Determining the Origins of Helix Glitches in LIGO's H1 Detector

Kara G. Shepard & Dr. Tiffany Z. Summerscales

Department of Physics, Andrews University
karas@andrews.edu

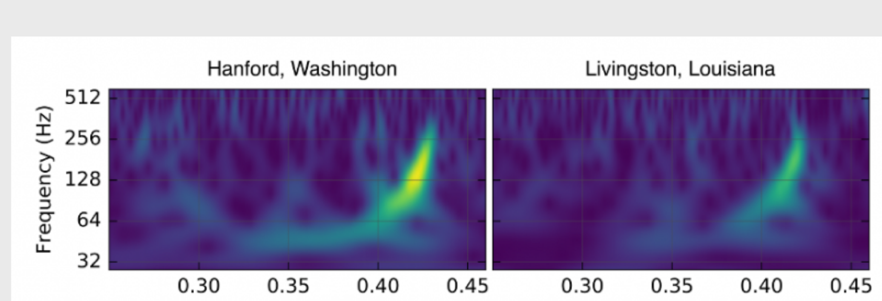
Abstract

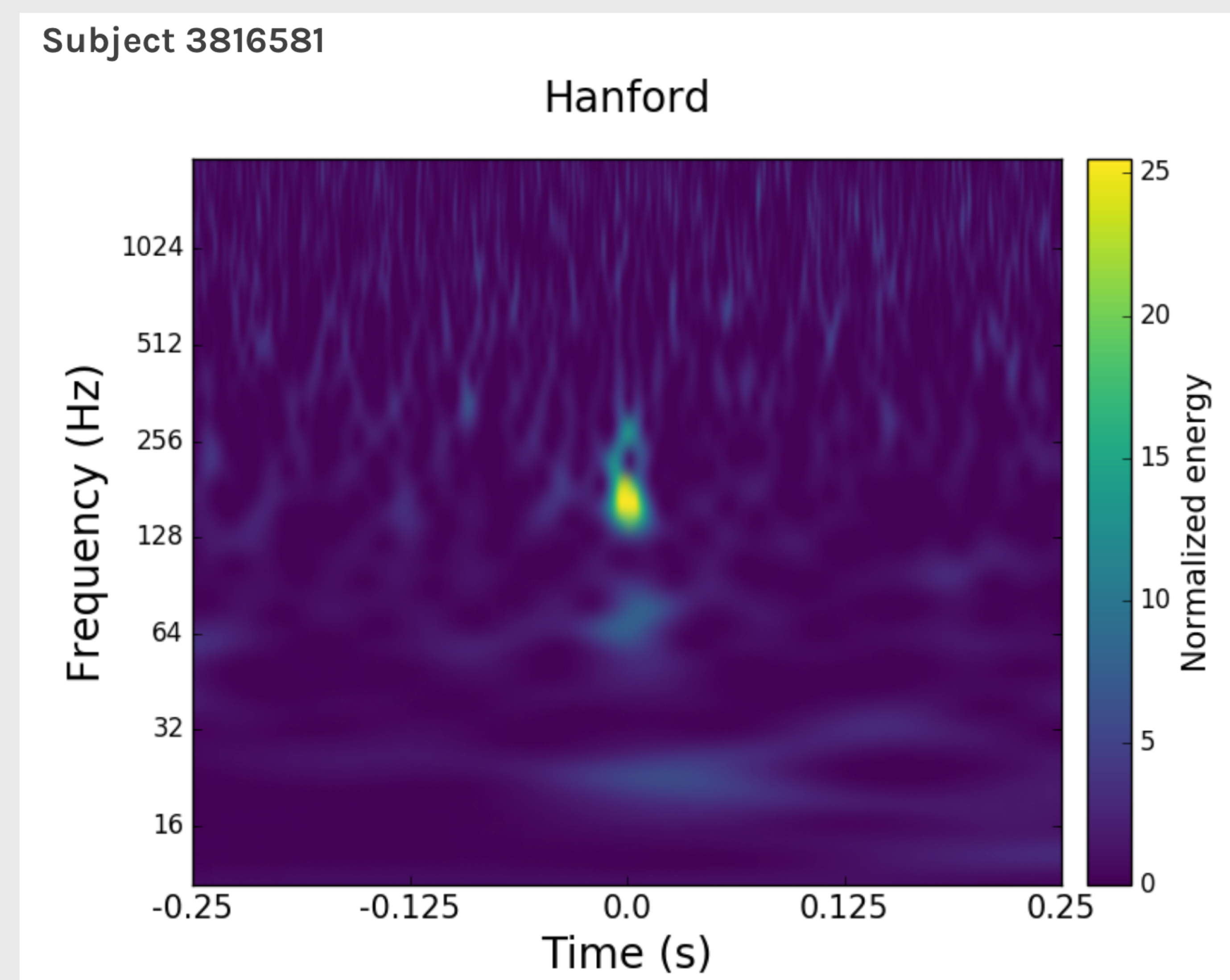
The LIGO detectors are ultra sensitive, making them susceptible to glitches from noise that can block gravitational wave signals. In order to reduce the number of glitches that occur in the detector, the cause of the glitches must be found.

I am researching the Helix glitch to try and determine its origin. This is accomplished by studying the times at which the glitch occurred in the detector and then looking for factors that may have caused a glitch to happen around the same time, to see if there are any correlations.

Background

The LIGO Collaboration has built the most sensitive detectors on the planet in order to detect gravitational waves. But due to their sensitivity, they also detect noise from other sources besides gravitational waves. These noise detections cause "glitches" in the detector, which can block or misconstrue true gravitational wave signals. Thus, it is important to know what causes the glitches, and how they can be reduced or even eliminated. There are currently 22 recognized types of glitches, and while most of their origins are known, there are 4 whose causes are still unknown. One of these is the Helix glitch.





Methodology

All of the glitches that occur in LIGO detectors are collected in a database where they are categorized according to: type of glitch, which detector the glitch occurred in, the date and exact universal time that the glitch occurred, and the glitch's peak frequency. Working with this database, I can look at all of the Helix glitches that have occurred in the Hanford (H1) detector. Using the daily data logs kept by the H1 detectors, I can compare the time the glitch occurred with any outside factor that could have possibly caused the glitch.

While looking through the logs, I am looking for several factors that could be linked to glitches in the detector. Examples of these factors are wind speed, calibration, transmitted and reflected power, and seismic activity.

Future Work

So far, 15 of the 270 occurrences of the Helix glitch in the H1 detector have been studied in depth, but no correlations have yet been seen. By studying all the occurrences of the Helix glitch in the H1 detector, I will be able to produce data that shows possible correlations between the occurrences of these glitches and outside factors. The graphs generated will lead me to the best potential relationships between the occurrences of the Helix glitches and various outside factors. If any correlations are found, the H1 detector can know when to expect Helix glitches. Further, the H1 detector may be able to address the issue in time to completely eliminate a glitch, which will improve the performance of the detector.

References

[1] Gravity Spy Collaboration. "Talk." zooniverse.org/projects/zooniverse/gravity-spy/talk/tags/helix?page=5

[2] Gravity Spy Collaboration. "The Field Guide." zooniverse.org/projects/zooniverse/gravity-spy/fieldguide/helix

[3] Zevin, M. et al. (2020). "Machine Learning for Gravity Spy: Dataset and Glitch Classification." dcc.ligo.org/DocDB/0144/P1700227/004/machine-learning-glitch.pdf

[4] Images courtesy of zooniverse.org/projects/gravity-spy and ligo.caltech.edu