SYEM 2: Symposium Extreme Matter II

Time: Wednesday 14:30–15:30 Location: C/HSO

SYEM 2.1 Wed 14:30 C/HSO

The BEC-BCS crossover in a two-dimensional system — •Andre Wenz, Martin Ries, Gerhard Zürn, Mathias Neidig, Luca Bayha, Dhruv Kedar, Puneet Murthy, and Selim Jochim — Physikalisches Institut, Universität Heidelberg

In recent years ultracold fermionic systems have been used to explore the three-dimensional BEC-BCS crossover. This crossover smoothly links bosonic superfluidity of dimers with a fermionic superfluid of Cooper pairs. Between these two limits lies the strongly interacting regime where the interaction parameter diverges and the critical temperature for superfluidity reaches a maximum. By freezing out the dynamics in some of the spatial directions, one can tune the dimensionality of the system and this leads to a qualitative change of the key properties of the system. For example, for 2D systems the phase transition to the bosonic superfluid phase is then expected to be driven by the BKT mechanism which leads to a topological phase transition associated with the pairing of vortices. We experimentally explore the 2D BEC-BCS crossover using a Fermi gas of ultracold lithium-6 atoms. We observe the phase transition to a low temperature phase by investigating the system's pair momentum distribution. On the bosonic side of the crossover, the observed transition temperature and phase coherence is consistent with the theoretical predictions for a BKT-type phase transition. However, where the 2D interaction strength $1/\ln(k_F a_{2D})$ diverges, theoretical prediction become extremely difficult and our measurements offer the first experimental benchmark to challenge and test theoretical models in this complex regime.

SYEM 2.2 Wed 14:45 C/HSO

Lattice gauge tensor networks, and the SU(2) gauge invariant model — •Pietro Silvi — Ulm universität, Ulm, Deutschland

A unified framework to describe lattice gauge theories by means of tensor networks is presented: this framework is efficient as it exploits the high amount of local symmetry content native of these systems describing only the gauge invariant subspace. The gauge symmetry is cast in terms of the quantum link formulation, which es exploited to achieve a substantial speed-up in real and imaginary time evolution, compared to standard tensor network techniques. This technology is then adopted to study an SU(2)-gauge invariant lattice model, and detect its different phases: this research is meant to idntify the analogies to QCD and other high energy field theories in low dimensions.

SYEM 2.3 Wed 15:00 C/HSO

Quark star matter in a SU(3) chiral Quark-Meson model — •Andreas Zacchi — Goethe Universität Frankfurt

The recent detections of the pulsars PSR J1614-2230 and of PSR J0348+0432 gives strong constraints on the parameter range in effective chiral models which describe *compact stars*. We discuss a chiral quark-meson model with a vacuum energy pressure based on a SU(3) linear-σ-model. Bosonic fluctuations are treated within the 2PI formalism. We study the impact of various parameters on the phase transition, the phase diagram and the equation of state for quark star matter. We solve the TOV-equations to check whether pure quark stars with $\gtrsim 2M_\odot$ are feasible within the quark meson model.

SYEM 2.4 Wed 15:15 C/HSO

String Breaking in a (1+1)d Quantum Link Model — •Thomas Pichler — Institut für komplexe Quantensysteme, Universität Ulm, Deutschland

The problem of simulating quantum systems is of ongoing interest in material science, information science and fundamental physics. Modern numerical algorithms allow us to tackle large quantum systems and several experimental implementations with atomic or solid state systems have already begun to perform simulations directly with quantum objects. The progress in the field has motivated to propose more possible applications of such quantum simulators. Recently there have been ideas for the simulation of gauge theories as known from high energy physics on an atomic quantum simulator. In this context we investigate possible applications of such simulators by numerically implementing the proposed gauge theories in tensor network algorithms. Particularly, we look at the (1+1)d quantum link model, also known as reduced Schwinger model, representing quantum electrodynamics in one spatial dimension. This model is a non-perturbative representation of a gauge theory allowing us to study the full out-of-equilibrium dynamics and ground state properties in different parameter regimes. A prominent mechanism expected in quantum chromodynamics is string breaking, which this talk will be focused on.