Prof. Theodor W. Hänsch
Professor, Nobel laureate in Physics, 2005

Most important awards, prizes and academies

California Scientist of the Year, Calif. Museum of Science and Industry; Alexander von Humboldt Senior U.S. Scientist Award (1977); Cyrus B. Comstock Prize, U.S. National Academy of Science (1983); Herbert P. Broida Prize, American Physical Society (1983); William F. Meggers Award, Optical Society of America (1985); Michelson Medal, The Franklin Institute, Philadelphia (1986); Italgas Prize for Research and Innovation, Italgas, Torino (1987); Gottfried Wilhelm Leibniz Preis, Deutsche Forschungsgemeinschaft (1988); King Faisal International Prize for Science, Saudi Arabia (1989); Einstein Medal for Laser Science (1995); Arthur L. Schawlow Prize for Laser Science, American Physical Society (1996); Philip Morris Research Prize (atomic clock) (1988); Stern-Gerlach Medal, Deutsche Physikalische Gesellschaft (2000); Arthur L. Schawlow Award, Laser Institute of America (2000); Philip Morris Research Prize (atom laser) (2000); Quantum Electronics and Optics Prize, European Physical Society (2001); SUNAMCO Medal, International Union of Pure and Applied Physics (2001); Matteucci Medal, Italian National Academy of Sciences (2002); Bundesverdienstkreuz 1. Klasse (Order of Merit, Germany) (2003); Bayerischer Maximiliansorden (Order of Merit, Bavaria) (2003); I.I. Rabi Award, IEEE (2005); Frederic Ives Medal, Optical Society of America (2005); Otto-Hahn-Prize for Chemistry and Physics, GDCh, and City of Frankfurt/M (2005); Nobel Prize in Physics, jointly with Prof. J.L. Hall and Prof. R. Glauber (2005); Grand Officer Cross (Order of Merit, Republic of Italy) (2006). *Professional Societies and*

Academies: American Physical Society (1973); Optical Society of America (1973); American Academy of Arts and Sciences (1983); The Franklin Institute, Philadelphia (1986); Bavarian Academy of Arts and Sciences (1991); U.S. National Academy of Science (2002); Accademia Nazionale dei Lincei, Italy (2002); Berlin-Brandenburg Academy of Sciences (2005); Académie des Sciences, Institut de France (2005); The Society of Sigma Xi (2005); German Academy of Natural Scientists Leopoldina (2006).

Summary of scientific research

Prof. Hänsch is widely known for his seminal contributions in the field of laser spectroscopy. His early work includes the first narrowband tunable dye laser, the invention of commonly used techniques of Doppler-free laser spectroscopy, and the first proposal for laser cooling of atomic gases. Since the early 1970s, Hänsch has pursued precision spectroscopy of the simple hydrogen atom, which permits unique confrontations between experiment and fundamental theory. This work has yielded accurate values of the Rydberg constant, the Lamb shift of the hydrogen ground state, and the charge radii of proton and deuteron. More recently, he has pioneered the revolutionary frequency comb technique for measuring the frequency of light with ultrashort pulses. Exploring the quantum physics of cold neutral atoms, Hänsch and his coworkers have realized the first two- and three-dimensional atomic lattices bound by light, they have demonstrated the first atom laser that emits a continuous beam of coherent matter waves, and they have shown how to integrate a quantum laboratory for ultracold atoms on a micro-fabricated 'atom chip'. With a Bose-Einstein condensate in an optical lattice potential, they have been the first to observe a quantum phase transition between a wave-like superfluid state and a particle-like Mott insulator crystal.

Main publications

Measurement of Atomic Parameters by Laser Differential Spectrometry (T.W. Hänsch, P. Toschek), *Phys. Letters*, 20, 273 (1966); Laser Differential Spectrometry Measurements on Neon Depolarization (T.W. Hänsch, P. Toschek), *Phys. Letters*, 22, 150 (1966); Observation of Saturation Peaks in a He-Ne Laser by Tuned Laser Differential Spectrometry (T.W. Hänsch, P. Toschek), *IEEE J. Quant. Electr.*, QE-4, 467 (1968); Image Amplification by Dye Lasers (T.W. Hänsch, *et al.*), *Appl. Phys. Letters*, 18, 108 (1971); Complete Hyperfine Structure of a Molecular Iodine Line (T.W. Hänsch, *et al.*), *Phys. Rev. Letters*, 26, 949 (1971); High Resolution Saturation Spectroscopy of the Sodium D Line with a Pulsed Tunable Dye Laser (T.W. Hänsch, *et al.*), *Phys. Rev. Letters*, 27, 707 (1971); Optical Resolution of the Lamb Shift in Atomic Hydrogen by Laser Saturation Spectroscopy (T.W. Hänsch, *et al.*), *Nature*, 235, 63 (1972); Two-Photon Spectroscopy of Na 3s-4d without Doppler Broadening, Using a CW Dye Laser (T.W. Hänsch, *et al.*), *Opt. Comm.*, 11, 50 (1974); Rydberg Constant (T.W. Hänsch), in *McGraw-Hill Yearbook of Science and Technology*, 1975; Cooling of Gases by Laser Radiation (T.W. Hänsch, A.L. Schawlow) *Opt. Comm.*, 13, 68 (1975); Doppler Effect (T.W. Hänsch), in *Encyclopedia of Physics*, Am. Inst. Phys., 1976; Rydberg Constant (T.W. Hänsch), in *McGraw-Hill Encyclopedia of Science and Technology*,

1977 ed., Vol. II, p. 713, 1980 ed., pp. 785-8, 1995 ed., 1999 ed.; High-Resolution Spectroscopy of Atoms and Molecules (T.W. Hänsch), *Physics Today*, 30, 34 (1977); A Self-Calibrating Grating (T.W. Hänsch), in *Laser Spectroscopy III*, Springer Series in Optical Sciences, Vol. 7, Springer Verlag, New York, Heidelberg, 1977, p. 423; Multiple Coherent Interactions (T.W. Hänsch), in *Laser Spectroscopy III*, Springer Series in Optical Sciences, Vol. 7, Springer Verlag, New York, Heidelberg, 1977, p. 149; Laser Spectroscopy (T.W. Hänsch), in *McGraw-Hill Yearbook of Science and Technology*, New York, 1979; The Spectrum of Atomic Hydrogen (T.W. Hänsch, *et al.*), Scientific American, 240, 94 (1979); Laser Spectroscopy (T.W. Hänsch), in *McGraw-Hill Encyclopedia of Science and Technology*, New York, 1980, pp. 556-60; Precision Laser Spectroscopy of Hydrogen (T.W. Hänsch), in *Quantum Electronics of Strong Fields* (NATO Advanced Study Institute, Lahnstein, Germany, 1981), Plenum Press, New York, 1983, pp. 669; Sub-Doppler Spectroscopy (T.W. Hänsch), in *Atomic Physics* 8, Plenum Publishing Corporation, New York, 1983, pp. 55-70; High Resolution Laser Spectroscopy (T.W. Hänsch), in *Advances in Laser Spectroscopy*, Plenum Press, New York, 1983, pp. 127; Precision Laser Spectroscopy (T.W. Hänsch), in *Precision Measurements and Fundamental Constants II*, NBS Special Publication 617 (1984), pp. 111; High Resolution Spectroscopy of Hydrogen (T.W. Hänsch), in *The Hydrogen Atom*, Springer Verlag, Berlin, Heidelberg, New York, 1989, p. 93; A Proposed Sub-Femtosecond Pulse Synthesizer Using Separate Phase-Locked Laser Oscillators (T.W. Hänsch), *Opt. Comm.*, 80, 71 (1990); Two-Dimensional Atomic Crystal Bound by Light (A. Hemmerich, T.W. Hänsch), *Phys. Rev. Letters*, 70, 410 (1993); Laser Spectroscopy of Hydrogen and Antihydrogen (T.W. Hänsch, C. Zimmermann),*Hyperfine Interactions*, 76, 47 (1993); Line Strengths in Vibrational Spectra of a 2D Optical Crystal (A. Hemmerich, T.W. Hänsch), *Phys. Rev. A*, Rapid Communications, 48, 1753 (1993); Measurement of the Temporal Coherence of Ultrashort Harmonic Pulses: Towards Coherent Spectroscopy in the Extreme Ultraviolet (M. Bellini, T.W. Hänsch), *Applied Physics B*, R 65, 677 (1997); Frequency Independent Laser Cooling Based on Interferometry (M. Weitz, T.W. Hänsch), *Europhys. Lett.* 49, 302 (2000); Measurement of the Spatial Coherence of a Trapped Bose Gas at the Phase Transition (I. Bloch, T.W. Hänsch, and T. Esslinger) *Nature* 403, 166 (2000); Bose-Einstein Condensation on a Microelectronic Chip (W. Hänsel, P. Hommelhoff, T.W. Hänsch, and J. Reichel), *Nature* 413 498 (2001); A New Type of Frequency Chain and Its Application to Optical Frequency Metrology (R. Holzwarth, J. Reichert, Th. Udem, and T.W. Hänsch), *Laser Physics* 11, 1100 (2001); Generation and Applications of Phase-Locked White-Light Continuum Pulses (M. Bellini, T.W. Hänsch),*Laser and Particle Beams* 19, 157 (2001); Optical Frequency Metrology (Th. Udem, R. Holzwarth, and T.W. Hänsch), *Nature*, 416, 233 (2002); Collapse and Revival of the matter wave field of a Bose-Einstein Condensate (M. Greiner, O. Mandel, T.W. Hänsch, and I. Bloch), *Nature* 419, 51 (2002); Tonks-Girardeau Gas of Ultracold Atoms in an Optical Lattice (B. Paredes, A. Widera, V. Murg, O. Mandel, S. Fölling, I. Cirac, G.V. Shlyapnikov, T.W. Hänsch and I. Bloch) *Nature* 429, 277-81 (2004); Atoms, Quanta and Relativity (T.W. Hänsch, *et al.*) A Century after Einsteins' Miraculous Year, Journal of Physics B-Atomic, Molecular & Optical Physics 38, Preface of Special Issue; A Frequency Comb in the Extreme Ultraviolet (Ch. Gohle, Th. Udem, J. Rauschenberger, R. Holzwarth, M. Herrmann, H.A. Schüssler, F. Krausz, and T.W. Hänsch) *Nature*, 436, 234-7 (2005);

Vibrationally Resolved Strong-Field Dissociation of D2+in Ion Beams (D. Pavicic, T.W. Hänsch, and H. Figger) *Phys. Rev. A* 72, 053413/1-9 (2005); Precision Spectroscopy of Hydrogen and Femtosecond Frequency Combs (T.W. Hänsch, *et al*.) *Phil. Trans. R. Soc.* A363 2155-63 (2005); Theodor W. Hänsch, Autobiographical Note, *Le Prix Nobel 2005*, Almquist & Wiksell Intl., Stockholm 2006, submitted for publication; A Passion for Precision, Nobel Lecture, *Le Prix Nobel 2005*, Almquist & Wiksell 2005, Stockholm 2006, submitted for publication; Carrier-Envelope Phase-Stabilized Amplifier Systems (J. Rauschenberger, T. Fuji, M. Hentschel, A.-J. Verhoef, T. Udem, C. Gohle, T.W. Hänsch, and F. Krausz) *Laser Physics Lett.* 3 37-42 (2006).

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