Progress Report

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1 Introduction

The range of an inteferometric gravitational wave detector is expected to be limited at the frequencies of great interest to astrophysicist by 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 concerntrated 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.

2 Progress

The past few weeks have been very intense as the mirrors arrived from Lyons France and we have been preparing them for installation into the vacuum chamber and obtaining thermal noise data. My particular project was to prepare the calibration for them and I learned how to analyze the data we would obtain from the thermal noise interferometer. I used MATLAB for the simulation of data and plotting of the graphs.

The first thing we did was to remove the existing mirrors with sapphire substrate from the vacuum chamber. Thereafter, the new mirrors were cleaned and then magnets were glued on them. These mirrors are 4 inches in diameter and 4 inches thick. Gluing the magnets to the mirrors was a very delicate procedure as these magnets are very small relative to the mirrors themselves, and you had to be careful in judging how much glue would be enough to hold the magnets in place. Too much glue could mean the magnets got stuck in the jig, where the mirrors were placed, and then removing the

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mirror from the jig would break the magnets off. And puttng too little glue, the magnets would not stay in place. With each slight mistake, an extra day is needed to re-glue the magnets on the mirror and allow it to dry. For the glue, we used epoxy because it is vacuum compatible.

After we had successfully glued all the magnets to the mirrors, we proceeded to install the mirrors into the chamber. Again this was a very delicate procedure because in the chamber the mirrors are suspended wholly on a thin strand of steel wire. Any slight imbalance could cause the mirror to fall out and break the magnets on them. This step was a very good preparatory lesson for me to help me develop the skill of 'magic hands'. I had to be very careful and make only very slight adjustments each time.

Now we have completed the installation of the mirrors and we am aligning the laser to the cavity after which we would lock the cavity and take measurements. If all goes well, we could get at least one thermal noise reading by August 5th. I have however observed through this experiment that it is possible to have some anomaly behaviours or setbacks which force my group to go back and troubleshoot. I admit that from each of these setbacks, I have learned a lot and each day, I am understanding my project better.

I would say the most challenging aspects have been trying to make very slight adjustments and being extremely delicate. This challenge has also led to some problems as the magnets on the mirrors have broken off a number of times. However, I have improved a great deal in the past few weeks. My mentor has been very helpful in the whole process of the experiment and has given advice and also come down to the lab on a daily basis to help out. He has been extremely patient and very encouraging and has helped me accomplish a lot. His research assistant also helps me in the lab and is there everyday. He is very knowledgeable and always has very valuable advice to give and help to render.

3 Conclusion

The goal for the week ahead still remains the same goal I had when I started this project and that is to obtain a thermal noise measurement of the silica/tantala mirrors with titanium doping and analyze the data to confirm that indeed the thermal noise is less than the thermal noise in the previous mirrors. I am aiming at being an expert in whatever I get to finish and do my best. Right now, completing this project is not as important as thoroughly learning how to run each part of the experiment smoothly, and developing the skill of 'magic hands'.