MP 2: Correlated States

Time: Tuesday 11:00–12:15 Location: KH 02.013

Invited Talk MP 2.1 Tue 11:00 KH 02.013

Frustration free Hamiltonians for Finitely Correlated States – ground space structure and spectral gap — •Norbert Schuch — Universität Wien, Wien, Austria

Finitely Correlated States (FCS), or Matrix Product States, form an efficiently representable class of states on infinite spin chains, with the AKLT model as a prominent example. I will present some new findings on FCS and their *parent Hamiltonians* – frustration free Hamiltonians constructed to have the FCS as an exact ground state. First, I will discuss how such Hamiltonians can have a remarkably rich ground space structure, ranging from unique ground states and critical systems all the way to systems with undecidable ground space structure. Second, I will explain how to use hierarchies of semidefinite relaxations to systematically obtain rigorous and precise lower bounds on the spectral gaps of such models, which provably improve on all known methods to bound such gaps.

MP 2.2 Tue 11:30 KH 02.013

Fractional quantum Hall states as infinite matrix product states — •Severin Schraven[1] and Simone Warzel[1,2,3] — [1]Department of Mathematics, TU Munich, Germany — [2]Munich Center for Quantum Science and Technology, Munich, Germany — [3]Department of Physics, TU Munich, Germany

In this work we present a novel matrix product representation of the Laughlin wave function on the plane. This representation enables the quantitative control of the coefficients of the Laughlin wave function when expanded in a Slater/permanent basis. It renders the properties such as factorization inherent in the Laughlin state transparent. We use the representation to show the exponential decay of connected correlations and a gap in the entanglement spectrum for the Laughlin state on a thin cylinder. All of the above also applies to the Laughlin state times a monomial symmetric polynomial.

MP 2.3 Tue 11:45 KH 02.013

Hyperinvariant Spin Network States – An AdS/CFT Model from First Principles — Fynn Otto[1], •Refik Mansuroglu[2], Norbert Schuch[2,3], Otfried Gühne[1], and Hanno Sahlmann[4] — [1]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany — [2]University of Vienna, Faculty of Physics, Boltzmanngasse 5, 1090 Vienna, Austria — [3]University of Vienna, Faculty of Mathematics, Oskar-Morgenstern-Platz 1, 1090 Vienna, Austria — [4]Department of Physics, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Staudtstraße 7, 91058 Erlangen, Germany

As discrete implementations of the anti de-Sitter/conformal field theory (AdS/CFT) correspondence, hyperinvariant tensor networks have created bridges between the fields of quantum information theory and quantum gravity. Adding SU(2) symmetry to the tensor network allows a direct connection to spin network states, a basis of the kinematic Hilbert space of loop quantum gravity (LQG). We discuss existence and limitations for hyperinvariant tensor networks incorporating a local SU(2) symmetry and provide examples of hyperinvariant tensor networks, but also prove constraints on their existence in the form of no-go theorems that exclude absolutely maximally entangled states as well as general holographic codes from local SU(2)-invariance. We finally discuss applications of this new connection and existing examples in the form of calculations of surface areas and geodesic lengths as expectation values of the LQG area and length operators.

MP 2.4 Tue 12:00 KH 02.013

Holography from Tensor Networks: An RT-like Formula from Homological codes — •Jorge Ortiz — Deutsches Elektronen-Synchrotron (DESY), Notkestr. 85, 22607 Hamburg, Germany — Universität Hamburg, Mittelweg 177, 20148 Hamburg, Germany

We present a microscopic approach to holographic duality based on tensor networks built from simple quantum error-correcting codes, specifically toric codes. We construct a layered network by gluing toric codes step by step to encode bulk degrees of freedom into boundary ones, in close analogy to holographic tensor-network models such as the HaPPY code. In this setup, bulk effective field theory operators are embedded into quantum-gravity degrees of freedom while remaining agnostic about the emergent spacetime curvature.

In the first non-trivial example, we compute entanglement entropies and obtain an RT-like formula. This realises entanglement-wedge reconstruction in a fully discrete, controllable model, dictated by the error-correcting properties of the code.

When adding further layers, the explicit computation of entropies quickly becomes intractable, which motivates a more abstract, topological-algebraic description of the network.