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The Snowball Chamber: Supercooled Water for Dark Matter, Neutrinos, and General Particle Detection

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The snowball chamber is analogous to the bubble and cloud chambers in that it relies on a phase transition, but it is new to high-energy particle physics. The concept of the snowball chamber relies on supercooled water (or a noble element, for scintillation for energy reconstruction), which can remain metastable for long time periods in a sufficiently clean and smooth container (on the level of the critical radius for nucleation). The results gleaned from the first prototype setup (20 grams) will be reviewed, as well as plans for the future, with an eye to future deployment of a larger (kg-scale) device underground for direct detection of dark matter WIMPs, with a special focus on low-mass (GeV-scale) WIMPs, capitalizing on the presence of H, which could potentially also lead to world-leading sensitivity to spin-dependent-proton interactions for O(1 GeV/cˆ2)-mass WIMPs and CEvNS. Supercooled water also has the potential advantage of a sub-keV energy threshold for nuclear recoils, but this remains an atmospheric chemistry prediction that must be verified by careful measurements.

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