

Gravitational Waveform Computation

Sara Gliorio

PhD



Supervisor:
Prof. Andrea Maselli

Master Degree



Master Thesis Supervisor:
Prof. Marta Orselli

Premio Nazionale INFN Milla Baldo Ceolin 2022

Galileo Galilei Institute - Villa Galileo in Arcetri (FI)

14th November 2023

Golden sources

Binary Black Hole Systems



Binary Neutron Star Systems



Gravitational Wave Era

Golden sources

Binary Black Hole Systems

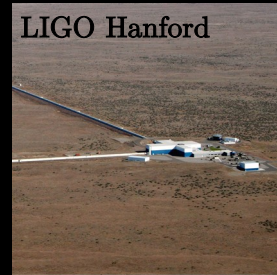


Binary Neutron Star Systems



Current detectors

LIGO Hanford



KAGRA



Virgo



LIGO Livingston



Gravitational Wave Era

Golden sources

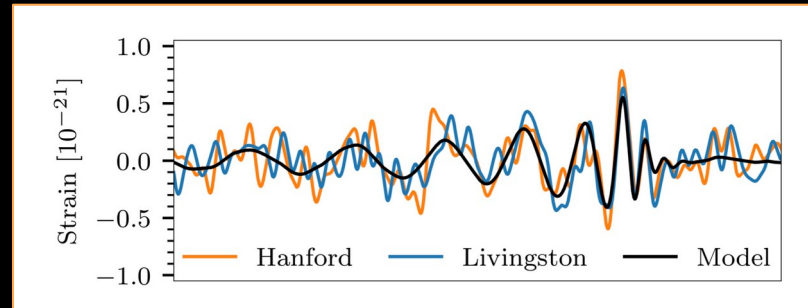
Binary Black Hole Systems



Binary Neutron Star Systems



Matched Filtering



Interferometer output
+
Theoretical computation

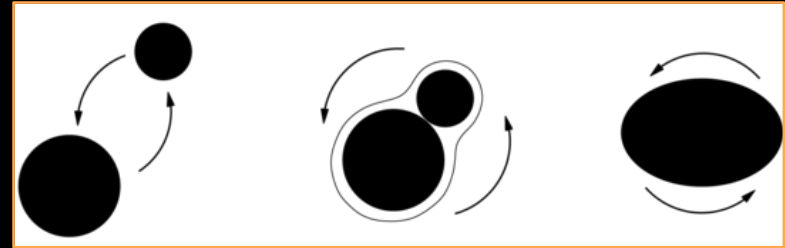
Current detectors



How to Model a Gravitational Wave Signal

Dynamics of a Binary System

(General Relativity)



Inspiral

*Post Newtonian
expansion (v/c)*

Merger

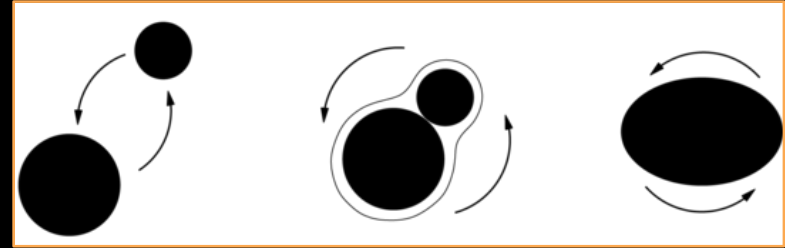
Numerical Relativity

Ringdown

How to Model a Gravitational Wave Signal

Dynamics of a Binary System

(General Relativity)



Inspiral

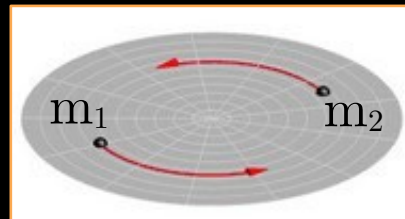
*Post Newtonian
expansion (v/c)*

Merger

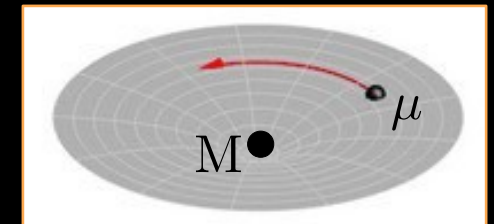
Numerical Relativity

Ringdown

Effective One - Body Approach



Two Body
Problem



Effective One - Body
Problem

We want: h_+ , h_\times

How: $H^{lm} = H_{inst}^{lm} + H_{hered}^{lm}$

We want: h_+ , h_\times

How: $H^{lm} = H_{inst}^{lm} + H_{hered}^{lm}$

Original Results:

Hereditary Contributions:

- › in the EOB model
- › up to 2.5 PN order
- › in a low-eccentricity expansion

We want: h_+ , h_\times

How: $H^{lm} = H_{inst}^{lm} + H_{hered}^{lm}$

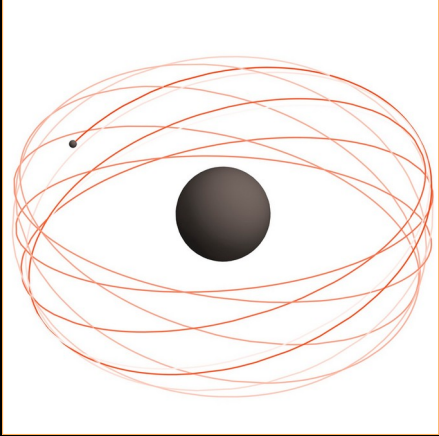
Original Results:

Hereditary Contributions:

- › in the EOB model
- › up to 2.5 PN order
- › in a low-eccentricity expansion

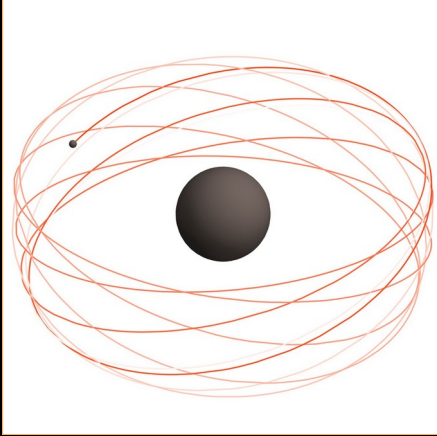
Valid for Binary Systems:

- › Composed of two black holes
- › non-spinning
- › eccentric

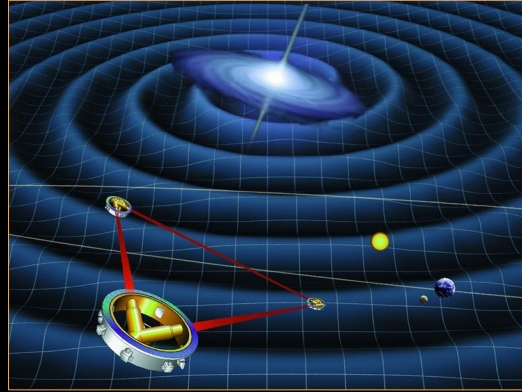


Extreme Mass
Ratio Inspirals

Asymmetric Binaries as Fundamental Physics Probes

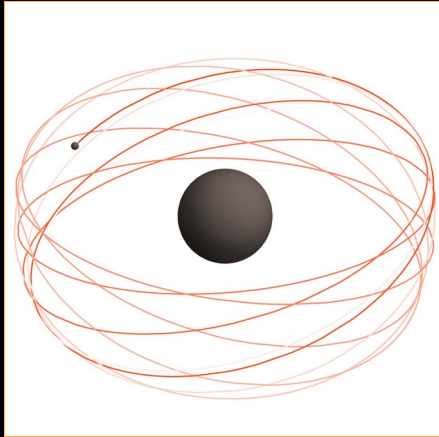


Extreme Mass
Ratio Inspirals

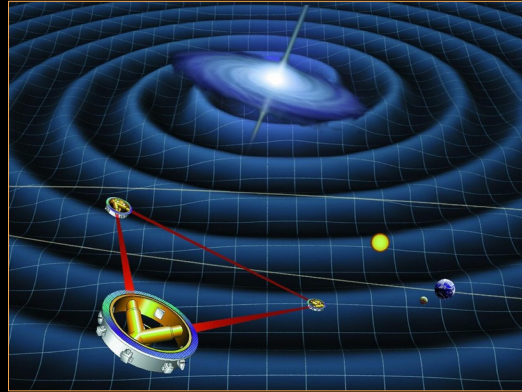


LISA

Asymmetric Binaries as Fundamental Physics Probes



Extreme Mass
Ratio Inspirals

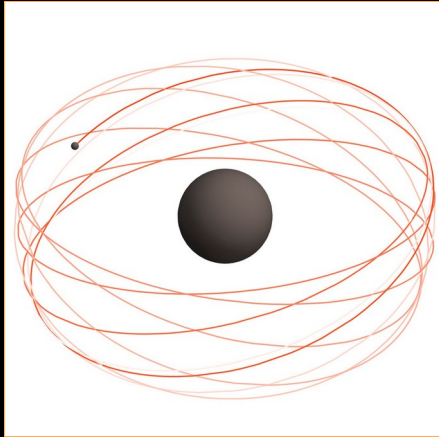


LISA

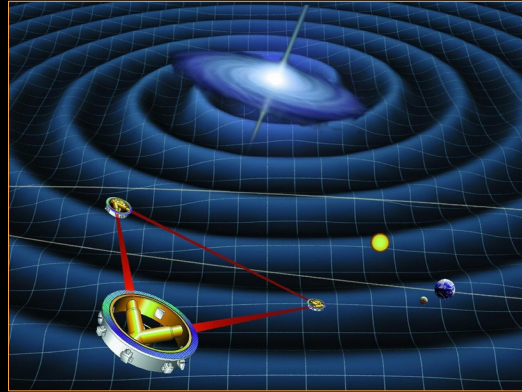


Environmental
and
Beyond GR
Effects

Asymmetric Binaries as Fundamental Physics Probes



Extreme Mass
Ratio Inspirals



LISA



Environmental
and
Beyond GR
Effects



Sara Gliorio
(sara.gliorio@gssi.it)