Detecting the axion dark matter wind project: brief outline

LOISAT

This is a brief outline of the longitudinal project to detect the axion dark matter wind with the same method used to measure the nuclear electric dipole moment of tantalum. For the details on that method, please see the corresponding ¡paper¿. LOISAT intends to collaborate with other institutions, especially those that have a strong record of retaining and graduating Black physics BSc students. Main benchmarks:

1. Design and manufacture a more compact modular sample assembly (see Fig. 1) with an option of including an absolute magnetic sensor. The first module includes the solenoids and the sample wire, a second module includes the SQUID, a third module may include an absolute magnetic sensor and a fourth module for the overall shielding. The advantages include
   - Better shielding from external fields.
   - For measuring nuclear EDM with an Adiabatic Demagnetization Refrigerator (ADR), a more compact design will reduce the heat load and increase the fixed temperature hold time. Longer fixed temperature hold times result in lower systematics.
   - Uniformity of design for more precise comparisons of datasets.
   - Ability to manufacture the solenoids+sample wire module for different sample elements or compounds.
   - Ability to quickly and precisely measure the nuclear EDM for many superconducting elements and compounds. This dataset will be valuable on its own but also for choosing the best sample for detecting dark matter axions.
2. Identify two laboratory locations at the same latitude within an angular span centered at the 48°N latitude where dense dark matter hairs at the surface of the Earth are most likely to exist. The purpose is to temporally correlate two datasets at the same latitude since each laboratory may would go through the same dense dark matter hair at different times as the Earth rotates.
3. A third laboratory location where dense dark hairs are unlikely to be found on Earth's surface can be used as a control.
4. Equip each laboratory with a Continuous Adiabatic Demagnetization Refrigerator (CADR) where the sample assembly can hold a sub-kelvin temperature in an uninterrupted fashion. Each CADR would hold multiple sample assemblies for additional verification of a potential signal.
5. Collect data over multiple years, as conditions permits.
6. Search the data for an oscillating supercurrent with the same frequencies and correlated oscillation amplitudes between the different datasets corresponding to sample wires composed of different elements or compounds.

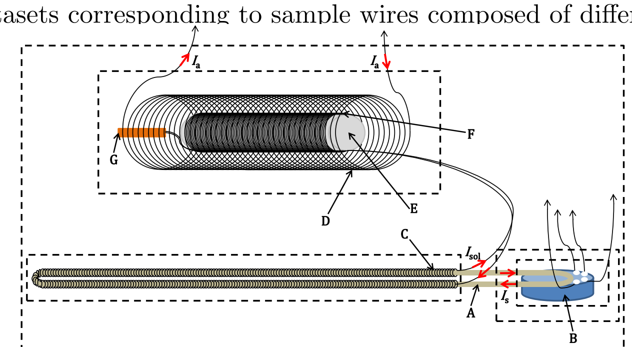

FIG. 1: Sample assembly components: A) sample wire; B) SQUID; C) sample solenoid; D) main solenoid; E) superconducting booster solenoid core with circular cross section; F) booster solenoid; G) superconducting joint of the booster solenoid wire leads. The currents are indicated with the red arrows: main solenoid current, $I_{\rm a}$; induced booster solenoid current, $I_{\rm sol}$; sample current detected by the SQUID, $I_{\rm s}$. The dashed rectangles represent shielding made from a superconducting material. The potential and current leads from the SQUID run to the exterior SQUID electronics while the main solenoid leads run to a DC current source.