Samuel Swanlund
Supervisor: Todd Averett
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The Uncertainty of Helium-3 Polarization in Particle Accelerator Targets

Polarized helium-3 nuclei are used extensively in subatomic collision experiments as polarized targets. They can be thought of as little bar magnets that, when polarized, are aligned parallel or anti-parallel to an external magnetic field with the end result being a target that can scatter particles from a beam passing through it. These experiments require precision at the 2% level to make meaningful observations, so any steps taken to reduce uncertainty in the ^{3}He polarization is an important step forward in understanding subatomic physics. My research focuses on reducing the uncertainty involving a constant, κ_0, that has to do with the magnetic interactions between two molecules coming in contact and altering the Zeeman splitting caused by the external magnetic field. The constant is used to obtain the target's polarization from EPR measurement. EPR is short for Electron Paramagnetic Resonance and is a process that involves exciting valence electrons so that they absorb and emit light. I explored various possible ways κ_0 is uncertain in our data due to unprovoked shifts in the EPR frequency. My work has consisted of creating a new oven and testing its effectiveness. The equipment used includes glass cells filled with helium-3, rubidium (Rb), and potassium (K) as well as ovens used to heat these cells to the about 200℃, where the metals turn into vapor. I designed a new oven with the intention to provide greater flexibility during experiments, as the previous oven was designed with the cell unaccessible once it was mounted. The new oven was then used to obtain κ_0 for rubidium and potassium. We succeeded in our goal by getting the uncertainty for potassium's κ_0 to 1.33%.