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Metastable Water: Breakthrough Technology for Dark Matter & Neutrinos

We will present a discussion of a new detector technology, the "Snowball Chamber," which is based on the phase transition (of liquid to solid) for metastable fluids. A water-based supercooled detector has the potential to move past the Neutrino Floor, and extend the reach of direct detection dark matter (DM) experiments to low-mass WIMP candidates for both spin-dependent (on the proton) and spin-independent interactions. The detector concept also has applications within coherent elastic neutrino-nucleus scattering experiments. Some of the foreseeable, potential pitfalls will be presented, alongside a brief vision of an R&D program toward the maturation of this technology.

In general, the marquee DM experiments are each mature, reliable, and expected to reach their sensitivity objectives; however, looking beyond the current generation, the parameter space of DM candidates accessible with current technology is limited. Instrumentation thresholds and the kinematics of elastic scattering constrain the lowest mass dark matter candidates that can be studied. The CEνNS of solar, atmospheric, and diffuse galactic supernova nu's will soon become a background (neutrino floor) that challenges the reach to lower cross-sections, made even more difficult by the required scale of future experiments. Without a new approach for detection technology, experimental searches will remain blind to important regions of parameter space. A new tech which pushes past the neutrino floor, extends sensitivities to low-mass dark matter candidate particles, and is insensitive to the conventional BGs could open up these new horizons. The path forward envisioned here builds on the transformative "Snowball Chamber" technology, a p-rich, supercooled liquid H2O detector. A host of related measurements within neutrino physics, utilizing the CEνNS interaction on O nuclei, and/or the potential of these detectors to track e- interactions, is likewise open to such a technology.

Primary frontier topic

Instrumentation Frontier

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