[1] *Dolcini F. and Montorsi A.*
Quantum phases of 1D Hubbard models with three- and four-body couplings.
arXiv:1308.5909 [cond-mat.str-el] (August 2013).
The experimental advances in cold atomic and molecular gases stimulate the investigation of lattice correlated systems beyond the conventional on-site Hubbard approximation, by possibly including multi-particle processes. We study fermionic extended Hubbard models in a one dimensional lattice with different types of particle couplings, including also three- and four-body interaction up to nearest neighboring sites. By using the Bosonization technique, we investigate the low-energy regime and determine the conditions for the appearance of ordered phases, for arbitrary particle filling. We find that three- and four-body couplings may significantly modify the phase diagram. In particular, diagonal three-body terms that directly couple the local particle densities have qualitatively different effects from off-diagonal three-body couplings originating from correlated hopping, and favor the appearance of a Luther-Emery phase even when two-body terms are repulsive. Furthermore, the four-body coupling gives rise to a rich phase diagram and may lead to the realization of the Haldane insulator phase at half-filling.

[2] *Wright A.R. and Veldhorst M.*
Localized many-particle Majorana modes with vanishing time-reversal symmetry breaking in double quantum dots.
Phys. Rev. Lett. **111**, 096801 (August 2013).
We introduce the concept of spinful many-particle Majorana modes with local odd operator products, thereby preserving their local statistics. We consider a superconductor-double-quantum-dot system where these modes can arise with negligible Zeeman splitting when Coulomb interactions are present. We find a reverse Mott-insulator transition, where the even- and odd-parity bands become degenerate. Above this transition, Majorana operators move the system between the odd-parity ground state, associated with elastic cotunneling, and the even-parity ground state, associated with crossed Andreev reflection. These Majorana modes are described in terms of one, three, and five operator products. Parity conservation results in a 4π periodic supercurrent in the even state and no supercurrent in the odd state.

[3] *Hao W., Nepomechie R.I., and Sommese A.J.*
On the completeness of solutions of Bethe's equations.
arXiv:1308.4645 [math-ph] (August 2013).
We consider the Bethe equations for the isotropic spin-1/2 Heisenberg quantum spin chain with periodic boundary conditions. We formulate a conjecture for the number of solutions with pairwise distinct roots of these equations, in terms of numbers of so-called singular (or exceptional) solutions. Using homotopy continuation methods, we find all such solutions of the Bethe equations for chains of length up to 14. The numbers of these solutions are in perfect agreement with the conjecture. We also discuss an indirect method of finding solutions of the Bethe equations by solving the Baxter T-Q equation. We briefly comment on implications for thermodynamical computations based on the string hypothesis.

[4] *RuGway W., Manning A.G., Hodgman S.S., Dall R.G., Truscott A.G., Lamberton T., and Kheruntsyan K.V.*
Observation of transverse Bose-Einstein condensation via Hanbury Brown-Twiss correlations.
Phys. Rev. Lett. **111**, 093601 (August 2013).
A fundamental property of a three-dimensional Bose-Einstein condensate is long-range coherence; however, in systems of lower dimensionality, not only is the long-range coherence destroyed but additional states of matter are predicted to exist. One such state is a "transverse condensate," first predicted by van Druten and Ketterle [Phys. Rev. Lett. **79** 549 (1997)], in which the gas condenses in the transverse dimensions of a highly anisotropic trap while remaining thermal in the longitudinal dimension. Here, we detect the transition from a three-dimensional thermal gas to a gas undergoing transverse condensation by probing Hanbury Brown–Twiss correlations.

[5] *Iqbal M.J., Levy R., Koop E.J., Dekker J.B., de Jong J.P., van der Velde J.H.M., Reuter D., Wieck A.D., Aguado R., Meir Y., and van der Wal C.H.*
Odd and even Kondo effects from emergent localization in quantum point contacts.
Nature (advance online publication) (August 2013), ISSN 1476-4687.
A quantum point contact (QPC) is a basic nanometre-scale electronic device: a short and narrow transport channel between two electron reservoirs. In clean channels, electron transport is ballistic and the conductance is then quantized as a function of channel width with plateaux at integer multiples of $2e^2/h$ (where e is the electron charge and h is Planck's constant). This can be understood in a picture where the electron states are propagating waves, without the

need to account for electron-electron interactions. Quantized conductance could thus be the signature of ultimate control over nanoscale electron transport. However, even studies with the cleanest QPCs generically show significant anomalies in the quantized conductance traces, and there is consensus that these result from electron many-body effects. Despite extensive experimental and theoretical studies, understanding these anomalies is an open problem. Here we report that the many-body effects have their origin in one or more spontaneously localized states that emerge from Friedel oscillations in the electron charge density within the QPC channel. These localized states will have electron spins associated with them, and the Kondo effect–related to electron transport through such localized electron spins–contributes to the formation of the many-body state. We present evidence for such localization, with Kondo effects of odd or even character, directly reflecting the parity of the number of localized states; the evidence is obtained from experiments with length-tunable QPCs that show a periodic modulation of the many-body properties with Kondo signatures that alternate between odd and even Kondo effects. Our results are of importance for assessing the role of QPCs in more complex hybrid devices and for proposals for spintronic and quantum information applications. In addition, our results show that tunable QPCs offer a versatile platform for investigating many-body effects in nanoscale systems, with the ability to probe such physics at the level of a single site.

[6] *Bauer F., Heyder J., Schubert E., Borowsky D., Taubert D., Bruognolo B., Schuh D., Wegscheider W., von Delft J., and Ludwig S.*
Microscopic origin of the 0.7-anomaly in quantum point contacts.
Nature (advance online publication) (August 2013), ISSN 1476-4687.
Quantum point contacts are narrow, one-dimensional constrictions usually patterned in a two-dimensional electron system, for example by applying voltages to local gates. The linear conductance of a point contact, when measured as function of its channel width, is quantized in units of $G_Q = 2e^2/h$, where e is the electron charge and h is Planck's constant. However, the conductance also has an unexpected shoulder at $\sim 0.7 G_Q$, known as the 0.7-anomaly, whose origin is still subject to debate. Proposed theoretical explanations have invoked spontaneous spin polarization, ferromagnetic spin coupling, the formation of a quasi-bound state leading to the Kondo effect, Wigner crystallization and various treatments of inelastic scattering. However, explicit calculations that fully reproduce the various experimental observations in the regime of the 0.7-anomaly, including the zero-bias peak that typically accompanies it, are still lacking. Here we offer a detailed microscopic explanation for both the 0.7-anomaly and the zero-bias peak: their common origin is a smeared van Hove singularity in the local density of states at the bottom of the lowest one-dimensional subband of the point contact, which causes an anomalous enhancement in the Hartree potential barrier, the magnetic spin susceptibility and the inelastic scattering rate. We find good qualitative agreement between theoretical calculations and experimental results on the dependence of the conductance on gate voltage, magnetic field, temperature, source-drain voltage (including the zero-bias peak) and interaction strength. We also clarify how the low-energy scale governing the 0.7-anomaly depends on gate voltage and interactions. For low energies, we predict and observe Fermi-liquid behaviour similar to that associated with the Kondo effect in quantum dots. At high energies, however, the similarities between the 0.7-anomaly and the Kondo effect end.

[7] *Daghofer M. and Hohenadler M.*
Phases of correlated spinless fermions on the honeycomb lattice.
arXiv:1308.6211 [cond-mat.str-el] (August 2013).
We use exact diagonalization and cluster perturbation theory to address the role of strong interactions and quantum fluctuations for spinless fermions on the honeycomb lattice. We find quantum fluctuations to be very pronounced both at weak and strong interactions. A weak second-neighbor Coulomb repulsion V_2 induces a tendency toward an interaction-generated quantum anomalous Hall phase, as borne out in mean-field theory. However, quantum fluctuations prevent the formation of a stable quantum Hall phase before the onset of the charge-modulated phase predicted at large V_2 by mean-field theory. Consequently, the system undergoes a direct transition from the semimetal to the charge-modulated phase. For the latter, charge fluctuations also play a key role. While the phase, which is related to pinball liquids, is stabilized by the repulsion V_2, the energy of its low-lying charge excitations scales with the kinetic energy t, as in a band insulator.

[8] *Gangadharaiah S., Schmidt T.L., and Loss D.*
Structure factor of interacting one-dimensional helical systems.
arXiv:1308.5982 [cond-mat.str-el] (August 2013).