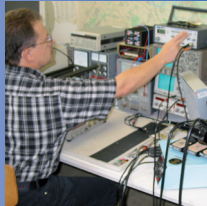


Support and contact details

Technical support

A dedicated support staff for:

- ▶ Electronic design and manufacture
- ▶ Computing / Networking
- ▶ Mechanical construction, including welding
- ▶ Laboratory assistance



Electronic workshop

Laboratory equipment

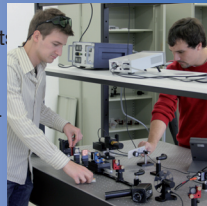
- ▶ Femtosecond laser optical frequency comb, with a H-maser reference
- ▶ Ti:sapphire, Nd:YAG, diode, fiber and high power pump lasers
- ▶ Range of electronic, rf and microwave test and diagnostic equipment
- ▶ 4 K cryostat
- ▶ Comprehensive UHV equipment



Femtosecond fiber laser frequency comb

Student Laser Lab

- ▶ A laboratory reserved for master's student training
- ▶ Teaches basic techniques: Gaussian beams, building and characterizing a Nd:YAG laser, cw and Q-switched operation, intra- and extracavity SHG, laser spectroscopy of molecules



Institut für Experimentalphysik

Heinrich-Heine Universität Düsseldorf
Gebäude 25.42, Ebene 01
Universitätsstraße 1
40225 Düsseldorf

Tel. +49 -81-12318 Fax: +49 -81-13116

E-Mail: exphysik@uni-duesseldorf.de

Internet: www.exphy.uni-duesseldorf.de

Study in Düsseldorf

Graduate and postgraduate opportunities

Ph.D. and post-doc positions in

- ▶ Two-component Bose-Einstein condensates
- ▶ Heteronuclear molecules
- ▶ Internal state preparation of molecular ions
- ▶ Spectroscopy of cold molecular ions
- ▶ Precision spectroscopy of atoms and molecules using femtosecond laser frequency combs
- ▶ Test of Lorentz invariance using ultrastable optical cavities
- ▶ Development of cw lasers for spectroscopy
- ▶ Ultrastable lasers for optical clocks
- ▶ Ytterbium lattice clock development

International Master's degrees

- ▶ Bachelor/Master degree structure (3 + 2 years)
- ▶ International Physics Master's course (taught in English)
- ▶ German language courses available free of charge on campus

Düsseldorf

Capital of the state of North-Rhine Westphalia

- ▶ A diverse city of 600 000 people
- ▶ Convenient location in the center of Europe

A city of culture

- ▶ Many galleries, museums and festivals
- ▶ Excellent recreation opportunities



Düsseldorf Altstadt - "the longest bar in Europe"

www.duesseldorf.de

Quantum Optics, Atomic and Molecular Physics

at the Institute for
Experimental Physics,
Heinrich-Heine-Universität
Düsseldorf, Germany

**Graduate and Post-Graduate
Research Opportunities**

People and projects at the Institute for Experimental Physics, Heinrich-Heine-Universität Düsseldorf

Professor Stephan Schiller

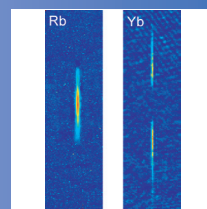
- ▶ Diploma - Technical University of Munich
- ▶ Ph.D. - Stanford University 1993
- ▶ Habilitation - University of Konstanz 1997
- ▶ Full Professor since 1999
- ▶ Otto Klung Prize 1997
- ▶ Gerhard Hess Prize 1998

step.schiller@uni-duesseldorf.de



Mixed quantum gases (Prof. Görlitz)

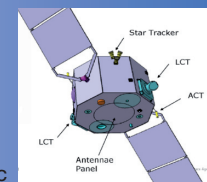
- ▶ Two-species Bose-Einstein condensation with Rb and Yb
- ▶ Strongly interacting mixtures
- ▶ Bose-Fermi mixtures
- ▶ Triple species mixtures



Phase separation of Rb and Yb

Satellite missions for fundamental tests of Physics (Prof. Schiller)

- ▶ Precision tests of the Einstein Equivalence principle and of time dilation
- ▶ ISS mission with ultraprecise optical atomic clock
- ▶ Satellite mission „STE-QUEST“ with cold-atom microwave clock and atom interferometer



Design concept of the STE-QUEST satellite (ESA)

Professor Axel Görlitz

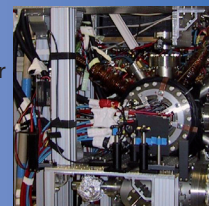
- ▶ Master in Physics - SUNY Stonybrook, USA
- ▶ Diploma - LMU Munich 1995
- ▶ Ph.D. - LMU Munich 1999
- ▶ Postdoc at MIT 1999-2001
- ▶ Group leader, Univ. Stuttgart 2001
- ▶ Associate Professor since 2003

axel.goerlitz@uni-duesseldorf.de



Ultracold molecules (Prof. Görlitz)

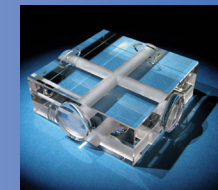
- ▶ Photoassociative production of heteronuclear molecules
- ▶ Dipolar interactions
- ▶ Search for electric dipole moment (EDM)
- ▶ spin-lattice models
- ▶ Feshbach resonances



Vacuum chamber for ultracold molecule production

Tests of Lorentz invariance with optical resonators (Prof. Schiller)

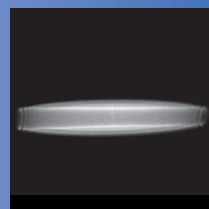
- ▶ Tests of the constancy of the speed of light
- ▶ Tests of Standard Model Extension
- ▶ Michelson-Morley experiment using high-finesse cavities and stabilised lasers



Optical resonators for a Michelson-Morley experiment

Ultra-cold molecular hydrogen ions (Prof. Schiller)

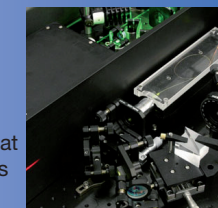
- ▶ Sympathetic cooling of H_2^+ and HD^+ by laser-cooled atomic ions in a rf trap
- ▶ Precision r.f., rotational and vibrational spectroscopy
- ▶ Tests of quantum electrodynamics calculations and measurement of the electron-proton and proton-deuteron mass ratios
- ▶ Internal-state laser cooling
- ▶ Creation of coherent superpositions



HD^+ molecules embedded in a Be^+ crystal

Optical frequency combs (Prof. Schiller)

- ▶ Er: fiber and Ti: Sapphire femtosecond laser frequency comb system
- ▶ Hydrogen maser reference
- ▶ Absolute optical frequency measurement at the 10^{-15} level for laser spectroscopy, tests of fundamental symmetries and optical clocks
- ▶ Frequency ratio measurements of dissimilar optical frequencies



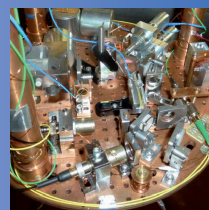
Optical frequency comb

An international group

- ▶ 4 Master students, 9 Ph.D. students,
- ▶ 4 post-doctoral staff.
- ▶ From countries including Germany, U.S.A., Russia, Jordania and China
- ▶ Working languages: English and German
- ▶ International travel opportunities

Cryogenic optical frequency references (Prof. Schiller)

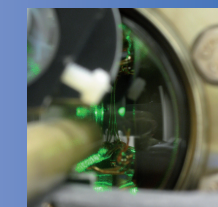
- ▶ Crystalline optical cavities cooled to < 4 Kelvin
- ▶ Holeburning spectroscopy of narrow optical transitions in rare earth ions in crystals at < 4 Kelvin
- ▶ Studies of potential applications as replacement for hydrogen masers



Cryostat breadboard with sapphire cavity and Europium-doped crystal

Optical atomic clocks (Prof. Görlitz, Prof. Schiller)

- ▶ A transportable optical lattice clock
- ▶ Fermionic and bosonic Ytterbium atoms
- ▶ Future application in space and on earth (for gravimetry)



Optical clock apparatus using cold atoms

