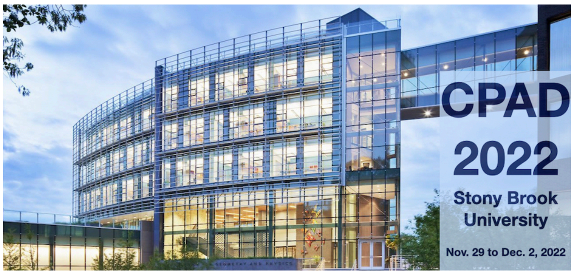

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Development of a Single Phase Liquid Xenon Detector for Reactor Antineutrino Detection

Tuesday, November 29, 2022 1:50 PM (20 minutes)

The purely electron antineutrino source and high flux makes nuclear power reactors an attractive place to set up a detector for reactor monitoring and searches for neutrino interactions. One such interaction is Coherent Elastic Neutrino Nucleus Scattering (CEvNS), which is one of the lowest energy processes predicted by the standard model, and has drawn experimental interest in recent years. CEvNS has been detected by the COHERENT collaboration [1][2] at the spallation neutron source, but has yet to be detected from the low energy antineutrinos from a nuclear reactor.
Liquid Xenon (LXe) detectors are capable of detecting sub-keV nuclear recoils [3], which reactor antineutrinos are able to produce via CEvNS. In addition, LXe detectors can be scaled up to large masses, making them capable of acquiring a large amount of statistics in a short amount of time. We estimate that a LXe detector placed 25m away from a 3GW power reactor can see O(100) events/100kg/day from CEvNS [4]. Dual phase LXe detectors used for dark matter experiments detect events via prompt scintillation light produced in the liquid, and ionization electrons which are converted to scintillation light by drifting these electrons through a gas gap under high electric fields – called electroluminescence. Such a dual-phase LXe detector was recently used to search for reactor neutrino CEvNS [5]. However, this design is known to have a large and long lasting single electron background following a large ionization signal [6][7]. This background is possibly due to impurities within the Xenon, but it may also be due to delayed extraction of electrons trapped at the liquid-gas interface. As such, we are developing a single-phase liquid xenon detector, capable of producing electroluminescence in liquid, named NUXE. Our goal is to be sensitive to single electrons in order to detect CEvNS from a power reactor.
In this talk, we will present our progress with this detector development. First we will discuss the physical motivations for building such a detector as outlined above. Next, we will present our recent results from a prototype detector, as well as a model for liquid phase electroluminescence. Finally, we will end with our future plan to upgrade our prototype, with SiPMs and a better light collection efficiency.

References

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