Poster Session #A
Laboratory tests of gravitation

A01

New ideas and results in searches for ultra-low-mass dark matter and macroscopic topological defects

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Ultra-low-mass bosonic dark matter may form a coherently oscillating classical field. These oscillating fields can in turn induce apparent temporal variations of the fundamental "constants" of nature, including fundamental interaction strengths and particle masses [1], as well as particle g-factors [2]. With the BASE collaboration at CERN, we proposed and performed a search for pseudoscalar (axionlike) dark matter interactions using antiprotons in a Penning trap, improving over astrophysical bounds by up to 5 orders of magnitude [2]. In another recent work [3], we identified novel signatures of scalar dark matter in laser-interferometric gravitational-wave detectors, such as LIGO/VIRGO and GEO600, the existing datasets of which may already be used to improve the sensitivity over current bounds from fifth-force searches by up to a factor of a few hundred. Ultra-low-mass bosons may also form macroscopic topological defects. In my recent work [4], I identified a number of novel signatures in previously-considered models of topological defects composed of scalar field(s) that interact with standard-model fields non-gravitationally. In particular, I have shown that the previously-overlooked back-action of ambient matter on the scalar field(s) results in an environmental dependence of the fundamental constants, as well as spatial variations of the fundamental constants in the vicinity of massive bodies such as Earth, due to the formation of a "bubble-like" defect structure surrounding the dense body [4]. Using existing data from torsion-pendulum experiments, clock comparison measurements at different heights and astrophysical spectra, I have derived new bounds on macroscopic domain walls that improve over previous bounds by up to 15 orders of magnitude [4]. References: [1] Stadnik and Flambaum, Physical Review Letters 114, 161301 (2015); Physical Review Letters 115, 201301 (2015). [2] Smorra, Stadnik et al., Nature 575, 310 (2019). [3] Grote and Stadnik, Physical Review Research 1, 033187 (2019). [4] Stadnik, arXiv:2006.00185; Physical Review D (In press).