Contribution ID: **88** Type: **Talk**

Scintillation yield from electronic and nuclear recoils in superfluid helium-4

Friday 27 March 2020 14:00 (15 minutes)

Superfluid He-4 is a promising target material for direct detection of light (< 1 GeV) dark matter. Signal channels for dark matter - nucleus interactions in superfluid helium include prompt photons, triplet excimers, rotons and phonons, but measurement of these signal strengths have yet to be performed for low energy nuclear recoils. A measurement of the prompt scintillation yield from electronic and nuclear recoils was carried out in superfluid He-4 at ˜1.75 Kelvin, with deposited energy in the range of 10-1000 keV. The scintillation from a 16 cubic cm volume of superfluid He-4, with tetraphenyl butadiene as wavelength shifter deposited on 1-mm thick quartz panels, was read out by six R8520-06 MOD PMTs immersed in the superfluid, each individually biased by a Cockcroft-Walton generator. Elastic scattering of 2.8 MeV neutrons (generated by a deuterium-deuterium neutron generator) from superfluid He-4, with a liquid organic scintillator module used as far-side detector, was used to determine the scintillation signal yield for a variety of nuclear recoil energies. For comparison, Compton scattering of Cs-137 gamma-rays with the superfluid He-4, with NaI scintillators used as far-side detectors, was used to determine the scintillation signal yield of electronic recoils.

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Session Classification: Session 13

Track Classification: Non-directional direct dark matter detection