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Optical Atomic Clocks - New Clocks for New Physics

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Given the extreme precision with which we can measure time, time (together with its inverse, frequency) plays a unique role in the International System (SI) of units and in a myriad of applications including tests of our most fundamental physical principles. The highest performing clocks are now those based on lasers whose frequency is stabilized to ultra-narrow optical transitions excited in samples of trapped atoms. This talk will explain the basic physics behind these revolutionary timepieces and review the state-of-the-art of the field. Included will be descriptions of experiments at NIST and JILA in Boulder, CO, where scientists are comparing the frequencies of optical clocks at the millihertz level, an uncertainty equivalent to one second in the age of the Universe. The talk will conclude with speculation about possible new experiments (e. g., geodesy via Relativity) made possible by frequency metrology at the 18^{th} digit.