PHYSICS
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Optical Frequency Metrology and Low Noise Microwave Generation with Optical Frequency Combs

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Abstract

The most frequency-stable electromagnetic radiation is now produced optically, enabling novel tests of fundamental physics, dark matter searches, cm-scale geodesy, and motivating a possible redefinition of the SI second. Lasers stabilized to passive optical reference cavities are already reaching instabilities below 10^{-16} at 1 second and optical atomic clocks are reaching 10^{-18} at 10,000 seconds. These optical frequency references can find new utility if their short and long term stability is transferred to the RF, microwave and millimeter-wave domains – applications including radar, microwave spectroscopy, radio astronomy, and timing synchronization at km-scale facilities. Moreover, compact and rugged components can enable applications outside a staid laboratory environment. In this talk I will cover two important aspects for realizing photonically generated low noise electronic signals for microwave applications. Rigidly-held, compact reference cavities will be discussed in the context of the generation of low noise microwave signals via Optical Frequency Division (OFD) with mode-locked frequency combs. Additionally, the study of high-speed photodiodes – another key piece of OFD – will be discussed and results regarding their amplitude-to-phase nonlinearity will be presented, whereby record low nonlinear coefficients have been obtained.