Condensed Matter Journal Club, 07.10.2014, Stefan Walter

1. **Confined quantum Zeno dynamics of a watched atomic arrow**
   Adrien Signoles, Adrien Facon, Dorian Grosso, Igor Dotsenko, Serge Haroche, Jean-Michel Raimond, Michel Brune and Sébastien Gleyzes

2. **Topological Polaritons and Excitons in Garden Variety Systems**
   Charles-Edouard Bardyn, Torsten Karzig, Gil Refael, Timothy C. H. Liew
   arXiv:1409.8282
   Topological polaritons (aka topolaritons) present a new frontier for topological behavior in solid-state systems. They combine light and matter, which allows to probe and manipulate them in a variety of ways. They can also be made strongly interacting, due to their excitonic component. So far, however, their realization was deemed rather challenging. Here we present a scheme which allows to realize topolaritons in garden variety zinc-blende quantum wells. Our proposal requires a moderate magnetic field and a potential landscape which can be implemented, e.g., via surface acoustic waves or patterning. We identify indirect excitons in double quantum wells as a particularly appealing alternative for topological states in exciton-based systems. Indirect excitons are robust and long lived (with lifetimes up to milliseconds), and, therefore, provide a flexible platform for the realization, probing, and utilization of topological coupled light-matter states.

3. **On orbital momentum of chiral superfluids**
   G.E. Volovik
   arXiv:1409.8638
   This is comment to preprint arXiv:1409.7459 by Y. Tada, Wenxing Nie and M. Oshikawa "Orbital angular momentum and spectral flow in two dimensional chiral superfluids", where the effect of spectral flow along the edge states on the magnitude of the angular momentum is discussed. The general conclusion of the preprint on the essential reduction of the angular momentum is confirmed. However, it is shown that similar reduction may take place also for the p-wave superfluids if parity is violated.

4. **Synchronization in an Optomechanical Cavity**
   Keren Shlomi, D.Yuvaraj, Ilya Baskin, Oren Suchoi, Roni Winik, Eyal Buks
   arXiv:1410.0278
   We study self-excited oscillations (SEO) in an on-fiber optomechanical cavity. Synchronization is observed when the optical power that is injected into the cavity is periodically modulated. A theoretical analysis based on the Fokker-Planck equation evaluates the expected phase space distribution (PSD) of the self-oscillating mechanical resonator. A tomography technique is employed for extracting PSD from the measured reflected optical power. Time-resolved state tomography measurements are performed to study phase diffusion and phase locking of the SEO. The detuning region inside which synchronization occurs is experimentally determined and the results are compared with the theoretical prediction.

5. **Efficient readout of a single spin state in diamond via spin-to-charge conversion**
   B. J. Shields, Q. P. Unterreithmeier, N. P. de Leon, H. Park, M. D. Lukin
   arXiv:1410.0370
   Efficient readout of individual electronic spins associated with atom-like impurities in the solid state is essential for applications in quantum information processing and quantum metrology. We demonstrate a new method for efficient spin readout of nitrogen-vacancy (NV) centers in diamond. The method is based on conversion of the electronic spin state of the NV to a charge state distribution, followed by single-shot readout of the charge state. Conversion is achieved through a spin-dependent photoionization process in diamond at room temperature. Using NVs in nanofabricated diamond beams, we demonstrate that the resulting spin readout noise is within a factor of three of the spin projection noise level. Applications of this technique for nanoscale magnetic sensing are discussed.

6. **Interacting bosons in topological optical flux lattices**
   A. Sterdyniak, B. Andrei Bernevig, Nigel R. Cooper, N. Regnault
   arXiv:1410.0357
   An interesting route to the realization of topological Chern bands in ultracold atomic gases is through the use of optical flux lattices. These models differ from the tight-binding real-space lattice models of Chern insulators that are conventionally studied in solid-state contexts. Instead, they involve the coherent coupling of internal

atomic (spin) states, and can be viewed as tight-binding models in reciprocal space. By changing the form of the coupling and the number N of internal spin states, they give rise to Chern bands with controllable Chern number and with nearly flat energy dispersion. We investigate in detail how interactions between bosons occupying these bands can lead to the emergence of fractional quantum Hall states, such as the Laughlin and Moore-Read states. In order to test the experimental realization of these phases, we study their stability with respect to band dispersion and band mixing. We also probe novel topological phases that emerge in these systems when the Chern number is greater than 1.

7. **Observation of Majorana Fermions in Ferromagnetic Atomic Chains on a Superconductor**
   Stevan Nadj-Perge, Ilya K. Drozdov, Jian Li, Hua Chen, Sangjun Jeon, Jungpil Seo, Allan H. MacDonald, B. Andrei Bernevig, Ali Yazdani
   arXiv:1410.0682
   Majorana fermions are predicted to localize at the edge of a topological superconductor, a state of matter that can form when a ferromagnetic system is placed in proximity to a conventional superconductor with strong spin-orbit interaction. With the goal of realizing a one-dimensional topological superconductor, we have fabricated ferromagnetic iron (Fe) atomic chains on the surface of superconducting lead (Pb). Using high-resolution spectroscopic imaging techniques, we show that the onset of superconductivity, which gaps the electronic density of states in the bulk of the Fe chains, is accompanied by the appearance of zero energy end states. This spatially resolved signature provides strong evidence, corroborated by other observations, for the formation of a topological phase and edge-bound Majorana fermions in our atomic chains.

8. **Non-sinusoidal current-phase relationship in Josephson junctions from the 3D topological insulator HgTe**
   Ilya Sochnikov, Luis Maier, Christopher A. Watson, John R. Kirtley, Charles Gould, Grigory Tkachov, Ewelina M. Hankiewicz, Christoph Brne, Hartmut Buhmann, Laurens W. Molenkamp, Kathryn A. Moler
   arXiv:1410.1111
   We use Superconducting QUantum Interference Device (SQUID) microscopy to characterize the current-phase relation (CPR) of Josephson Junctions from 3-dimentional topological insulator HgTe (3D-HgTe). We find clear skewness in the CPRs of HgTe junctions ranging in length from 200 nm to 600 nm. The skewness indicates that the Josephson current is predominantly carried by Andreev bound states with high transmittance, and the fact that the skewness persists in junctions that are longer than the mean free path suggests that the effect may be related to the helical nature of the Andreev bound states in the surface of HgTe.

9. **Topological properties of linear circuit lattices**
   Victor V. Albert, Leonid I. Glazman, Liang Jiang
   arXiv:1410.1243
   Motivated by the topologically insulating (TI) circuit of capacitors and inductors proposed and tested in arXiv:1309.0878, we present a related circuit with less elements per site. The normal mode frequency matrix of our circuit is unitarily equivalent to the tight-binding matrix of a quantum spin Hall insulator (QSHI). Spinful fermionic time-reversal symmetry manifests itself in the TI circuit context as a result of a discrete symmetry of the circuit; elastic backscattering between edge modes does not occur whenever a circuit perturbation is invariant under such a symmetry. We make such testable predictions with regards to backscattering for both circuits. The idea behind these models is generalized, providing a platform to simulate tunable and locally accessible lattices with arbitrary complex spin-orbit hopping of any range. A simulation of a non-Abelian Aharonov-Bohm effect using such linear circuit designs is discussed.

10. **Phonon counting and intensity interferometry of a nanomechanical resonator**
    Justin D. Cohen, Sean M. Meenehan, Gregory S. MacCabe, Simon Gröblacher Amir H. Safavi-Naeini, Francesco Marsili, Matthew D. Shaw, Oskar Painter
    arXiv:1410.1047
    Using an optical probe along with single photon detection we have performed effective phonon counting measurements of the acoustic emission and absorption processes in a nanomechanical resonator. Applying these measurements in a Hanbury Brown and Twiss set-up, phonon correlations of the nanomechanical resonator are explored from below to above threshold of a parametric instability leading to self-oscillation of the resonator. Discussion of the results in terms of a "phonon laser", and analysis of the sensitivity of the phonon counting technique are presented.