CREDO Visegrad Workshop Presentation

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Over the past year, we worked on data using sound to separate signal from background noise within the data.
In Particular, we studied short duration pulses.

We selected an event that is very well known to the Gravitational Wave Community, The Binary Neutron star merger of august 17th,2017
The data was initially collected by the VIRGO, LIGO and KAGRA observatiroes

We did this so we could compare our results to other results using more traditional methods of analysis.

What we were able to do is not only get the same results but also discover other events not found during any other analysis.

We did this using 5 ranges of timbres and listening for the energy content of the data.
We used the sound of a Timpani to sonify the data, taking in consideration of the sound power, sound pressure and volume and. The data was mapped in volume rather than pitch because this allowed us to better hear the low frequency data without needing to alter or transpose the data

As you may know, noise is a mechanical wave that propagates through the air and carries energy.
In astronomy, everything is about signal and noise.
We heard the low frequency and low sound pressure levels of the sound due to the low audio energy levels, rapid sampling rate and the change in sound pressure.

With this we transformed the audio energy into a power output that we could time stamp with the detector characterisation. This is important because the Detector works at a standard operational point. The detector characterisation group work really hard on identifying changes in the information that may contaminate the measurements. For example, there is non stationary behaviour where the noise appears to be higher, or transitional behaviour in which the level of noise increases and then disappears.
Once the change was made, we inserted those energies into the corresponding mathematical formulations for two objects moving.

We were able to clearly hear this event without modelling the random values of the masses distribution.

We were able to confirm our values of the neutron stars masses in isolation as =1.35 solar masses for the binary mass of M=2.70 in solar masses and the angular momentum.

When listening, pay attention to the non periodic in different lengths. Small pulsation cycles are clearly heard in the gravitational wave signal with respect to the peak time at the time merger of the system. You will hear it at the end of the data.

Those may be associated to the way the system is rotating and the non symmetric distribution of the mass among other things but we need further confirmation. What we know is that our numbers are confirmed by the literature and those pulsations that are not coinciding with polluting events marked by the detector characterisation team need to be further characterised based on natural events.

The full documentation of audio characterisation of the detector has never been done extensively such as when the noise is
not stationary or when it harms the sensitivity to gravitational waves. What remains to be done is to check if those lower tones do correspond to other changes reported in the literature, like angular masses and other parameters.