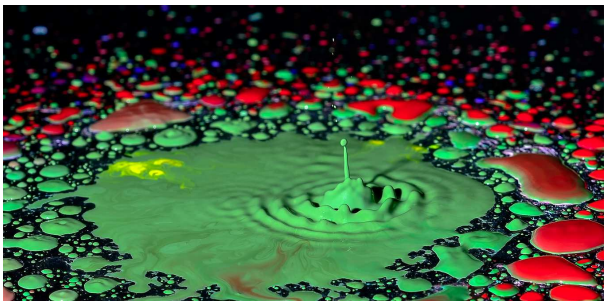
THE CONVERSATION



Gravitational waves add a new note to our musical universe

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Music has always played a part in investigating the universe. Sonic visualisation of 'The Storm' by Peter Drach. , CC BY-SA

Stewart Riddle
Senior Lecturer, University of Southern Queensland

Last week's announcement on the existence of gravitational waves confirms something philosophers and musicians have known for a long time: the universe is musical.

The key pursuit of metaphysics is to understand the nature of reality. For thousands of years, philosophers have grappled with trying to figure out what is real and how we might know. Music has always been central to that task.

Pythagoras understood music to be part of a quadrivium of mathematics, forming the basis of his philosophical inquiry. Plato placed significant value on rhythm and harmony as central to the organising of the universe.

More recently, in the 20th century philosophers Gilles Deleuze and Felix Guattari claimed that it is rhythm (chronos) that brings spatio-temporal order to the universe (chaos). Deleuze also made the claim that music is able to render different forces sonorous, which seems particularly apt when we think of black holes colliding.

In other words, our understanding of space and time is musical. As with Einstein's notion of relativity bringing matter, space, time and gravity together, music weaves actual and virtual worlds together.

One good example of what this looks like is composer Nigel Stanford's beautiful video Cymatics: science vs. music, seen here:

Cymatics: science vs music.

Edgard Varèse, considered by many to be the father of electronic music, refers to music as "organised sound" and of working in rhythms, frequencies and intensities. It is not a big leap to go from frequencies, harmonies, vibrations, resonances and waves to the work of astrophysicists who are trying to listen to the secrets of black holes, neutron stars and the origins of the universe.

Scientists have long searched for the underlying meaning of the universe. Nietzsche may have been correct in claiming:

> *without music, life would be a mistake.*

This is unsurprising perhaps, given that, along with Sartre and Barthes, Nietzsche was a fairly accomplished pianist and composer.

Einstein, himself an enthusiastic violinist, often remarked about the centrality of music to his own scientific thought and intuition.

It took a century, but Einstein's musical perception of the universe operating in vibrations and waves has now been proven, in effect by a really big pair of bionic ears listening to the universe.

Listening to the sounds of gravity

According to online science magazine Nature:

> *As vibrations in the fabric of space-time, gravitational waves are often compared to sound, and have even been converted into sound snippets.*
>
> *In effect, gravitational-wave telescopes allow scientists to "hear" phenomena at the same time as light-based telescopes "see" them.*

By understanding changes in amplitude and frequency, it is possible to listen to distant cosmic events that produce gravitational waves, including black holes and neutron stars. We are only just beginning to really hear our universe.

So what is the sound of two black holes colliding? Apparently it sounds like this:

The sound of two black holes colliding.

The technical name for the sound is a "chirp" – it has been compared to "increasing the pitch rapidly on a slide whistle".

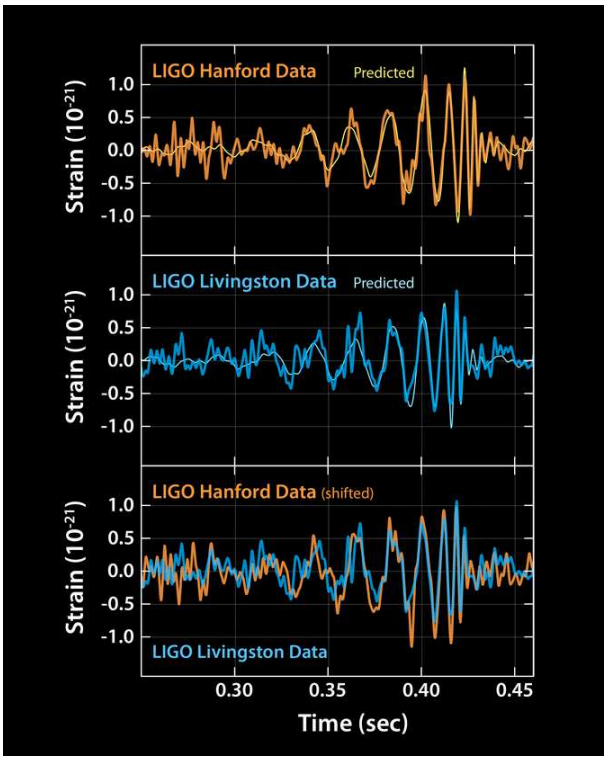
It seems strange that this would be the sound of such a cataclysmic event like two black holes colliding; an event where time itself comes to an end. Wagner would be most unimpressed.

It took no time for electronic music producers to begin working with the sounds of black holes eating each other in their compositions.

According to researchers at the Advanced Laser Interferometer Gravitational Wave Observatory (LIGO), the transient gravitational-wave signal they recorded saw a frequency sweep from 35 to 250 Hertz, with a waveform consistent with those modelled from Einstein's theory of general relativity.

The sound is not dissimilar to a glissando – running your fingernails across the keys from the low end of a piano up to Middle C.

Here is what the waveform looks like:



Recorded waveform of Gravity waves from LIGO. LIGO

In case you've been in a vacuum over the past few days, let's put it bluntly: this is the sound of ripples in the very fabric of space-time pushing out from two massive black holes smashing into each other.

It would not be an understatement to claim that gravitational waves can provide us with a soundtrack to the universe. And, most amazingly, an amateur violinist got it right over a century ago!

A new soundtrack to the universe

As Szabolcs Marka, astrophysicist at Columbia University and LIGO team member, said last week:

> *Until this moment, we had our eyes on the sky and we couldn't hear the music. The skies will never be the same.*

To astrophysics, and science more generally, this is akin to being deaf your whole life and then suddenly being able to hear. As Marka put it:

> *When we hear the universe, we will learn about the secret life of black holes.*

No doubt, the universe will never sound the same to us again. Yet one thing is a fairly safe bet: it won't be getting any less musical.

See also: Good vibrations: the role of music in Einstein's thinking.