# Q 21: Quantum Gases (Bosons) II

Time: Monday 16:15–17:45 Location: S HS 037 Informatik

Q 21.1 Mon 16:15 S HS 037 Informatik

**Adiabatically ramping artificial magnetic fields: the role of the final gauge** — •Botao Wang[1], Xiaoyu Dong[1,2], F. Nur Ünal[1], and André Eckardt[1] — [1]Max Planck Institute for the Physics of Complex Systems, Noethnitzer Strasse 38, 01187 Dresden, Germany — [2]Department of Physics and Astronomy, California State University, Northridge, CA, 91330, USA

Artificial gauge fields are a powerful tool for quantum simulation, allowing e.g. for the investigation of quantum Hall physics with charge neutral atoms in optical lattices. Considering an interacting bosonic ladder system, we investigate state preparation protocols, where a homogeneous magnetic field is switched on smoothly. Using simulations based on density matrix renormalization group (DMRG), we find that the fidelity for the degree of adiabaticity depends dramatically on the choice of the vector potential (i.e. the Peierls phases) used to implement the magnetic field, i.e. on the final gauge. This effect can be explained in terms of artificial electric fields resulting from the time-dependent vector potentials.

Q 21.2 Mon 16:30 S HS 037 Informatik

**Topological study of a double kicked Bose Einstein condensate** — •Alexander Wagner[1] and Sandro Wimberger[2,3] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Deutschland — [2]Dipartimento di Scienze Matematiche, Fisiche e Informatiche, Università di Parma, Parco Area delle Scienze 7/a, 43124 Parma, Italy — [3]INFN, Sezione di Milano Bicocca, Gruppo Collegato di Parma, Parco Area delle Scienze 7/a, 43124 Parma, Italy

The application of topological concepts, rooted in mathematics, to physical systems has proved to be very useful, for example in the context of the quantum Hall effect. Among the powerful tools provided by topology is the Bulk-Edge-Correspondence, which draws a connection between protected states forming at the edge or rather the boundary of the system and the topological properties of its bulk, that is unaffected by boundary effects. We study how the Bulk-Edge-Correspondence manifests itself for the double kicked quantum rotor and analyse how reliably (with regards to experimental perturbations) the observable mean chiral displacement converges towards the topological invariant of the system in the winding number. Our results show that recently implemented quantum walks of a spinor Bose-Einstein condensate [1] offer a versatile platform for topological investigations.

[1] S. Dadras, A. Gresch, C. Groiseau, S. Wimberger, and G. S. Summy, Quantum walk in momentum space with a Bose-Einstein condensate, Phys. Rev. Lett. **121**, 070402 (2018)

Q 21.3 Mon 16:45 S HS 037 Informatik

**Engineering Feshbach resonances by time-periodic driving** — •Christoph Dauer, Axel Pelster, and Sebastian Eggert — Physics Department and Research Centre OPTIMAS, Technische Universität Kaiserslautern, Erwin-Schrödinger Straße 46, 67663 Kaiserslautern, Germany

Magnetic Feshbach resonances are a powerful tool in order to control the scattering length in ultracold gas experiments [1], but are limited to given atomic species or applied magnetic field strengths. Here we investigate a periodically driven two-channel model describing magnetic Feshbach resonances using the Floquet formalism [2-4]. Position and width of the resulting resonances, which appear in the scattering length, turn out to be tunable by both driving strength and frequency. An extension of our two-channel model also allows to describe the corresponding case of an optical Feshbach resonance [5], where either the Rabi frequency or the detuning is modulated periodically in time. The goal of these investigations is to check whether the variability of the accessible s-wave scattering lengths can be increased by the time-periodic modulation.

[1] C. Chin et al. Rev. Mod. Phys. 82 1225 (2010).
[2] D.H. Smith. Phys. Rev. Lett. 115, 193002 (2015).
[3] A.G. Sykes, H. Landa, and D.S. Petrov. PRA. 95, 062705 (2017).
[4] S.A. Reyes et al. New J. Phys. 19, 043029 (2017).
[5] O. Thomas et al. Nature Comm. 9, 2238 (2018).

Q 21.4 Mon 17:00 S HS 037 Informatik

**Mapping between a slow evolution and a Floquet problem using a Bose gas in the mean-field regime** — •Etienne Wamba, Axel Pelster, and James Anglin — Technische Universität Kaiserslautern, 67663, Kaiserslautern, Germany

Based on our recent results on the exact quantum field mappings between different experiments on quantum gases [1], we construct a mean-field model of many-body systems with rapid periodic driving. The single-particle potential and the inter-particle interaction strength are both time-dependent at once, in a related way. We map the evolutions of the model system onto evolutions with slowly varying parameters. Such a mapping between a Floquet evolution and a very slow process allows us to investigate non-equilibrium many-body dynamics and examine how rapidly driven systems may avoid heating up, at least when mean-field theory is still valid. From that special but interesting case, we learn that rapid periodic driving may not yield heating because the time evolution of the system has a kind of hidden adiabaticity, inasmuch as it can be mapped exactly onto that of an almost static system.

Q 21.5 Mon 17:15 S HS 037 Informatik

**Universal spectral and statistical properties of quantum fields far from equilibrium** — •Linda Shen[1,2] and Jürgen Berges[1] — [1]Institut für Theoretische Physik, Philosophenweg 16, 69120 Heidelberg, Germany — [2]Kirchhoff-Institut für Physik, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany

We investigate the universal dynamics close to a non-thermal fixed point where the non-equilibrium time-evolution is characterized by self-similar scaling solutions. Using 2PI effective action methods, the unequal-time correlation functions including statistical and spectral components are computed within a relativistic scalar quantum field theory.

We extract scaling exponents from the self-similar particle transport towards lower momenta, where we find exponents in agreement to previous analyzes using classical-statistical methods.

Here, we also study unequal-time correlation functions which contain information about the excitation spectrum of the theory. We find that the infrared momentum regime cannot be described in terms of the relativistic quasi-particle degrees of freedom. Furthermore, the fluctuation-dissipation theorem is broken for low momenta.

Q 21.6 Mon 17:30 S HS 037 Informatik

**Scrambling and quantum butterfly effect in critical systems: instability vs. chaos** — •Benjamin Geiger, Quirin Hummel, Juan Diego Urbina, and Klaus Richter — Universität Regensburg

The investigation of scrambling of information in interacting quantum systems has recently attracted a lot of attention as a manifestation of many-body quantum chaos. However, it has been demonstrated that certain integrable systems that are subject to quantum phase transitions allow for fast information scrambling if they are tuned close to their critical point [1]. To investigate the origin of this quasi-chaotic behavior we studied a momentum-truncated model of an attractive one-dimensional Bose gas using established semiclassical methods. We find that the quantum critical behavior has its origin in the appearance of a separatrix in the classcial phase space that renders the classical dynamics locally unstable. This leads to quasichaotic features the underlying quantum system, i.e., a fast growth of multiparticle entanglement and exponential growth of certain out-of-time ordered correlators, in counter-intuitive coexistence with asymptotic periodicity of the respective quantities.

[1] Dvali et al. Phys. Rev. D **88**, 124041 (2013)