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Frequency combs for optical clocks and low-noise oscillators

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The optical frequency comb from a femtosecond mode-locked laser has become an indispensible tool for high-precision optical frequency metrology and as the clockwork for optical atomic clocks. Beyond precision timing applications, optical frequency combs are also used for ultraviolet and infrared spectroscopy, optical waveform generation, and the calibration of astronomical spectrographs. The wide utility of the frequency comb stems from the fact that it forms a phase-coherent link between optical and microwave domains in a simple, compact, and robust manner. When stabilized to an optical frequency reference, the various modes of the frequency comb can be used individually as ultrastable optical references, or they can be combined to synthesize pure tones or even waveforms with low phase noise in the microwave domain This talk will focus on the description of experiments at NIST in which frequency combs are used to count the petahertz oscillations of optical clocks, as well as to generate the lowest noise microwave timing signals ever produced. A new generation of chip-scale frequency combs based on nonlinear parametric oscillation in high-Q micro-resonators will also be described.

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