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Employing Precision Frequency Metrology for Axion Detection

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Due to its extraordinary precision reaching 10^{-18} level, frequency metrology is one of the most sensitive tools used in many tests of fundamental physics such as detection of violations of the Lorentz Invariance and special relativity, drifts of the fine structure constant, etc. In this presentation, we consider how to adopt these tool for axion searches and demonstrate the key differences with the power detection techniques used by all previous studies.
The proposed approach is based on a photonic cavity supporting two mutually orthogonal modes. We demonstrate how axion modified Maxwell electrodynamics leads to either a beam splitter or parametric interaction between the modes in the axion up- or downconversion cases respectively and how these axion mediated interaction terms could be detected using frequency observation. Prospects of the proposed system are analysed based on the current technological level, and particular measurement schemes are considered. We will discuss the key advantages of the frequency metrology comparing to the traditional power detection methods, such as absence of strong magnetic fields, mode volume independence, power ration improvement, etc. Some preliminary experimental results will be discussed. Finally, a method to boost the sensitivity of such metrological setup using exceptional points in the eigenvalues and eigenvectors of the system will be discussed.

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