Prototyping of a Neutron Veto for SuperCDMS

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Abstract

We seek to answer many of the questions open in the design process for a neutron veto for the Cryogenic Dark Matter Search (CDMS). CDMS is a leading dark matter experiment attempting to directly detect the dark matter that scientists believe makes up most of the matter in the universe. The dark matter detector is made out of crystals kept at very cold temperatures. When a particle hits the center of an atom in the crystal, it causes very small vibrations. Dark matter particles are predicted to interact in that manner. If a particle hits the electrons of the atom instead of the nucleus, it can be ruled out and we know it was not dark matter. The problem is that neutrons, one of the three particles that make up atoms and are involved in certain radioactive decays, would be indistinguishable from dark matter particles in the detector because they also cause the vibrations. This means that neutrons need to be kept out of the detector or somehow be ruled out of the data. The purpose of the neutron veto is to detect and capture the neutrons so we know the detector has detected something else. The research this summer was aimed at building and testing a ¼-scale prototype of one piece of the neutron veto. We designed and tested the liquid that captures neutrons and produces light to be detected; we studied the new technology of silicon photomultipliers, which will be used to detect that light; and we overcame many engineering challenges regarding the construction of the box itself to learn how to build the real detector, which will be much larger. We found that the silicon photomultipliers are sensitive to temperature, so we ran them at around -8 °C.