

LIGO-SURF Project Proposal

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Background:

In 1916, Einstein predicted that gravitational waves of cosmic origins existed in his general theory of relativity, but at that time, no technology existed that would be able to detect gravitational waves. Since then, many experiments have indirectly detected through electromagnetic experiments, but none directly.

In 2002, LIGO, or the Laser Interferometer Gravitational-Wave Observatory, opened with an Observatory in Hanford, WA and one in Livingston, LA. These observatories use laser interferometers, which utilize lasers and mirrors to detect any space-time ripples. Both observatories house the same interferometer that run simultaneously. The Hanford observatory also has a smaller second interferometer. The goal of having two observatories is that through triangulation, the source of any gravitational waves could be located.

The current project being done at both observatories is the implementation of Advanced LIGO. A new detector that will increase the sensitivity by a factor of ten is currently being installed with the goal that the increased sensitivity will allow much more detailed data to be taken. With the implementation of Advanced LIGO, gravitational wave science should be transformed and a powerful new observation tool should be unveiled.

Objectives:

The new Advanced LIGO system will be able to detect gravitational wave radiation through the measurement of test mass motions as small as $1 \times 10^{-20} \text{ m}/\sqrt{\text{Hz}}$, which makes it necessary to limit the motions from environmental signals from overwhelming the motions produced by astrophysical signals and to have a way of distinguishing between the two types of signals.

The objective of this project is to work with the group at LIGO Hanford responsible for the environmental monitor system, which includes seismometers, accelerometers, microphones, radio receivers, magnetometers, and other monitors used to distinguish the environmental signals from the astrophysical ones, in order to fine tune the system to distinguish between the types of signals. The project will involve setting up some monitors, repairing, calibrating and troubleshooting them as well as updating the website on this system.

Some studies will also be done on how environmental signals injected into the system couple into the detector, and possible working with the system to limit the level of coupling to produce a better signal.

Approach:

Reaching the objective in this project is very hard to do without the help of the entire group working on the environmental monitoring system at Hanford. Since LIGO is an ongoing project, it is unreasonable to assume that the environmental monitor system will

be perfectly calibrated with the largest amount of error reduction after ten weeks of working on it. Hopefully, throughout the ten-week period with the help of the rest of the team, I will be able to help produce a better environmental monitoring system and impact the accuracy of LIGO's interferometer through this. The equipment utilized in this project will be the entire environmental monitoring system, which I will inherit and work on. Since machines are always bound to break down or develop problems, this project will be continuous and depending on the equipment I inherit with the project.