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Precision low energy experiments to test fundamental physics and search for dark matter

Abstract

At the University of Western Australia, the Frequency and Quantum Metrology research group within the Department of Physics has a rich history of developing precision tools for both fundamental physics and industrial applications. This includes the development of novel high-Q resonant photonic cavities such as whispering gallery modes and re-entrant cavities for example. These photonic cavities have been used in a range of applications, including highly stable low noise classical and atomic oscillators, low noise readout and measurement systems, high sensitivity displacement sensors, high precision electron spin resonance spectroscopy, high precision measurement of material properties and high-Q hybrid quantum systems strongly coupled to form quasi-particles.
The aforementioned technology has allowed the realization of precision measurement tools and techniques to test some of the core aspects of fundamental physics, such as searches for Lorentz invariance violations in the photon [1]*, phonon [2,3]* and gravity sectors [4-6]*, variations in fundamental constants [7,8]* and searching for ultra-light dark matter (ULDM) and weakly interacting sub-eV particle (WISP) dark matter[9-19]*. We have also studied modified Maxwell's equations and as a result have developed new experiments to test for Lorentz invariance violations, dark matter axions and hidden sector photons. We continue to follow this tradition and have recently gained funding to apply our expertise to new directions in fundamental physics with particular focus on detecting ULDMs and axions [9-19]*. An overview of our current experiments, including status and future directions will be given. This includes experiments that take advantage of axion-photon coupling and axion-spin coupling to search for axion dark matter [9-19]*. High acoustic Q phonon systems to search for high frequency gravity waves, scalar dark matter and tests of quantum gravity [20,21]*.

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*The complete reference list is available at **https://agenda.infn.it/e/tobar**