

## Curriculum Vitae

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### • EDUCATION

2004            Habilitation at Ludwig-Maximilians-Universität Munich / Germany  
1997            PhD (summa cum laude) at Ludwig-Maximilians-Universität Munich / Germany  
1993            Diploma at Justus Liebig Universität Giessen / Germany  
1987-1993     Physics at Justus Liebig Universität Giessen / Germany  
1990-1991     Physics at University of Washington / Seattle, USA

### • CURRENT POSITIONS

2016 –            Professor at Ludwig-Maximilians-Universität Munich / Germany  
2004 –            Permanent research associate  
                      Laser spectroscopy division / Max Planck Institute of Quantum Optics / Garching,  
                      Germany

### • PREVIOUS POSITIONS

1998 – 2004     Research associate  
                      Laser spectroscopy division / Max Planck Institute of Quantum Optics / Garching,  
                      Germany  
2000            Postdoc  
                      NIST / Boulder, USA

### • SCIENTIFIC ACHIEVEMENTS

I graduated in 1997 with the first phase coherent optical frequency measurement on atomic hydrogen using. The key instruments at that time have been the optical interval dividers and modulator type optical comb generators. Already during my PhD I tested certain properties of combs generated by mode locked lasers, like recording beat notes with other lasers. Right after graduation I assembled the first self-referenced optical comb generator based on the  $7f$ - $8f$  technique. Soon after, I could replace this by a much more compact  $f$ - $2f$  technique. The long lasting problem of optical frequency measurement was solved and from then on, I devoted myself to improving spectroscopy. The uncertainty of the 1S-2S transition frequency has been reduced right after the introduction of the frequency comb by a factor of 2 and subsequently by a factor 40 through improvements of the spectrometer. To generate more hydrogen data, I designed and supervised a new experiment on the 1S-3S transition using two-photon direct comb spectroscopy. Another activity includes the usage of our 1S-2S apparatus as a source of cold 2S atoms for an improved measurement of the 2S-4P transitions. Meanwhile both experiments contributed significantly to the so-called “proton radius puzzle”, that has been a serious discrepancy between precision spectroscopy and predictions from Quantum Electrodynamics. Another experiment that I have started, aims at high-resolution laser spectroscopy in the extreme ultraviolet on stored hydrogen-like helium ions. I was leading a project that designed and implemented astronomical frequency combs that are now routinely used to detect extrasolar planets at the largest telescopes operated by the European Southern Observatory (ESO).

- **COLLABORATIONS**

Over the years I have collaborated with a large number of groups worldwide. Currently we work closely with other groups that work on high resolution spectroscopy of atomic hydrogen. These include Prof. Dylan Yost at Colorado State University and Prof. Randolph Pohl at the University of Mainz. On the theory side we are occasionally in contact with Prof. Ulrich Jentschura at the University of Missouri and with Prof. Krzysztof Pachucki at the University of Warsaw to name few. On high power lasers we have a close collaboration with the Fraunhofer-Institut für Lasertechnik (ILT) at Aachen. Within the MPG-PTB-RIKEN Center on Time, Constants and Fundamental Symmetries, we are working on improving laser spectroscopy for metrology.

- **FELLOWSHIPS AND AWARDS**

2022	IFCS Rabi Award
2017	ERC Advanced Grant
2013	EPS Prize for Research in Laser Science and Applications
2011	Elected fellow of the American Physical Society
2010	Elected fellow of the Optical Society of America
2006	Röntgen Award of the University of Giessen
2006	Habilitation Award of the Ludwig-Maximilians-Universität Munich
1998	Philip Morris Research Award
1994	WE-Hereaus Student Award

- **SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS**

2004 – Supervised 19 postdocs, 23 PhD students and 23 master/diploma students.  
One former postdoc and one former PhD student became professors.

- **TEACHING ACTIVITIES**

2001 – Teaching at the Ludwig-Maximilians-Universität Munich various classes on optics, quantum optics, spectroscopy, ion traps and non-linear optics. Among those classes is a 3<sup>rd</sup> semester course on optics with more than 300 students that I have been teaching 7 times since 2008, and a first semester class mechanics with more than 500 students that I have been teaching 3 times.

- **ORGANISATION AND REVIEWING ACTIVITIES**

2022	International steering committee of Frequency Standards and Metrology 2023
2022	Program committee of Laser Spectroscopy 2023
2021	General chair EQEC 2021
2020-	Member CERN SPSC committee
2019	Program committee International Conference on Atomic Physics (ICAP)
2019	Program chair EQEC 2019
2016-2020	Journal of Physics B editorial board member
2012-2016	Advisory board Polish excellence in quantum optics and photonics
2014-2021	EGAS board member
2014	Program committee of Laser Spectroscopy 2015
2014	International steering committee of Frequency Standards and Metrology 2015
2014	Sub-committee chair CLEO EQEC 2015
2004-2012	Served many times as sub-committee member for CLEO and CLEO Europe

- **MEMBERSHIPS OF SCIENTIFIC SOCIETIES**

Fellow Member of the American Physical Society  
Fellow Member of the Optical Society of America  
Member, German Physical Society

- **PUBLICATIONS THAT RECEIVED THE LARGEST NUMBER OF CITATIONS**

**Optical Frequency Metrology**

Nature 416, 233 (2002), 2241 citations\*.

**Attosecond Control of Electronic Processes by Intense Light Fields**

Nature 421, 611 (2003), 1337 citations\*.

**Optical Frequency Synthesizer for Precision Spectroscopy**

Phys. Rev. Lett. 85, 2264 (2000), 970 citations\*.

**Direct Link between Microwave and Optical Frequencies with a 300 THz Femtosecond...**

Phys. Rev. Lett. 84, 5102 (2000), 942 citations\*.

**Absolute Optical Frequency Measurement of the Cesium D1 Line with a Mode Locked Laser**

Phys. Rev. Lett., 82, 3568 (1999), 619 citations\*.

**An Optical Clock Based on a Single Trapped  $^{199}\text{Hg}^+$  Ion**

Science 293, 825 (2001), 542 citations\*.

**Laser frequency combs for astronomical observations**

Science 321, 1335 (2008), 490 citations\*.

**Measurement of the Hydrogen 1S-2S Transition Frequency by Phase Coherent Comparison...**

Phys. Rev. Lett. 84, 5496 (2000), 483 citations\*.

**A frequency comb in the extreme ultraviolet**

Nature 436, 234 (2005), 462 citations\*.

\* ISI Science Citation Index as of June 20<sup>nd</sup> 2023. The same database lists 217 publications that I am co-authoring and my h-index as 55. The full publication list is available [here](#).

- **RECENT REPRESENTATIVE SENIOR AUTHOR PUBLICATIONS**

**Very large bandwidth lasers**

Nature Photonics, <https://doi.org/10.1038/s41566-021-00788-w> (2021)

**Two-photon Frequency Comb Spectroscopy of atomic Hydrogen**

Science 370, 1061 (2020).

**Optical Frequency Combs: Coherently uniting the electromagnetic Spectrum**

Science 269, 267 (2020).

**Quantum Electrodynamics and the Proton Size**

Nature Physics, 14, 632 (2018).

**The Rydberg Constant and Proton size from atomic Hydrogen**

Science 358, 97 (2017).

- **MONOGRAPHS**

**Precision Physics of Simple Atomic Systems**

European Physical Journal D Topical Issue, July 2023.

Edited by Krzysztof Pachucki, Thomas Udem, Wim Ubachs, Paolo Crivelli and Stefan Ulmer

**Das Atom der Erkenntnis**

Physik in unserer Zeit, Januar 2022.

**Exploring the World with the Laser**

Springer, dedicated to Theodor Hänsch on his 75th birthday

Edited by Dieter Meschede, Thomas Udem and Tilman Esslinger

**Durchkämte Spektren**

Physik Journal p. 45, Juli 2012.

**Frequency Comb Benefits**

Nature Photonics 3, 82 (2009).

**Constant Insights from Recoils**

Nature Physics 2, 153 (2006).

**Light-Insensitive Optical Clock**

Nature 435, 291 (2005).

**Short and Sharp-Spectroscopy with Frequency Combs**

Science 307, 364 (2005).

- **GRANTED PATENTS**

**Generating laser pulses and spectroscopy using the temporal talbot effect**

US patent US20180233877, Inventors: Th. Udem and A. Ozawa

**Optical Resonator with direct geometric access the optical axis**

US patent US8988766B2, Inventors: P. Russbuldt, J. Weitenberg, I. Pupeza and Th. Udem

**Method and device for producing radio frequency waves**

US patent US2004021056, Inventors: R. Holzwarth, Th. Udem and T.W. Hänsch

**Generation of stabilized, ultra-short light pulses and the use thereof for synthesizing optical ...**

US patent US6785303, Inventors: R. Holzwarth, J. Reichert, Th. Udem and T.W. Hänsch

**Method and device for producing stabilized ultrashort laser light pulses**

International patent WO221644, Inventors: R. Holzwarth, Th. Udem and T.W. Hänsch

**Method and device for generating radiation with stabilized frequency**

International patent WO221649, Inventors: R. Holzwarth, Th. Udem and T.W. Hänsch

- **INVITED PRESENTATIONS SINCE 2013 (without colloquia)**

Short course on frequency combs at CLEO/Europe **2013, 2015, 2017, 2019, 2021 and 2023**. Time and Matter **2013**. International Conference on Laser Spectroscopy (ICOLS), **2013**. Annual Congress of the Swiss Academy of Sciences, **2013**. Enrico Fermi International Summer School, **2014**. Europhoton conference, **2014**. Annual Meeting of the Swiss Physical Society, **2014**. Light and Atoms Celebration of the international Year of Light, **2015**. Collège de France, **2015**. ERATO International Workshop “Challenges in Precision Science” **2016**. ICTP Winter School **2016**. APS Division of Atomic, Molecular and Optical Physics (DAMOP), **2016**. Enrico Fermi Summer School, **2016**. Les Houches Summer School **2016**. Gordon Conference on Atomic Physics **2017**. International Conference on Atomic Physics (ICAP) **2018**. 7<sup>th</sup> International Conference on Trapped Charged Particles and Fundamental Physics (TCP) **2018**. Tutorial on atomic Hydrogen and QED CLEO/US **2019**. Frontiers of Quantum and Mesoscopic Thermodynamics **2019**. PLATAN **2019**. All conferences 2021 cancelled due to the pandemic. Les Houches Summer School **2022**. National Optics Congress Denmark **2022**. Keynote presentation CLEO/Europe **2023**. Symposium on Frequency Standards and Metrology **2023**. Searching for new Physics at the Quantum Technology Frontier, Congressi Stefano Frascini **2023**.