Quantum Sensing for the Hidden Sector

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ADMX

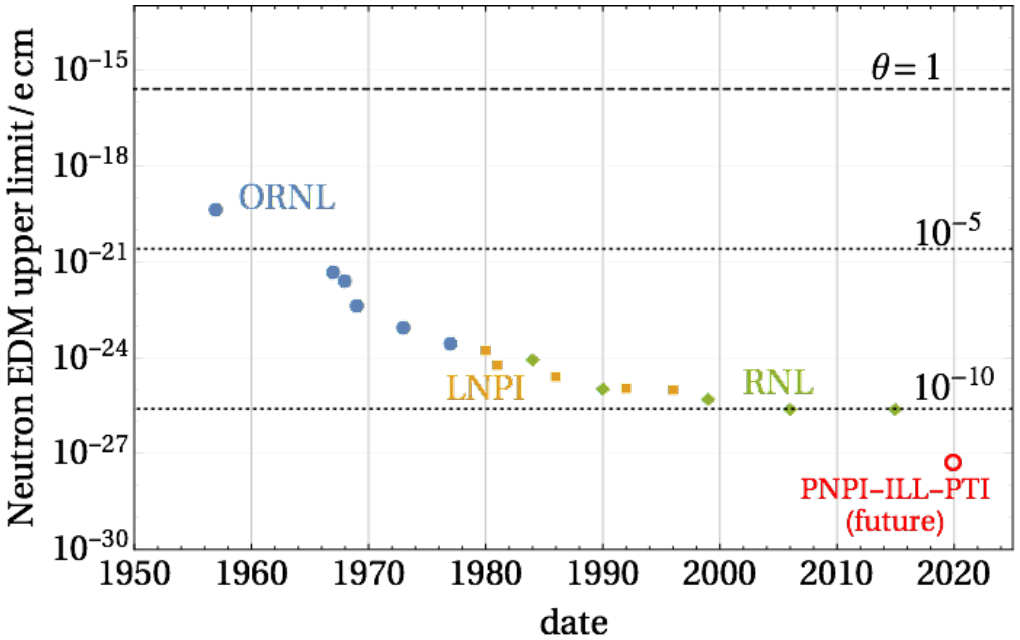
A portion of our work is in collaboration with the U.S. Axion Dark Matter eXperiment collaboration.

Hidden sector dark matter

- The nature of dark matter is one of the important questions in modern physics.
- Light hidden sector fields make compelling dark matter.
- The same fields can solve outstanding problems with the standard model.
- Probably the best motivated particle is the QCD axion.

DARK MATTER PROBLEM

STRONG CP PROBLEM



- Our central aim is to build, in the UK, the world's leading facility for quantum measurements in the hidden sector.
- In the first 3.5 years, we will focus on demonstration of technology, with the axion as our primary science goal. Modelling indicates that 20-40 μeV is the most probable mass range. It is unexplored.

Axion Detectors and the Current Landscape

SUPERCONDUCTING QUANTUM ELECTRONICS:
- SQUIDs
- Josephson Parametric Amplifiers
- Travelling Wave Parametric Amplifiers
- Bolometers
- Qubits / QuBit arrays

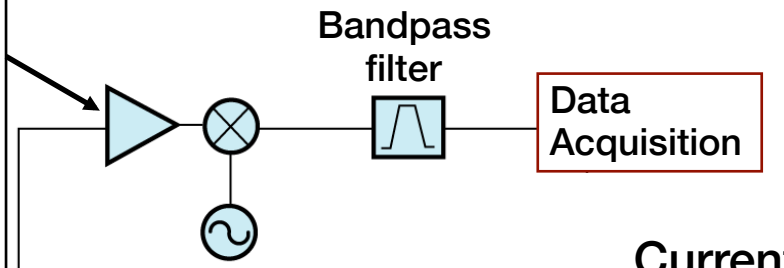
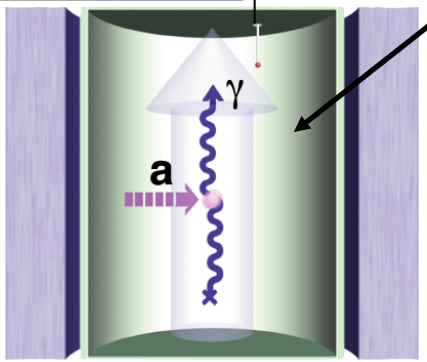


Figure of merit for detector sensitivity: $\frac{B^2 V}{T}$



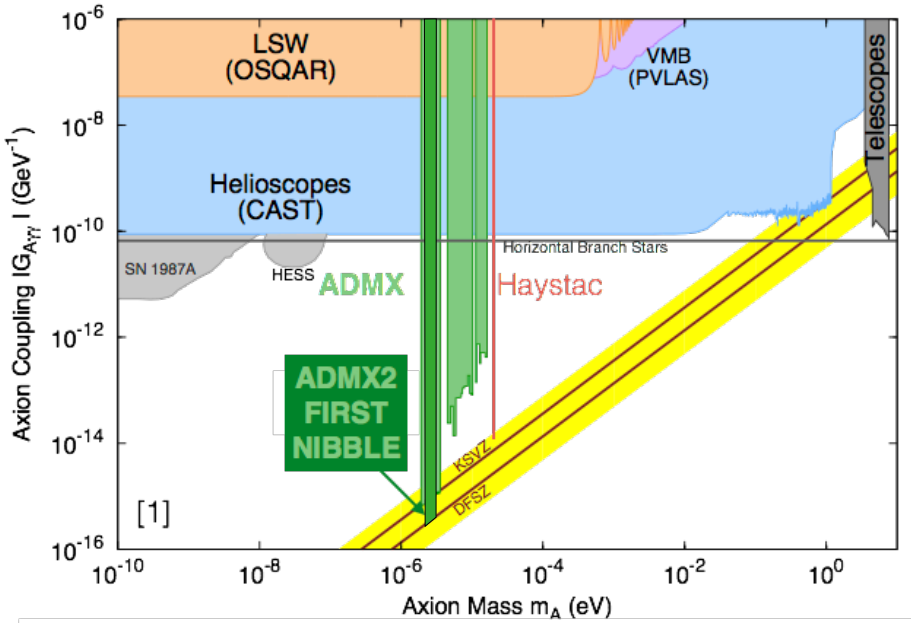
Electromagnetic resonantor volume V

Halo axions convert to photons in a magnetic field

System noise temperature: T

Static Magnetic Field B

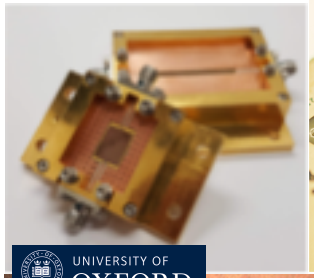
Current experimental landscape

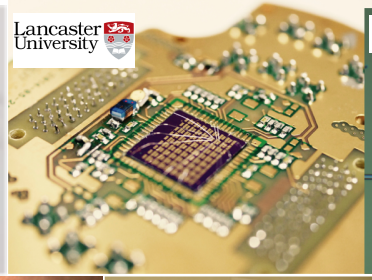


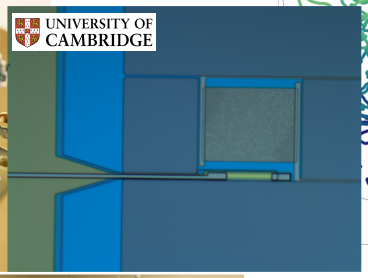
- Non resonant experiments have broad mass coverage, but insufficiently sensitive to detect QCD axions.
- Resonant experiments much more sensitive. ADMX is the only experiment to have probed a broad range of existing axion models. However, mass coverage too slow. Can speed up: 1. By using a new generation of quantum electronics; 2. By using a larger, higher field magnet; 3. Using multiple resonators in parallel.

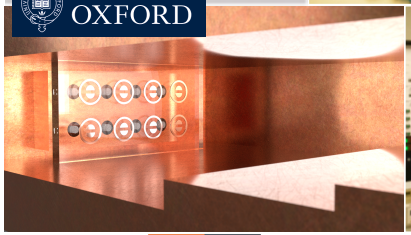
Expertise:

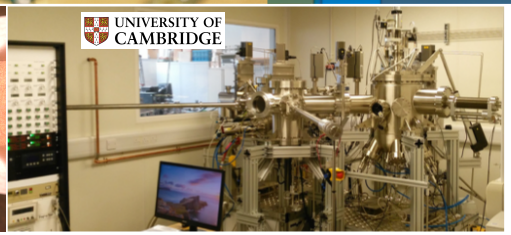
QUANTUM ELECTRONICS

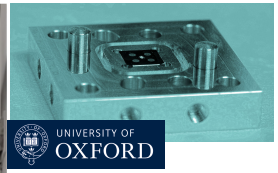




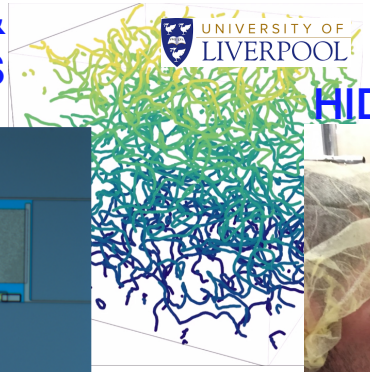






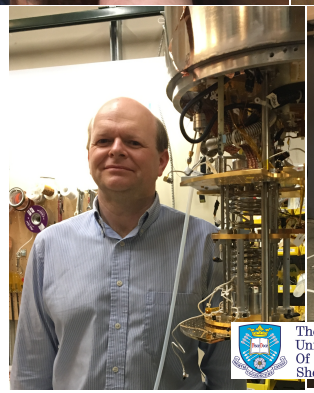


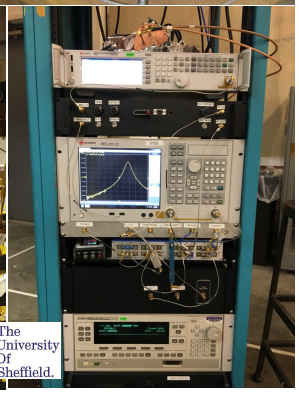
THEORY & SIMULATIONS



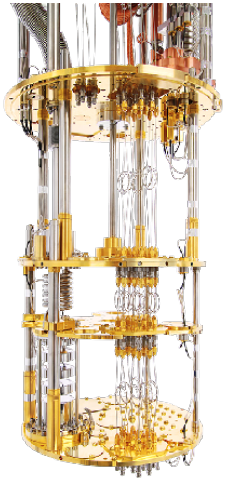
HIDDEN SECTOR SEARCHES

Key background technology 1: large magnets

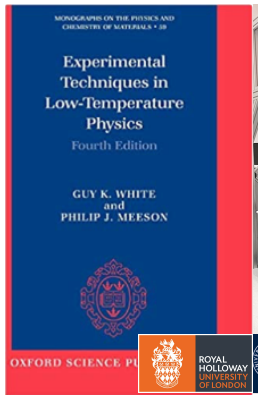




Key background technology 2: 10mK fridges



VACUUM & CRYOGENICS



RESONANT MICROWAVE ELECTRONICS