ABSTRACT

The LUX dark matter experiment liquid xenon detector uses an electric field created by grids to increase the drift velocity of electrons into xenon gas causing them to produce additional scintillation photons. These photons combined with the data from the original event photons are used to help determine the location and type of the original event. Electrons accelerate differently in liquid and gas phase xenon. Because of this we need to be sure the grids are level with the liquid—gas boundary. To measure the liquid level capacitive level sensors are used. To remove parasitic capacitance from cables a charge amp is used. The charge amp is capable of removing the noise in the cable as much as possible, the charge amp will be connected as closely as possible to the capacitors. The liquid xenon is constantly on the verge of boiling, so the liquid—gas boundary is not smooth and needs to be monitored.

INTRODUCTION

Scientists have long theorized that there is additional mass in our galaxy that cannot be observed through an interaction with light. The outer edge of galaxies have been observed moving at much higher velocities than would be physically possible without additional hidden mass involved. We also can observe this hidden mass through gravitational lensing, a phenomena where light is bent by a huge mass and its gravitational effects. Other experiments have been done that hint at a hidden mass in the universe. A huge goal in the world of physics is to predict and find the particle making up this hidden mass. One prospective group of particles is weakly interacting massive particles, or WIMPS for short. As the name states these are extremely massive particles that don’t interact strongly with light. These particles interact with other matter through gravitational interactions and the weak nuclear force. The mass of the particles ranges from approximately 101 GeV to 103 GeV [1].

This LUX dark matter (figure 1) detector works by detecting when a WIMP collides with liquid xenon and produces light. The LUX detector has a large mass of liquid xenon. Light is released when a WIMP collides with a xenon particle. There are arrays of photo multiplier tubes located at the top and bottom of the detector. The arrays in conjunction can be used to locate the location of the collision in the x—y plane of the detector. Near the liquid gas barrier there is a set of grids with a high electric field between them. This takes electrons from the initial collision and accelerates them causing more photons to be released. From this we are able to calculate the z location of the interaction. This data is used to eliminate noise and to make sure that the signal is actually from a WIMP and not unwanted radiation from the surroundings. The detector is located underground at the Davis Cavern at the Sanford Underground Research Facility in Lead, South Dakota [2]. The detector is located underground to block cosmic radiation to increase sensitivity.

The detector needs to be leveled to work properly. Currently we use capacitive level sensors to detect the level of the liquid inside the detector. These sensors work by using the fact that liquid and gaseous xenon have different dielectric constants and the fact that the capacitance of a capacitor changes with respect to the dielectric constant of the material inside it. A simple diagram of our capacitive level sensors can be seen in Figure 2. Currently our level sensors do a good job of leveling the sensor, but do not have much precision beyond that.

MATERIALS & METHODS

Multiple methods were used to improve the circuit characteristics. The level sensors were attached to a charge amp circuit. The output is fed into an independent lock in amplification chip and low pass filter. The noise reducing circuit will be placed as near as possible to the parallel plates of the level sensor. The parallel plates themselves will be made of copper. A test chamber will be constructed to make test measurements with the new level sensors.

RESULTS/ SUMMARY

- Currently have a working circuit
- Measurements need to be made
- Improvements to the circuit design

CONCLUSIONS

- A lot of future works need to be done to get a working system
- Measurements with a test capacitor have been made
- Need to build an actual test parallel plate level sensor.

REFERENCES