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Development of High Pressure Xenon Detectors for Dark Matter and Neutrino-less Double Beta Decay

At present, some of the most sensitive dark matter and neutrino-less double beta decay search experiments use liquid xenon as the detection medium. However, at the expense of larger volumes and bulkier containment vessels, operation in the gas phase at room temperature and high pressure offers multiple important advantages and new opportunities. Molecules that enhance the performance (such as in-gas wavelength shifting for improved light measurement or columnar recombination enhancement for dark matter directionality measurement) can be easily added to the gas. Other advantages include the proven 6x (six times) better energy resolution and the demonstrated ability to do track imaging in pure high-pressure xenon and the potential of improved nuclear-recoil/electron-recoil discrimination with respect to the liquid.
At LBNL, as part of the NEXT Collaboration, we are measuring neutron-induced nuclear recoils and gamma-ray-induced electron recoils in pure gaseous xenon and its mixtures with neon and TMA in two dedicated R&D detectors to explore these prospects. In addition we have developed a detailed recombination simulation to assess the nuclear recoil directionality sensitivity in high-pressure xenon and its admixtures.

Primary author: Mr GOLDSCHMIDT, Azriel (Lawrence Berkeley National Lab)

Co-authors: OLIVEIRA, Carlos (Lawrence Berkeley national Laboratory); NYGREN, David (Lawrence Berkeley National Laboratory); SHUMAN, Derek (Lawrence Berkeley national Laboratory); Dr MATIS, Howard (LBNL); RENNER, Joshua (Lawrence Berkeley national Laboratory); LONG, Megan (Lawrence Berkeley National Laboratory); MILLER, Tom (Lawrence Berkeley National Laboratory); Dr GEHMAN, Victor (Lawrence Berkeley National Laboratory); Dr NAKAJIMA, Yasuhiro (Lawrence Berkeley National Laboratory)

Presenter: Mr GOLDSCHMIDT, Azriel (Lawrence Berkeley National Lab)

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