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Institut für Experimentalphysik

HEARINGS
im Rahmen des Besetzungsverfahrens
für die Laufbahnstelle
THEORIE ATOMARER QUANTENGASE

Montag, 27.1.2020 ICT, Technikerstraße 21a – Erwin-Schrödinger-Saal (IQOQI)	
Sebastiano PEOTTA	
14:00 – 14:45	Öffentlicher Forschungsvortrag und anschließende Diskussion: **“Superfluidity and non-Fermi liquid physics in flat Bloch bands”** *An important development in the field of ultracold gases has been the experimental realization of multiorbital optical lattices, for instance the hexagonal lattice of graphene or the decorated square lattice known as the Lieb lattice. Contrary to lattices with a single orbital per unit cell, the band structure of multiorbital lattices can be geometrically and topologically nontrivial. Exploring the interplay between interparticle interactions and the geometric and topological properties of the single-particle band structure is likely to become a driving theme in the field of ultracold gases in the near future. I will present our theoretical works on superfluidity in lattice models with flat bands, which go precisely in this direction. We have identified geometrically nontrivial bands as the one that can host a superfluid state even in the flat band limit since the quantum metric, a geometric invariant of the band structure, controls the superfluid weight, which is the transport coefficient characterizing all superfluids. A corollary of this result is that topological invariants, such as the Chern number, give lower bounds on the superfluid weight, an unexpected relation between band topology and bulk transport properties. I will also present recent and ongoing works showing that the normal state of a flat band superfluid is necessary not a Landau-Fermi liquid and how this could be observed experimentally in the case of the Lieb lattice. I will conclude by delineating possible future research directions, in particular in relation to disorder in multiorbital lattice models.*
Rick van BIJNEN	
14:45 – 15:30	Öffentlicher Forschungsvortrag und anschließende Diskussion: **“Programmable Quantum Simulators”** *Experiments with ultracold atoms and ions have proven to be an excellent platform for building 'analog' quantum simulators, where highly controllable quantum systems directly realize specific model Hamiltonians. Recent advances have seen these experiments evolve into a new role of “Programmable quantum simulators” (PQS), which are experimental platforms that are able to produce families of interesting quantum states by letting large collections of particles interact in a precise fashion under their native Hamiltonians, thus generating large-scale entanglement. The resulting quantum many-body states can be further manipulated via intermittent single particle operations. The quantum states produced in this way are thus programmable in the sense that they are parametrized by control parameters provided by the experimentalist. The quantum states are not universal, they belong to a restricted class of states, yet for which interesting applications exist. PQS platforms can be viewed as an interpolating step between dedicated, single-purpose quantum simulators, and fully-fledged universal quantum computers. In this talk, we will discuss PQS based on ultracold atoms and trapped ions, what kind of algorithms can be run on them and what physics can be studied, and how to make the most of the data that is generated.*

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Donnerstag, 30.1.2020 ICT, Technikerstraße 21a – Erwin-Schrödinger-Saal (IQOQI)	
Russell BISSET	
11:00 – 11:45	Forschungsvortrag via Skype und anschließende Diskussion: **"Quantum gases and the next generation of quantum liquids"** *Cooled to nano-Kelvin temperatures, dilute gases acquire macroscopic quantum properties that are observable with a camera, opening a window directly into the exotic world of quantum physics. Over the last few years, landmark experiments have pushed the boundaries of what is possible by coaxing quantum gases to form novel phases of matter with truly counter-intuitive properties. This includes ultra-dilute self-bound liquids - around eight orders of magnitude less dense than ordinary liquids - and supersolids, simultaneously exhibiting superfluidity and solid-like properties. Exploration of the exciting physics has only just begun, with numerous unanswered questions and further surprises surely lying just over the horizon. In this talk I will review recent advances in the field and then outline my research agenda for the next few years.*
Martin GÄRTTNER	
13:30 – 14:15	Öffentlicher Forschungsvortrag und anschließende Diskussion: **"Readout and benchmarking of quantum simulators"** *Two major challenges that quantum simulation experiments are faced with are 1) relating accessible observables to more complex quantities of interest like entanglement and 2) verifying simulation results by efficient numerical calculations on classical computers. I will report on recent progress on these fronts and outline possible future directions. First, I will present work on detecting entanglement in an ultracold atomic gas using steering inequalities. Second, I will outline ideas on measuring unequal-time correlation functions, in particular out-of-time-order correlators in BECs and Rydberg gases. Third, I will describe progress on neural network inspired efficient variational approaches for representing quantum states, which can also serve a tool for quantum state tomography.*

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Freitag, 31.1.2020 ICT, Technikerstraße 21a – Erwin-Schrödinger-Saal (IQOQI)	
Alessio RECATI	
13:00 – 13:45	Öffentlicher Forschungsvortrag und anschließende Diskussion: **"Ultra-cold gases: from Fermi gases to analog gravity"** *The field of ultra-cold gases has been able to characterise itself as an interdisciplinary field. Thanks to the possibility of engineering very different models, ultra-cold gases are playing an important role in the study of fundamental questions in quantum many-body physics, as well as quantum simulators. In this talk I will highlight their versatility by discussing a few topical cases, which have opened or are opening new research directions and which, aside from the specific examples, can be put in a wider context involving other fields. Specifically, I will focus on: (i) strongly interacting Fermi gases, (ii) superfluidity in Bose gases, (iii) cold-gases in optical lattices. Special emphasis will be given to the perspective and the open questions of such research lines.*
Bihui ZHU	
13:45 – 14:30	Forschungsvortrag via Skype und anschließende Diskussion: **"Controlling ultracold quantum matter out of equilibrium"** *The rapid progresses in preparing and probing ensembles of cold atoms provide unique opportunities for investigating nonequilibrium quantum many-body phenomena, ranging from addressing important open questions in the equilibration of quantum systems, to engineering new phases of matter. In this talk, I will first present several recent progresses, both in theory and experiment, towards understanding the quantum dynamics of interacting atomic ensembles. I will focus on two platforms, featuring strong, long-range interactions between magnetic dipoles, and photon-mediated interactions, respectively. In particular, it is found the interplay between long-range interactions and quantum fluctuations results in interesting features in the many-body behaviors. I will further discuss prospects offered by these systems for pushing the frontiers of fundamental physics and to generate quantum correlated many-body states for applications in both quantum computation and metrology.*

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