Cryogenic Detectors and Techniques

Tuesday AM II: 106 Stanley

Chair: Michael Rabin, LANL

Tuesday AM II: 106 Stanley-1

Liquid Xenon Time Projection Chamber for LUX

Adam Bradley, Case Western Reserve University

[Adam Bernstein, LLNL, will present a substitute talk regarding LUX]

LUX is a new dark matter search experiment to be carried out in the renewed underground laboratory at the Homestake (SD) old gold mine. The detector's large size supports effective internal shielding from natural radioactivity of the surrounding materials and environment. The LUX detector consists of a cylindrical vessel containing 350 kg of liquid xenon (LXe) cooled down using a novel cryogenic system. We tested a small-scale four PMT prototype utilizing over 200 gm of active xenon, installed in the full-sized cryostat. We report the efficiency of a unique internal heat exchanger and liquid level stabilizer system, with standard gas phase purification with a heated getter, which allows for very high flow purification without requiring large cooling power. A stable LXe surface is required for good energy resolution. Such a system is required for multi-ton scale up.

Tuesday AM II: 106 Stanley-2

Ultra-High Resolution Alpha Particle Spectroscopy Using Superconducting Microcalorimeter Detectors

Robert Horansky, National Institute of Standards and Technology (NIST)
J.N. Ullom, J.A. Beall, G.C. Hilton, K.D. Irwin (NIST); D.E. Dry, M.W. Rabin, E. Hastings, S.P. Lamont, C.R. Rudy (Los Alamos National Laboratory)

Alpha spectroscopy is the preferred technique for analyzing trace samples of radioactive material because the alpha particle flux from many materials of interest is significantly higher than the gamma-ray flux. Traditionally, alpha spectroscopy is performed with silicon detectors whose resolution is limited to 8 keV FWHM or higher for 5 MeV alpha particles. Here, we describe the design and operation of a superconducting microcalorimeter alpha detector with energy resolution of 1.4 keV FWHM at 5 MeV. We demonstrate the ability of the microcalorimeter to clearly resolve the alpha particles Pu-239 and Pu-240 at 5.157 and 5.168 MeV, respectively, in a mixed isotope Pu sample. The Pu-239/Pu-240 ratio differentiates reactor-grade Pu from weapons-grade and is a vital identifier for safeguards and materials accounting applications. Hence, our detector may eliminate the need for costly and time-consuming mass spectrometry analysis of trace Pu samples. We also demonstrate the first direct observation of the 4.885 MeV alpha decay of Po-209 to the ground state of Pb-205 which has traditionally been obscured by a much stronger alpha line 2 keV away. The unprecedented resolution of microcalorimeters may allow elements in mixed actinide samples to be individually identified and would eliminate the need for time-consuming chemical separation of these elements prior to alpha counting. Measurements of mixed actinide samples are currently under way and will be presented. Finally, the 1.4 keV resolution observed for alpha particles is far worse than the 0.12 keV resolution predicted from thermal fluctuations and measurement of