GW200129_065458: Sonification of Gravitational Wave

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I. Abstract

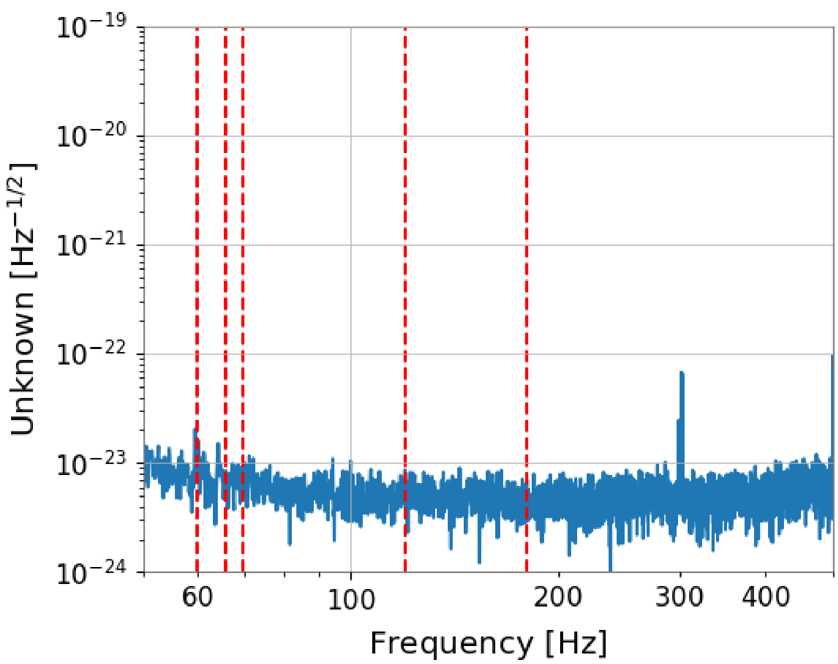
On January 29, 2020, at 06:54:58 am, a gravitational wave was detected by both the Livingston and Hanford LIGO machines. This gravitational wave was created by two black holes, one with mass of $34.5_{\odot}$ and the other with mass of $28.9_{\odot}$. Once these black holes merged, they created a total mass of $63.4_{\odot}$. Gravitational waves are considered ripples or waves in space-time that are created by either black holes or neutron stars merging. We can detect these waves using LIGO machines, but due to the distance from the machines to the merger event we often receive a fraction of the full event. Using coding, I was able to form this wave into a sound file so that we can hear the gravitational wave pass through Earth.

II. Motivation

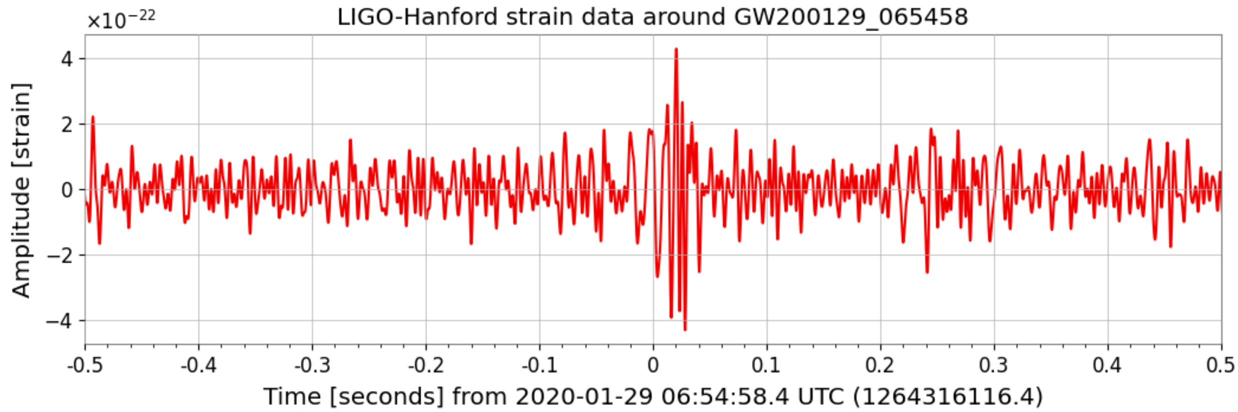
During this project, my main goal was to be able to turn the gravitational wave that was detected by both the Livingston and Hanford LIGO machines into a sound file. I wanted to be able to hear the merger of the two black holes. I was able to complete this task by using different coding functions and packages to plot the wave, filter out unwanted frequency, and then eventually beautify the sound to create a file where we can only hear the “chirp” of the merger.

III. Methods

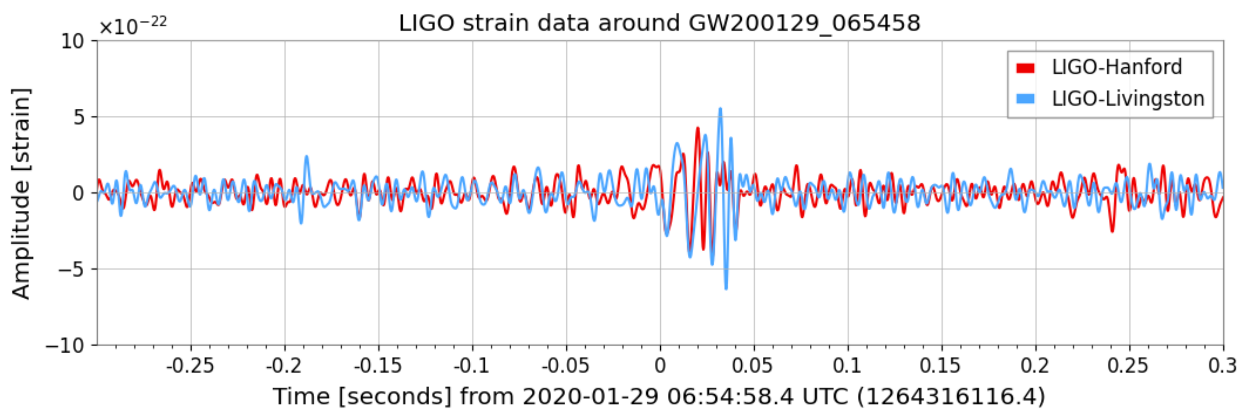
I started out by determining which merger event I wanted to turn in to a sound file. After looking through the GWTC event catalog and choosing the event I wanted, I started that coding process by plotting the gravitational wave to determine which sounds I needed to filter out to isolate the gravitational wave itself. As seen in figure 1, the red dashed lines determine spikes in the sound that are covering up the gravitational wave sound. After this, I replotted the gravitational wave to show a spike solely where the gravitational wave is. For this new graph, the Y-axis depicts time in seconds and the X-axis depicts the amplitude of the frequency as seen in figure 2. After I determined what this isolated gravitational wave looked like, I needed to compare the frequency from the Livingston and Hanford LIGO stations to ensure that it was a merger event and not an interference from something around the station. As seen in figure 3, we can see that the frequency plots both depict the same increase in frequency around the same time. The times and frequency jumps are expected to differ by little amounts due to their distance from each other. After determining that the event was in fact a merger event, I needed to turn my data into a sound file.



[Figure 1]



[Figure 2]



[Figure 3]

After creating the sound file for this merger event, I needed to beautify the event, so it was easier to hear. I accomplished this by adding more cycles between the frequencies to stretch the sound without affecting the pitch of the sound. After this, I needed to slow down the sound so I could hear the "chirp" of the merger event clearer.

IV. Results

After multiple trials of coding and messing around with the frequencies and lengths of the sound, I was able to create a sound file that was long enough to hear the merger event. It was a 6 second sound file that excluded all background noise and interfering frequencies to show the full beauty of the sound of the black hole merger event. Eventually, the "chirp" I was about to detect and create will be added to many more merger event “chirps” creating a gravitational wave symphony.

V. Conclusion

I concluded that the event I was able to document was indeed a merger event. I learned how to manipulate the sound to hear the gravitational wave better. Using code, I was able to graph the frequency of the event multiple different ways and exclude certain aspects of the sound to get a better reading of the merger event alone.

References

GWTC Event Catalog. GW Open Science Center. (n.d.). https://gwosc.org/