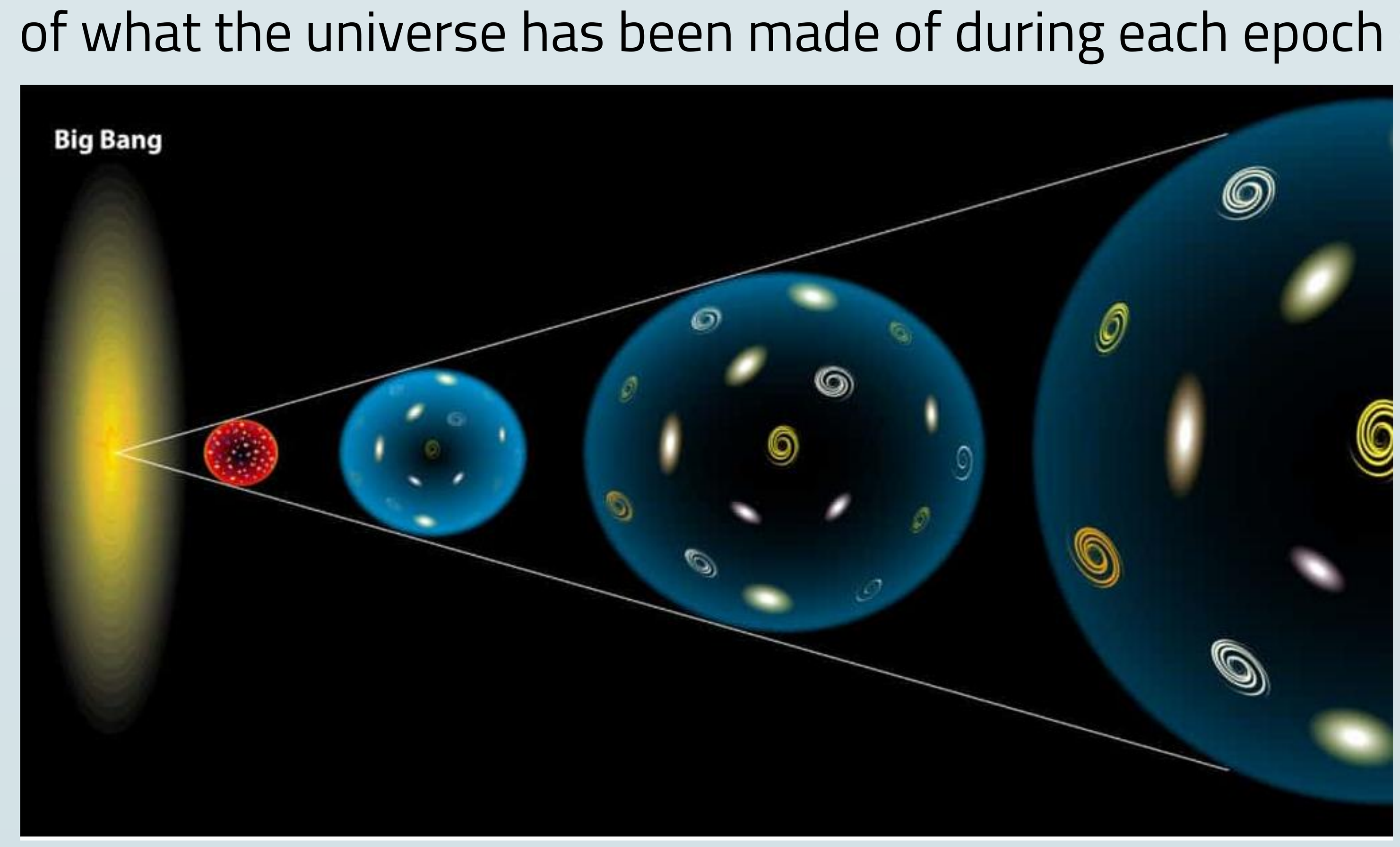
The gravitational wave background

The superposition of many gravitational waves which are too week to be seen one by one, produces the so-called **gravitational wave background**. The background[4] brings information coming from very **far compact object** binaries and from events happened in **the early universe**, therefore improving our understanding on its history. It may also provide evidence for the existence of **new physics** at a fundamental level.



Probing the expanding universe

Gravitational waves carry information also on the **evolution** of the **universe** at early times, allowing us to make precise measurements of what the universe has been made of during each epoch of his life



A key parameter for this analysis is the **Hubble constant**, which represents the rate of expansion of the universe

References

[1] Hurt/Caltech-JPL **[2]** Caltech/MIT/LIGO Lab **[3]** Mentasti G. and Peloso M., JCAP03(2021)080 **[4]** Sathyaprakash B. S. and Evans M.