Paris Centre for Cosmological Physics

FRONTIERS

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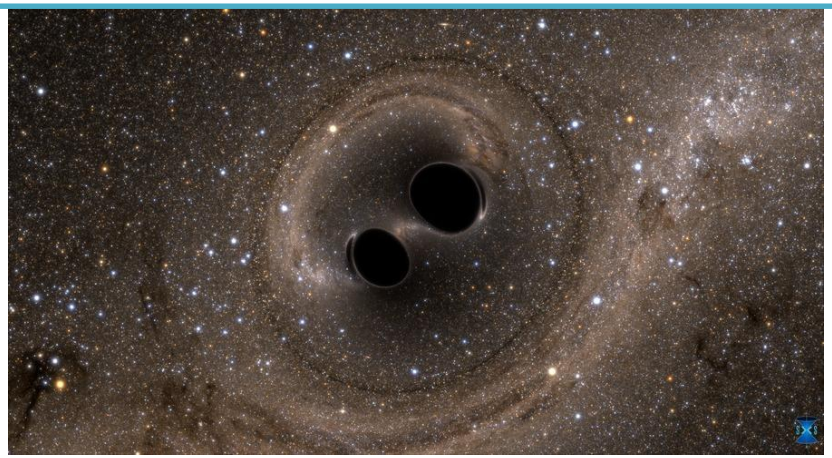
“Finding black-holes in a chirp”: how to understand the first gravitational-wave detection



Frontiers has been funded within the framework of the European Union Erasmus+ programme

Metadata

Name of Demonstrator	**“Finding black-holes in a chirp”: how to understand the first gravitational-wave detection**
Short description	In this lesson you will be able to analyse the data of the first gravitational wave signal ever detected. You will retrace in your classroom the steps that lead to the Nobel Prize in Physics 2017 to the LIGO collaboration. You will also learn about General Relativity, black holes and binary systems.
Keywords	Physics; gravitational waves; black holes; general relativity
Target age group of students	16 - 18
Expected Duration	3 h
Connection with school curriculum	Astronomy, solving equations, plotting results.
Connection to research center/experiment	Ligo – Virgo collaborations

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Description

Calculating the source parameters for the first gravitational wave ever detected (GW150914).

- Orientation phase: introduction to the concept of General Relativity's space-time and gravitational waves.
- Exploratory phase: How do we detect gravitational waves? What is the first gravitational-wave signal telling us? How can we understand what the source is and, specifically, that the source is a pair of black holes? From simple plots and basic formulae, students calculate the mass and the radius of the system that produced GW150914.
- Consolidation phase: Questions and insights, verbal and written reporting on the exercise.

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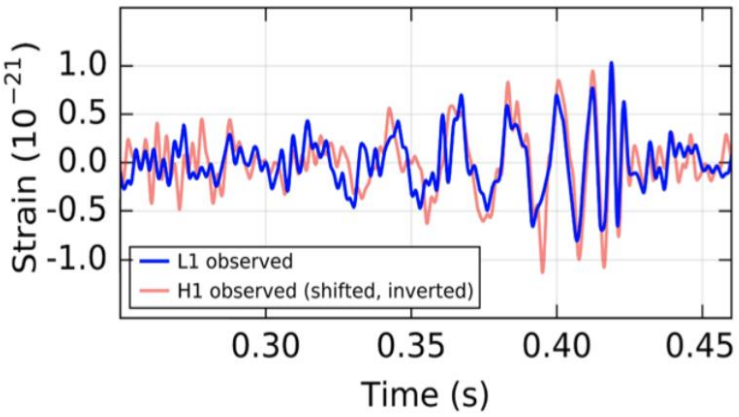
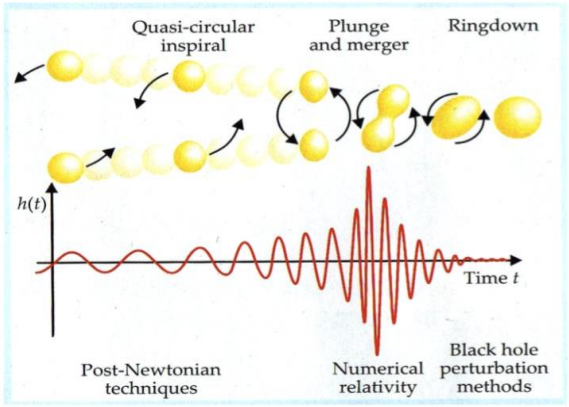
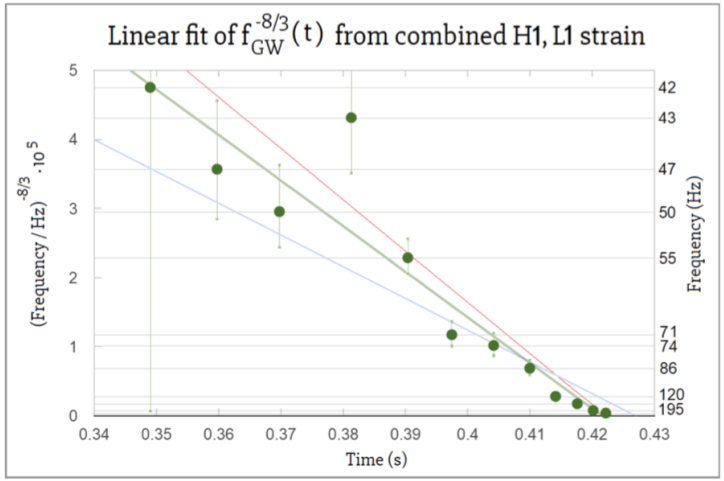
Description

A taste of the type of plots and level of mathematics present in the exercise.



GW150914 signal in the two LIGO detectors





$$\mathcal{M} = \left[\frac{5K}{(8\pi)^{8/3}}\right]^{3/5} \frac{c^3}{G}$$

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Key features

- Basics on exiting research topics: black holes, gravitational waves, general relativity, GW detectors.
- Support of numerous and diverse media (videos, scientific papers, Wikipedia, scientific algorithms…).
- Exercise carried out with pen and paper calculation (but need to be able to read and interpret a scientific plot).

- Insight on the workings of big modern scientific collaborations: internationality and team work.
- Taste of how science is produced and communicated both within the scientific community and to the general public.

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