Working Group "Young DPG"
Arbeitskreis junge DPG (AKjDPG)

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Overview of Invited Talks and Sessions

(Lecture halls C 2, C 3, and Mittlerer Kreuzbau)

Tutorials

AKjDPG 1.1	Sun	14:00–14:45	C 02	**Many-body physics with Rydberg atoms** — •Christian Gross
AKjDPG 1.2	Sun	14:45–15:30	C 02	**Neutral Atom Quantum Computing using Rydberg Physics** — •Yuri van der Werf
AKjDPG 2.1	Sun	14:00–15:30	C 03	**Scientific Writing Workshop for Early Career Researchers** — •Tracy E. Northup
AKjDPG 3.1	Sun	16:00–16:45	C 02	**Opportunities for experiments on atoms, molecules and clusters at the European X-Ray Free Electron Laser** — •Michael Meyer
AKjDPG 3.2	Sun	16:45–17:30	C 02	**Your first Free-Electron Laser experiment: What to know before you go** — •Kirsten Schnorr
AKjDPG 4.1	Sun	16:00–16:45	C 03	**Optical atomic clocks and applications** — •Tanja Elisabeth Mehlstäubler
AKjDPG 4.2	Sun	16:45–17:30	C 03	**Quantum enhanced measurements** — •Karol Gietka

Sessions

AKjDPG 1.1–1.2	Sun	14:00–15:30	C 02	**Rydberg Atoms**
AKjDPG 2.1–2.1	Sun	14:00–15:30	C 03	**Scientific Writing Workshop**
AKjDPG 3.1–3.2	Sun	16:00–17:30	C 02	**Free-Electron Lasers**
AKjDPG 4.1–4.2	Sun	16:00–17:30	C 03	**Metrology**
AKjDPG 5	Sun	18:00–21:00	Mittlerer Kreuzbau Foyer 1. OG	**Open Space**
AKjDPG 6.1–6.1	Sun	18:00–19:30	Mittlerer Kreuzbau Room Newton	**AlgoRhythm**

AKjDPG 1: Rydberg Atoms

Time: Sunday 14:00–15:30 Location: C 02

Tutorial AKjDPG 1.1 Sun 14:00 C 02
Many-body physics with Rydberg atoms — •Christian Gross — Physikalisches Institut, Universität Tübingen

In this tutorial we will discuss the potential of Rydberg atoms for exploring quantum many-body physics for quantum simulation and computing. We will highlight the unique properties of this platform for precision experiments with synthetic and fully controlled quantum magnets. After setting the stage with this general overview, we will discuss key experiments to showcase the experimental state of the art for different atomic spin encoding schemes. We will end with a brief discussion of future prospects and challenges in this rapidly evolving field.

Tutorial AKjDPG 1.2 Sun 14:45 C 02
Neutral Atom Quantum Computing using Rydberg Physics — •Yuri van der Werf — Eindhoven University of Technology, De Rondom 21, 5612 AP, Eindhoven, the Netherlands

Single atoms trapped in arrays of optical tweezers have lately been on the rise as a scalable architecture for quantum computing applications. Constructing a complete gate set for these neutral atom qubits requires the full coherent control over the internal qubit state as well as a means to deterministically entangle two qubits.

This entanglement is achieved by employing highly-excited Rydberg states, which inherently exhibit strong long-range interactions. These interactions result in an excitation blockade effect which can be used to coherently manipulate the two-qubit state of pairs of atoms.

In this tutorial we will explore the recent developments in tweezer platforms for quantum computing, including the two machines being built in Eindhoven. We will discuss the choice of atomic species and qubit type, qubit control mechanisms and computational architectures.

We then focus on how to construct a two-qubit gate using the Rydberg excitation blockade. There are several technical limitations that impact the achievable gate fidelity, such as Rydberg state lifetime, atom temperature, and laser phase noise. We will go into how to overcome these limitations by the choice of Rydberg state, pulse optimization, and laser locking techniques and architectures.

AKjDPG 2: Scientific Writing Workshop

Time: Sunday 14:00–15:30 Location: C 03

Tutorial AKjDPG 2.1 Sun 14:00 C 03
Scientific Writing Workshop for Early Career Researchers — •Tracy E. Northup — University of Innsbruck, Department of Experimental Physics

An integral part of being scientists is being able to communicate the aims, methods, and results of our research clearly to others. However, many physicists receive no formal training in scientific writing. In this workshop, we will look at some key principles of scientific writing and discuss steps that early career researchers can take to improve their writing. The workshop will be based on a course that the speaker has taught for PhD students at the University of Innsbruck.

AKjDPG 3: Free-Electron Lasers

Time: Sunday 16:00–17:30 Location: C 02

Tutorial AKjDPG 3.1 Sun 16:00 C 02
Opportunities for experiments on atoms, molecules and clusters at the European X-Ray Free Electron Laser — •Michael Meyer — European XFEL, Schenefeld, Germany

The unique characteristics of X-ray Free Electron Lasers (XFELs), especially the high intensity (up to $10^{19} W/cm^2$) and the short duration (down to the sub-femtosecond regime) of the generated X-ray pulses, open access to various new research opportunities for investigations of atoms, molecules, ions and nanoparticles. Using typical recent experiments as showcase, the tutorial will illustrate which novel information is obtained for example in studies of multi-photon processes in the short wavelength regime and how dynamical information can be extracted from site-specific time-resolved pump-probe experiments.

The relevant instrumentation, required experimental conditions and important photon beam parameters enabling this type of studies will be presented and discussed, taking the Small Quantum Systems (SQS) scientific instrument at the European XFEL as example. In the presentation, strong emphasis will be given to provide a basic guideline for successful experiments, addressing especially new users of FEL facilities. Practical information about the experimental infrastructure available to users as well as the operational support provided by the facility to the researchers for the preparation, execution and subsequent analysis of an experimental campaigns will be outlined.

Tutorial AKjDPG 3.2 Sun 16:45 C 02
Your first Free-Electron Laser experiment: What to know before you go — •Kirsten Schnorr — Paul Scherrer Institut, Villigen, Switzerland

X-ray Free-Electron Lasers (XFELs) have emerged as uniquely powerful light sources that enable experiments on the femtosecond time scale due to their ultrashort pulses with atomic resolution exploiting the short wavelengths or state-selectivity of X-rays. This tutorial will introduce the fundamental properties of XFEL radiation and give an overview of the current XFEL landscape.

Building on this foundation, we will survey key application areas of XFELs with a focus on atomic, molecular and optical (AMO) physics. The fundamental interaction mechanisms of X-rays and matter will be reviewed. We will discuss how a temporal resolution down to the femto- and even atto-second time scale can be achieved using the pump-probe technique. We will look into typical XFEL applications in AMO sciences either making use of the extreme X-ray intensities which result in the absorption of multiple X-ray photons within one pulse by a target and/or exploiting the high achievable temporal resolution. Finally, the tutorial will provide a practical overview of the architecture of a typical XFEL beamline and experimental station for AMO sciences.

AKjDPG 4: Metrology

Time: Sunday 16:00–17:30 Location: C 03

Tutorial AKjDPG 4.1 Sun 16:00 C 03
Optical atomic clocks and applications — •Tanja Elisabeth Mehlstäubler — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany — Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany

Time and frequency are the most precise measurable quantities in physics today. Optical atomic clocks have reached relative frequency

uncertainties as low as 1e-18 inside laboratories and are used in fundamental and applied research. The dependence of the atomic frequencies on the gravitational potential makes atomic clocks ideal candidates for the search for deviations in the predictions of Einstein's general relativity, tests of modern unifying theories and the development of new sensors for gravity. I will introduce the concepts of atomic clocks and present the current status of international clock development and comparison. Further on, I will discuss the status of some fundamental tests of our standard model by means of high-precision spectroscopy and future applications of time and frequency metrology. Besides a continuous improvement in stability and accuracy of today's best clocks, a large effort is put into increasing the reliability and technological readiness for out of lab measurements with compact, portable devices. In the near future, optical clocks are foreseen to contribute together with satellite missions to the precise determination of the Earth's geoid with a height resolution on the cm-level.

Tutorial AKjDPG 4.2 Sun 16:45 C 03
Quantum enhanced measurements — •Karol Gietka — University of Innssbruck

This tutorial offers an elementary and self-contained introduction to quantum-enhanced measurements, aimed at participants with a basic background in quantum mechanics. We discuss how quantum noise sets fundamental limits to measurement precision and how these limits can be overcome using genuinely quantum resources. The tutorial focuses on two representative platforms: noise squeezing in harmonic oscillators and entanglement in collective spin systems. In the first part, we introduce quadrature squeezing and show how redistributing quantum noise enables enhanced sensitivity. In the second part, we explore the role of maximally entangled spin states in precision measurements and illustrate how they lead to improved scaling beyond classical limits. Emphasis is placed on physical intuition and simple models.

AKjDPG 5: Open Space

Time: Sunday 18:00–21:00 Location: Mittlerer Kreuzbau Foyer 1. OG

The Young DPG welcomes everyone arriving on Sunday to an open space to meet, talk and connect. Board games may be brought along. A group pizza order for dinner will be available.

AKjDPG 6: AlgoRhythm

Time: Sunday 18:00–19:30 Location: Mittlerer Kreuzbau Room Newton

Workshop AKjDPG 6.1 Sun 18:00 Mittlerer Kreuzbau Room Newton
AlgoRhythm – the Physics of Tango — •David Ohse[1] and Yumi Johanna Tanabe[2] — [1]science 42 — [2]jDPG

Argentine Tango is the art of dreaming passionately with your feet and has almost nothing to do with the European tango. As a freely improvised couple dance, the original tango is surprisingly closely related to physics and mathematics. In this workshop, we will programme our first tango steps, swing Schrödinger's dancing leg and compile simple algorithms on the dance floor. Finally, we will dance CPT transformations, which means we will mirror dance figures in relation to charge, space and time. As a refreshing break from sitting around at the conference, this workshop will get you moving to tango music. So this tango workshop is fun even without previous dance experience.