1. Description

The longstanding quest to discover the nature of dark matter constitutes perhaps the greatest treasure hunt in history. We have convincing evidence that approximately 25% of the universe consists of matter we cannot yet account for, but whose gravitational effects can be seen in a variety of astrophysical phenomena. For several years, the leading dark matter paradigm has been Weakly Interactive Massive Particles (WIMPs), hypothetical heavy "beyond the Standard Model" particles motivated by theories such as supersymmetry. The Large Hadron Collider has been searching extensively for WIMPs, as have "direct detection" experiments that seek to spot rare interactions of dark matter with Standard Model particles. Yet the WIMPs haven't shown up. While they may still exist (just with very feeble interactions, making them very difficult to detect), attention has been increasingly turning to a zoo of other dark matter candidates, such as lighter WIMP-like particles, self-interacting dark matter, dark photons, and axions. The challenge for the next generation of dark matter experiments is to cover as many of these possibilities as we can.

SuperCDMS (Cryogenic Dark Matter Experiment) is a direct-detection experiment that looks for interactions of dark matter in cryogenic germanium and silicon detectors equipped with sensors for the thermal energy of particle interactions. Applying a high bias voltage across these detectors amplifies the ionization signal into a large phonon signal that can also be measured. The clean, well-shielded detectors are operating deep underground, to avoid interference from cosmic rays. The chief advantage of SuperCDMS's cryogenic technology is the extremely low detection thresholds achievable, which provides sensitivity to very feebly-interacting WIMPs as well as a variety of lower-mass dark matter candidates. SuperCDMS operated in an underground laboratory in Soudan, Minnesota until 2015. Now, the collaboration is building an even more powerful version of the experiment in SNOLAB, Canada's world-leading astroparticle physics facility located 2 km below the surface in the Vale Creighton Mine near Sudbury. First operations of SuperCDMS SNOLAB are expected in 2021, but a Cryogenic Underground TEst (CUTE) facility has already opened to support the detector development, characterization and calibration.

The summer project will focus on analysis of data from CUTE. This will be an exciting time: our first data from various prototype detectors, as well as "pathfinder" versions of the main detectors. The data analysis can be performed remotely, and hours are flexible. The analysis framework is mainly Python, with some C++ and MATLAB components. Aspects of the analysis include application of data quality criteria, discrimination of signal from background, statistical methods, and interpretation of results in terms of specific dark matter models. The student will have the opportunity to collaborate with graduate students in the research group, and remotely with other collaboration members. The research group, as well as the wider collaboration, emphasizes principles of Equity, Diversity & Inclusion in the work environment.

For more information:

https://supercdms.slac.stanford.edu/

http://www.snolab.ca/

2. Requirements:

- 3rd year or above

- Familiarity with Python; some C++ and/or MATLAB preferred

- Some familiarity with statistics and/or data analysis preferred