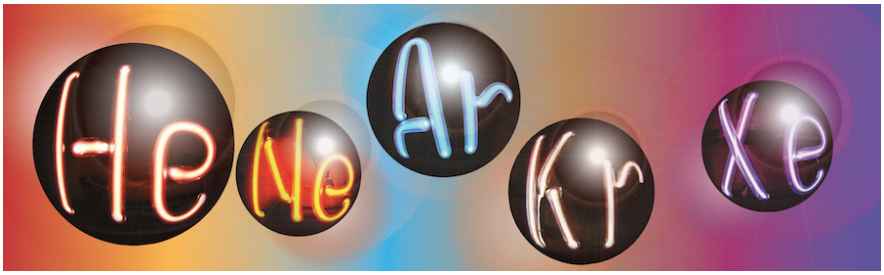

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A Path to the Direct Detection of sub-GeV Dark Matter Using Calorimetric Readout of a Superfluid He-4 Target

Sunday, 24 September 2017 10:20 (20 minutes)

Superfluid helium has many merits as a detector target material to probe sub-GeV dark matter, including good kinematic matching with light dark matter, excellent intrinsic radiopurity, and ability to be cooled down to milli-Kelvin temperature to enable phonon readout using transition edge sensor. At the same time, this uniform liquid may be used to make a monolithic detector. We propose to readout the rotons and phonons in superfluid helium by using quantum evaporation of helium atoms, with an array of calorimeters suspended in vacuum above the helium, aiming to achieve below 10 eV energy threshold in a first generation detector. The scintillation photons can be read out either by placing cryogenic photodetectors submerged in the liquid or placing them outside and using wavelength shifter. Using the amplification of the roton/phonon signal via the helium atom evaporation/absorption process, such a detector should be able to probe very low-mass dark matter. Taking into account the radioactive background and the detector discrimination power, sensitivity projections show that a small detector (~kg scale) can already explore new parameter space in the dark matter - nucleon elastic scattering cross-section. An experimental effort to measure the scintillation light yield of superfluid helium under nuclear recoil excitation is also discussed.

Primary author: Dr HERTEL, Scott (University of Massachusetts Amherst)

Co-authors: BIEKERT, Andreas; MCKINSEY, Daniel; LIN, Junsong; VELAN, Vetri

Presenter: LIN, Junsong

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