“Light, Time, and Einstein’s Relativity”
Special Public Nobel Laureate Lecture*

Colorado State University
7:30 pm, Monday Evening; October 26, 2015
Public Reception with Refreshments following the lecture
Location: BSB101 (Behavioral Sciences Building)

Dr. John Lewis Hall
JILA, University of Colorado and NIST
Boulder CO 80309-0440

*Sponsored by the Department of Physics and the College of Natural Science,
Colorado State University
Abstract

Even though this is the 55th year of the invention of the laser, the progress in the laser control and application to precision measurements is still accelerating. The Optical Frequency Comb technology, developed in 1999-2000, was the result from the synthesis of advances in independent fields of laser stabilization, ultrafast lasers, and nonlinear optical fibers. The ability to measure the frequency of light was improved drastically by a thousand times, and this allowed physicists to verify, to the 17th decimal digit, if physical constants are really constant in time, or if they have changed during the course of the universe. At present, "Time" is defined in the SI (metric) system by the well-established Cs atomic clock. Several Optical Frequency Standards already have far better performance than the Cs clock, and proposals are being considered to redefine "Time" by adopting a new “Atomic Clock” to “tick out the Seconds”. Advances in ultra-precise locking are also making possible stable optical frequencies defined by length and the speed of light, as well as by locking lasers to the resonant frequency of atoms. These two “clocks” represent our current prototypes of the clocks postulated by Einstein in 1905 in formulating the theory of Special Relativity, which now should be testable into the 18th decimal in a proposed Space-based experiment now being planned by our international Space-Time Asymmetry Research collaboration (STAR). An improvement in the modulation strategy may allow unexpectedly good frequency standard performance in a compact device, and so be useful on earth as well.

Biographical Information

Dr John L Hall was raised in Colorado and earned his PhD in 1961 at Carnegie Tech (Pittsburgh PA). At the National Bureau of Standards (now NIST in Boulder, CO), he pioneered the use of stabilized lasers to accomplish measurements of unprecedented accuracy and of fundamental physical interest. He introduced the methane/HeNe stabilized laser and, with his NBS team, used it to measure accurately the speed of light. In collaboration with other National Metrology Institutes (NPL, PTB, NRC and NMJ) the SI Meter was re-defined in 1983. His group has stabilized various tunable lasers (even diode lasers) to sub-Hz linewidths. He showed how fiber noise could be actively suppressed to deliver phase-stable light at a distant site. His group pioneered the “Optical Comb” techniques which allow simple and direct measurement of optical frequencies. For these works he was awarded the 2005 Nobel Prize in Physics, jointly with Prof. Hänsch of Munich and Prof. Glauber of Harvard. He has received numerous other peer-generated awards, has more than 235 refereed publications, and holds 11 US patents. He has been the thesis sponsor for 15 PhD students, co-advisor for 50 more, and his laboratory has hosted more than 150 Postdoctoral, Professional, and Visiting Faculty colleagues from all over the world.