[1] *Jacob D., Shao L., Corre V., Zibold T., Sarlo L.D., Mimoun E., Dalibard J., and Gerbier F.*
Phase diagram of spin 1 antiferromagnetic bose-einstein condensates.
arXiv: **1209.2533**.
We study experimentally the equilibrium phase diagram of a spin 1 Bose-Einstein condensate with antiferromagnetic interactions, in a regime where spin and spatial degrees of freedom are decoupled. For a given total magnetization mz, we observe for low magnetic fields an "antiferromagnetic" phase where atoms condense in the m=+/-1 Zeeman states, and occupation of the m=0 state is suppressed. Conversely, for large enough magnetic fields, a phase transition to a "broken axisymmetry" phase takes place: The m=0 component becomes populated and rises sharply above a critical field $B_c(m_z)$. This behavior results from the competition between antiferromagnetic spin-dependent interactions (dominant at low fields) and the quadratic Zeeman energy (dominant at large fields). We compare the measured B_c as well as the global shape of the phase diagram with mean-field theory, and find good quantitative agreement.

[2] *Viola G., Das S., Grosfeld E., and Stern A.*
Thermoelectric probe for neutral edge modes in the fractional quantum hall regime.
Phys. Rev. Lett. **109**, 146801 (Oct 2012).
The $\nu = 5/2$ anti-Pfaffian state and the $\nu = 2/3$ state are believed to have an edge composed of counterpropagating charge and neutral modes. This situation allows the generation of a pure thermal bias between two composite edge states across a quantum point contact as was experimentally established by Bid et al. [Nature 466 585 (2010)]. We show that replacing the quantum point contact by a quantum dot provides a natural way for detecting the neutral modes via the dc current generated by the thermoelectric response of the dot. We also show that the degeneracies of the dot spectrum, dictated by the conformal field theories describing these states, induce asymmetries in the thermoelectric current peaks. This in turn provides a direct fingerprint of the corresponding conformal field theory.

[3] *Osterloh A. and Siewert J.*
Invariant-based entanglement monotones as expectation values and their experimental detection.
Phys. Rev. A **86**, 042302 (Oct 2012).
Characterization and quantification of multipartite entanglement is one of the challenges in state-of-the-art experiments in quantum-information processing. According to theory, this is achieved via entanglement monotones, that is, functions that do not increase under stochastic local operations and classical communication (SLOCC). Typically such monotones include the wave function and its time reversal (antilinear-operator formalism) or they are based on not completely positive maps (e.g., partial transpose). Therefore, they are not directly accessible to experimental observations. We show how entanglement monotones derived from polynomial local SL(2) invariants can be re-written in terms of expectation values of observables. Consequently, the amount of entanglement -of specific SLOCC classes-in a given state can be extracted from the measurement of correlation functions of local operators.

[4] *Barzanjeh S., Abdi M., Milburn G.J., Tombesi P., and Vitali D.*
Reversible optical-to-microwave quantum interface.
Phys. Rev. Lett. **109**, 130503 (Sep 2012).
We describe a reversible quantum interface between an optical and a microwave field using a hybrid device based on their common interaction with a micromechanical resonator in a superconducting circuit. We show that, by employing state-of-the-art optoelectromechanical devices, one can realize an effective source of (bright) two-mode squeezing with an optical idler (signal) and a microwave signal, which can be used for high-fidelity transfer of quantum states between optical and microwave fields by means of continuous variable teleportation.

[5] *Safavi-Naini A., von Stecher J., Capogrosso-Sansone B., and Rittenhouse S.T.*
First-order phase transitions in optical lattices with tunable three-body onsite interaction.
Phys. Rev. Lett. **109**, 135302 (Sep 2012).
We study the two-dimensional Bose-Hubbard model in the presence of a three-body interaction term, both at a mean-field level and via quantum Monte Carlo simulations. The three-body term is tuned by coupling the triply occupied states to a trapped universal trimer. We find that, for a sufficiently attractive three-body interaction, the n=2 Mott lobe disappears and the system displays first-order phase transitions separating the n=1 from the n=3 lobes and the n=1 and n=3 Mott insulator from the superfluid. We also analyze the effect of finite temperature and find that transitions are still of first order at temperatures T $\approx$ J, where J is the hopping matrix element.

[6] *Fukuhara T., Kantian A., Endres M., Cheneau M., Schauss P., Hild S., Bellem D., Schollwöck U., Giamarchi T., Gross C., Bloch I., and Kuhr S.*

Quantum dynamics of a single, mobile spin impurity.
arXiv: **1209.6468**.
Quantum magnetism describes the properties of many materials such as transition metal oxides and cuprate superconductors. One of its elementary processes is the propagation of spin excitations. Here we study the quantum dynamics of a deterministically created spin-impurity atom, as it propagates in a one-dimensional lattice system. We probe the full spatial probability distribution of the impurity at different times using single-site-resolved imaging of bosonic atoms in an optical lattice. In the Mott-insulating regime, a post-selection of the data allows to reduce the effect of temperature, giving access to a space- and time-resolved measurement of the quantum-coherent propagation of a magnetic excitation in the Heisenberg model. Extending the study to the bath's superfluid regime, we determine quantitatively how the bath strongly affects the motion of the impurity. The experimental data shows a remarkable agreement with theoretical predictions allowing us to determine the effect of temperature on the coherence and velocity of impurity motion. Our results pave the way for a new approach to study quantum magnetism, mobile impurities in quantum fluids, and polarons in lattice systems.

[7] *Papic Z., Haldane F.D.M., and Rezayi E.H.*
Quantum phase transitions and the $\nu = 5/2$ fractional hall state in wide quantum wells.
arXiv: **1209.6606**.
We study the nature of the $\nu = 5/2$ quantum Hall state in wide quantum wells under the mixing of electronic subbands and Landau levels. We introduce a general method to analyze the Moore-Read Pfaffian state and its particle-hole conjugate, the anti-Pfaffian, under periodic boundary conditions in a "quartered" Brillouin zone scheme containing both even and odd numbers of electrons. We examine the rotational quantum numbers on the torus, and show spontaneous breaking of the particle-hole symmetry can be observed in finite-size systems. In the presence of electronic-subband and Landau-level mixing the particle-hole symmetry is broken in such a way that the anti-Pfaffian is unambiguously favored, and becomes more robust in the vicinity of a transition to the compressible phase, in agreement with recent experiments.

[8] *Adachi H., ichi Uchida K., Saitoh E., and Maekawa S.*
Theory of the spin seebeck effect.
arXiv: **1209.6407**.
The spin Seebeck effect refers to the generation of a spin voltage caused by a temperature gradient in a ferromagnet, which enables the thermal injection of spin currents from the ferromagnet into an attached nonmagnetic metal over a macroscopic scale of several millimeters. The inverse spin Hall effect converts the injected spin current into a transverse charge voltage, thereby producing electromotive force as in the conventional charge Seebeck device. Recent theoretical and experimental efforts have shown that the magnon and phonon degrees of freedom play crucial roles in the spin Seebeck effect. In this article, we present the theoretical basis for understanding the spin Seebeck effect and briefly discuss other thermal spin effects.

[9] *Breyer D. and Bienert M.*
Light scattering in an optomechanical cavity coupled to a single atom.
arXiv: **1209.6553**.
We theoretically analyze the light scattering of an optomechanical cavity which strongly interacts with a single two-level system and couples simultaneously to a mechanical oscillator by radiation forces. The analysis is based on the assumptions that the system is driven at low intensity, and that the mechanical interaction is sufficiently weak, permitting a perturbative treatment. We find quantum interference in the scattering paths, which allows to suppress the Stokes-component of the scattered light. This effect can be exploited to reduce the motional energy of the mechanical oscillator.

[10] *Pedrocchi F.L., Hutter A., Wootton J.R., and Loss D.*
Local 3d spin hamiltonian as a thermally stable surface code.
arXiv: **1209.5289**.
We study a 2D toric code embedded in a 3D Heisenberg ferromagnet in a broken-symmetry state at finite temperature. Stabilizer operators of the toric code are locally coupled to individual spins of the ferromagnet. The effects of the Goldstone modes of the ferromagnet in the ordered phase lead to an energy penalty for anyons that grows linearly with L, the linear size of the toric code. This $O(L)$ energy barrier for logical errors leads to a lifetime of the quantum memory that grows exponentially with L, assuming that the toric code is weakly coupled to a thermal bath with temperature below the phase transition of the ferromagnet. This provides a stable quantum memory with strictly local bounded-strength interactions in less than four dimensions.