MON 4: DPG Promotionskolleg Next Generation Computing

Time: Monday 14:15–16:15 Location: ZHG004

MON 4.1 Mon 14:15 ZHG004

From Qubits to Neuromorphic Computing: Technologies Shaping the Future of Computing (Part 1) — •Jonah Elias Nitschke[1], Noah Stiehm[2], Sebastian Grossenbach[3], and Alexander Cornelius Heinrich[4] — [1]TU Dortmund university, Dortmund, Germany — [2]TU Ilmenau, Ilmenau, Germany — [3]Uni Konstanz, Konstanz, Germany — [4]QuantumBW, Stuttgart, Germany

What will the future of computing look like? Which technologies will define it, and what might succeed classical digital computation?

The technological landscape is diverse and rapidly evolving, with emerging fields such as analog and neuromorphic computing, as well as quantum computing. The German Physical Society (DPG) has launched its first Graduate Program (DPG-Promotionskolleg) to provide a structured perspective on these developments.

This initiative is not only focused on a new topic but also introduces an innovative format. The DPG Graduate School is a pilot initiative designed to encourage interdisciplinary and cross-institutional collaboration among PhD students over a period of 18 months. Participants will work alongside experts from academia, industry, and consulting to address complex questions related to the future of computing. The program emphasizes collaboration across various disciplines and encourages participants to look beyond their research topics and answer questions such as: How does my research contribute to the broader development of next generation computer technology, and why is it relevant to society?

MON 4.2 Mon 14:30 ZHG004

From Qubits to Neuromorphic Computing: Technologies Shaping the Future of Computing (Part 2) — David Ohse[1], •David Steffen[2], Julia Diana Küspert[3], Sebastian Bürger[4], and Verena Feulner[5] — [1]Uni of Bonn, Bonn, Germany — [2]DLR Institue of Engineering Thermodynamics, Ulm, Germany — [3]The European Synchrotron, Grenoble, France — [4]University of Leipzig, Leipzig, Germany — [5]University of Erlangen-Nuremberg, Erlangen, Germany

In our first session, we will introduce the DPG Graduate Program concept and share practical insights from its first cohort. Participants will present key findings from their research on emerging computing technologies, with a particular emphasis on quantum computing. We provide an overview of the status of various hardware implementations, software architectures, and algorithm development. We further discuss how the DPG Graduate Program Next Generation Computing encouraged scientific collaboration and outreach.

In the following sessions, selected participants will provide an introduction to their research topic and explain their motivation for joining the first cohort of the DPG Graduate School. In the last part, our scientific advisory board will join us for a panel discussion to address the significant challenges the field is expected to face over the next decade and how acceptance and trust in new computing technologies can be fostered in society.

MON 4.3 Mon 14:45 ZHG004

Towards a Parallel Electrical Read-Out for Spin-Wave-Based Spectrometers — •Johannes Greil[1], Felix Naunheimer[1], Valentin Ahrens[1], Manuel Wilke[1], Tobias Mohr[1], Levente Maucha[2], Ádám Papp[2], György Csaba[2], and Markus Becherer[1] — [1]Technical Universtiy of Munich, Munich, Germany — [2]Pázmány Peter Catholic University, Budapest, Hungary

This work presents the fine-tuning and electrical characterization of a demonstrator that combines a magnonic spectrometer in the Rowland circle arrangement with an RF circuit board for electrical read-out. We fabricate the Rowland circles by sputter deposition of Yttrium-Iron-Garnet (YIG) on a Gadolinium-Gallium-Garnet (GGG) substrate, followed by wet-chemical etching of the amorphous YIG film. In a subsequent lithography step, we fabricate a curved stripline transducer as input and several u-shaped transducers as local pick-ups for the output. We have achieved a mono-frequent detection resolution of around 45MHz in a usable band of 180MHz using time-resolved MOKE (trMOKE) measurements. With this system, we could successfully show that two-tone excitation and, consequently, wavefront separation is possible. The next step toward a more self-standing demonstrator device is the electrical detection of the locally picked-up magnonic signals. For this, we suggest a simple yet powerful method of power detection using RF diodes instead of RF amplifiers or mixers. To perform such measurements, we designed a circuit board providing one RF power detector per pick-up transducer, which can be read using any analog-to-digital converter (ADC).

MON 4.4 Mon 15:00 ZHG004

Quantum Computing with Trapped Ions — •Florian Ungerechts — Institut für Quantenoptik, Leibniz Universität Hannover, Germany

Trapped ions are a leading platform for quantum computing, providing high gate fidelities, long coherence times, and all-to-all connectivity between the qubits. But how does quantum computing with trapped ions work?

We begin by motivating what makes trapped ions great qubits, followed by an introduction to the basics of ion traps and how they allow for precise control of individual ions. Finally, we give a brief insight into the current status of ion-trap quantum processors in research and industry.

MON 4.5 Mon 15:15 ZHG004

Robustly optimal dynamics for active matter reservoir computing — •Mario U. Gaimann and Miriam Klopotek — Stuttgart Center for Simulation Science (SimTech), Cluster of Excellence EXC 2075, University of Stuttgart, Germany

Information processing abilities of active matter are studied in the reservoir computing (RC) paradigm to infer the future state of a chaotic signal. We uncover an exceptional regime of agent dynamics that has been overlooked previously. It appears robustly optimal for performance under many conditions, thus providing valuable insights into computation with physical systems more generally. The key to forming effective mechanisms for information processing appears in the system's intrinsic relaxation abilities. These are probed without actually enforcing a specific inference goal. The dynamical regime that achieves optimal computation is located just below a critical damping threshold, involving a relaxation with multiple stages, and is readable at the single-particle level. At the many-body level, it yields substrates robustly optimal for RC across varying physical parameters and inference tasks. A system in this regime exhibits a strong diversity of dynamic mechanisms under highly fluctuating driving forces. Correlations of agent dynamics can express a tight relationship between the responding system and the fluctuating forces driving it. As this model is interpretable in physical terms, it facilitates re-framing inquiries regarding learning and unconventional computing with a fresh rationale for many-body physics out of equilibrium. Reference: Gaimann, M. U., & Klopotek, M. (2025), arXiv:2505.05420.

MON 4.6 Mon 15:30 ZHG004

Silicon-germanium: A platform for both, spin qubit and superconducting planar qubit circuits — •Pauline Drexler and Jakob Walsh — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D-93040 Regensburg, Germany

Silicon-germanium in principle offers a unique possibility to implement two very different types of solid-state qubits within the same materials platform: semiconductor spin qubits and superconducting flux qubits. In this approach, spin qubits are realized in Coulomb blockade-based quantum dots. Flux qubits are envisioned to be created via assemblies of gate-tunable hybrid Josephson junctions, based on a superconducting film, in proximity interaction with the semiconductor. The common basis of both types of quantum circuits is an epitaxially grown silicon-germanium quantum-confined semiconductor thin film structure. Each type of qubit then essentially relies on different planar, surface electrode circuitry layouts. In my presentation, I will discuss the epitaxy of hybrid semiconductor structures and practical aspects of the realization of both types of qubits quantum circuits. I will highlight the advantages of the planar circuit approach regarding scaling of future quantum processors and the high compatibility of the silicon-germanium platform with the current semiconductor chip industry.

MON 4.7 Mon 15:45 ZHG004

Panel discussion about Next Generation Computing and its impact on industry and society (Part 1) — •Andreas

Böhm[1], Adrian Auer[2], Jeanette Lorenz[3], Hans Huebl[4], Niclas Götting[5], and Markus Hoffmann[6] — [1]Bayern Innovativ, Nuremberg, Germany — [2]IQM GmbH, Munich, Germany — [3]Fraunhofer IKS, Munich, Germany — [4]Walther-Meißner-Institut, Munich, Germany — [5]University of Bremen, Bremen, Germany — [6]FAU Erlangen-Nuremberg, Erlangen, Germany

In this panel discussion, we will focus on how to strengthen the exchange between science and industry in the dynamic field of next generation computing. Joined by our scientific advisory board consisting of Jeanette Lorenz (Fraunhofer Gesellschaft), Andreas Böhm (Bayern Innovativ), Adrian Auer (IQM), and Hans Hübl (Bavarian Academy of Sciences and Humanities), we will discuss which strategies and platforms can encourage knowledge transfer and accelerate innovation.

MON 4.8 Mon 16:00 ZHG004

Panel discussion about Next Generation Computing and its impact on industry and society (Part 2) — •Martin Mauser[1], Christoph Huettl[2], Max Mangold[3], Niclas Popp[4], and Nils-Erik Schütte[5] — [1]University of Vienna, Vieann, Austria — [2]Charité Berlin, Berlin, Germany — [3]TUM, Munich, Germany — [4]Eberhard Karl University of Tübingen, Tübingen, Germany — [5]University of Bremen, Bremen, Germany

Another key focus will be on the major challenges the field is expected to face over the next decade, ranging from technological challenges to ethical considerations. Furthermore, the discussion will address how society can be actively involved in the development and application of new computing technologies to foster acceptance and trust. Our goal is to bring together diverse perspectives and develop concrete recommendations for future-oriented collaboration.