

## Bibliography

- [1] D. J. Jones, S. A. Diddams, J. K. Ranka, A. Stentz, R. S. Windeler, J. L. Hall, and S. T. Cundiff, "Carrier-envelope phase control of femtosecond mode-locked lasers and direct optical frequency synthesis," *Science* **288**, 635–639 (2000).
- [2] A. Apolonski, A. Poppe, G. Tempea, C. Spielmann, T. Udem, R. Holzwarth, T. W. Hänsch, and F. Krausz, "Controlling the Phase Evolution of Few-Cycle Light Pulses," *Phys. Rev. Lett.* **85**, 740–743 (2000).
- [3] H. S. Margolis, G. P. Barwood, G. Huang, H. A. Klein, S. N. Lea, K. Szymaniec, and P. Gill, "Hertz-Level Measurement of the Optical Clock Frequency in a Single  $^{88}\text{Sr}^+$  Ion," *Science* **306**, 1355–1358 (2004).
- [4] S. A. Diddams, T. Udem, J. C. Bergquist, E. A. Curtis, R. E. Drullinger, L. Hollberg, W. M. Itano, W. D. Lee, C. W. Oates, K. R. Vogel, and D. J. Wineland, "An optical clock based on a single trapped  $^{199}\text{Hg}^+$  ion," *Science* **293**, 825–828 (2001).
- [5] J. Ye, L.-S. Ma, and J. L. Hall, "Molecular iodine clock," *Phys. Rev. Lett.* **87**, 270 801 (2001).
- [6] J. D. Jost, J. L. Hall, and J. Ye, "Continuously tunable, precise, single frequency optical signal generator," *Opt. Exp.* **10**, 515–520 (2002).
- [7] T. M. Fortier, D. J. Jones, and S. T. Cundiff, "Phase stabilization of an octave-spanning Ti:sapphire laser," *Opt. Lett.* **28**, 2198–2200 (2003).
- [8] A. Baltuska, T. Fuji, and T. Kobayashi, "Controlling the Carrier-Envelope Phase of Ultrashort Light Pulses with Optical Parametric Amplifiers," *Phys. Rev. Lett.* **88**, 133 901 (2002).
- [9] R. K. Shelton, L.-S. Ma, H. C. Kapteyn, M. M. Murnane, J. L. Hall, and J. Ye, "Phase-coherent optical pulse synthesis from separate femtosecond lasers," *Science* **293**, 1286–1289 (2001).
- [10] A. Baltuska, T. Udem, M. Uiberacker, M. Hentschel, E. Goulielmakis, C. Gohle, R. Holzwarth, V. S. Yakovlev, A. Scrinzi, T. W. Hänsch, and F. Krausz, "Attosecond control of electronic processes by intense light fields," *Nature* **421**, 611–615 (2003).

- [11] T. C. Weinacht, J. Ahn, and P. H. Bucksbaum, “Controlling the shape of a quantum wavefunction,” *Nature* **397**, 233–235 (1999).
- [12] T. M. Fortier, P. A. Roos, D. J. Jones, S. T. Cundiff, R. D. R. Bhat, and J. E. Sipe, “Carrier-Envelope Phase-Controlled Quantum Interference of Injected Photocurrents in Semiconductors,” *Phys. Rev. Lett.* **92**, 147 403 (2004).
- [13] E. O. Potma, D. J. Jones, J.-X. Cheng, X. S. Xie, and J. Ye, “High-sensitivity coherent anti-Stokes Raman scattering microscopy with two tightly synchronized picosecond lasers,” *Opt. Lett.* **27**, 1168–1170 (2002).
- [14] D. Meshulach and Y. Silberberg, “Coherent quantum control of two-photon transitions by a femtosecond laser pulse,” *Nature* **396**, 239–242 (1998).
- [15] T. Udem, J. Reichert, R. Holzwarth, and T. W. Hänsch, “Accurate measurement of large optical frequency differences with a mode-locked laser,” *Opt. Lett.* **24**, 881–883 (1999).
- [16] M. T. Asaki, C.-P. Huang, D. Garvey, J. Zhou, H. C. Kapteyn, and M. M. Murnane, “Generation of 11-Fs pulses from a self-mode-locked Ti-Sapphire laser,” *Opt. Lett.* **18**, 977–979 (1993).
- [17] C. Salomon, D. Hils, and J. L. Hall, “Laser stabilization at the millihertz level,” *J. Opt. Soc. Am. B* **5**, 1576–1587 (1988).
- [18] T. Udem, J. Reichert, R. Holzwarth, and T. Hänsch, “Absolute optical frequency measurement of the cesium  $D_1$  line with a mode-locked laser,” *Phys. Rev. Lett.* **82**, 3568–3571 (1999).
- [19] S. A. Diddams, D. J. Jones, L.-S. Ma, S. T. Cundiff, and J. L. Hall, “Optical frequency measurement across a 104-THz gap with a femtosecond laser frequency comb,” *Opt. Lett.* **25**, 186–188 (2000).
- [20] S. A. Diddams, D. J. Jones, J. Ye, S. T. Cundiff, J. L. Hall, J. K. Ranka, R. S. Windeler, R. Holzwarth, T. Udem, and T. W. Hänsch, “Direct link between microwave and optical frequencies with a 300 THz femtosecond laser comb,” *Phys. Rev. Lett.* **84**, 5102–5105 (2000).
- [21] H. R. Telle, G. Steinmeyer, A. Dunlop, J. Stenger, D. Sutter, and U. Keller, “Carrier-envelope offset phase control: A novel concept for absolute optical frequency control and ultrashort pulse generation,” *Appl. Phys. B* **69**, 327–332 (1999).
- [22] J. K. Ranka, R. S. Windeler, and A. J. Stentz, “Visible continuum generation in air-silica microstructure optical fibers with anomalous dispersion at 800 nm,” *Opt. Lett.* **25**, 25–27 (2000).
- [23] S. T. Cundiff and J. Ye, “*Colloquium*: Femtosecond optical frequency combs,” *Rev. Mod. Phys.* **75**, 325–342 (2003).
- [24] T. W. Hänsch, Tunable Lasers and Applications, section “Spectroscopic Applications of Tunable Lasers”, A. Mooradian, T. Jaeger and P. Stokseth, Editors (Springer-Verlag, Berlin, 1976).

- [25] R. Teets, J. Eckstein, and T. W. Hänsch, “Coherent two-photon excitation by multiple light pulses,” *Phys. Rev. Lett.* **38**, 760–764 (1977).
- [26] A. I. Ferguson, J. N. Eckstein, and T. W. Hänsch, “A subpicosecond dye laser directly pumped by a mode-locked argon laser,” *J. Appl. Phys.* **49**, 5389–5391 (1978).
- [27] J. N. Eckstein, A. I. Ferguson, and T. W. Hänsch, “High-resolution two-photon spectroscopy with picosecond light pulses,” *Phys. Rev. Lett.* **40**, 847–850 (1978).
- [28] S. T. Cundiff, J. Ye, and J. L. Hall, “Optical frequency synthesis based on mode-locked lasers,” *Rev. Sci. Instr.* **72**, 3749–3771 (2001).
- [29] K. M. Evenson, J. S. Wells, F. R. Petersen, B. L. Danielson, and G. W. Day, “Accurate frequencies of molecular transitions used in laser stabilization: the 3.39- $\mu\text{m}$  transition in  $\text{CH}_4$  and the 9.33- and 10.18- $\mu\text{m}$  transitions in  $\text{CO}_2$ ,” *Appl. Phys. Lett.* **22**, 192–195 (1973).
- [30] K. M. Evenson, J. S. Wells, F. R. Petersen, B. L. Danielson, G. W. Day, R. L. Barger, and J. L. Hall, “Speed of Light from Direct Frequency and Wavelength Measurements of the Methane-Stabilized Laser,” *Phys. Rev. Lett.* **29**, 1346–1349 (1972).
- [31] D. A. Jennings, C. R. Pollock, F. R. Petersen, R. E. Drullinger, K. M. Evenson, J. S. Wells, J. L. Hall, and H. P. Layer, “Direct frequency measurement of the  $\text{I}_2$  stabilized He-Ne 473-THz (633-nm) laser,” *Opt. Lett.* **8**, 136–138 (1983).
- [32] H. Schnatz, B. Lipphardt, J. Helmcke, F. Riehle, and G. Zinner, “First phase-coherent frequency measurement of visible radiation,” *Phys. Rev. Lett.* **76**, 18–21 (1996).
- [33] J. E. Bernard, A. A. Madej, L. Marmet, B. G. Whitford, K. J. Siemsen, and S. Cundy, “Cs-Based Frequency Measurement of a Single, Trapped Ion Transition in the Visible Region of the Spectrum,” *Phys. Rev. Lett.* **82**, 3228–3231 (1999).
- [34] C. Schwob, L. Jozefowski, B. de Beauvoir, L. Hilico, F. Nez, L. Julien, F. Biraben, O. Acaf, and A. Clairon, “Optical frequency measurement of the 2S-12D transitions in hydrogen and deuterium: Rydberg constant and lamb shift determinations,” *Phys. Rev. Lett.* **82**, 4960–4963 (1999).
- [35] T. H. Yoon, A. Marian, J. L. Hall, and J. Ye, “Phase-coherent multilevel two-photon transitions in cold Rb atoms: Ultrahigh-resolution spectroscopy via frequency-stabilized femtosecond laser,” *Phys. Rev. A* **63**, 011 402(R) (2000).
- [36] O. S. Heavens, “Radiative transition probabilities of the lower excited states of the alkali metals,” *J. Opt. Soc. Am.* **51**, 1058–1061 (1961).
- [37] D. Felinto, C. A. C. Bosco, L. H. Acioli, and S. S. Vianna, “Coherent accumulation in two-level atoms excited by a train of ultrashort pulses,” *Opt. Commun.* **215**, 69–73 (2003).

- [38] D. Felinto, L. H. Acioli, and S. S. Vianna, “Accumulative effects in the coherence of three-level atoms excited by femtosecond-laser frequency combs,” *Phys. Rev. A* **70**, 043403 (2004).
- [39] N. V. Vitanov and P. L. Knight, “Coherent excitation of a two-state system by a train of short pulses,” *Phys. Rev. A* **52**, 2245–2261 (1995).
- [40] M. M. Salour, “Quantum interference effects in two-photon spectroscopy,” *Rev. Mod. Phys.* **50**, 667–681 (1978).
- [41] M. Stowe, “Private communication,” .
- [42] Femtosecond Optical Frequency Comb Technology: Principle, Operation and Application, J. Ye and S. T. Cundiff, Editors (Springer, New York, 2005).
- [43] T. M. Fortier, “Phase Stabilized Modelocked Lasers: from optical frequency metrology to waveform synthesis of ultrashort pulses,” Ph. D Thesis, JILA and University of Colorado (2004).
- [44] J. Reichert, R. Holzwarth, T. Udem, and T. Hänsch, “Measuring the frequency of light with mode-locked lasers,” *Opt. Commun.* **172**, 59–68 (1999).
- [45] S. Cundiff, L. Hollberg, and J. Hall, “Creating and Applying Optical Frequency Synthesizers using Mode-Locked Lasers,” FY2000 Competence Proposal (March 1999).
- [46] K. W. Holman, R. J. Jones, A. Marian, S. T. Cundiff, and J. Ye, “Intensity-related dynamics of femtosecond frequency combs,” *Opt. Lett.* **28**, 851–853 (2003).
- [47] K. W. Holman, R. J. Jones, A. Marian, S. T. Cundiff, and J. Ye, “Detailed Studies and Control of Intensity-Related Dynamics of Femtosecond Frequency Combs from Mode-Locked Ti:Sapphire Lasers,” *IEEE J. Sel. Top. Quantum Electron.* **9**, 1018–1024 (2003).
- [48] H. J. Metcalf and P. van der Straten, Laser Cooling and Trapping (Springer-Verlag, New York, 1999).
- [49] J. R. Ensher, “The First Experiments with Bose-Einstein Condensation of  $^{87}\text{Rb}$ ,” Ph. D. Thesis, JILA and University of Colorado (1998).
- [50] B. DeMarco, “Quantum Behavior of an Atomic Fermi Gas,” Ph. D. Thesis, JILA and University of Colorado (2001).
- [51] H. J. Lewandowski, “Coherences and correlations in an ultracold Bose gas,” Ph. D. Thesis, JILA and University of Colorado (2002).
- [52] C. Monroe, W. Swann, H. Robinson, and C. Wieman, “Very cold trapped atoms in a vapor cell,” *Phys. Rev. Lett.* **65**, 1571–1574 (1990).
- [53] K. B. MacAdam, A. Steinbach, and C. Wieman, “A narrow-band tunable diode laser system with grating feedback, and a saturated absorption spectrometer for Cs and Rb,” *Am. J. Phys.* **60**, 1098–1111 (1992).

- [54] C. E. Wieman and L. Hollberg, “Using diode lasers for atomic physics,” *Rev. Sci. Instr.* **62**, 1–20 (1991).
- [55] L. Ricci, M. Weidemüller, T. Esslinger, A. Hemmerich, C. Zimmermann, V. Vuletic, W. König, and T. Hänsch, “A compact grating-stabilized diode laser system for atomic physics,” *Opt. Commun.* **117**, 541–549 (1995).
- [56] G. C. Bjorklund, “Frequency-modulation spectroscopy: a new method for measuring weak absorptions and dispersions,” *Opt. Lett.* **5**, 15–17 (1980).
- [57] J. L. Hall, L. Hollberg, T. Baer, and H. G. Robinson, “Optical heterodyne saturation spectroscopy,” *Appl. Phys. Lett.* **39**, 680–682 (1981).
- [58] E. L. Raab, M. Prentiss, A. Cable, S. Chu, and D. E. Pritchard, “Trapping of neutral Sodium atoms with radiation pressure,” *Phys. Rev. Lett.* **59**, 2631–2634 (1987).
- [59] P. D. Lett, R. N. Watts, C. I. Westbrook, W. D. Philips, P. L. Gould, and H. J. Metcalf, “Observation of atoms laser cooled below the Doppler limit,” *Phys. Rev. Lett.* **61**, 169–172 (1988).
- [60] A. Marian, M. C. Stowe, J. R. Lawall, D. Felinto, and J. Ye, “United time-frequency spectroscopy for dynamics and global structure,” *Science* **306**, 2063–2068 (2004).
- [61] B. Cagnac, G. Grynberg, and F. Biraben, “Spectroscopie d’Absorption Multiphotonique sans Effet Doppler,” *Journal de Physique* **34**, 845–858 (1973).
- [62] D. Pritchard, J. Apt, and T. W. Ducas, “Fine Structure of Na  $4d^2D$  Using High-Resolution Two-Photon Spectroscopy,” *Phys. Rev. Lett.* **32**, 641–642 (1974).
- [63] F. Biraben, B. Cagnac, and G. Grynberg, “Experimental Evidence of Two-Photon Transition without Doppler Broadening,” *Phys. Rev. Lett.* **32**, 643–645 (1974).
- [64] M. D. Levenson and N. Bloembergen, “Observation of Two-Photon Absorption without Doppler Broadening on the  $3S - 5S$  Transition in Sodium Vapor,” *Phys. Rev. Lett.* **32**, 645–648 (1974).
- [65] J. E. Bjorkholm and P. F. Liao, “Resonant enhancement of two-photon absorption in Sodium vapor,” *Phys. Rev. Lett.* **33**, 128–131 (1974).
- [66] O. Poulsen and N. I. Winstrup, “Resonant two-photon spectroscopy in a fast accelerated atomic beam,” *Phys. Rev. Lett.* **47**, 1522–1525 (1981).
- [67] M. M. Salour and C. Cohen-Tannoudji, “Observation of Ramsey’s Interference Fringes in the Profile of Doppler-Free Two-Photon Resonances,” *Phys. Rev. Lett.* **38**, 757–760 (1977).
- [68] Y. V. Baklanov, V. P. Chebotayev, and B. Y. Dubetsky, “The resonance of two-photon absorption in separated optical fields,” *Appl. Phys.* **11**, 201–202 (1976).
- [69] J. C. Bergquist, S. A. Lee, and J. L. Hall, “Saturated absorption with spatially separated laser fields: Observation of optical “Ramsey” fringes,” *Phys. Rev. Lett.* **38**, 159–162 (1977).

- [70] M. J. Snadden, A. S. Bell, E. Riis, and A. I. Ferguson, “Two-photon spectroscopy of laser-cooled Rb using a mode-locked laser,” *Opt. Commun.* **125**, 70–76 (1996).
- [71] N. Dudovich, B. Dayan, S. M. Gallagher Faeder, and Y. Silberberg, “Transform-Limited Pulses Are Not Optimal for Resonant Multiphoton Transitions,” *Phys. Rev. Lett.* **86**, 47–50 (2001).
- [72] E. Gomez, S. Aubin, L. A. Orozco, and G. D. Sprouse, “Lifetime and hyperfine splitting measurements on the  $7s$  and  $6p$  levels in rubidium,” *J. Opt. Soc. Am. B* **21**, 2058–2067 (2004).
- [73] J. Ye, J.-L. Peng, R. J. Jones, K. W. Holman, J. L. Hall, D. J. Jones, S. A. Diddams, J. Kitching, S. Bize, J. C. Bergquist, L. W. Hollberg, L. Robertsson, and L.-S. Ma, “Delivery of high-stability optical and microwave frequency standards over an optical fiber network,” *J. Opt. Soc. Am. B* **20**, 1459–1467 (2003).
- [74] P. F. Liao and J. E. Bjorkholm, “Direct observation of atomic energy level shifts in two-photon absorption,” *Phys. Rev. Lett.* **34**, 1–4 (1975).
- [75] F. Nez, F. Biraben, R. Felder, and Y. Millerioux, “Optical frequency determination of the hyperfine components of the  $5S_{1/2}$ – $5D_{3/2}$  two-photon transitions in rubidium,” *Opt. Commun.* **102**, 432–438 (1993).
- [76] A. Marian, M. C. Stowe, D. Felinto, and J. Ye, “Direct frequency comb measurements of absolute optical frequencies and population transfer dynamics,” *Phys. Rev. Lett.* **95**, in press (2005).
- [77] R. Holzwarth, A. Y. Nevsky, M. Zimmermann, T. Udem, T. W. Hänsch, J. von Zanthier, H. Walther, J. C. Knight, W. J. Wadsworth, P. S. J. Russell, M. N. Skvortsov, and S. N. Bagayev, “Absolute frequency measurement of iodine lines with a femtosecond optical synthesizer,” *Appl. Phys. B* **73**, 269–271 (2001).
- [78] S. Witte, R. T. Zinkstok, W. Ubachs, W. Hogervorst, and K. S. E. Eikema, “Deep-Ultraviolet Quantum Interference Metrology with Ultrashort Laser Pulses,” *Science* **307**, 400–403 (2005).
- [79] M.-S. Ko and Y.-W. Liu, “Observation of rubidium  $5S_{1/2} \rightarrow 7S_{1/2}$  two-photon transitions with a diode laser,” *Opt. Lett.* **29**, 1799–1801 (2004).
- [80] H. T. Duong, S. Liberman, J. Pinard, and J.-L. Vialle, “Measurement of the Hyperfine Structure of the  $5^2S_{1/2}$  State of  $^{23}\text{Na}$  by Two-Step Excitation Using Two cw Dye Lasers,” *Phys. Rev. Lett.* **33**, 339–341 (1974).
- [81] H.-C. Chui, M.-S. Ko, Y.-W. Liu, J.-T. Shy, J.-L. Peng, and H. Ahn, “Absolute frequency measurement of rubidium  $5S7S$  two-photon transitions with a femtosecond laser comb,” *Opt. Lett.* **30**, 842–844 (2005).
- [82] J. Ye, S. Swartz, P. Jungner, and J. L. Hall, “Hyperfine structure and absolute frequency of the  $^{87}\text{Rb}$   $5P_{3/2}$  state,” *Opt. Lett.* **21**, 1280–1282 (1996).

- [83] G. P. Barwood, P. Gill, and W. R. C. Rowley, "Frequency Measurements on Optically Narrowed Rb-Stabilised Laser Diodes at 780 nm and 795 nm," *Appl. Phys. B* **53**, 142–147 (1991).
- [84] V. Gerginov, C. E. Tanner, S. A. Diddams, A. Bartels, and L. Hollberg, "High-resolution spectroscopy with a femtosecond laser frequency comb," *Opt. Lett.* **30**, in press (2005).
- [85] R. J. Jones, I. Thomann, and J. Ye, "Precision stabilization of femtosecond lasers to high-finesse optical cavities," *Phys. Rev. A* **69**, 051 803(R) (2004).
- [86] D. Kielpinski, "Laser cooling and trapping with ultrafast pulses," <http://arxiv.org/abs/quant-ph/0306099> (2003).
- [87] R. J. Jones, K. D. Moll, M. J. Thorpe, and J. Ye, "Phase-Coherent Frequency Combs in the Vacuum Ultraviolet via High-Harmonic Generation inside a Femtosecond Enhancement Cavity," *Phys. Rev. Lett.* **94**, 193 201 (2005).
- [88] K. W. Holman, D. J. Jones, J. Ye, and E. P. Ippen, "Orthogonal control of the frequency comb dynamics of a mode-locked laser diode," *Opt. Lett.* **28**, 2405–2407 (2003).