

John L. Hall

Degrees:

B.S. 1956, Carnegie Institute of Technology
M.S. 1958, Carnegie Institute of Technology
Ph.D. 1961, Carnegie Institute of Technology

Appointments:

NRC Postdoctoral Fellow, National Bureau of Standards, 1961-1962
Physicist, National Bureau of Standards, 1962-1971
Fellow, Joint Institute for Laboratory Astrophysics (now JILA), 1964-present
Lecturer, Physics Department, University of Colorado, 1967-present
Senior Scientist, National Bureau of Standards (now National Institute of Standards and Technology), 1971-present

Honors and Awards:

National Carbon Company Fellow in Physics, 1957-1961
Department of Commerce Gold Medal, 1969
Samuel W. Stratton Award, 1971
Department of Commerce Gold Medal, 1974 (group awards)
IR-100: Laser stabilizer selected as one of “100 best new products of the year,” 1975
IR-100: Laser wavelength meter (“Lambdameter”) selected as one of “100 best new products of the year,” 1977
E. U. Condon Award, 1979
Charles Hard Townes Award of the Optical Society of America, 1984, jointly with V. P. Chebotayev (Academy of Sciences, USSR)
Davisson-Germer Prize of the American Physical Society, 1988
Docteur Honoris Causa de l’Universite Paris Nord, 1989
Frederic Ives Medal of the Optical Society of America, 1991
Arthur L. Shawlow Prize of the American Physical Society, 1993
Allen V. Astin Measurement Science Award, 2000
Max Born Award of the Optical Society of America, 2002
Presidential Rank Award from the Office of Personnel Management, 2002
Department of Commerce Gold Medal, 2002 (group awards)
I. I. Rabi Prize of the IEEE Society for Ultrasonic, FerroElectricity, and Frequency Control, 2004
Légion d’Honneur Membership, 2004
Nobel Prize in Physics, 2005
Nobel Prize Citation: “contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique”

Professional Associations:

Fellow, American Physical Society
Fellow, Optical Society of America
Member, International Union of Radio Science (URSI) Commission VII
Delegate, Consultative Committee for the Definition of the Meter (BIPM) Sevres, France, 1970-present
Member, NAC/Army Research Office Committee on Recommendations, 1976-1979

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Member, NRC/NAS National Research Committee on Fundamental Constants,
1976-1979
Member, Program Committee for International Conference on Quantum Electronics,
1978, 1996
Member, Academy of Science, 1984-present
Member, Program Committee for CLEO/QELS Conference, 1996

Publications:

- “Electron spin resonance of interstitial hydrogen atoms in CaF₂,” unpublished Ph.D. thesis, Carnegie Institute of Technology, August 1961.
- “Paramagnetic spectrum of interstitial hydrogen atoms in CaF₂,” Bull. Am. Phys. Soc. 6, 247 (1961), with R. T. Schumacher.
- “Overhauser polarization of Li nuclei in irradiated LiH,” Phys. Rev. 125, 428 (1962), with R. T. Schumacher.
- “Electron spin resonance of hydrogen atoms in CaF₂,” Phys. Rev. 127, 1892 (1962), with R. T. Schumacher.
- “Electron spin resonance of interstitial hydrogen atoms in CaF₂,” in LOW Symposium on Paramagnetic Resonances (Academic Press, New York, 1963), Vol. 1, pp. 206-216, with R. T. Schumacher.
- “Study of anthracene fluorescence excited by the ruby giant-pulse laser,” Phys. Rev. Lett. 11, 364 (1963), with D. A. Jennings and R. M. McClintock.
- “Laser double-quantum photodetachment of I⁻,” Phys. Rev. Lett. 14, 1013 (1965), with E. J. Robinson and L. M. Branscomb.
- “Two-quantum photoionization of Cs and I⁻,” IEEE J. Quantum Electron. QE-2, 361 (1966).
- “Optical heterodyne measurement of neon laser’s millimeter wave difference frequency,” Appl. Phys. Lett. 10, 152 (1967), with W. W. Morey.
- “Electron affinity of helium via laser photodetachment of its negative ion,” Phys. Rev. Lett. 19, 737 (1967), with B. Brehm and M. A. Gusinow.
- “Angular dependence of the laser photodetachment of the negative ions of carbon, oxygen and hydrogen,” J. Chem. Phys. 48, 943 (1968).
- “Laser wavelength standards,” IEEE J. Quantum Electron. QE-4, 367 (1968).
- “Precision long-path interferometry and the velocity of light,” IEEE J. Quantum Electron. QE-4, 371 (1968), with R. L. Barger, P. L. Bender, H. S. Boyne, J. E. Faller and J. Ward.

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Publications: (continued)

- “The laser absolute wavelength standard problem,” IEEE J. Quantum Electron. QE-4, 638 (1968).
- “Pressure shift and broadening of methane line at 3.39 μ studied by laser-saturated molecular absorption,” Phys. Rev. Lett. 22, 4 (1969), with R. L. Barger.
- “Collision effects on the line shape of laser-saturated molecular resonance absorption,” in Vith International Conference on the Physics of Electronic and Atomic Collisions: Abstracts of Papers (M.I.T. Press, Cambridge, MA, 1969), pp. 994-996.
- “Use of laser saturated absorption of methane for laser frequency stabilization,” in Proceedings, Frequency Control Symposium, Atlantic City, New Jersey, May 6-8, 1969, p. 309, with R. L. Barger.
- “Precision long-path interferometry and the velocity of light,” Electron Technology (Warsaw) 2, 53 (1969), with R. L. Barger, P. L. Bender, H. S. Boyne and J. E. Faller.
- “Absolute strain measurements with a 30 meter vacuum interferometer,” in Laser Applications in the Geosciences (Western Periodicals, North Hollywood, CA, 1970), pp. 215-225, with H. S. Boyne, R. L. Barger, P. L. Bender, J. Ward, J. Levine and J. Faller.
- “Laser stabilization on the 3.39 micron line of methane using saturated absorption,” Summary in Proceedings of the Symposium on Physics of Gas Lasers, Novosibirsk USSR, June 30-July 4, 1969.
- “Precision acceleration of gravity and velocity of light experiments using lasers,” Abstract in Proceedings, URSI Conference, Ottawa, Canada, August, 1969.
- “Laser frequency standards,” invited paper presented at Sixth International Quantum Electronics Conference, Kyoto, Japan, September 1970.
- “A methane-absorption stabilized 3.39 micron laser interferometer,” paper presented at Sixth International Quantum Electronics Conference, Kyoto, Japan, September 1970, with J. Levine.
- “Precision wavelength measurement of the methane 3.39 μm saturated absorption line by laser-controlled interferometry,” paper presented at Sixth International Quantum Electronics Conference, Kyoto, Japan, September 1970, with R. L. Barger.
- “A tunable dye laser with narrow spectral output,” Appl. Phys. Lett. 17, 239 (1970), with H. Walther.

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Publications: (continued)

- “Precision wavelength measurement of the methane 3.39 μm saturated absorption line by laser-controlled interferometry,” in Precision Measurement and Fundamental Constants (D. N. Langenberg and B. N. Taylor, Eds., NBS Spec. Publ. 343, 1971), p. 51, with R. L. Barger.
- “The implication of saturated molecular absorption for the laser wavelength standard problem,” in Precision Measurement and Fundamental Constants (D. N. Langenberg and B. N. Taylor, Eds., NBS Spec. Publ. 343, 1971), p. 49, with R. L. Barger.
- “Precision infrared Zeeman spectra of CH_4 studied by laser-saturated absorption,” *Phys. Rev. Lett.* 26, 289 (1971), with E. E. Uzgiris and R. L. Barger.
- “Design and operation of a methane absorption stabilized laser strainmeter,” *J. Geophys. Res.* 77, 2595 (1972), with J. Levine.
- “Molecular photodetachment spectrometry. I. The electron affinity of nitric oxide and the molecular constants of NO^- ,” *Phys. Rev. A* 6, 607 (1972), with M. W. Siegel, R. J. Celotta, J. Levine and R. A. Bennett.
- “Molecular photodetachment spectrometry. II. The electron affinity of O_2 and the structure of O_2^- ,” *Phys. Rev. A* 6, 631 (1972), with R. J. Celotta, R. A. Bennett, M. W. Siegel and J. Levine.
- “Frequency reproducibility of saturated absorption-stabilized lasers: The line center problem,” for Conference on Precision Electro-magnet Measurements, Boulder, June 1972, with G. Kramer and R. L. Barger.
- “Transient effects in saturated absorption,” in VIth International Conference on Quantum Electronics, Montreal, May 1972, Digest of Technical Papers, p. 74, with G. Kramer and R. L. Barger.
- “The speed of light from direct frequency and wavelength measurements of the methane stabilized laser,” *Phys. Rev. Lett.* 29, 1346 (1972), with K. M. Evenson, J. S. Wells, F. R. Peterson, B. L. Danielson, G. W. Day and R. L. Barger.
- “Saturated absorption optical heterodyne spectroscopy of some single methyl compounds,” VII International Quantum Electronics Conference, May 1972, Digest of Technical Papers, p. 44, with J. A. Magyar.
- “The line shape problem in laser saturated molecular absorption,” in Lectures in Theoretical Physics, Vol. XII (K. T. Mahanthappa and W. E. Brittin, Eds., Gordon and Breach, New York, 1973), pp. 161-210.
- “Saturated absorption line shape,” in Fundamental and Applied Laser Physics, Proceedings, Esfahan Symposium, August 29-September 5, 1971 (M. S. Feld, A.

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Publications: (continued)

Javan and N. Kurnit, Eds., Wiley, New York, 1973), pp. 463-477.

“Wavelength of the 3.39-micron laser-saturated absorption line of methane,” *Appl. Phys. Lett.* 22, 196 (1973), with R. L. Barger.

“Saturated absorption spectroscopy with applications to the 3.39 micron methane transition,” in Atomic Physics 3, Proceedings, Third International Conference on Atomic Physics, Boulder, CO, August 1972 (S. J. Smith and G. K. Walters, Eds., Plenum, New York, 1973), pp. 615-646.

“Frequency stabilization of a cw dye laser,” *Appl. Phys. Lett.* 22, 573 (1973), with R. L. Barger and M. C. Sorem.

“Measurement of methane hyperfine structure using laser saturated absorption,” *Phys. Rev. Lett.* 30, 1101 (1973), with C. J. Borde.

“Measurement of the relativistic Doppler shift using laser standing-wave saturation spectroscopy,” in Fourth International Conference on Atomic Phys: Abstracts of Contributed Papers, Heidelberg, July 22-26, 1974, with J. J. Snyder and M. S. Sorem.

“Sub-Doppler spectroscopy, methane hyperfine spectroscopy, and the ultimate resolution limits,” Colloques Internationaux du C.N.R.S. No. 217 - Methodes de Spectroscopie sans Largeur Doppler de Niveaux Excites de Systemes Moleculaires Simples (C.N.R.S., Paris, 1974), pp. 105-125.

“Laser photodetachment determination of the electron affinities of OH, NH₂, NH, SO₂ and S₂,” *J. Chem. Phys.* 60, 1740 (1974), with R. J. Celotta and R. A. Bennett.

“Ultrahigh resolution saturation absorption spectroscopy,” in Laser Spectroscopy, Proceedings of the Laser Spectroscopy Conference, Vail, Colorado, June 1973 (R. G. Brewer and A. Mooradian, Eds., Plenum, New York, 1974), pp. 125-142.

“Accuracy limitation of saturated absorption optical frequency standards by transverse Doppler effect,” *Bull. Am. Phys. Soc.* 19, 448 (1974), with C. J. Borde and C. V. Kunasz.

“A new measurement of the relativistic Doppler shift,” in Lecture Notes in Physics 43, Laser Spectroscopy, Proceedings, Second International Conference, Megeve, June 1975 (S. Haroche, J. C. Pebay-Peyroula, T. W. Hänsch and S. E. Harris, Eds., Springer-Verlag, Berlin, 1975), pp. 6-17, with J. J. Snyder.

“Progress in the theory of saturated absorption line shape,” Proceedings of the 2nd Symposium on Gas Laser Physics, Novosibirsk, USSR, June 1975, with C. J. Borde.

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Publications: (continued)

- “Direct resolution of the recoil doublets using saturated absorption techniques,”
Proceedings, Second Symposium on Gas Laser Physics, Novosibirsk, USSR,
June 1975, with C. J. Borde.
- “Stabilized lasers and the speed of light,” in Atomic Masses and Fundamental Constants,
Vol. 5 (J. H. Sanders and A. H. Wapstra, Eds., Plenum, New York, 1976), pp.
322-329.
- “Saturated absorption line shape: Calculation of the transit time broadening by a
perturbation approach,” *Phys. Rev. A* 14, 236 (1976), with C. J. Borde, C. V.
Kunasz and D. G. Hummer.
- “Interferometric real-time display of cw dye laser wavelength with sub-Doppler
accuracy,” *Appl. Phys. Lett.* 29, 367 (1976), with S. A. Lee.
- “High resolution saturated absorption studies of methane and some methyl-halides,” in
Topics in Applied Physics, Vol. 13: High Resolution Laser Spectroscopy (K.
Shimoda, Ed., Springer-Verlag, Berlin, 1976), pp. 173-199, with J. A. Magyar.
- “Control techniques for cw dye lasers,” in Tunable Lasers and Applications, Proceedings,
Leon Conference, Norway, 1976 (A. Mooradian, T. Jaeger and
P. Stokseth, Eds., Springer-Verlag, Berlin, 1976), pp. 361-366, with S. A. Lee.
- “Direct optical resolution of the recoil effect using saturated absorption spectroscopy,”
Phys. Rev. Lett. 37, 1339 (1976), with C. J. Borde and K. Uehara.
- “Shift and broadening of saturated absorption resonance due to curvature of the laser
wave fronts,” *Appl. Phys. Lett.* 29, 788 (1976), with C. J. Borde.
- “Saturated absorption with spatially separated laser fields: Observation of optical
‘Ramsey’ fringes,” *Phys. Rev. Lett.* 38, 159 (1977), with J. C. Bergquist and
S. A. Lee.
- “A traveling Michelson interferometer with phase-locked fringe interpolation,” in Laser
Spectroscopy III, Proceedings, Third International Conference, Jackson Lake
Lodge, Wyoming (J. L. Hall and J. L. Carlsten, Eds., Springer-Verlag, 1977),
pp. 421-422, with S. A. Lee.
- “Ramsey fringes in saturation spectroscopy,” in Laser Spectroscopy III, Proceedings,
Third International Conference, Jackson Lake Lodge, Wyoming (J. L. Hall and
J. L. Carlsten, Eds., Springer-Verlag, 1977), pp. 142-148, with J. C. Bergquist
and S. A. Lee.
- (Editor), Laser Spectroscopy III, Proceedings, Third International Conference, Jackson
Lake Lodge, Wyoming (Springer-Verlag, 1977), with J. L. Carlsten.

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Publications: (continued)

- “Spectroscopic investigations in ^{209}Bi I using tunable-cw-dye-laser spectroscopy,” *Phys. Rev. A* 18, 1089 (1978), with O. Poulsen.
- “Two photon transitions to Rydberg levels: Convenient, useful and precise reference wavelengths for dye lasers,” *Opt. Lett.* 3, 141 (1978), with S. A. Lee, J. Helmcke and B. P. Stoicheff.
- “Stabilized lasers and precision measurements,” *Science* 202, 147 (1978).
- “An improved laser test of the isotropy of space,” *Phys. Rev. Lett.* 42, 549 (1979), with A. Brillet.
- “Hyperfine splitting of the $^{13}\text{CH}_4$ line at 3.39 μm observed by laser-saturated absorption,” *Opt. Lett.* 4, 214-215 (1979), with K. Uehara.
- “High resolution two-photon spectroscopy of Rb Rydberg levels,” in Laser Spectroscopy IV, Proceedings, 4th International Conference, Rottach-Egern, Germany (H. Walther and K.W. Rothe, Eds., Springer-Verlag, 1979), pp. 130-141, with S. A. Lee and J. Helmcke.
- “An improved test of the isotropy of space using laser techniques,” in Laser Spectroscopy IV, Proceedings, 4th International Conference, Rottach-Egern, Germany (H. Walther and K.W. Rothe, Eds., Springer-Verlag, 1979), pp. 12-20, with A. Brillet.
- “Frequency stabilization of a 0.633 μm He-Ne longitudinal Zeeman laser,” *Appl. Opt.* 19, 3173-3177 (1980), with T. Baer and F. V. Kowalski.
- “Accurate wave-number measurements of uranium spectral lines,” *J. Opt. Soc. Am.* 71, 948-952 (1981), with B. A. Palmer, R. A. Keller and F. V. Kowalski.
- “Stable lasers and optical frequency standards for testing the postulates of physics,” in Atomic Physics, Vol. 7 (D. Kleppner and F. M. Pipkin, Eds., Plenum, New York, 1981), pp. 267-296.
- “Stabilized Lasers,” in Solar Instrumentation—What’s Next? (R. B. Dunn, Ed., SAC Peak National Observatory, Sunspot, NM, 1981), pp. 142-149, with T. Baer.
- “Optical heterodyne saturation spectroscopy,” *Appl. Phys. Lett.* 39, 680-683 (1981), with L. Hollberg, T. Baer and H. G. Robinson.
- “Precision spectroscopy and laser frequency control using FM sideband optical heterodyne techniques,” in Laser Spectroscopy, Proceedings, Fifth International Conference on Laser Spectroscopy (A. R. W. McKellar, T. Oka and B. P. Stoicheff, Eds., Springer-Verlag, Heiderberg, 1981), pp. 15-24, with T. Baer, L. Hollberg and H. G. Robinson.

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Publications: (continued)

- “Progress toward phase-stable optical frequency standards,” Proceedings, Third Symposium on Frequency Standards and Metrology, *J. Physique-Colloque* 42, Suppl. 12, C8 59-71 (1981), with L. Hollberg, L.-S. Ma, T. Baer and H. G. Robinson.
- “Lambda meter resolution enhancement using a novel frequency meter,” in CLEO Laser Conference, 1981, with J. J. Snyder, T. Baer and L. Hollberg.
- “Dye laser spectrometer for ultrahigh spectral resolution: Design and performance,” *Appl. Opt.* 21, 1686-1694 (1982), with J. Helmcke and S. A. Lee.
- “Laser phase and frequency stabilization using an optical resonator,” *Appl. Phys. B* 31, 97-105 (1983), with R. W. P. Drever, F. V. Kowalski, J. Hough, G. M. Ford, A. J. Munley and H. Ward.
- “Direct frequency measurement of the I₂-stabilized He-Ne 473-THz (633 nm) laser,” *Opt. Lett.* 8, 136 (1983), with D. A. Jennings, C. R. Pollock, F. R. Petersen, R. E. Drullinger, K. M. Evenson, J. S. Well and H. P. Layer.
- “Tunable laser stabilization techniques for ultrahigh resolution spectroscopy,” in Beijing/Shanghai Proceedings of an International Conference on Lasers, May 1980 (China Academic Publishers, Wiley, 1983), pp. 15-33.
- “Some remarks on the interaction between precision physical measurement and fundamental physical theories,” in Quantum Optics, Experimental Gravity, and Measurement Theory (P. Meystre and M. O. Scully, Eds., Plenum, New York, 1983), pp. 347-361.
- “The line shapes of sub-Doppler resonances observable with FM side-band (optical heterodyne) laser techniques,” in Advances in Laser Spectroscopy, NATO ASI Series B, Vol. 95 (F. T. Arecchi, F. Strumia and H. Walther, Eds., Plenum, 1983), pp. 99-126, with H. G. Robinson, T. Baer and L. Hollberg.
- “Laser gravitational wave experiment in space,” in 10th International Conference on General Relativity and Gravitation, Padova, Italy, July 1983, Contributed Papers Vol. 2 (B. Bertotti, F. de Felice and A. Pascolini, Eds., Consiglio Nazionale delle Ricerche, Rome, 1983), pp. 960-962, with J. E. Faller, P. L. Bender, Y. M. Chan, D. Hils and J. Hough.
- “Cooling of an atomic beam with frequency-sweep techniques,” in Laser-Cooled and Trapped Atoms, Proceedings, Workshop on Spectroscopic Applications of Slow Atomic Beams, NBS, Gaithersburg, MD, April 1983 (W. D. Phillips, Ed.) NBS Spec. Publ. 653 (1983), pp. 142-153, with R. Blatt and W. Ertmer.
- “Some candidate atoms and ions for frequency standards research using laser radiative cooling techniques,” in Laser-Cooled and Trapped Atoms, Proceedings,

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Publications: (continued)

Workshop on Spectroscopic Applications of Slow Atomic Beams, held at NBS, Gaithersburg, MD, April 1983 (W. D. Phillips, Ed.) NBS Spec. Publ. 653 (1983), pp. 154-161, with W. Ertmer and R. Blatt.

“Measurement of the positronium $1^3S_1 \rightarrow 2^3S_1$ two-photon transition,” in Laser Spectroscopy VI, Proceedings, Sixth International Conference, Interlaken, Switzerland, June 27-July 1, 1983 (H. P. Weber and W. Luthy, Eds., Springer-Verlag, 1983), pp. 28-33, with S. Chu and A. P. Mills, Jr.

“State-dependent hyperfine coupling of HF studied with a frequency-controlled color-center laser spectrometer,” in Laser Spectroscopy VI, Proceedings, Sixth International Conference, Interlaken, Switzerland, June 27-July 1, 1983 (H. P. Weber and W. Luthy, Eds., Springer-Verlag, 1983), pp. 138-143, with Ch. Breant, T. Baer and D. Nesbitt.

“Observation of energy level shifts of Rydberg atoms due to thermal fields,” in Laser Spectroscopy VI, Proceedings, Sixth International Conference, Interlaken, Switzerland, June 27-July 1, 1983 (H. P. Weber and W. Luthy, Eds., Springer-Verlag, 1983), pp. 229-232, with L. Hollberg.

“Dye-laser frequency stabilization using optical resonators,” Appl. Phys. B **33**, 179-185 (1984), with J. Hough, D. Hils, M. D. Rayman, L.-S. Ma and L. Hollberg.

“Measurement of the positronium $1^3S_1 \rightarrow 2^3S_1$ interval by Doppler-free two-photon spectroscopy,” Phys. Rev. Lett. **52**, 1689-1692 (1984), with S. Chu and A. P. Mills, Jr.

“Relativistic time dilation: A latter-day Ives-Stillwell experiment,” in Precision Measurement and Fundamental Constants II (B. N. Taylor and W. D. Phillips, Eds., NBS Spec. Publ. 617, 1984) pp. 671-673, with P. Nachman and M. D. Rayman.

“Optical frequency standards: Progress and applications,” in Precision Measurement and Fundamental Constants II (B. N. Taylor and W. D. Phillips, Eds., NBS Spec. Publ. 617, 1984) pp. 43-44.

“Precision measurements by optical heterodyne techniques,” in Laser-Based Ultrasensitive Spectroscopy and Detection V (SPIE, San Diego, CA, 1983), Vol. 426, pp. 91-98, with L. Hollberg, L.-S. Ma and M. Hohenstatt.

“Measurement of the shift of Rydberg energy levels induced by blackbody radiation,” Phys. Rev. Lett. **53**, 230-233 (1984), with L. Hollberg.

“External dye laser frequency stabilizer,” Opt. Lett. **9**, 502-504 (1984), with T. Hansch.

“Laser manipulation of atomic beam velocities: Demonstration of stopped atoms and

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Publications: (continued)

velocity reversal,” *Phys. Rev. Lett.* 54, 996-999 (1985), with W. Ertmer, R. Blatt and M. Zhu.

“Space antenna for gravitational wave astronomy,” Proceedings, Colloquium on Kilometric Optical Arrays in Space, October 1984, Corgese, Corsica, France (ESA SP-226, April 1985), pp. 157-163, with J. E. Faller, P. L. Bender, D. Hils and M. A. Vincent.

“Servo control of amplitude modulation in FM spectroscopy: Demonstration of shot-noise limited detection,” *J. Opt. Soc. Am. B* 2, 1527-1533 (1985), with N. C. Wong.

“Servo control of amplitude modulation in FM spectroscopy: Shot-noise limited measurement of water vapor pressure broadening,” in Laser Spectroscopy VII, Proceedings of the Seventh International Conference, Hawaii, 24-28 June 1985 (T. W. Hansch and Y. R. Shen, Eds., Springer-Verlag, 1985), pp. 393-394.

“Intracavity frequency doubling for the generation of squeezed states of light,” in Quantum Optics IV, Proceedings, Fourth International Symposium, Hamilton, New Zealand, February 1986 (J. D. Harvey and D. F. Walls, Eds., Springer, 1986), pp. 58-69, with H. J. Kimble.

“Stabilizing lasers, for applications in quantum optics,” in Quantum Optics IV, Proceedings, Fourth International Symposium, Hamilton, New Zealand, February 1986 (J. D. Harvey and D. F. Walls, Eds., Springer, 1986), pp. 273-284.

“Practical sound-reducing enclosure for laboratory use,” *Rev. Sci. Instrum.* 57, 2532-2534 (1986), with D. Hils and J. E. Faller.

“Atomic beam cooling: A simulation approach,” *Phys. Rev. A* 34, 3022-3033 (1986), with R. Blatt, W. Ertmer and P. Zoller.

“Generation of squeezed states by parametric down conversion,” *Phys. Rev. Lett.* 57, 2520-2523 (1986), with L.-A. Wu, H. J. Kimble and H. Wu.

“Principles of optical phase locking: Application to internal mirror He-Ne lasers phased locked via fast control of the discharge current,” *IEEE J. Quant. Electron.* QE-23, 427-437 (1987), with L.-S. Ma and G. Kramer.

“Response of a Fabry-Perot cavity to phase modulated light,” *Rev. Sci. Instrum.* 58, 1406-1412 (1987), with D. Hils.

“Towards the ultimate laser resolution,” in Laser Spectroscopy 8 (W. Persson and S. Svanberg, Eds., Springer-Verlag, Heidelberg, 1987), pp. 376-380, with D. Hils, C. Salomon and J.-M. Chartier.

“Fundamental tests of special relativity and the isotropy of space,” in Laser Spectroscopy

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Publications: (continued)

8 (W. Persson and S. Svanberg, Eds., Springer-Verlag, Heidelberg, 1987), pp. 52-55, with S. A. Lee, L.-U. A. Andersen, N. Bjerre, O. Poulsen and E. Riis.

“High resolution optical multiplex spectroscopy,” in Laser Spectroscopy 8 (W. Persson and S. Svanberg, Eds., Springer-Verlag, Heidelberg, 1987), pp. 388-389, with K. P. Dinse and M. P. Winters.

“Test of the isotropy of the speed of light using fast-beam laser spectroscopy,” Phys. Rev. Lett. 60, 81-84 (1988), with E. Riis, L.-U. A. Andersen, N. Bjerre, O. Poulsen and S. A. Lee.

“Frequency stability measurement on polarization-stabilized He-Ne lasers,” Appl. Opt. 27, 1285-1289 (1988), with T. M. Niebauer, J. E. Faller, H. M. Godwin and R. L. Barger.

“Laser stabilization at the millihertz level,” J. Opt. Soc. Am. B 5, 1576-1587 (1988), with Ch. Salomon and D. Hils.

“Doppler-free optical multiplex spectroscopy with stochastic excitation,” J. Opt. Soc. Am. B 5, 1825-1831 (1988), with K. P. Dinse and M. P. Winters.

“Generation of squeezed light by intracavity frequency doubling,” Phys. Rev. A 38, 4931-4934 (1988), with S. F. Pereira, M. Xiao and H. J. Kimble.

“Toward the ultimate laser spectroscopic resolution,” in XVI International Conference on Quantum Electronics Technical Digest (Japan Society of Applied Physics, Tokyo, 1988), pp. 4-5.

“External frequency stabilization of a commercial dye laser at the sub-Hertz level,” in XVI International Conference on Quantum Electronics Technical Digest (Japan Society of Applied Physics, Tokyo, 1988), pp. 374-375, with M. Zhu, F. Shimizu and K. Shimizu.

“Precise laser frequency scanning using frequency-synthesized optical frequency sidebands: Application to isotope shifts and hyperfine structure of mercury,” J. Opt. Soc. Am. B 6, 539-549 (1989), with M. D. Rayman and C. G. Aminoff.

“Ultrastable cavity-stabilized lasers with sub-Hertz line width,” Proceedings, Fourth International Symposium on Frequency Standards and Metrology (A. De Marchi, Ed., Springer-Verlag, Heidelberg, 1989), pp. 162-173, with D. Hils.

“Fundamental tests of the isotropy of space using fast-beam laser spectroscopy,” in Atomic Physics 11 (S. Haroche, J. C. Gay and G. Grynberg, Eds., World Scientific, Singapore, 1989), pp. 589-611, with O. Poulsen, N. Bjerre, E. Riis and S. A. Lee.

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Publications: (continued)

- “Riis et al. reply to Comment on ‘Test of the isotropy of the speed of light using fast-beam laser spectroscopy’,” *Phys. Rev. Lett.* 62, 842 (1989), with E. Riis, L.-U. Andersen, N. Bjerre, O. Poulsen and S. A. Lee.
- “A high resolution measurement of water vapor overtone absorption in the visible by frequency modulation spectroscopy,” *J. Opt. Soc. Am. B* 6, 2300-2308 (1989), with N. C. Wong.
- “A laser interferometer for gravitational wave astronomy in space,” Proceedings, Fifth Marcel Grossman Conference on General Relativity (World Scientific, Singapore, 1989), pp. 1759-1767, with R. T. Stebbins, P. L. Bender, J. E. Faller, D. Hils and M. A. Vincent.
- “Optical interferometer in space,” in Relativistic Gravitation Experiments in Space (R. W. Hellings, Ed., NASA Conf. Publ. 3046, 1989), pp. 80-88, with P. L. Bender, J. E. Faller, D. Hils, R. T. Stebbins and M. A. Vincent.
- “An antenna for laser gravitational-wave observations in space,” Proceedings, XXVII COSPAR Symp. 15 on Relativistic Gravitation, *Adv. Space Res.* 9, 107-111 (1989), with J. E. Faller, P. L. Bender, D. Hils, R. T. Stebbins and M. A. Vincent.
- “Prospects for using laser-prepared atomic fountains for optical frequency standards applications,” *J. Opt. Soc. Am. B* 6, 2194-2205 (1989), with M. Zhu and P. Buch.
- “Improved Kennedy-Thorndike experiment—a preliminary report,” in Laser Spectroscopy IX, (M. S. Feld and J. E. Thomas, Eds., Academic, 1989), pp. 376-381, with D. Hils.
- “Improved Kennedy-Thorndike experiment to test special relativity,” *Phys. Rev. Lett.* 64, 1697-1700 (1990), with D. Hils.
- “Microwave and optical lunar transponders,” in Astrophysics from the Moon, AIP Conf. Proc. 207 (Am. Instit. Phys., 1990), pp. 647-653, with P. L. Bender, J. E. Faller, J. J. Degnan, J. O. Dickey, X X Newhall, J. G. Williams, R. W. King, L. O. Macknik, D. O’Gara, R. L. Ricklefs, P. J. Shelus, A. L. Whipple, J. R. Wiant and C. Veillet.
- “Correlated spontaneous emission in a Zeeman laser,” in New Frontiers in Quantum Electrodynamics and Quantum Optics, Proceedings, NATO Advanced Study Institute, August 1989, Istanbul, Turkey (A. O. Barut, Ed., Plenum, 1990), pp. 193-201, with M. P. Winters.
- “Correlated spontaneous emission in a Zeeman laser,” *Phys. Rev. Lett.* 65, 3116-3119 (1990), with M. P. Winters and P. Toschek.
- “Optical heterodyne spectroscopy enhanced by an external optical cavity: Toward

J. L. Hall

Publications: (continued)

improved working standards,” *IEEE J. Quant. Electron.* 26, 2006-2012 (1990), with L.-S. Ma.

“Continuous high-flux monovelocity atomic beam based on a broadband laser cooling technique,” *Phys. Rev. Lett.* 67, 46-49 (1991), with M. Zhu and C. W. Oates.

“Coherent atomic mirrors and beam splitters by adiabatic passage in multilevel systems,” *Phys. Rev. A* 44, R4118-4121 (1991), with P. Marte and P. Zoller.

“High-resolution optical multiplex spectroscopy,” *J. Opt. Soc. Am. B* 9, 498-506 (1992), with M. P. Winters, C. W. Oates and K. P. Dinse.

“Coherent deflection of atoms by adiabatic passage in multilevel systems,” in Coherence Phenomena in Atoms and Molecules in Laser Fields (A. D. Bandrauk and S. C. Wallace, Eds., NATO ASI Series Vol. B-287, Plenum, 1992), pp. 231-240, with P. Marte and P. Zoller,

“Atomic beam splitters and mirrors by adiabatic passage in multilevel systems,” in Foundations of Quantum Mechanics, Santa Fe Workshop, May 1991 (T. D. Black et al., Eds., World Scientific, Singapore, 1992), pp. 298-307, with P. Marte and P. Zoller.

“Correlated spontaneous emission in a Zeeman laser,” in Foundations of Quantum Mechanics, Santa Fe Workshop, May 1991 (T. D. Black et al., Eds., World Scientific, Singapore, 1992), pp. 349-355, with P. Winters.

“Dreams about the next generation of super-stable lasers,” in Tenth International Conference on Laser Spectroscopy (M. Ducloy et al., Eds., World Scientific 1992), pp. 83-90, with M. Zhu and D. Hils.

“An introduction to phase-stable optical sources,” in International School of Physics ‘Enrico Fermi’, Course CXVIII, Laser Manipulation of Atoms and Ions (E. Arimondo, W.D. Phillips, and F. Strumia, Eds., North Holland, 1992), pp. 671-702.

“Stabilization of optical phase/frequency of a laser system—application to a commercial dye laser with an external stabilizer,” *J. Opt. Soc. Am. B* 10, 802-816 (1993), with M. Zhu.

“Frequency stabilized lasers—a parochial review,” in Frequency-Stabilized Lasers and Their Applications, SPIE Proc. Vol. 1837 (1993), pp. 2-15.

“Improved hyperfine measurements of Na 5p excited state through frequency-controlled Dopplerless spectroscopy in a Zeeman magneto-optic laser trap,” *Opt. Lett.* 18, 1186-1188 (1993), with M. Zhu and C. W. Oates.

J. L. Hall

Publications: (continued)

“A low-noise high-speed diode laser current controller,” *Rev. Sci. Instrum.* 64, 2133-2135 (1993), with K. G. Libbrecht.

“Intensity dependent phase shifts infrequency modulation spectroscopy,” in Laser Spectroscopy, 11th International Conference (L. Bloomfield et al., Eds., AIP Conf. Proc. 290, 1994), pp. 302-304, with H.-R. Xia, J. I. Cirac, S. Swartz, B. Kohler, D. S. Elliott and P. Zoller.

“Phase shifts and intensity dependence in frequency-modulation spectroscopy,” *J. Opt. Soc. Am. B* 11, 721-730 (1994), with H.-R. Xia, J. I. Cirac, S. Swartz, B. Kohler, D. S. Elliott and P. Zoller.

“Frequency stabilized lasers—a driving force for new spectroscopies,” Proceedings, International School of Physics ‘Enrico Fermi’ Course CXX, Frontiers in Laser Spectroscopy (T. Hansch and M. Inguscio, Eds., North Holland, Amsterdam, 1994), pp. 217-239.

“Frequency stabilized lasers—from the beginning toward the future,” *Laser Physics* (Moscow) Memorial Issue Honoring V. P. Chebotayev (January 1994).

“Delivering the same optical frequency at two places: Accurate cancellation of phase noise introduced by optical fiber or other time-varying path,” *Opt. Lett.* 19, 1777-1779 (1994), with L.-S. Ma, P. Jungner and J. Ye.

“Stability and absolute frequency of molecular iodine transitions near 532 nm,” in Laser Frequency Stabilization and Noise Reduction, SPIE Proc. Vol. 2378 (1995), pp. 22-34, with P. Jungner, M. Eichhoff, S. Swartz and J. Ye.

“Optical frequency standard at 532 nm,” Proceedings, Conference on Precision Electromagnetic Measurements, *IEEE Trans. Instrum. Meas.* 44, 155-158 (1995), with M. L. Eickhoff.

“Absolute frequency of the molecular iodine transition R(56) 32-0 near 532 nm,” in Proceedings, Conference on Precision Electromagnetic Measurements, *IEEE Trans. Instrum. Meas.* 44, 151-154 (1995), with P. Jungner, S. Swartz, M. Eickhoff, J. Ye and S. Waltman.

“Accurate cancellation (to milliHertz levels) of optical phase noise due to vibration or insertion phase in fiber transmitted light,” in Laser Frequency Stabilization and Noise Reduction, SPIE Proc. Vol. 2378 (San Jose, 1995), pp. 165-175, with L.-S. Ma, P. Jungner and J. Ye.

“Hyperfine structure and absolute frequency of the ⁸⁷Rb 5P_{3/2} state,” *Opt. Lett.* 21, 1280-1282 (1996), with J. Ye, S. Swartz and P. Jungner.

“Sub-Doppler optical frequency reference at 1.064 μm via ultrasensitive cavity-enhanced

J. L. Hall

Publications: (continued)

- FM spectroscopy of C₂HD overtone transition,” Opt. Lett. 21, 1000-1002 (1996), with J. Ye and L.-S. Ma.
- “A new modulation method for sensitive nonlinear spectroscopy—application to molecular overtones as visible frequency references,” in Laser Spectroscopy XII (M. Inguscio, M. Allegrini and A Sasso, Eds., World Scientific, Singapore, 1996), pp. 199-203, with L.-S. Ma, J. Ye, and P. Dube.
- “High precision linewidth measurement of laser-cooled atoms: Resolution of the Na 3p ²P_{3/2} lifetime discrepancy,” Phys. Rev. Lett. 16, 2866-2869 (1996), with C. W. Oates and K. R. Vogel.
- “Thermally-induced self-locking by overtone absorption from acetylene gas in an external optical cavity,” J. Opt. Soc. Am. B 13, 2041-2054 (1996), with P. Dube, L.-S. Ma and J. Ye.
- “Optical frequency standards—some improvements, some measurements and some dreams,” Proceedings, Fifth Symposium on Frequency Standards and Metrology (J. C. Bergquist, Ed., World Scientific, 1996), pp. 267-276, with J. Ye, L.-S. Ma, S. Swartz, P. Jungner and S. Waltman.
- “Free-induction decay in molecular iodine measured with an extended-cavity diode laser,” Opt. Lett. 22, 184-186 (1997), with P. Dube and M. D. Levenson.
- “Real-time precision refractometry: new approaches,” Appl. Opt. 36, 1223-1234 (1997), with M. L. Eickhoff.
- “Ultrastable optical frequency reference at 1.064 micrometers using a C₂HD molecular overtone transition,” IEEE Trans. Instrum. Meas. 46, 178-182 (1997), with J. Ye and L.-S. Ma.
- “Highly-selective terahertz optical frequency comb generator,” Opt. Lett. 22, 301-303 (1997), with J. Ye, L.-S. Ma and T. Day.
- “Ultrasensitive high resolution laser spectroscopy and its application to optical frequency standards,” in 28th Annual Precise Time and Time Interval (PTTI), Applications and Planning Meeting (US Naval Observatory, 1997), pp. 289-303.
- “Ultrasensitive detections in atomic and molecular physics: demonstration in molecular overtone spectroscopy,” J. Opt. Soc. Am. B 15, 6-15 (1998), with J. Ye and L.-S. Ma.
- “Influence of decorrelation on Heisenberg-limited interferometry with quantum correlated photons,” Phys. Rev. A 57, 4004-4013 (1998), with T. Kim, O. Pfister, J. Noh and M. J. Holland.

J. L. Hall

Publications: (continued)

- “Frequency stabilization of tunable lasers,” in Atomic, Molecular and Optical Physics: Electromagnetic Radiation (F. B. Dunning and R. G. Hulet, Eds., Experimental Methods in the Physical Sciences Series, Vol. 29C, Academic, San Diego, 1997), pp. 103-136, with M. Zhu.
- “Precise wavelength measurement of tunable lasers,” in Atomic, Molecular, and Optical Physics: Electromagnetic Radiation (R. B. Dunning and R. G. Hulet, Eds., Experimental Methods in the Physical Sciences Series, Vol. 29C, Academic, San Diego, 1997), pp. 311-341.
- “A portable I_2^- stabilized Nd:YAG laser for wavelength standards at 532 nm and 1064 nm,” in Recent Developments in Optical Gauge Block Metrology (SPIE Conf. Vol. 3477, 1998), pp. 2-10, with F. L. Hong, J. Ishikawa, T. H. Yoon, L.-S. Ma and Y. Ye.
- “Experimental demonstration of some aspects of LISA interferometry,” in Laser Interferometer Space Antenna (W. M. Folkner, Ed., AIP Conf. Proc. 456, 1998), pp. 169-171, with J. A. Giaime, R. T. Stebbins, P. L. Bender and J. E. Faller.
- “Optical heterodyne detection at a silver scanning tunneling microscope junction,” J. Appl. Phys. 85, 1311-1316 (1999), with T. Kokubo and A. Gallagher.
- “Cold collisions of Sr^*-Sr in a magneto-optical trap,” Phys. Rev. A 59, 1216-1222 (1999), with T. P. Dinneen, K. R. Vogel and A. Gallagher.
- “Using FM methods with molecules in a high finesse cavity: a demonstrated path to $<10^{-12}$ absorption sensitivity,” in Ultrasensitive Detection (K. Busch and M. Busch, Eds., American Chemical Society, 1999), pp. 233-253, with J. Ye and L.-S. Ma.
- “Frequency comparison of $^{127}I_2^-$ stabilized Nd:YAG lasers,” IEEE Trans. Instrum. Meas. 48, 532-536 (1999), with F.-L. Hong, J. Ishikawa, J. Yoda, J. Ye and L.-S. Ma.
- “Absolute frequency atlas of molecular I_2 lines at 532 nm,” IEEE Trans. Instrum. Meas. 48, 544-549 (1999), with J. Ye, L. Robertsson, S. Picard and L.-S. Ma.
- “Stabilization and frequency measurement of the I_2^- stabilized Nd:YAG laser,” IEEE Trans. Instrum. Meas. 48, 583-586 (1999), with L.-S. Ma, M. Taubman, B. Tiemann, P.-L. Hong, O. Pfister and Y. Ye.
- “Narrow-line Doppler cooling of strontium to the recoil limit,” IEEE Trans. Instrum. Meas. 48, 618-621 (1999), with K. R. Vogel, T. P. Dinneen and A. Gallagher.
- “Short and long term stability of optical oscillators,” Proceedings, IEEE Frequency Control Symposium, pp. 44-55, with M. Zhu.
- “Optical frequency standards: Progress and applications,” in Laser Spectroscopy XIII, pp. 75-80, with J. Ye, L.-S. Ma, K. Vogel and T. Dinneen.

J. L. Hall

Publications: (continued)

- “Ultrasensitive detections of weak resonances—applications to optical frequency standards,” in Laser Spectroscopy XIII, pp. 81-86, with J. Ye and L.-S. Ma.
- “Experiments with strontium in a vapor cell magneto-optic trap,” in Methods for Ultrasensitive Detection (B. L. Fearey, Ed., SPIE Proc. Vol. 3270), pp. 77-84, with K. R. Vogel, T. P. Dinneen and A. Gallagher.
- “Cavity-enhanced frequency modulation spectroscopy: Advancing optical detection sensitivity and laser frequency stabilization,” in Methods for Ultrasensitive Detection (B. L. Fearey, Ed., SPIE Proc. Vol. 3270), pp. 85-97, with J. Ye and L.-S. Ma.
- “Near-recoil-limited temperatures obtained by laser trapping on the narrow $^1S_0 \rightarrow ^3P_1$ intercombination transition of neutral strontium,” in 1999 Joint Meeting EFTF - IEEE International Frequency Control Symposium (IEEE, 1999), pp. 692-695, with K. R. Vogel, T. P. Dinneen and A. Gallagher.
- “Ultrasensitive FM spectroscopy enhanced by a high finesse optical cavity: theory and application to overtone transitions of C_2H_2 and C_2HD ,” J. Opt. Soc. Am. B 16, 2255-2268 (1999), with L.-S. Ma, J. Ye and P. Dube.
- “Broadband optical frequency comb generation with a phase modulated parametric oscillator,” Opt. Lett. 24, 1747-1749 (1999), with S. A. Diddams, L.-S. Ma and J. Ye.
- “Broadband optical comb generation with a frequency modulated parametric oscillator,” Proceedings, ICOLS 99, pp. 350-351, with S. A. Diddams, L.-S. Ma and J. Ye.
- “Optical phase lock in the microradian domain--potential application to the NASA spaceborne optical measurement,” Opt. Lett. 24, 1838-1840 (1999), with J. Ye.
- “Cancellation of laser FM dither from optical frequency standards,” Opt. Lett. 25, 311-313 (2000), with J. S. Taubman.
- “Optical frequency measurement across a 104 THz gap using a femtosecond laser frequency comb,” Opt. Lett. 25, 186-188 (2000), with S. A. Diddams, D. J. Jones, L.-S. Ma and S. T. Cundiff.
- “Frequency comb generation using femtosecond pulses and cross-phase modulation in optical fiber at arbitrary center frequencies,” Opt. Lett. 25, 308-310 (2000), with D. J. Jones, S. A. Diddams, M. S. Taubman, S. T. Cundiff and L.-S. Ma.
- “Stabilizing and measuring optical frequencies,” in Laser Spectroscopy XIV International Conference (R. Blatt et al., Eds., World Scientific, 1999), pp. 51-60, with M. S. Taubman, S. A. Diddams, B. Tiemann, J. Ye, L.-S. Ma, D. Jones and S. T. Cundiff.

J. L. Hall

Publications: (continued)

- “Kilohertz linewidth from frequency-stabilized mid-infrared quantum cascade lasers,” *Opt. Lett.* 24, 1844-1846 (1999), with R. M. Williams, J. F. Kelly, J. S. Hartman, S. W. Sharpe, M. S. Taubman, F. Capasso, C. Gmachl, D. L. Sivco, J. N. Baillargeon and A. Y. Cho.
- “A new high-resolution frequency standard at 1030 nm for Yb:YAG solid state lasers,” *J. Opt. Soc. Am. B* 17, 927-931 (2000), with J. Ye and L.-S. Ma.
- “Experimental demonstration of signal extraction for LISA,” in (AIP Conf. Proc., in press), with O. Jennrich, R. T. Stebbins, P. L. Bender, J. A. Giaime and J. E. Faller.
- “Laser stabilization,” in *Handbook of Optics, Vol. IV: Fiber Optics and Nonlinear Optics* (M. Bass, Ed., McGraw-Hill, 2001), pp. 27-1-27.24, with M. S. Taubman and J. Ye.
- “Measurement of mirror birefringence at the sub-ppm level: proposed application to a test of QED,” *Phys. Rev. A* 62, 013815/1-8 (2000), with J. Ye and L.-S. Ma.
- “Cavity ringdown heterodyne spectroscopy: High sensitivity with microwatt light power,” *Phys. Rev. A* 61, 061802(R)/1-4 (2000), with J. Ye.
- “Carrier-envelope phase control of femtosecond mode-locked lasers and direct optical frequency synthesis,” *Science* 288, 635-639 (2000), with D. J. Jones, S. A. Diddams, J. K. Ranka, A. Stentz, R. S. Windeler and S. T. Cundiff.
- “Absolute frequency measurement of the iodine-stabilized He-Ne laser at 633 nm,” *Appl. Phys. B* 72, 221-226 (2001), with T. H. Yoon and J. Ye.
- “Common-path heterodyne interferometer for surface profiling in microelectronic fabrication,” *Rev. Sci. Instrum.* 72, 2455-2466 (2001), with E. J. Klein and W. F. Ramirez.
- “Precision phase control of ultrawide bandwidth fs laser – A network of ultrastable frequency marks across the visible spectrum,” *Opt. Lett.* 25, 1675-1677 (2000), with J. Ye and S. A. Diddams.
- “Accuracy comparison of optical frequency measurement between harmonic-generation synthesis and a frequency division femtosecond-comb,” *Phys. Rev. Lett.* 85, 3797-3800 (2000), with J. Ye, T. H. Yoon, A. A. Madej, J. E. Bernard, K. J. Siemsen, L. Marmet, J.-M. Chartier and A. Chartier.
- “Phase-coherent multi-level two-photon transitions in cold Rb atoms: Ultrahigh resolution spectroscopy via frequency stabilized femtosecond laser,” *Phys. Rev. A* 63, 011402(R)/1-4 (2001), with T. H. Yoon, A. Marian and J. Ye.
- “Rotation dependence of electric quadrupole hyperfine interaction in the ground state of molecular iodine by high resolution laser spectroscopy,” *J. Opt. Soc. Am. B* 18,

J. L. Hall

Publications: (continued)

379-387 (2001), with F.-L. Hong, J. Ye, L.-S. Ma, S. Picard and C. J. Borde.

“Precision measurement with lasers/The first four revolutions,” *IEEE J. Quantum Electron.* (submitted).

“Merging the ultrasensitive, the ultrastable, and the ultrafast: A new epoch of frequency standards and optical frequency measurement,” *Optics and Photonics News* February 2001, pp. 45-50, with J. Ye.

“Direct rf to optical frequency measurements with a femtosecond laser comb,” in *Proceedings, CPEM 2000, IEEE Trans. Instrum. Meas.* **IM-50**, 552-555 (2001), with S. A. Diddams, D. J. Jones, J. Ye, S. T. Cundiff, J. K. Ranka and R. S. Windeler.

“Optical frequency synthesis based on modelocked lasers,” *Rev. Sci. Instrum.* 72, 3749-3771 (2001), with S. T. Cundiff and J. Ye.

“Carrier-envelope phase stabilization of modelocked lasers,” in Optical Pulse and Beam Propagation III (T. B. Band, Ed., SPIE Vol. 4271, 2001), pp. 188-192, with T. M. Fortier, D. J. Jones, S. A. Diddams, J. Ye and S. T. Cundiff.

“Optical frequency measurement: 40 years of technology revolutions,” *IEEE J. Selected Topics Quantum. Electron.* 6, 1136-1144 (2000).

“High-resolution Rb two-photon spectroscopy with ultrafast lasers,” in Laser Frequency Stabilization, Standards, Measurement, and Applications (J. L. Hall and J. Ye, Eds., SPIE Proc. Vol. 4269, 2001), pp. 50-58, with T. H. Yoon, A. Marian and J. Ye.

“Active synchronization and carrier phase locking of two separate mode-locked femtosecond lasers,” *J. Mod. Opt.* 49, 401-409 (2002), with R. K. Shelton, L.-S. Ma, H. C. Kapteyn, M. M. Murnane and Y. Je.

“Synchronization and phase lock of two mode-locked femtosecond lasers,” in Laser Frequency Stabilization, Standards, Measurement, and Applications (J. L. Hall and J. Ye, Eds., SPIE Proc. Vol. 4269, 2001), pp. 1105-1111, with R. K. Shelton, L.-S. Ma, H. C. Kapteyn, M. M. Murnane and J. Ye.

“Ultra-sensitive spectroscopy, the ultra-stable lasers, the ultrafast lasers, and the seriously-nonlinear fiber: A new alliance for physics and metrology,” *J. Quantum Electron.* (special issue on Optical Frequency Measurement) 37, 1482-1492 (2001), with J. Ye, S. A. Diddams, L.-S. Ma, S. T. Cundiff and D. J. Jones.

“Phase-coherent optical pulse synthesis from separate femtosecond lasers,” *Science* 293, 1286-1289 (2001), with R. K. Shelton, L.-S. Ma, H. C. Kapteyn, M. M. Murnane and J. Ye.

J. L. Hall

Publications: (continued)

- “Molecular iodine clock,” *Phys. Rev. Lett.* 87, 270801/1-4 (2001), with J. Ye and L.-S. Ma.
- “Laser frequency Stabilization, Standards, Measurement, and Applications,” (*SPIE Proc.*, Vol. 4269, 2001), p. 280, with J. Ye, Eds.
- “Analysis/reduction of residual amplitude modulation in phase/frequency modulation by an EOM,” in 2002 Conference on Quantum Electronics (QELS), pp. 91-92, with C. Ishibashi and J. Ye.
- “Quantum noise limited detection of absorption in high finesse cavities enabled by modulation techniques,” in *Cavity Enhanced Spectroscopy* (Academic, in press), with J. Ye.
- “Sub-Doppler molecular iodine transitions near the dissociation limit (523 to 498 nm),” *Opt. Lett.* 27, 571-573 (2002), with W.-Y. Cheng, L. Chen, T. H. Yoon and J. Ye.
- “Subfemtosecond timing jitter between two independent actively synchronized, mode-locked lasers,” *Opt. Lett.* 27, 312-314 (2002), with R. K. Shelton, S. M. Foreman, L.-S. Ma, H. C. Kapteyn, M. M. Murnane, M. Notcutt and J. Ye.
- “Issues and applications in ultra-sensitive molecular spectroscopy,” in *Photonics West 2002 LASE* (*SPIE Proc.* Vol. 4634, 2002) pp. 58-69, with C. Ishibashi and J. Ye.
- “Absolute frequency measurement of the iodine-based length standard at 514.67 nm,” *Appl. Phys. B* 74, 597-701 (2002), with R. J. Jones, W.-Y. Cheng, K. W. Holman, L. Chen and J. Ye.
- “Dynamics in a two-level atom magneto-optical trap,” *Phys. Rev. A* 66, 011401(R)/1-4 (2002), with X. Xu, T. H. Loftus, M. J. Smith, A. Gallagher and J. Ye.
- “A new type of frequency chain and its application to fundamental frequency metrology,” in *Hydrogen II: The Physics of Simple Atomic Systems* (S. G. Karshenboim et al., Eds., Springer, 2001), p. 125, with T. Udem, J. Reichert, R. Holzwarth, S. Diddams, D. Jones, J. Ye, S. Cundiff and T. Hansch.
- “Continuously tunable, precise, single frequency optical signal generator,” *Opt. Lett.* 10, 515-520 (2002), with J. D. Jost and J. Ye.
- “External laser stabilization,” in *Laser Physics at the Limit*, in Honour of the 60th birthday of Theodor W. Hansch (H. Figger, D. Meschede and C. Zimmerman, Eds., 2002), pp. 51-59.
- “Merging two independent femtosecond lasers into one,” in *ICOLS 2001* (S. Chu, Ed., World Scientific, Singapore, 2002), pp. 309-312, with L.-S. Ma, R. K. Shelton, H. C. Kapteyn, M. M. Murnane, and J. Ye.

J. L. Hall

Publications: (continued)

- “Coherent optical frequency synthesis and distribution,” in ICOLS 2001 (S. Chu. Ed., World Scientific, Singapore, 2002), pp. 97-105, with J. Ye, J. Jost, L.-S. Ma and J.-L. Peng.
- “Phase-coherent synthesis of optical frequencies and waveforms,” *Appl. Phys. B* 74, (Suppl.) S27-S34 (2002), with J. Ye, S. T. Cundiff, S. Foreman, T. M. Fortier, K. W. Holman, D. J. Jones, J. D. Jost, H. C. Kapteyn, K. A. H. V. Leeuwen, L. S. Ma, M. M. Murnane, J. L. Peng and R. K. Shelton.
- “Measurement of dynamics in strontium magneto-optical trap,” in Quantum Electronics and Laser Science Conference Technical Digest (QELS 2002), pp. 53-54, with X. Xu, M. J. Smith, A. Gallagher and J. Ye.
- “Satellite-satellite laser links for future gravity missions,” in Proceedings, ISSI Workshop on Earth Gravity Field from Space, *Space Sci. Rev.* 108, 377-384 (2003), with P. L. Bender, J. Ye and W. M. Klipstein.
- “Optical frequency standards and measurement,” in Proceedings, CPEM 2002, U. Feller, Ed., *IEEE Trans. Instrum. Meas.* 52, 240-244 (2003), with J. Ye.
- “Cooling and trapping of atomic strontium,” *J. Opt. Soc. Am. B* 20, 968-976 (2003), with X. Xu, T. H. Loftus, A. Gallagher and J. Ye.
- “Carrier-envelope phase stabilization of single and multiple femtosecond lasers,” in Few Cycle Pulse Generation and Its Applications, Topics in Applied Physics 95 (F. X. Kaertner, Ed., Springer, 2004), pp. 317-343, with D. J. Jones, S. T. Cundiff, T. M. Fortier and J. Ye.
- “Delivery of high stability optical and microwave frequency standards over an optical fiber network,” *J. Opt. Soc. Am. B* 20, 1459-1467 (2003), with J. Ye, J.-L. Peng, R. J. Jones, K. W. Holman, D. J. Jones, S. A. Diddams, J. Kitching, S. Bize, J. C. Bergquist, L. W. Hollberg, L. Robertsson and L.-S. Ma.
- “From stable lasers to optical-frequency clocks,” in Proceedings of the 6th Symposium on Frequency Standards and Metrology (P. Gill, Ed., World Scientific, 2002), pp. 387-400, with J. Ye, L.-S. Ma, J.-L. Peng, M. Notcutt, J. D. Jost and A. Marian.
- “Control of coherent light and its broad applications,” in Proceedings, 2002 International Conference on Atomic Physics (H. R. Sadeghpour et al., Eds., 2002) available on the web at “XVIII ICAP 2002 Proceedings,” with J. Ye, R. J. Jones, K. Holman, S. Foreman, D. J. Jones, S. T. Cundiff, T. M. Fortier and A. Marian.
- “Single-stage sub-Doppler cooling of alkaline earth atoms,” *Phys. Rev. Lett.* 90, 193002/1-4 (2003), with X. Xu, T. H. Loftus, J. W. Dunn, C. H. Greene, A. C. Gallagher and J. Ye.

J. L. Hall

Publications: (continued)

- “Optical frequency standards and their measurement,” in An Isolated Atomic Particle at Rest in Free Space, (E. N. Fortson, Ed., Narosa Publishing House, New Delhi, 2004) p. 2321, with J. Ye (Invited).
- “Comparison of independent optical frequency measurements using a portable iodine-stabilized Nd:YAG laser,” *IEEE Trans. Instrum. Meas.* 52, 240-244 (2003), with F.-L. Hong, J. Ishikawa, K. Sugiyama, A. Onae, H. Matsumoto and J. Ye.
- “Optical clockwork without carrier-envelope phase control,” in Proceedings, 17th Annual Meeting IEEE Lasers and Electro-Optics Society (LEOS, 2004), Vol. 2, pp. 525-526, with O. D. Mucke, O. Kuzucu, F. Wong, E. P. Ippen, F. X. Kaertner, S. M. Foreman, D. J. Jones, L.-S. Ma and J. Ye.
- “Experimental implementation of optical clockwork without carrier-envelope phase control,” in Proceedings, Conference on Lasers and Electro-Optics (CLEO, 2004), pp. 1060-1061, with O. D. Mucke, O. Kuzucu, N. C. Wong, E. P. Ippen, F. X. Kaertner, S. M. Foreman, D. J. Jones, L.-S. Ma and J. Ye..
- “Carrier-envelope phase stabilization of single and multiple femtosecond lasers,” in *Few Cycle Pulse Generation and Its applications, Topics in Applied Physics 95* (F. X. Kaertner, Ed., Springer, 2004), pp. 317-343.
- “Simple and compact Hz-level linewidth laser system via improved mounting configuration of a reference cavity,” in 2005 Conference on Lasers & Electro-Optics (CLEO), pp. 1408-1410, with M. Notcutt, A. Ludlow, J. Ye and L.-S. Ma.
- “Simple and compact 1-Hz laser system via improved mounting configuration of a reference cavity,” *Opt. Lett.* 30, 1815-1817 (2005), with M. Notcutt, L.-S. Ma and J. Ye.
- “Contribution of thermal noise to frequency stability of rigid optical cavity via Hertz-linewidth lasers,” *Phys. Rev. Lett.* 73, 031804(R)/1-4 (2006), with M. Notcutt, L.-S. Ma, A. D. Ludlow, S. M. Foreman and J. Ye.
- “Improving laser coherence,” in Proceedings, Laser Spectroscopy XVII, (E. Hinds, A. Ferguson and E. Riis, Eds., World Scientific, Singapore, 2006), p. 3, with M. Notcutt and J. Ye.
- “Defining and measuring optical frequencies,” in 2005 Nobel Lecture in Physics, http://nobelprize.org/nobel_prizes/physics/laureates/2005/nobelfoundation/publications/lesprix.html, Les Prix Nobel (K. Grandin, Ed., Nobel Foundation, 2006).
- “Nobel lecture: Defining and measuring optical frequencies,” *Rev. Mod. Phys.* 78, 1279-1295 (2006).
- “Vibration-induced elastic deformation of Fabry-Perot cavities,” *Phys. Rev. A* 74, 053801/1-13 (2006), with L. Chen, J. Ye, T. Yang, E. Zang and T. Li.

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Publications: (continued)

“Collaboration and style in laser physics - my interactions with and recollections of Herbert Walther,” *Laser Physics* 17, 908-911 (2007).

“Rulers of light,” *Sci. Am.* 298, 74-81 (April 2008), with S. T. Cundiff and J. Ye.

“Laser stabilization, 2008 version,” in *OSA Handbook of Optics, Fiber Optics and Nonlinear Optics* (in press), with M. S. Taubman and J. Ye.

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Patents:

- #4,165,183, August 21, 1979, "Fringe-counting interferometric system for high accuracy measurements," with S. A. Lee.
- #4,398,293, August 9, 1983, "Frequency stabilization for two-mode laser," with T. M. Baer and F. V. Kowalski.
- #4,590,597, May 20, 1986, "Modulation transfer spectroscopy for stabilizing lasers," with M.-S. Ma, L. Hollberg and J. H. Shirley.
- #4,700,150, October 13, 1987, "An external laser frequency stabilizer," with T. W. Hansch.
- #4,856,009, August 8, 1989, "rf sigmameter: apparatus for scanning tunable lasers," with M. Zhu.
- #5,218,426, June 8, 1993, "Highly accurate in-situ determination of the refractivity of an ambient atmosphere," with P. J. Martin, M. L. Eickhoff and M. P. Winters.
- #6,201,638, March 13, 2001, "Comb generating optical cavity that includes an optical amplifier and an optical modulator," with S. A. Diddams, L.-S. Ma and J. Ye.
- #6,727,492, April 27, 2004, "Cavity ringdown spectroscopy system using differential heterodyne detection," with J. Ye.
- #6,850,543, February 1, 2005, "Mode-locked pulsed laser system and method," with S. T. Cundiff, S. A. Diddams and D. J. Jones.
- #6,831,935, December 14, 2004, "Multistage synchronization of pulsed radiation sources," with J. Ye, H. Kapteyn, R. K. Shelton, M. Murnane and L.-S. Ma.
- Filed August 25, 2006, "Simple, compact and robust optical reference system for lasers with narrow linewidth," CU TTO File No. CU1469B.

Patent disclosures:

- "An interferometer system intended to detect the anisotropy of space," March 1994, with M. Mizushima.
- "Delivering the same frequency in two places: Accurate cancellation of phase noise introduced by optical fiber or other time-varying path," April 1994, with L.-S. Ma, P. Jungner and J. Ye.
- "Precise external removal from a laser beam of large frequency modulations generated either internally or externally to the laser," January 1999, with M. S. Taubman.
- "Delivering the same frequency in two places: Accurate cancellation of phase noise introduced by optical fiber or other time-varying path," April 1994, with L.-S. Ma,

P. Jungner and J. Ye.

“Vibration-resistant, micron-sized surface profile monitor,” 2000, with E. Klein and F. Ramirez.

“Method for supporting and thermally tuning optical cavities, Spring 2004, with M. Notcutt.

“Reflection spectrometer to measure index of refraction changes, with strong noise reduction due to common-path interferometry,” March 29, 2005.