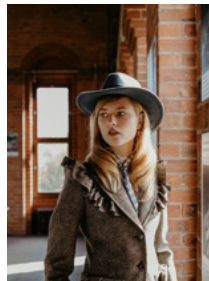


Transforming gravitational-wave detections into musical structure

My first encounter with the idea that eventually led me to LIGO was quite unusual. While on a family vacation, I was working on a haute couture dress for my performances and collecting shells with my aunt, Suely. During one of our walks on the beach, I found a shell whose markings resembled four spectrogram lines. Looking at it, I felt as though I was holding a musical score written by nature itself.

At that time, I had been studying vocal spectrograms – visualizations that show how the frequency (or pitch) and harmonics of a voice change over time. As part of that journey, I had recently visited Pinuccio Sciola's Giardino Sonoro in Sardinia – an open-air installation of large stone sculptures that produce musical tones when touched [1].

That shell stayed in my mind long after the vacation. It led me to explore how patterns emerge in sound and nature and, via an extensive project exploring infrasound (sounds below the nominal lower threshold of human audibility) and sound visualisation, eventually to LIGO, Virgo and KAGRA (LVK). A long discussion with



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the Virgo Brazil team brought me to a question that would ultimately change the direction of my work:

“Can we create a scientific method to decode the universe into the audible range using gravitational-wave detections in harmonic and chronological order?”

That question became the foundation of what is now “The Harmonic Universe (Chirp Symphony)” [2, 3]. Together with physicists Cassius de Melo and Regiley Pimenta (Aeronautics Institute of Technology), we developed a methodology that transforms gravitational-wave detections into musical structure.

We begin with six gravitational-wave detections of merging black holes or neutron stars from the LIGO-Virgo-KAGRA catalog. Preserving the signal's characteristic “chirp”, the changing frequency is translated directly into musical pitches and each signal becomes one musical motif within the symphony.

The six motifs are then arranged according to their redshift (a measurement that tells us how far back in the universe's history each event occurred). From the oldest event to the most recent, this sequence shapes both the order of the motifs and the harmony of the symphony. The composition weaves the signals into a single musical journey whose structure is guided entirely by real data from the Universe. For this reason, I often describe myself less as a composer and more as a decoder.



Visiting the Virgo gravitational-wave detector.

I love to collaborate with scientists and these interdisciplinary collaborations form part of a broader initiative referred to as Scientific Music, which seeks to develop reproducible methods for translating scientific data and natural phenomena into musical languages while preserving meaningful relationships with the original data.

The collaboration with members of the LVK community has been extraordinary. Visiting Virgo in Pisa was one of the most inspiring experiences of my career. Seeing the interferometer, the laser systems, the control room, and meeting the scientists who dedicate their lives to understanding these signals gave me a deeper appreciation of the immense human effort behind every detection. I am especially grateful for the support and insights shared by the Virgo and EGO (European Gravitational Observatory) teams, including Vincenzo Napoli and Guglielmo Rossi from the communications and public outreach team at EGO.

Beyond gravitational-waves, I am exploring other scientific datasets. My collaboration with Dr. Kimberly Jameson (University of California, Irvine) explores the work of Conchetta Antico, who has been studied for her rare tetrachromatic color vision. We have been investigating methods for translating visual information into sound and exploring whether musical representations can offer new perspectives on tetrachromatic color vision. In Argentina, I am collaborating with biologist Dr. Rosario Jacoby on the analysis of bird vocalizations. With astronomers Ana Clara Rocha and Thiago Flauzino Haber, I am also working with stellar evolution data. The long-term goal is to build an open scientific database that may allow future generations to become “decoders” of patterns across nature and the cosmos.

This year, we performed “The Harmonic Universe (Chirp Symphony)” at the Aeronautics Institute of Tech-

nology and in Sao Jose dos Campos alongside a local orchestra and wind quintet, respectively. Next year we will present a new live performance exploring the lifecycle of a star for Astronomy Day at the European Southern Observatory in Chile

Discovering gravitational-wave science has transformed the direction of my artistic and research life. One of my dreams is to visit LIGO itself one day and it would be an incredible honor to see the observatories firsthand and meet more of the people whose work makes these discoveries possible. My goal is to unite minds and share knowledge.

Pinuccio Sciola’s sound garden

[1] <https://www.psmuseum.it>

The Harmonic Universe (Chirp Symphony)

[2] https://youtu.be/_5VvFpW7Hn0

[3] <https://open.spotify.com/track/0Sd9EyZ5ZnaNRI46zEZwmb>

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A performance of “The Harmonic Universe (Chirp Symphony)” at the Aeronautics Institute of Technology in Brazil alongside a local orchestra.