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Modern Optical Tests of Special Relativity

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"The speed of light is finite and does not depend on the motion of either source or observer". This is the fundamental statement underlying Albert Einstein's theory of Special Relativity. First formulated early in the 20th century, this theory now is one of the cornerstones of our scientific understanding of the world and tightly woven into the fabric of modern physical theories. Due to this outstanding role, it always has been of prime importance to experimentally verify the validity of the underlying theory. Today, further incentive for such tests is provided by new theoretical attempts – such as string theory or loop quantum gravity – aiming at unifying the forces of nature, which indeed suggest small violations of Lorentz-Invariance. This talk will discuss modern tests based on optical methods, which are especially well suited for the task at hand. A specific example is a modern version of the classic Michelson-Morley experiment testing the isotropy of light propagation, where the measurement is performed by monitoring the resonance frequency of an optical resonator continuously rotating on a precision turntable. This currently allows a sensitivity at the $\Delta c/c = 10^{-17}$ level for a direction dependent variation of the speed of light, with the potential for improvements in precision by up to three orders of magnitude in the near future.