Q 21: Quantum Computing and Simulation III

Time: Tuesday 11:00–13:00 Location: P 10

Invited Talk Q 21.1 Tue 11:00 P 10

Interfacing with Quantum Information Processors—From Readout to Control — •Benjamin Lienhard[1,2], Shivang Arora[1,2], Emily Guo[1,2], Priyanka Yashwantrao[1,2], Patryk Dabkowski[1,2,3], and Stefan Filipp[1,2] — [1]Technical University of Munich, Garching 85748, Germany — [2]Walther-Meißner-Institut, Garching 85748, Germany — [3]Zurich Instruments, 8005 Zürich, Switzerland

Balancing the effort required for controlling quantum systems—especially during characterization and calibration—is essential for making quantum computing practical. This effort must remain lightweight enough to track drifting system parameters, yet efficient enough to enable rapid recalibration. Although theoretical models offer valuable intuition, they often fail to capture the full complexity of real devices. Conversely, exhaustive system characterization can yield accurate numerical models, but it is typically too resource-intensive to scale. Model-free learning approaches provide a flexible, data-driven alternative; however, they also require substantial measurement overhead. As quantum processors continue to grow, these challenges intensify. In this presentation, I will introduce machine-learning-based protocols that we have developed to enhance superconducting qubit readout, as well as strategies for scalable calibration of large-scale quantum processors.

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Q 21.2 Tue 11:30 P 10

The sub-Riemannian geometry of measurement based quantum computation — •Lukas Hantzko — Institut für Theoretische Physik, Leibniz Universität Hannover, Hannover, Germany

The computational power of symmetry-protected phases of matter can be accessed through local measurements, but what is the most efficient way of doing so? In this work, we show that minimizing operational resources in measurement-based quantum computation (MBQC) on subsystem symmetric resource states amounts to solving a sub-Riemannian geodesic problem between the identity and the target logical unitary. This reveals a geometric structure underlying MBQC and offers a principled route to optimize quantum processing in computational phases. (arxiv:2508.17808)

Q 21.3 Tue 11:45 P 10

Can parity measurements be implemented for continuous quantum error correction? — •Anton Halaski and Christiane P. Koch — Freie Universität Berlin, Berlin, Germany

In time-continuous quantum error correction, required in computations with time-varying Hamiltonians, the commonly employed strong projective measurements for syndrome extraction are replaced by weak continuous measurements. These protocols rely on sufficiently strong and continuous multi-qubit parity measurements to extract the error syndromes. The implementation of such measurements is challenging since they require a perpetual three-body interaction between two qubits and a meter. Here we show that, for the circuit QED architecture, known parity measurement protocols destroy the information encoded in the qubits when used in continuous operation since it is impossible to protect both the logical subspace and the error subspace from measurement backaction at the same time. We find the failure to be rooted in the approximation of the three-body interaction by a sum over two-body interactions between meter and qubits. Our findings suggest that continuous quantum error correction is possible only for architectures based on erasure qubits, such as dual-rail encodings, where there is no need to protect the error subspace from measurement backaction.

Q 21.4 Tue 12:00 P 10

Sample-Based Krylov Quantum Diagonalization for the Schwinger Model on Trapped-Ion and Superconducting Quantum Processors — •Jurek Eisinger[1], Emil Rosanowski[2], Lena Funcke[2], Ulrich Poschinger[1], and Ferdinand Schmidt-Kaler[1] — [1]QUANTUM, University of Mainz, Department of Physics, Staudingerweg 7, Germany — [2]University of Bonn, Nussallee 14-16, 53115 Bonn, Germany

We apply the Sample-based Krylov Quantum Diagonalization (SKQD) method to lattice gauge theories, using the Schwinger model with a θ-term as a benchmark. SKQD approximates the ground state of a Hamiltonian, employing a hybrid quantum*classical approach: (i) constructing a Krylov space from bitstrings sampled from time-evolved quantum states, and (ii) classically diagonalizing the Hamiltonian within this subspace. We implement the algorithm on both, trapped-ion and superconducting quantum processors, and study the dependence of the ground-state energy and particle number on the value of the θ-term, accurately capturing the model*s phase structure. A striking advantage of SKQD is the substantial reduction of the effective Hilbert space, although the Krylov space dimension still scales exponentially with the system size. Thus, SKQD is a promising method for simulating lattice gauge theories in larger volumes. The methods and results are described in more detail in [Rosanowski et al., arXiv:2510.26951 (2025)].

Q 21.5 Tue 12:15 P 10

QCMobility: Quantum Computing & Mobility — •Matthias Zimmermann and the QCMobility-Team — Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute of Quantum Technologies, Ulm, Germany

This talk provides an overview of the project QCMobility [1] within the DLR Quantum Computing Initiative. Here, we explore application problems in mobility which might benefit from the usage of quantum computers. These include strategic and tactical planning processes in air transport, optimization problems in demand-driven traffic in road transport, planning and dispatching processes in rail transport, route and trajectory optimization in highly automated/autonomous systems in maritime transport, and optimization of multidimensional logistics networks in intermodal transport. In close collaboration with several contractors from industry and various DLR institutes, we aim at developing customized quantum algorithms and demonstration problems to implement them on quantum computing hardware. The project results will be incorporated into the Quantum Computing and Mobility application roadmap.

[1] https://qci.dlr.de/en/qcmobility/

Q 21.6 Tue 12:30 P 10

Truncated Wigner Approximation of Quantum annealing on large Graph instances — •Dennis Breu, Simon Ohler, and Michael Fleischhauer — Department of Physics and Research Center OPTIMAS, RPTU-University of Kaiserslautern-Landau, D-67663 Kaiserslautern, Germany

Solving NP-Hard problems like traveling salesman and Max-Cut are of great interest in industry, for example to optimise shipping routes and supply changes. Quantum Annealing (QA) algorithm is a contender to achieve quantum supremacy on near-term non fault-tolerant quantum computers for these kinds of problems. However, there is no mathematical proof for the quantum advantage and current experimental scales are too small to draw objective conclusions. Thus there is a need to better understand the behavior of QA on intermediate scales. To make larger system sizes computationally accessible we make use of the truncated Wigner approximation (TWA), a semi-classical approximation which, through Monte-Carlo sampling, takes lowest order quantum-fluctuations into account. With TWA it is possible to simulate several hundred spins and better quantify the scaling of the computational effort of QA with the system size than previous methods like ED. Preliminary results seem to indicate that the computational effort for QA on a quantum computer becomes exponential in the same cases where it does for state of the art algorithms on classical computers.

Q 21.7 Tue 12:45 P 10

Boosting Classification with Quantum-Inspired Augmentations — Matthias Tschöpe[1], Vitor Fortes Rey[1,2], Sogo Pierre Sanon[1], Paul Lukowicz[1,2], Nikolaos Palaiodimopoulos[1,2], and •Maximilian Kiefer-Emmanouilidis[1,2] — [1]DFKI Kaiserslautern — [2]RPTU Kaiserslautern-Landau

Small quantum gate perturbations, common in quantum hardware but absent in classical computing, are typically viewed as errors, yet they may serve as a form of data augmentation and offer advantages in quantum machine learning. In this work, we study random Bloch sphere rotations, fundamental SU(2) transformations, as a simple quantum-inspired augmentation method for classical image classification. Unlike standard techniques such as flipping or cropping, these transformations lack intuitive spatial interpretation. Rather than using quantum models or quanvolutional layers, we apply small-angle Bloch rotations directly to classical data and evaluate their effect. Experiments on the ImageNet dataset show consistent performance gains, including a 3% improvement in Top-1 accuracy, a 2.5% gain in Top-5 accuracy, and an increase in F1 score from 8% to 12% over standard augmentation pipelines. We also explore stronger unitary transformations, which produce visually unrecognizable images with potential relevance to privacy. However, we find no measurable improvements in differential privacy and discuss the implications.