# Astro 1221 Written Report #3:

Jacob Mathew (Motivations and Conclusions), Owen Urban (Methods and Results)

**Motivations:**

In 1915, Einstein formulated his Theory of General Relativity in which he stated that gravity isn't necessarily a force of attraction, but rather it's caused by distortions in spacetime. He proposed the idea that space is actually flat and planets and other cosmic events cause distortions in spacetime that causes us to experience gravity and going even further causes gravitational waves in space. Gravitational waves are like the ripples in spacetime due to large cosmic events. In our project, we looked into building models for gravitational waves based on the gravitational waves released from two black holes merging.

**Methods:**

The main method we used to make our model includes graphs. The graphs allow us to show the data collected from the LIGO detectors, the Hanford and Livingston detectors. LIGO detectors are massive devices that utilize lasers in order to detect gravitational waves. We use graphs to show the frequency of the gravitational waves and the behavior of the waves. We also inserted an image of the frequency of the waves from the LIGO website to have a different way to view the frequency of the waves versus the graphs we made. We also used equations to predict the mass and the radius of the black holes that combined to make the gravitational waves that the LIGO detectors detected. To calculate the radius of the black holes while they were merging, we used the equation: $R = GM/c^2$. The equation we used to calculate the mass of the black holes was: $M = \delta tc^3/16\pi G$. We also estimated the amount of energy the black holes released with the equation: $\Delta M$ = 0.1 x the Mass of the black holes.

**Results:**

So based on the equations we had, we calculated the radius. We calculated the mass of the blackholes together to be about 40.39 solar masses and the radius of the black holes to be 2.95 kilometers. We also were able to estimate the distance of the merger event to be 1932.86 megaparsecs, along with the energy release, which was 7.23 x $10^{47}$ joules.

**Conclusions:**

So based on the results of our project, we were able to come to the conclusion that there is sufficient evidence for the existence of gravitational waves and that spacetime is actually flat and can be distorted by looking at data about merging black holes. Based on the data about the merging blackholes that we received we were also able to calculate the masses of the combined blackholes and the energy released by the merger. On top of that, we were also able to find how far the merging of the blackholes were from us. Merging blackholes are just one example of many types of cosmic events that happen in the universe and cause distortions in spacetime. Overall, with the powerful LIGO detectors, we can detect small or large gravitational waves and discover new causes for them and in turn learn more about our universe.

**Contributions:**

**Owen Urban:** Motivations and Methods

**Jacob Mathew:** Worked on Results and Conclusions

**AI Statement:**

We did not have to utilize AI much for this project.