Cold Atom Quantum Technology to Explore Fundamental Physics

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I will outline in the presentation the scientific opportunities of a multi-stage programme based on cold atom quantum technology. The central goals of the programme are to search for ultra-light dark matter, to explore gravitational waves in the mid-frequency range between the peak sensitivities of LISA and LIGO/Virgo/ KAGRA/INDIGO/Einstein Telescope/Cosmic Explorer experiments, and to probe other frontiers in fundamental physics. This programme would complement other planned searches for dark matter, as well as probe mergers involving intermediate-mass black holes and explore early-universe cosmology.

I will especially focus on key activities in the field: the recently funded AION project [1] in the UK, the proposed space mission proposal AEDGE and STE-QUEST [2,3], and summarise the recent Cold Atoms in Space Workshop Summary & Roadmap [4]. I will also discuss the opportunity to build an international community to support a comprehensive and coordinated programme for terrestrial long-baseline atom interferometry experiments.

These projects are uniquely interdisciplinary missions that will harness cold atom quantum technologies to address key issues in fundamental physics, astrophysics and cosmology that can be realized in the next few decades.

[1] AION, JCAP 05 (2020) 011, arXiv:1911.11755
[2] AEDGE, EPJ Quant. Tec. 7 (2020) 6, EPJ QT, arXiv:1908.00802
[3] SET-QUEST, https://indico.cern.ch/event/1138902/attachments/2406800/4119588/STE_QUEST_M7_phase1_public.pdf
[4] https://arxiv.org/abs/2201.07789