FRI 1: Quantum Information: Concepts and Methods II

Time: Friday 10:45–12:30 Location: ZHG001

FRI 1.1 Fri 10:45 ZHG001

Metainformation in quantum guessing games — •Teiko Heinosaari and Hanwool Lee — Faculty of Information Technology, University of Jyväskylä, Finland

Quantum guessing games form a framework for analyzing quantum information processing tasks, where information is encoded into quantum states and retrieved through measurements. Classical side information is partial knowledge about the input. It can significantly influence the guessing strategy and earlier work has shown that the timing of such side information, whether revealed before or after the measurement, can affect the structure of optimal strategies and success probabilities. We go beyond this established distinction by introducing the concept of metainformation. Metainformation is information about information, and in our context it is knowledge that additional side information of certain type will become later available, even if it is not yet provided. We show that this seemingly subtle difference between having no expectation of further information versus knowing it will arrive can have operational consequences for the guessing task. Our results demonstrate that metainformation can, in certain scenarios, enhance the achievable success probability up to the point that post-measurement side information becomes as useful as prior-measurement side information, while in others it offers no benefit. By distinguishing metainformation from actual side information, we uncover a finer structure in the interplay between timing, information, and strategy, offering new insights into the capabilities of quantum systems in information processing tasks.

FRI 1.2 Fri 11:00 ZHG001

From bosons and fermions to spins: A multi-mode extension of the Jordan-Schwinger map — Benoît Dubus[1], •Tobias Haas[1,2], and Nicolas J. Cerf[1] — [1]Centre for Quantum Information and Communication, Université libre de Bruxelles — [2]Institut für Theoretische Physik, Universität Ulm

The Jordan-Schwinger map is widely employed to switch between bosonic or fermionic mode operators and spin observables, with numerous applications ranging from quantum simulation and ultracold quantum gases to quantum optics. While the construction of observables obeying the algebra of spin operators across multiple modes is straightforward, a mapping between bosonic or fermionic Fock states and spin states has remained elusive beyond the two-mode case. Here, we generalize the Jordan-Schwinger map by algorithmically constructing complete sets of spin states over several bosonic or fermionic modes, allowing one to describe arbitrary multi-mode systems faithfully in terms of spins. We discuss our method's potential for efficiently simulating complex many-body dynamics with spin systems.

FRI 1.3 Fri 11:15 ZHG001

Optimising measurement of correlators for fermionic quantum simulators — •Ahana Ghoshal[1], Carlos de Gois[1], Kiara Hansenne[1,2], Otfried Guehne[1], and Hai-Chau Nguyen[1] — [1]Naturwissenschaftlich-Technische Fakultat, Universitat Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany — [2]Université Paris-Saclay, CEA, CNRS, Institut de Physique Théorique, 91191 Gif-sur-Yvette, France

Simulating many-body fermionic systems on conventional quantum computers poses significant challenges due to the overheads associated with the encoding of fermionic statistics in qubits, leading to the proposal of native fermionic simulators as an alternative. This raises the question of characterising the state of a fermionic simulator, which often boils down to measuring certain overlapping sets of few-point correlators from the output of the quantum simulation. We present a systematic framework for optimising the measurement of two- and four-point correlators in fermionic simulators based on their native fermionic gates.This is obtained by developing a graph representation for the set of correlators to be measured, which is then overlaid by a graph describing the constraints from the fermionic gates. Optimising measurement settings is then mapped to graph theoretical problems, for which various algorithms can be applied. We illustrate our methods for the recently proposed fermionic simulators with various sets of two- and four-point correlators as examples.

FRI 1.4 Fri 11:30 ZHG001

Lindblad engineering for quantum Gibbs state preparation under the eigenstate thermalization hypothesis — •Eric Brunner[1], Luuk Coopmans[1], Gabriel Matos[1,2], Matthias Rosenkranz[1], Frederic Sauvage[1], and Yuta Kikuchi[3,4] — [1]Quantinuum, London SW1P 1BX, United Kingdom — [2]Quantinuum, Oxford OX1 2NA, United Kingdom — [3]Quantinuum K.K., Tokyo, Japan — [4]iTHEMS, RIKEN, Wako, Saitama 351-0198, Japan

Building upon recent progress in Lindblad engineering for quantum Gibbs state preparation algorithms, we propose a simplified protocol that is shown to be efficient under the eigenstate thermalization hypothesis (ETH). The ETH reduces circuit overheads of the Lindblad simulation algorithm and ensures a fast convergence toward the target Gibbs state. Moreover, we show that the realized Lindblad dynamics exhibits an inherent resilience against stochastic noise, opening up the path to a first demonstration on quantum computers. We complement our claims with numerical studies of the algorithm's convergence in various regimes of the mixed-field Ising model. In line with our predictions, we observe a mixing time scaling polynomially with system size when the ETH is satisfied. In addition, we assess the impact of algorithmic and hardware-induced errors on the algorithm's performance by carrying out quantum circuit simulations of our Lindblad simulation protocol with a local depolarizing noise model. This work bridges the gap between recent theoretical advances in dissipative Gibbs state preparation algorithms and their eventual quantum hardware implementation.

FRI 1.5 Fri 11:45 ZHG001

Discrete Quantum Walks with Near-Term Neutral Atom Hardware Error Modelling — •Stephanie Foulds and Vivien Kendon — University of Strathclyde, Glasgow, UK

Quantum walks, the quantum analogue to the classical random walk, have been shown to be able to model fluid dynamics [1,2]. Neutral atom hardware is a promising choice of platform for implementing quantum walks due to its ability to implement native multiqubit gates and to dynamically re-arrange qubits [3]. Using error modelling for multiqubit Rydberg gates via two-photon adiabatic rapid passage [4], we present the gate sequences and final state fidelities for some toy quantum walks, including 'lazy' quantum walks.

[1] S.Succi et al., EPJ Quantum Technol. 2, 12 (2015).
[2] S. Hatifi et al., arXiv:2503.05393v2.
[3] K. McInroy et al., arXiv:2402.02127v1.
[4] G. Pelegrí et al., Quantum Sci. Technol. 7 (2022) 045020.

FRI 1.6 Fri 12:00 ZHG001

Universal dissipators for driven open quantum systems and the correction to linear response — •Lorenzo Bernazzani, Balázs Gulácsi, and Guido Burkard — University of Konstanz, D-78457 Konstanz, Germany

We investigate in parallel two common pictures used to describe quantum systems interacting with their surrounding environment, i.e., the stochastic Hamiltonian description, where the environment is implicitly included in the fluctuating internal parameters of the system, and the explicit inclusion of the environment via the time-convolutionless projection operator method. Utilizing these two different frameworks, we show that the dissipator characterizing the dynamics of the reduced system, determined up to second order in the noise strength or bath-system coupling, is universal. That is, it keeps the same form regardless of the drive term, as long as the drive is weak. We thoroughly discuss the assumptions on which this treatment is based and its limitations. By considering the first non-vanishing higher-order term in our expansion, we also derive the linear response correction due to memory-mediated environmental effects in driven-dissipative systems. We demonstrate this technique to be highly accurate for the problems of dephasing in a driven qubit and for the theory of pseudomodes for quantum environments [1].

[1] L. Bernazzani, B. Gulácsi, G. Burkard. arXiv:2505.19262 (2025).

FRI 1.7 Fri 12:15 ZHG001

Turning qubit noise into a blessing: automatic state preparation and long-time dynamics for impurity models on quantum computers — •Corentin Bertrand[1], Pauline Besserve[1,2,3], Michel Ferrero[2,3], and Thomas Ayral[1] — [1]Eviden Quantum Lab, 78340 Les Clayes-sous-Bois, France — [2]Collège de France, Université PSL, 11 place Marcelin Berthelot, 75005 Paris, France — [3]CPHT, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, 91128 Palaiseau, France

Noise is often regarded as a limitation of quantum computers. In this work, we show that in the dynamical mean field theory (DMFT) approach to strongly-correlated systems, it can actually be harnessed to our advantage. Indeed, DMFT maps a lattice model onto an impurity model, namely a finite system coupled to a dissipative bath. While standard approaches require a large number of high-quality qubits in a unitary context, we propose a circuit that harvests amplitude damping to reproduce the dynamics of this model with a blend of noisy and noiseless qubits. We find compelling advantages with this approach: a substantial reduction in the number of qubits, the ability to reach longer time dynamics, and no need for ground state search and preparation. This method would naturally fit in a partial quantum error correction framework.