TT 19: Quantum Liquids, Miscellaneous 2

Time: Monday 15:00–16:30 Location: H21

TT 19.1 Mon 15:00 H21

Structures forming out of quantum seeds in Bose condensates with time-dependent tunnel coupling — Clemens Neuenhahn[1], Anatoli Polkovnikov[2], and •Florian Marquardt[1] — [1]Universität Erlangen-Nürnberg, Germany — [2]Boston University, USA

Quantum fluctuations can be amplified into macroscopic structures in the course of time. This can happen in quench scenarious, where some parameter is time-dependent, and it has wide-ranging implications, from condensed matter physics to cosmology.

Here, we investigate the behaviour of a model system of two 1D clouds of bosonic atoms. Specifically, we track the time-evolution of the quantum field that describes the relative phase between the quasi-condensates as a function of position. When suddenly switching on the tunnel-coupling, the subsequent dynamics is first governed by parametric amplification of the initial quantum fluctuations. At a later stage, nonlinear dynamics takes over, and localized phase structures form. These structures, which we term 'quasi-breathers', then stochastically form and decay, and we characterize their features using numerical simulations of the underlying sine-Gordon equation based on the truncated Wigner approximation. We then turn to a scenario where the tunnel coupling is changed smoothly over time. It turns out this can be mapped to the evolution of the quantum sine-Gordon field in an expanding 1+1 dimensional toy universe, giving insight into nonlinear structure formation in cosmology.

TT 19.2 Mon 15:15 H21

Interference effects in Fock space in Bose-Hubbard systems — •Thomas Engl[1], Juan Diego Urbina[1], Arturo Argüelles Parra[2], Julien Dujardin[2], Peter Schlagheck[2], and Klaus Richter[1] — [1]Universität Regensburg — [2]Universite de Liege

Semiclassical techniques have so far been applied mainly to single particle systems. For these systems they provide a powerful toolbox to study interference effects and allow analytical calculations even in the presence of classical chaos.

On the other hand there have been attempts to apply the semiclassical approximation to the Feynman path integral for bosonic quantum fields in coherent state representation. The resulting coherent state path integral however leads to complex actions which does not give clear insight in interference effects.

We have succeeded in finding a representation in which the semiclassical approximation leads to a van-Vleck propagator with real action and therefore shows interference in Fock space explicitly. We use this propagator to predict various interference effects for Bose-Hubbard systems in three different regimes of the ratio of interaction and hopping strength, and we show that the probability of return is enhanced due to interference.

TT 19.3 Mon 15:30 H21

Fractional charge separation in the hard-core Bose Hubbard Model on the Kagome Lattice — •Xuefeng Zhang and Sebastian Eggert — Department of the Physics,Univ. Kaiserslautern, Kaiserslautern, Germany

We consider the hard core Bose Hubbard Model on a Kagome lattice with fixed (open) boundary conditions on two edges. We find that the fixed boundary conditions lift the degeneracy and freeze the system at 1/3 and 2/3 filling at small hopping. At larger hopping strengths, fractional charges spontaneously separate and are free to move to the edges of the system, which leads to a novel compressible phase with solid order. The compressibility is due to excitations on the edge which display a chiral symmetry breaking that is reminiscent of the quantum Hall effect. Large scale Monte Carlo simulations confirm the analytical calculations.

TT 19.4 Mon 15:45 H21

Propagation of lines of excitations in the two-species Bose Hubbard model — •Carlo Krimphoff[1], Masud Haque[2], and Andreas M. Läuchli[1] — [1]Institut für Theoretische Physik, Universität Innsbruck, Österreich — [2]Max-Planck-Institut für Physik komlexer Systeme, Dresden, Deutschland

We investigate numerically and analytically the time evolution of lines of overturned spins in the one and two-dimensional spin-1/2 Heisenberg XXZ model after a local quench of the magnetic field. In one dimension a rich sequence of bound states has already been observed, and these states propagate at different velocities. We investigate here how this picture changes and enriches as we move from decoupled one-dimensional chains towards the two-dimensional plane.

As the spin-1/2 Heisenberg model is the strong coupling limit of the two-species Bose Hubbard model at unit filling, our results will shed light on the expected dynamics of lines of mobile spin impurities in two-species bosonic atoms confined to a two-dimensional optical lattice.

TT 19.5 Mon 16:00 H21

Exotic Ising dynamics in a Bose-Hubbard model — •Luis Seabra and Frank Pollmann — Max-Planck-Institut fur Physik komplexer Systeme, 01187 Dresden, Germany

We explore the dynamical properties of a one-dimensional Bose-Hubbard model, where two different bosonic species interact via Feshbach resonance. We focus on the region in the phase diagram which is described by an effective, low-energy ferromagnetic Ising model in both transverse and longitudinal fields. In this regime, we numerically calculate the Ising dynamical structure factor of the Bose-Hubbard model using the Time-Evolving Block Decimation method. In the ferromagnet phase, we observe both the continuum of excitations and the bound states for different values of the longitudinal field. Near the Ising critical point, we observe the celebrated E_8 mass spectrum in the excited states. We also discuss possible measurements which could be used to detect these excitations in an optical lattice experiment.

TT 19.6 Mon 16:15 H21

Damping of phase fluctuations in superfluid Bose gases — •Philipp Lange[1], Peter Kopietz[1], and Andreas Kreisel[2] — [1]Institut für Theoretische Physik, Universität Frankfurt, Max-von-Laue Strasse 1, 60438 Frankfurt, Germany — [2]Department of Physics, University of Florida, 32611 Gainesville, FL, USA

Using Popov's hydrodynamic approach we derive an effective Euclidean action for the long-wavelength phase fluctuations of superfluid Bose gases in D dimensions. We then use this action to calculate the damping of phase fluctuations at zero temperature as a function of D. For $D > 1$ and small wavevectors $k = |\mathbf{k}|$ we find that, to leading order, the damping γ_k is proportional to $A_D k^{2D-1}$, where A_D is a constant prefactor that depends on the dimensionality. However, for $D = 1$ the coefficient A_D vanishes and one has to go beyond perturbation theory. Within a self-consistent calculation we find that in $D = 1$ the damping acquires an additional power of k, leading to the long wavelength behavior $\gamma_k \propto k^2$. In one dimension, we also calculate the entire spectral function of phase fluctuations.