Prospectus

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June 2022

1 Introduction

Past prototypes of the Cos-Theta coil have exerted some groggy faults in the design. Gabija Ziemyte created a prototype that would eliminate the issues created by grooves. Her design encapsulates the cooper wiring's diameter and allows for easy replacement if a wire is having issues. The goal of this project is to use computer aided design (CAD) to design a plastic "arch" like encasing that embodies Ziemyte's idea. We will then use the mapper robot to measure the magnetic fields and compare it against what we anticipated.

During the first week of the summer REU, I have been able to learn about some of the fundamentals of physics. Amongst all the topics, CP violation stood out the most to me. It was discovered in 1967 by Cronin and Fitch. Andrei Sakharov then tried to make reason of why the visible universe appeared to be almost entirely matter even though equal quantities of matter and antimatter should have been produced in the Big Bang. Sakharov realized that CP violation was necessary to convert antimatter to matter without it converting back in equal amounts. Obtaining non zero (nEDM) would in theory provide evidence of a P violation and time reversal in-variance violation that leads to CP violation. This discovery could in turn explain this imbalance.

The Neutron Electric Dipole Moment (nEDM) is a minuscule separation of electric charged quarks within a neutron. It behaves differently in a mirror reflected world (parity symmetry) than in one where time runs backwards, because $d_n = \vec{d} \cdot \vec{\sigma} = q\vec{r} \cdot \vec{r} \times m\frac{d\vec{r}}{dt}$. Parity is violated because when $P : \vec{r} \to -\vec{r}$, d_n is also reversed, and time reversal is violated because $T : t \to -t$ the same thing happens.d_n is the observable EDM range of frequency. $\vec{d}$ is the EDM vector that is not measured. $\vec{\sigma}$ Sigma pertains to the spin or angular momentum of a neutron. $q\vec{r}$ q is the charge of quarks and $\vec{r}$ is how much is being separated. $\cdot$ is the vector dot product, or in other words, length of vector a $\times$ length of vector b. $\vec{r}$ is how far off center you are. Lastly, $m\frac{d\vec{r}}{dt} = P$ where P is momentum or mass times velocity. Neutrons have a hypersensitivity to magnetic fields. Nuclear Magnetic Resonance (NMR) can measure that Electric Dipole Moment (EDM)—or the strength and orientation of that charge. When the radio-frequency field is turned on for a short pulse, all of the neutron spins are tipped perpendicular to the field and begin precessing. Magnetic Resonance Imaging (MRI) is a medical application of NMR.

2 Procedure

Accompanying the first couple of weeks, we will be mostly reading and soaking up as much information available to us that will benefit the study. For myself, I have been learning about different programs such as Overleaf, Python Coding, and Matlab as well as reading College Physics by Serway 11th edition. We will then look at the past research conducted by our fellow peers and identify areas of opportunity to help strengthen the magnetic fields. Using the CAD program, we will design a model made of resin that will mesh the designs of the past collaborators. This new encasing will include multiple pieces that will attach to a metal cylinder. The casing will have grooves that hug the cooper wire; this will avoid the cooper wiring from shifting. We will then use math to predict the exact magnetic fields and annotate and collect data. Lastly we will compare what we had predicted to the mapper robot's measurements.

3 References

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