Progress report for Chinyere Ifeoma Nwabugwu

Thermal Noise Issues

The range of an interferometric gravitational wave detector is expected to be limited, at the frequencies of great interest to astrophysicists by the thermal noise in the mirror coatings. This thermal noise is due to the thermal motion of the atoms. Mirrors with low mechanical loss or internal friction have their thermal noise concentrated around their resonant frequencies. Therefore we aim at isolating the resonant frequencies far from the frequency range of great interest thereby extending the effective range of a gravitational wave detector. Much research has been done into developing low-loss dielectric coatings. The first of these coatings is now available through our collaborators in Lyons France.

My job is to measure the thermal noise in the mirrors which is expected to have a reduced thermal noise by about half. I would remove the existing mirrors, glue magnets unto the new mirrors and then mount them. Following this, I would measure the thermal noise in the new mirrors. The mirrors which were to have arrived on May 31st were extended till June 15th but were further delayed and just arrived today, Thursday June 30th. While waiting for the mirrors, I have learned how to align the Fabry-Perot cavity and mastered the Pound-Drever Hall locking technique. All these are preparatory steps in the project. They would ensure smoothness in the sequence of events as soon as the advanced mirrors arrive. I have also been reviewing papers and giving presentations on them. I have reviewed a thesis on ‘Frequency stabilized solid state lasers’ by Timothy Day and a paper on ‘Relations between attenuation and phase in feedback amplifier design’ by H.W. Bode. These weekly presentations have improved my communication and presenting skills and are preparing me for my final presentation.

The earthquake that occurred on Thursday June 16th was a deterring factor to my progress but ended up being a learning experience for me. After the earthquake, the alignment of our cavity was affected and we had to open the vacuum chamber of our Thermal Noise Interferometer in order to recover the beam. Opening the chamber was a very involved process but was good practice as the chamber would have to be opened and the re-alignment done anyways when the new mirrors arrive. I am currently working on measuring the thermal noise as it exists in the current mirrors. I would lock the mode cleaner, the south arm cavity and the north arm cavity, perform calibrations and then measure the thermal noise. I hope to have completed this by next week, after which the new mirrors would have arrived.