1. **Photonic Floquet topological insulators**
M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, Y. Lumer, D. Podolsky, F. Dreisow, S. Nolte, M. Segev, and A. Szameit
Nature **496**, 196 (2013)

2. **Transition from Majorana to Weyl fermions and anapole moments**
S. Esposito
arXiv:1304.3669

The apparent splitting of zero-bias conductance peaks, apparently observed in recent experiments concerning Majorana fermions in nanowires coupled to superconductors, can be interpreted as a manifestation of a transition in the structure from (massive) Majorana to (massless) Weyl fermions. A modification of the experiments in order to test such phenomenon is proposed by making recourse to the only possible electromagnetic interaction allowed to (massive) Majorana particles and medi- ated by their anapole moment. In suitably designed heterostructures with toroidal symmetry, the additional anapole interaction manifests itself in the lowering of the critical magnetic field required for the appearance of the zero-bias peak, a shift that can be directly measured and thus reveal the presence of Majorana (rather than Weyl) fermions. Anapole interactions, though not previously considered, may also be a powerful method to control the dynamics of Majorana fermions, and then to manipulate the qubit state in quantum computation.

3. **FFLO or Majorana superfluids: Quantum phases of fermionic cold atoms in spin-orbit coupled optical lattices.**
C. Qu, M. Gong, and C. Zhang
arXiv:1304.3926

The recent experimental realization of spin-orbit coupling (SOC) for ultra-cold atoms opens a completely new avenue for exploring new quantum matter. In experiments, the SOC is implemented simultaneously with a Zeeman field. Such spin-orbit coupled Fermi gases are predicted to support Majorana fermions with non-Abelian exchange statistics in one dimension (1D). However, as shown in recent theory and experiments for 1D spin-imbalanced Fermi gases, the Zeeman field can lead to the long-sought Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) superfluids with non-zero momentum Cooper pairings, in contrast to the zero momentum pairing in Majorana superfluids. Therefore a natural question to ask is which phase, FFLO or Majorana superfluids, will survive in spin-orbit coupled Fermi gases in the presence of a large Zeeman field. In this paper, we address this question by studying the mean field quantum phases of 1D spin-orbit coupled fermionic cold atom optical lattices.

4. **Microscopic Theory of a Quantum Hall Ising Nematic: Domain Walls and Disorder**
A. Kumar, S. A. Parameswaran, and S. L. Sondhi
arXiv:1304.4255

We study the the interplay between spontaneously broken valley symmetry and spatial disorder in multivalley semiconductors in the quantum Hall regime. In cases where valleys have anisotropic electron dispersion a previous long-wavelength analysis identified two new phases exhibiting the QHE. The first is the quantum Hall Ising nematic (QHIN), a phase with long-range orientational order manifested in macroscopic transport anisotropies. The second is the quantum Hall random-field paramagnet (QHRFPM) that emerges when the Ising ordering is disrupted by quenched disorder, characterized by a domain structure with a distinctive response to a valley symmetry-breaking strain field. Here we provide a more detailed microscopic analysis of the QHIN, which allows us to (i) estimate its Ising ordering temperature; (ii) study its domain-wall excitations, which play a central role in determining its properties; and (iii) analyze its response to quenched disorder from impurity scattering, which gives an estimate for domain size in the descendant QHRFPM. Our results are directly applicable to AlAs heterostructures, although their qualitative aspects inform other ferromagnetic QH systems, such as Si(111) heterostructures and bilayer graphene with trigonal warping.

5. **Observation of Intense Second Harmonic Generation from MoS2 Atomic Crystals**
L. M. Malard, T. V. Alencar, A. P. M. Barboza, K. F. Mak, and A. M. de Paula
arXiv:1304.4289

The nonlinear optical properties of few-layer MoS2 two-dimensional crystals are studied using femtosecond laser pulses. We observed highly efficient second harmonic generation from the odd-layer crystals, which shows a polarization intensity dependence that directly reveals the underlying symmetry and orientation of the crystal. Additionally, the measured second-order susceptibility spectra provide information about the electronic structure of the material. Our results open up new opportunities for studying the non-linear optical properties in these novel 2D crystals.

6. **Unconventional magnetism via optical pumping of interacting spin systems**
T. E. Lee, S. Gopalakrishnan, and M. D. Lukin
arXiv:1304.4959

We consider strongly interacting systems of effective spins, subject to dissipative spin-flip processes associated with optical pumping. We predict the existence of novel magnetic phases in the steadystate of this system, which emerge due to the competition between coherent and dissipative processes. Specifically, for strongly anisotropic spin-spin interactions, we find ferromagnetic, antiferromagnetic, spin-density-wave, and staggered-XY steady states, which are separated by nonequilibrium phase transitions meeting at a Lifshitz point. These transitions are accompanied by quantum correlations, resulting in spin squeezing. Experimental implementations in ultracold atoms and trapped ions are discussed.

7. **Dicke Quantum Spin and Photon Glass in Optical Cavities: Non-equilibrium theory and experimental signatures**
M. Buchhold, P. Strack, S. Sachdev, and S. Diehl
arXiv:1304.5196

In the context of ultracold atoms in multimode optical cavities, the appearance of a quantum-critical glass phase of atomic spins has been predicted recently. Due to the long-range nature of the cavity-mediated interactions, but also the presence of a driving laser and dissipative processes such as cavity photon loss, the quantum optical realization of glassy physics has no analog in condensed matter, and could evolve into a cavity glass microscope for frustrated quantum systems out-of-equilibrium. Here we develop the non-equilibrium theory of the multimode Dicke model with quenched disorder and Markovian dissipation. Using a unified Keldysh path integral approach, we show that the defining features of a low temperature glass, representing a critical phase of matter with algebraically decaying temporal correlation functions, are seen to be robust against the presence of dissipation due to cavity loss. The universality class however is modified due to the Markovian bath. The presence of strong disorder leads to an enhanced equilibration of atomic and photonic degrees of freedom, including the emergence of a common low-frequency effective temperature. The imprint of the atomic spin glass physics onto a photon glass makes it possible to detect the glass state by standard experimental techniques of quantum optics. We provide an unambiguous characterization of the superradiant and glassy phases in terms of fluorescence spectroscopy, homodyne detection, and the temporal photon correlation function.

8. **Effects of Electron-Electron Interactions on Electronic Raman Scattering of Graphite in High Magnetic Fields**
Y. Ma, Y. Kim, N. G. Kalugin, A. Lombardo, A. C. Ferrari, J. Kono, A. Imambekov, and D. Smirnov
arXiv:1304.5415

We report the observation of strongly temperature-dependent, asymmetric spectral lines in electronic Raman scattering of graphite in a high magnetic field up to 45 T applied along the c-axis. The magnetic field quantizes the in-plane motion, while the out-of-plane motion remains free, effectively reducing the system dimension from three to one. Optically created electron-hole pairs interact with, or shake up, the one-dimensional Fermi sea in the lowest Landau subbands. Based on the Tomonaga-Luttinger liquid theory, we show that interaction effects modify the van Hove singularity. We predict a thermal broadening factor that increases linearly with the temperature. Our model reproduces the observed temperature-dependent line-shape, determining to be 0.05 at 40 T.