Intangibles: Black Hole Collision

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Interdisciplinary Approaches to Perceptualizing Intangible Phenomena through Sound and Listening

1. Introduction

Our team focused on interdisciplinary practices applied to intangible phenomena:

Intangible phenomena are concepts or things that are known to happen but can't be directly or easily perceived.

We experimented with the process of sonification, with the intention of making these intangible phenomena more tangible:

Sonification is the process of generating sound from data to help better understand its implications.

Chosen phenomena:
Two black holes colliding

2. Aims

Our aim of this project is to sonify gravitational wave data of two black holes colliding, to allow us to achieve the following goals:

1. **Represent two black holes colliding using sound and visuals elements**
2. **Achieve a better understanding of the scale of such an event**
3. **Demonstrate how interdisciplinary practices can link together the fields of Physics, Music and Art.**

3. Background

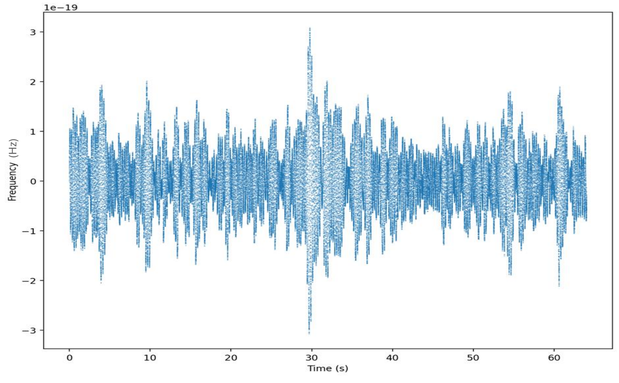
Gravitational waves are "ripples" in space-time caused by extremely energetic processes in the Universe, such as colliding black holes [1].

4. Methods

- We took gravitational wave data across three detectors from the LIGO and VIRGO observatories. We chose data from the 21st May 2019 (event "GW190521"), as this recorded a **binary black hole merger** i.e. two black holes colliding
- These detectors use large laser interferometers to measure very small changes in wave characteristics, therefore highlighting any major events occurring.
- Python was used to plot this data as a frequency (Hz) versus time (s) graph to help visually demonstrate the changes in gravitational wave amplitude over time.
- We then sonified the GW190521 data in Ableton Live and Audacity, mapping amplitude to volume and frequency to pitch changes, creatively emphasising the results through the addition of changes to texture, harmony and tonality.

Amplitude → **Volume**

Frequency → **Pitch**



Data sources:
- VIRGO observatory – detector located in Italy
- LIGO observatory – 2 detectors located across America

5. Installation

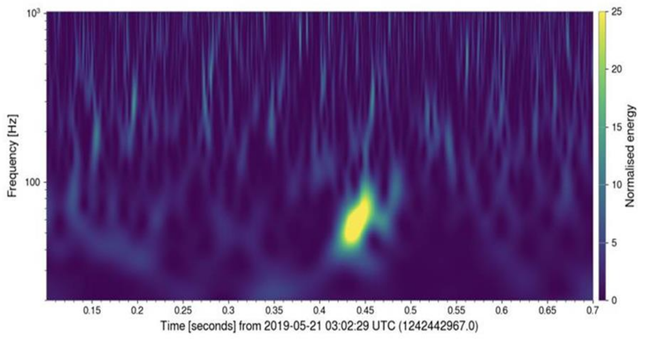
Our final result was presented as an immersive installation. We presented this using 5.1 surround sound speakers with a projector displaying some visuals created using JavaScript. These visuals were used to add another sensory element to our work, whilst not being created directly from the data and instead taking a more interpretive style.
We divide our soundscape into three sections:
- Low frequency
- High frequency
- Base

These sections were sent to different speakers placed around the room to represent the distance between the data collection points and create a more immersive environment. The audience could then experience this installation to gain a physical and sonic interpretation of gravitational waves and black holes colliding.

6. Results & Conclusion

Our project has achieved the following results:

- We have demonstrated that sound can be used to help understand scientific phenomena which are otherwise conceptually very challenging to grasp
- We have shown that interdisciplinary practices between physics, music and art can be used to create new ways to engage with scientific events
- We have managed to create a way of physically experiencing gravitational waves, creating a more accessible way to understand the data.



Acknowledgments

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References

[1] LIGO Lab (no date), Caltech, What are Gravitational Waves? Available at: https://www.ligo.caltech.edu/page/what-are-gw. (Accessed: 9th June 2025)
Image of 'GW190521' taken from the LIGO website.