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Detecting topological dark matter with GNSS

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Despite multiple observational evidence for the existence of dark matter (∼25% of the global energy budget in the Universe), its nature remains a mystery and a direct challenge to modern physics. In this work we use the existing GPS constellation as a 50,000 km-aperture dark matter sensor array. We focus on dark matter in a form of stable configurations of light fields (topological defects or TDs). Such defects may lead to occasional transient changes of particle masses and coupling constants thereby affecting atomic clock frequencies and thus clock phases across GNSS[1]. Based on cosmological models, the most probable speed of TDs in the barycentric reference frame is ∼300 km/sec. A TD sweep across the constellation would generate step-like signatures in clock phase across an aperture of ∼200 s for the GPS constellation, and ∼40 s for ground stations. Since GPS carrier phase data is routinely acquired with few-mm precision at intervals of 1 s, detecting ∼1 ns signals in the atomic clock phase over a 200 s aperture is easily achievable. The phase deviations would propagate across the GPS system with a preferred directionality. Observing such a signature would provide decisive evidence of the existence of TDs with a high confidence level, as there is no known mechanism for background events that would mimic such a signature. We present preliminary results of our analysis.

[1] Hunting for topological dark matter with atomic clocks, A. Derevianko and M. Pospelov, arXiv:1311.1244.