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motivation

By studying black hole mergers via gravitational waves, we can figure out the distance from Earth. Comparing this to redshift of the light from these events allows us to better understand the universe's expansion.

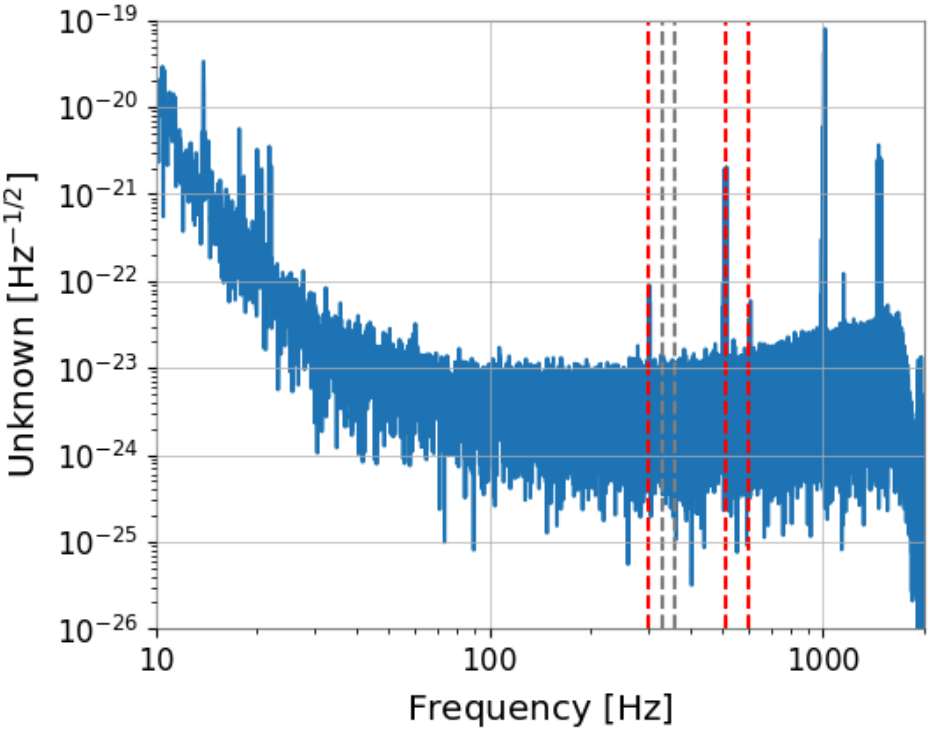
methods

assumptions + calculations

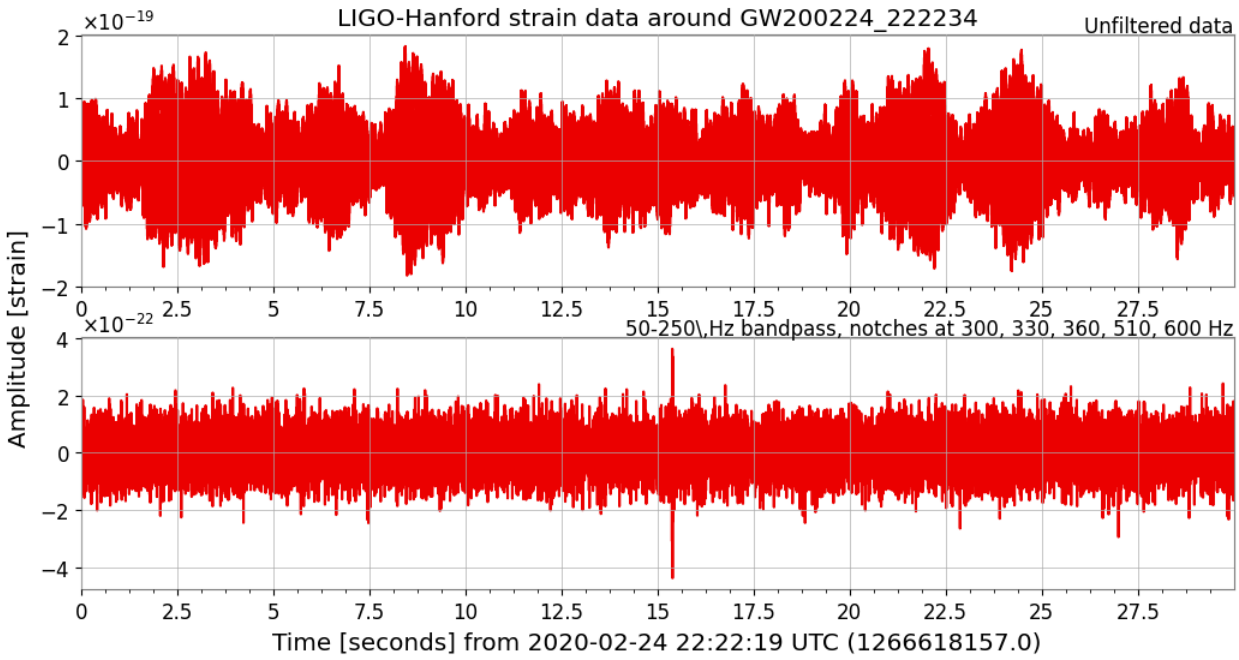
By using gravitational wave data collected from LIGO we should be able to calculate the masses of the two black holes that merged in order to cause the wave. Using data from the two different locations, we assume the Earth is round in order to account for their distance difference in order to line up the data.

results

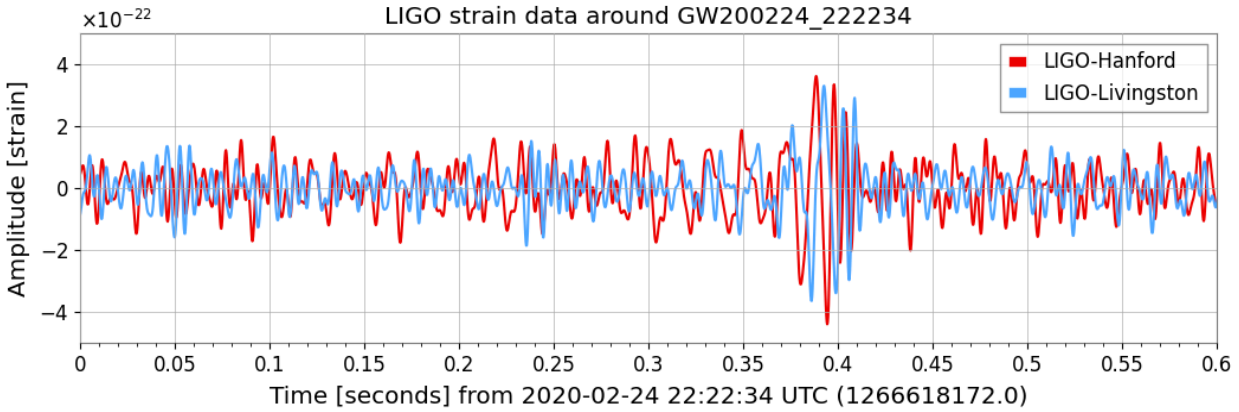
By applying a fast fourier transform on the data we get this graph which represents which frequencies are dominant in the wave.



We can also process the data to reduce noise, which gives us a better picture of the gravitational wave. Here is the before and after.



After that, we can use the data from Livingston as well as Hanford, and after shifting the data to account for a round Earth's location differences, we can overlay them to see the differences and similarities. Measuring strain is like measuring the tiny bit of change in distance that the gravitational wave causes. LIGO measures this by splitting a laser in half that bounce between mirrors in each arm of the observatory. The gravitational wave changes the distance between these two mirrors, which is how the wave is measured.



conclusions

Had I been able to use the gravitational wave to estimate the masses of the two black holes that caused it I would have also been able to estimate the distance from Earth. That, combined with light data from the same event, using redshift, would have helped to better understand the universe's expansion.

AI acknowledgement

I used AI to generate the code for the masses of the two black holes that ended up not working, as well as helping to contextualize what each part of that code did so I could understand it better. Not that understanding it helped much.