TT 30: Correlated Electrons: 1D Theory

Time: Tuesday 14:00–15:45 Location: H4

TT 30.1 Tue 14:00 H4

Static properties of an atomic Luttinger liquid superimposed on a linear ion chain — •Andreas B. Michelsen[1,2,3], Manuel Valiente[4], Nikolaj T. Zinner[1,5], and Antonio Negretti[6] — [1]Department of Physics and Astronomy, Aarhus University, DK-8000 Aarhus C, Denmark — [2]Physics and Materials Science Research Unit, University of Luxembourg, L-1511 Luxembourg — [3]SUPA, School of Physics and Astronomy, University of St. Andrews, St. Andrews KY16 9SS, United Kingdom — [4]SUPA, Institute of Photonics and Quantum Sciences, Heriot-Watt University, Edinburgh EH14 4AS, United Kingdom — [5]Aarhus Institute of Advanced Studies, Aarhus University, DK-8000 Aarhus C, Denmark — [6]Zentrum für Optische Quantentechnologien and The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg, Germany

We investigate the one-dimensional physics of a linear chain of ions immersed in a Luttinger liquid (LL) of spin-polarized fermionic atoms. Such systems have recently become experimentally realizable and host an interesting interplay between atom-atom interactions and atom-ion interactions. We compute the LL parameter and the speed of sound as a function of the quantum defect parameters, the latter of which can be controlled e.g. by manipulating the ions' internal state. We find a strong dependence of the LL parameter and the speed of sound on the quantum defect parameters, enabling us to modify the static properties of the quantum liquid via external driving of the ionic impurities.

TT 30.2 Tue 14:15 H4

Dynamical and entanglement properties of a one-dimensional many-body-localized system coupled to a bath — •Elisabeth Wybo, Michael Knap, and Frank Pollmann — Technische Universität München

Interactions and disorder can lead to a novel many-body localized phase provided the disorder is strong enough. We study how a dephasing bath destroys many-body localization by investigating interferometric protocols known from nuclear magnetic resonance. We determine the time scale, governed by the dephasing rate, at which the localization will be destroyed. We also investigate various measures of entanglement in these systems, and study how their typical behavior is modified by the presence of a bath. For this research we develop exact Krylov methods and tensor-network techniques, to exactly address the effect of the environment on the quantum dynamics.

TT 30.3 Tue 14:30 H4

Dimensional phase transitions from 1D quantum liquids to 3D condensates — •Polina Matveeva[1], Imke Schneider[1], Sebastian Eggert[1], Axel Pelster[1], Denis Morath[1], and Dominik Strassel[1,2] — [1]Technical University of Kaiserslautern, Kaiserslautern, Germany — [2]Competence Center for High Performance Computing, Fraunhofer ITWM, Kaiserslautern,Germany

We consider weakly coupled strongly interacting quantum chains, such as quantum wires, anisotropic ultracold gases, or quasi-1D spin-chain compounds. It is known that a phase transition from the 1D Luttinger liquid behavior to a 3D ordered states can be qualitatively descibed by a chain mean field theory to determine the critical temperature, but the quantitative corrections and the range of validity is not well established. We therefore simulate the transition using a fully 3D microscopic model with very large scale quantum Monte Carlo calculations and compare with theoretical prediction including higher order terms in the chain mean field theory. We not only determine the very strong quantitative corrections, but also find a new regime of low density behavior where long range quantum correlations between the chains dominate the behavior, which leads qualitatively different powerlaws as a function of interchain couplings.

TT 30.4 Tue 14:45 H4

Effective narrow ladder model for quantum multi-wires on a semiconducting substrate — •Anas Abdelwahab and Eric Jeckelmann — Leibniz Universität Hannover, Institut für Theoretische Physik, Appelstr. 2, 30167 Hannover

We propose a lattice model for quantum multi wires on a three dimensional substrate and map them onto effective two-dimensional lattice using the Block-Lanczos algorithm. This mapping is a generalization of the mapping introduced in [1] for single-wire system. Then, we approximate the resulting two-dimensional lattice by taking only a limited number of legs to form a narrow ladder model. We investigate the validity of this approximation and discuss the influence of the wire-substrate hybridization on the wire-wire coupling using noninteracting two-wire systems. We discuss the possibility to realize Luttinger liquid properties in correlated two-wire systems.

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[1] A. Abdelwahab, E. Jeckelmann, and M. Hohenadler, Phys. Rev. B 96, 035445 (2017)

TT 30.5 Tue 15:00 H4

Phase diagram of spin-1 chains with Dzyaloshinskii-Moriya interaction — •Hugo Tschirhart[1], Ernest Teng Siang Ong[2], Pinaki Sengupta[2], and Thomas L. Schmidt[1] — [1]University of Luxembourg, Luxembourg, Luxembourg — [2]Nanyang Technological University, Singapore, Singapore

We investigate an antiferromagnetic spin-1 Heisenberg chain in the presence of Dyzaloshinskii-Moriya interactions (DMI) and an external magnetic field. We study the resulting spin chain using a combination of numerical and analytical techniques. Using DMRG simulations to determine the spectral gap and the entanglement spectrum, we map out the phase diagram as a function of magnetic field strength and DMI strength. We provide a qualitative interpretation for these numerical findings by mapping the spin-1 chain on a spin-1/2 ladder and using a bosonization approach.

TT 30.6 Tue 15:15 H4

Understanding the Difference between a Hole in the 1D and 2D Antiferromagnet: Crucial Role of Magnon-Magnon Interactions — •Piotr Wrzosek[1], Krzysztof Bieniasz[2,3], Andrzej Michał Oleś[2,4], and Krzysztof Wolhfeld[1] — [1]Faculty of Physics, University of Warsaw, Pasteura 5, PL-02093 Warsaw, Poland — [2]Marian Smoluchowski Institute of Physics, Jagiellonian University, Prof. S. Łojasiewicza 11, PL-30348 Kraków, Poland — [3]Stewart Blusson Quantum Matter Institute, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z4 — [4]Max Planck Institute for Solid State Research, Heisenbergstrasse 1, D-70569 Stuttgart, Germany

We determine the spectral function of a hole for the one-dimensional (1D) Ising t-J_z model using the variational approximation which converges to the exact result with increasing magnon number, however only when the magnon-magnon interactions are properly included. Surprisingly, although the creation of subsequent magnons beyond the first one does not cost any energy, a (modified) self-consistent Born approximation requires also infinite number of magnons to reproduce the exact 1D spectrum. This demonstrates that a single spinon is reproduced by infinite number of magnons. In contrast, in two dimensions magnon-magnon interactions do not change the spectral function qualitatively, explaining why the hole is subject to the string potential, absent in the 1D model.

TT 30.7 Tue 15:30 H4

The spin Drude weight of the XXZ chain and generalized hydrodynamics — •Yahya Öz[1], Andrew Urichuk[2], Andreas Klümper[1], and Jesko Sirker[2] — [1]Bergische Universität Wuppertal, Deutschland — [2]University of Manitoba, Canada

Based on a generalized free energy we derive exact thermodynamic Bethe ansatz formulas for the expectation value of the spin current, the spin current-charge, charge-charge correlators, and consequently the Drude weight. These formulas agree with recent conjectures within the generalized hydrodynamics formalism. They follow, however, directly from a proper treatment of the operator expression of the spin current. The result for the Drude weight is identical to the one obtained 20 years ago based on the Kohn formula and TBA. We numerically evaluate the Drude weight for anisotropies $\Delta = \cos\gamma$ with $\gamma = \frac{\pi n}{m}$, $n \leq m$ integer and coprime. We prove, furthermore, that the high-temperature asymptotics for general $\gamma = \frac{\pi n}{m}$ obtained by analysis of the quantum transfer matrix eigenvalues agrees with the bound which has been obtained by the construction of quasi-local charges.