**INTRODUCTION AND MOTIVATION**

Growing interest in searching for wave dark matter candidates due to a lack of WIMP detection or signatures of supersymmetry.

The Dark Matter Radio (DM Radio) will search for sub-keV axion and hidden photon dark matter over a wide mass range.

DM Radio detector consists of a superconducting, tunable lumped-element LC resonator with SQUID-based readout.

DM Radio Pathfinder has the ability to detect hidden photon dark matter and informs scaling to larger experiments.

**WAVE DARK MATTER CANDIDATES**

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Spin</th>
<th>Production Mechanism</th>
<th>Coupling</th>
</tr>
</thead>
<tbody>
<tr>
<td>QCD Axion/ALP</td>
<td>0</td>
<td>Pseudoscalar</td>
<td>Misalignment mechanism</td>
</tr>
<tr>
<td>Hidden Photon</td>
<td>1</td>
<td>Inflationary fluctuations, misalignment mechanism</td>
<td>Kinetic mixing</td>
</tr>
</tbody>
</table>

- Local dark matter density (≈0.4 GeV/cm³) requires light fields to be bosonic.
- Oscillation frequency determined by rest mass (h=mc²) plus small contribution from kinetic energy.
- Kinetic energy from virialized dark matter sets f/Δf = 10⁸, field is coherent within detector volume.
- Hidden photons/axions act on an oscillating background current density sourcing a real, oscillating electromagnetic field.

\[ f \approx 2.5 \text{MHz} \times (m/10^{−22} \text{eV}) \]

\[ \Delta f \approx 0.4 \times (10^{−22} \text{eV/m}) \]

\[ c \approx 100 \text{km/s} \times (10^{−22} \text{eV/m}) \]

**DETECTION TECHNIQUE**

Superconducting shield blocks electromagnetic background, but is easily penetrated by hidden photons/axions

**HIDDEN PHOTONS**

- Effective spin current produces oscillating magnetic field

**AXIONS**

Adiabatic current from dark matter

Effective axion-induced current

Axions interact with DC magnetic field, generating effective current which produces oscillating magnetic field

**PATHFINDER AT STANFORD**

- 670 mL hidden photon detection volume, will cover 100 kHz – 10 MHz in full scan
- Operates in liquid helium, tuning performed by position of sapphire dielectric plates
- Initial Q=200,000, determined by overcoupled SQUID

**PROJECTED SENSITIVITY**

- DM Radio-m²

**REFERENCES**