Dr. Brittany Kamai - Research Summary

My mission is to develop instrumentation that will enhance our fundamental understanding of dark energy. Currently, I experiment with novel ideas about how to improve gravitational wave detectors. With increased detector sensitivity, we can move beyond measurements in the local universe and out towards precision tests of cosmology. My work focuses on reducing the amount of seismic and coating noise within the LIGO detectors, which has a direct impact on our ability to measure heavier mass black hole mergers further out into the universe.

Building a Seismic Cloaking Shield around LIGO

Within the last decade, revolutionary experiments have demonstrated that invisibility cloaks of science fiction are becoming a reality. Seismic cloaking is the ability to manipulate incident seismic waves around a region, which has broad applications such as protecting hospitals, nuclear reactors and other precious infrastructure. Major experiments released within the last 5 years have indicated that we could design a configuration of resonators to act as the shield from low frequency (10-50 Hz) surface waves. I launched an investigation to see whether we could design a seismic cloak for LIGO. The application to LIGO would aid in reducing the impact of Newtonian noise, which originates when the change in mass density occurs near the detectors from traveling Rayleigh waves. My work focuses on making the connection between seismic cloaking design and the impact on LIGO sensitivity. If successful, this will present ideas for a new type of passive seismic isolation system for gravitational wave sites.

Can we make future LIGO cold?

One proposed design for next-generation interferometers, LIGO Voyager, will improve the sensitivity by a factor of 10. This will increase the accessible volume of the universe by 1,000. The idea is to make significant changes to the core optics within the current 4 km LIGO facility by moving from fused silica to pure silicon. The benefits of moving in this direction are that silicon has much better mechanical and length stability if you cool them to 123K. Also, this design will also use radiative cooling rather than conductive cooling to reduce the vibrational effects from the cooling itself. The next stage is to perform experimentation on whether this could be practically implemented at larger scales.

The central question that my research addresses is - what type of coatings would we apply to cold silicon optics? I designed and built a cryogenic test facility for exploring different coatings on silicon optics with Caltech graduate student, Aaron Markowitz. Our apparatus is capable of rapidly iterating with coating vendors on different deposition processes such as amorphous silicon for reflective coatings. Throughout 2019, we will provide high quality factor measurements on their samples, which is an indicator of whether that particular coating will be feasible for improving detector sensitivity.