Cryogenic Large Liquid Xenon Detector for Dark Matter Searches

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Observation of rotational curve of spiral galaxies shows that a large fraction ($\sim$23%) of the mass density of the universe is unaccounted for. Such a significant percentage of missing "dark matter" suggests that the universe may consist of new types of elementary particles. A compelling explanation for the new particles is the existence of Weakly Interacting Massive Particles (WIMPs), which are non-baryonic particles characterized by particle physics theories beyond the Standard Model. A terrestrial direct observation of WIMPs would have enormous intellectual merit. WIMPs are believed to only interact through the weak force and gravity; hence the interaction cross section with ordinary matter is extremely small. Therefore, experimental techniques that combine low radioactivity, low energy thresholds, efficient discrimination against electronic recoil backgrounds, and scalability to large detector masses can only be performed at a deep underground environment where the interference of cosmic rays is obviated. In this paper, we report a cryogenic large liquid xenon detector for dark matter searches at Sanford Lab in the Homestake Mine, USA. The goal of the large underground xenon (LUX) two-phase detector is to clearly detect (or exclude) WIMPs with a spin independent cross-section per nucleon of 7×10^{-46} cm^2, equivalent to $\sim$0.5 events/100 kg/month in an inner 100 kg fiducial volume (FV) of a 300 kg LXe detector.