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

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Overview of Invited Talks and Sessions

(Lecture halls HS 3+4, HS 5+6, and WP-HS)

jDPG events within the Plenary Special Talks programme

PSV I	Mon	13:00–14:30	HS 1+2	**Live-Podcast: Meet Your Future – Produktmanagement in der Medizintechnik** — •Olivia Noack
PSV III	Tue	13:00–14:30	HS XVI	**Panel Discussion: Finding your Path after Graduation – Different Perspectives** — • jDPG
PSV VII	Thu	13:00–14:30	HS XVI	**Berufsperspektiven für Physiker:innen in der Schule** — •Victor Schneider

Invited Talks

AKjDPG 5.1	Sun	18:00–20:00	WP-HS	**Exploring Science Through Board Games** — •Stefanie Kroker, Mika Gaedtke, Liam Shelling Neto, Jens Junge

Invited Talks of the joint Symposium Quantum Science and more in Ghana and Germany (SYGG)

See SYGG for the full program of the symposium.

SYGG 1.1	Tue	11:00–11:05	WP-HS	**Welcome Adress** — •Birgit Münch
SYGG 1.2	Tue	11:05–11:20	WP-HS	**Quantum Education in Ghana** — •Dorcas Attuabea Addo
SYGG 1.3	Tue	11:20–11:45	WP-HS	**Mathematical and Computational Physics Research In Ghana: To Cultivate a Knowledge-Based and Sustainable Development Economy** — •Henry Martin, Henry Elorm Quarshie, Mark Paal, Francis Kofi Ampong, Eric Kwabena Kyeh Abavare, Matteo Colangeli, Alessandra Continenza, Jaime Marian
SYGG 1.4	Tue	11:45–12:10	WP-HS	**Forecasting the Economic Health of Ghana Using Quantum-Enhanced Long Short-Term Memory Model** — •Peter Nimbe, Henry Martin, Dorcas Attuabea Addo, Nicodemus Songose Awarayi
SYGG 1.5	Tue	12:10–12:40	WP-HS	**Quantum Technology with Spins** — •Joerg Wrachtrup
SYGG 1.6	Tue	12:40–13:00	WP-HS	**Renewable Energy Technologies for Rural Ghana: The Role of Appropriate Technology for Tailored solutions** — •Michael Kweku Edem Donkor

Prize and Invited Talks of the joint Awards Symposium (SYAS)

See SYAS for the full program of the symposium.

SYAS 1.1	Thu	14:30–15:10	HS 1+2	**A journey in mathematical quantum physics** — •Reinhard F. Werner
SYAS 1.2	Thu	15:10–15:50	HS 1+2	**Precision Tests of the Standard Model at Low Energies Using Stored Exotic Ions in Penning Traps** — •Klaus Blaum
SYAS 1.3	Thu	15:50–16:30	HS 1+2	**Controlling light by atoms and atoms by light: from dark-state polaritons to many-body spin physics** — •Michael Fleischhauer
SYAS 1.4	Thu	16:30–16:35	HS 1+2	**Quantum history at your fingertips: Launch of the DPG's Quantum History Wall** — •Arne Schirrmacher

Sessions

AKjDPG 1.1–1.2	Sun	14:00–15:40	HS 3+4	**Open Quantum Systems**
AKjDPG 2.1–2.2	Sun	16:00–17:40	HS 3+4	**Quantum Control**
AKjDPG 3.1–3.2	Sun	14:00–15:40	HS 5+6	**Time-resolved Spectroscopy**
AKjDPG 4.1–4.1	Sun	16:00–17:30	HS 5+6	**The Theory of Accurate and Accessible Figure Design**
AKjDPG 5.1–5.1	Sun	18:00–22:00	WP-HS	**Exploring Science Through Board Games**
AKjDPG 6.1–6.2	Wed	11:00–12:30	HS ROT	**Hacky Hour (joint session AGI/AKjDPG)**

AKjDPG 1: Open Quantum Systems

Time: Sunday 14:00–15:40 Location: HS 3+4

Tutorial AKjDPG 1.1 Sun 14:00 HS 3+4

Solving Quantum Dynamics with QuTiP and HEOM — •Alexander Pitchford[1], Simon Cross[2], and Neill Lambert[3] — [1]Department of Mathematics, Aberystwyth University, Wales, UK — [2]Zurich Instruments, Zurich, Switzerland — [3]Theoretical Quantum Physics Laboratory, RIKEN, Wakoshi, Saitama, Japan

QuTiP, the Quantum Toolkit in Python, is an open source code library for the simulation of quantum dynamics, best known for its open quantum system solvers. We give an overview of the features of the core package and some of the associated 'family' packages.

We introduce the solvers, starting with unitary dynamics, then moving on to modelling interactions of the quantum system with its environment. We demonstrate solutions to the Lindblad master equation (LME), showing the effects of decoherence and dissipation on the ensemble through jump operators. We compare this with Monte-Carlo simulations and see how the random jumps converge to the deterministic solution with sufficient iterations.

LME assumes that interactions with the environment are Markovian in nature. The Hierarchical Equations of Motion (HEOM) provide an exact model of the effects of the environment on a quantum system. We describe how this is configured using auxiliary operators and solved as coupled differential equations. We compare QuTiP's HEOM solver with the LME solver and examine bath characteristics that exhibit Markovian noise.

Tutorial AKjDPG 1.2 Sun 14:50 HS 3+4

Non-Markovian Quantum Dynamics: Physical Concepts and Mathematical Methods Describing Memory in Open Systems — •Heinz-Peter Breuer — Physikalisches Institut, Universität Freiburg, Hermann-Herder- Straße 3, D-79104 Freiburg, Germany — EUCOR Centre for Quantum Science and Quantum Computing, University of Freiburg, Hermann-Herder-Straße 3, D-79104 Freiburg, Germany

The dynamics of open quantum systems is often approximated by means of a Markovian process in which the open system irretrievably loses information to its surroundings, expressing the memoryless nature of the dynamics. However, open systems out of equilibrium often exhibit a pronounced non-Markovian behavior distinguished by a flow of information from the environment back to the open system. This information backflow leads to the emergence of memory effects and represents the key feature of non-Markovian quantum dynamics. In the talk I will discuss fundamental physical concepts and mathematical methods used to characterize, to quantify and to model quantum memory effects in open systems.

AKjDPG 2: Quantum Control

Time: Sunday 16:00–17:40 Location: HS 3+4

Tutorial AKjDPG 2.1 Sun 16:00 HS 3+4

Floquet engineering for quantum simulation — •Marín Bukov — Max Planck Institute for the Physics of Complex Systems

This lecture introduces periodically driven systems, with particular emphasis on applications in AMO-based quantum simulators. After introducing Floquet's theorem, we will focus on the physical intuition behind it and discuss how to design effective Hamiltonians with prescribed properties. In particular, we will discuss how to use strong high-frequency periodic drives to stabilize unstable equilibria, localize quantum matter, and engineer artificial magnetic fields. Time permitting, we will mention the primary role of periodic drives for the investigation of energy absorption and thermalization in closed interacting quantum systems, and introduce Floquet time crystals – a nonequilibrium phase of matter with no equilibrium counterpart.

Tutorial AKjDPG 2.2 Sun 16:50 HS 3+4

Quantum Optimal Control in a Nutshell — •Daniel Reich — Dahlem Center for Complex Quantum Systems and Fachbereich Physik, Freie Universität Berlin, Berlin, Germany

Since the start of the 21st century, research and development of technologies actively exploiting quantum properties of light and matter has experienced a surge in popularity. To this end, quantum optimal control is one of the main tools for devising concrete protocols to manipulate quantum systems in order to achieve specific tasks in the best way possible. In this tutorial I tell you about the main principles of quantum optimal control and provide a brief summary of the key techniques used in the field. Furthermore, I demonstrate the power of the quantum optimal control toolbox via practical use cases and introduce some of the available software packages such that you can start controlling quantum systems, too.

AKjDPG 3: Time-resolved Spectroscopy

Time: Sunday 14:00–15:40 Location: HS 5+6

Tutorial AKjDPG 3.1 Sun 14:00 HS 5+6

Ultrafast spectroscopy — •Anchit Srivastava — Max Planck Institute for the Science of Light, Staudstrasse 2, 91058 Elangen, Germany.

Ultrafast spectroscopy has become a powerful tool for unravelling fundamental interactions in molecules, nanostructures, and solids. It enables the observation of processes on timescales from picoseconds to attoseconds. In this tutorial, I will introduce three pivotal techniques in modern ultrafast science: pump-probe, dual-comb, and field-resolved spectroscopy. We begin by discussing the pump-probe method, which monitors transient states by exciting a sample with an ultrashort pump pulse and tracking its dynamics with a temporally delayed probe pulse. Next, we explore dual-comb spectroscopy, emphasizing how two precisely stabilized frequency combs yield rapid, high-resolution data over broad spectral ranges. Lastly, we delve into field-resolved spectroscopy, a novel approach that allows direct measurement of the electric field of light pulses in ambient conditions. Through technological developments, field-resolved methods now extend from the terahertz to the petahertz domain, providing unprecedented temporal resolution down to the attosecond regime. By combining these techniques, researchers can thoroughly characterize ultrafast processes in a variety of materials, thereby deepening our understanding of energy transfer, charge dynamics, and fundamental light-matter interactions. This tutorial aims to equip students with the essential knowledge to tackle these rapidly evolving methodologies.

Tutorial AKjDPG 3.2 Sun 14:50 HS 5+6

Ultrafast spectroscopy: probing and controlling quantum dynamics on the fastest timescales — •Gergana D. Borisova — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The fundamental processes in atoms, molecules, and solids occur on remarkably fast timescales – from picoseconds down to attoseconds. The rapid development of ultrafast physics and attosecond science, driven by advances in the generation of shorter and more intense laser pulses, has opened new frontiers in accessing these timescales. We can now measure, understand, and even control electron and nuclear dynamics within natural quantum systems at a fundamental level.

In this tutorial, we will explore the principles of ultrafast light-matter interactions using short and intense laser fields. Key tools of ultrafast spectroscopy, including table-top high-harmonic sources for generating attosecond pulses and large-scale free-electron lasers, will be introduced. We will get to know two prominent time-resolved spectroscopic techniques in the extreme ultraviolet (XUV) regime – time-delay spectroscopy and photoelectron-photoion spectroscopy – and examine their applications in probing and manipulating ultrafast dynamics in quantum systems. Through practical examples, participants will gain insight how ultrafast spectroscopy advances our understanding of dynamical quantum phenomena.

AKjDPG 4: The Theory of Accurate and Accessible Figure Design

Time: Sunday 16:00–17:30 Location: HS 5+6

Tutorial AKjDPG 4.1 Sun 16:00 HS 5+6

The theory of accurate and accessible figure design — •Fabio Crameri — Undertone.design, Bern, Switzerland — International Space Science Institute (ISSI), Bern, Switzerland

In the vast landscape of scientific data, graphics serve as a golden key to its comprehension. From the depths of the cosmos to the intricacies of elementary particles, the deliberate use of diagrams, colour, typefaces and fonts, and other graphic elements in scientific visualisation enriches our understanding and enables us to appreciate the beauty and complexity of the natural world. From the properties of the light source to the ultimate recognition in the visual cortex, the study of human visual perception is extensive and has a long history. Creating accessible and accurate scientific visualization with colour has, in contrast, become easy. All necessary aspects are understood. All necessary tools exist. Here, I will provide you with the basic understanding to use–and not misuse–the most basic graphic elements like colour for visualising everything from the Standard Model of particle physics to the Island of Stability. I will also introduce you to the newest version of the Scientific colour maps and the different palette and gradient types available therein. In just this one lecture, you shall be equipped to navigate the most-basic use of colour in your daily routine. I also hope you will then become an advocate of the scientific use of colour and other basic graphic elements yourself so that after having mastered our theory of everything, we as a community will not fail the one job left: to accurately show it to everybody else.

AKjDPG 5: Exploring Science Through Board Games

Time: Sunday 18:00–22:00 Location: WP-HS

Invited Talk AKjDPG 5.1 Sun 18:00 WP-HS

Exploring Science Through Board Games — •Stefanie Kroker[1,2], Mika Gaedtke[1], Liam Shelling Neto[1], and Jens Junge[3] — [1]Institut für Halbleitertechnik, Technische Universität Braunschweig — [2]Physikalisch-Technische Bundesanstalt Braunschweig — [3]Institut für Ludologie, SRH Hochschule für Kommunikation und Design

Board games offer a unique way to communicate scientific concepts, combining education with entertainment. We invite early-career scientists to explore the intersection of science and game design. By sharing our insights as first-time developers of Quantista, a board game project funded by the BMBF that explores quantum technology, we aim to spark new creative ideas. Participants will gain insight into the challenges of translating complex scientific topics into engaging gameplay. The workshop will include a hands-on session where attendees will work in small groups to brainstorm and develop their own scientific board game ideas on a variety of intriguing topics.

Board games evening starting at 20:00: Board games are a great way to get people chatting. If you enjoy board games and would like to meet other conference participants on the day of arrival, just drop by. You can bring your favourite game with you, but we also have a large selection of games available.

AKjDPG 6: Hacky Hour (joint session AGI/AKjDPG)

In this new format, introduced by AGI and jDPG, tools are presented that can be helpful in your everyday scientific work. Whenever possible a hands-on part will be offered where the tool can be used directly preferably on your own laptop. Furthermore there will be a discussion of the tool where e.g. aspects of compatibility and extensibility can be addressed.

If installation of software is necessary in advance instructions on this and further information in general can be found at https://hacky-hour.dpg-physik.de

Time: Wednesday 11:00–12:30 Location: HS ROT

AKjDPG 6.1 Wed 11:00 HS ROT

DFT Tone-extraction made easy: A toolbox to extract all important parameters from a Fourier-Transformed Time-Series — •Timon Damböck and Ilja Gerhardt — light and matter group, Institute for Solid State Physics, Leibniz University of Hannover, Appelstrasse 2, 30167 Hannover

When measuring with a quantum sensor, e.g. a magnetometer, the sensing information is contained in a time–series. The parameters of this 'tone'–response from the sensor is limited to the response of it in the measurement bandwidth. While those parameters can be obtained via a fit in the time–domain, this extraction is both slow and prone to systematical errors due to mis– or overestimation of those parameter. To circumvent this, a Discrete–Fourier–Transform (DFT) is used for the extraction of the parameters. It reveals the amplitude and the noise content in a specific bandwidth – if done correctly. Although conventional fitting methods can be used to reconstruct the amplitude and frequency below their internal resolution in the frequency domain, the use of wrong response functions in frequency space can lead to biases when comparing results with others. To overcome all this, we implemented a toolbox, which relies on estimating the parameters solely from the transformation into frequency domain – without the need for fitting. Hereby we aim to reduce the influence of systematical errors, while being fast and resource–efficient enough to assure real–time extraction and tracking of parameters in the lab.

AKjDPG 6.2 Wed 11:45 HS ROT

Set up a quantum simulation from a screenshot — •Gregory Varghese Manalumbhagath — HQS Quantum Simulations

Setting up quantum simulation is often a daunting task, fraught with intricate parameter configurations and strict adherence to tool-specific conventions. To alleviate this challenge, the HQS Modeling Assistant provides an efficient way of generating requisite inputs, guiding users through module functionalities and assisting in the creation of simulation inputs through the simple and yet familiar interface of chat.

The assistant can perform simulations, as well as analyse results by generating plots and reformatting into tables. The assistant can process structured and unstructured data like figures of quantum circuits, scientific equations, scientific texts from scientific papers thereby reducing the cognitive load on researchers. In this talk, the users will learn how to setup and run a quantum computing simulation by merely uploading a screenshot of equation or image of circuit or just chatting with the HQS Modeling Assistant. This way the focus is shifted from the technical implementation of the scientific paper to the underlying concepts and insights.