1. **Equilibrium currents in chiral systems with non-zero Chern number**
   E. G. Mishchenko and O. A. Starykh
   arXiv:1404.7535

   We describe simple quantum-mechanical approach to calculating equilibrium particle current along the edge of a system with non-trivial band spectrum topology. The approach does not require any a priori knowledge of the band topology and, as a matter of fact, treats topological and non-topological contributions to the edge currents on the same footing. We illustrate its usefulness by demonstrating the existence of 'topologically non-trivial' particle currents along the edges of three different physical systems: two-dimensional electron gas with spin-orbit coupling and Zeeman magnetic field, surface state of a topological insulator, and kagome antiferromagnet with Dzyaloshinskii-Moriya interaction. We describe relation of our results to the notion of orbital magnetization.

2. **Collapse of superconductivity in a hybrid tingraphene Josephson junction array**
   Zheng Han, Adrien Allain, Hadi Arjmandi-Tash, Konstantin Tikhonov, Mikhail Feigelman, Benjamin Sacp, and Vincent Bouchiat
   Nature physics, 10, 380, (2014)

   For a Josephson junction array with hybrid superconductor/metal/superconductor junctions, a quantum phase transition from a superconducting to a two-dimensional (2D) metallic ground state is predicted to occur on increasing the junction normal state resistance. Owing to its surface-exposed 2D electron gas and its gate-tunable charge carrier density, graphene coupled to superconductors is the ideal platform to study such phase transitions between ground states. Here, we show that decorating graphene with a sparse and regular array of superconducting discs enables the continuous gate-tuning of the quantum superconductor-to-metal transition of the Josephson junction array into a zero-temperature metallic state. The suppression of proximity-induced superconductivity is a direct consequence of the emergence of quantum fluctuations of the superconducting phase of the discs. Under perpendicular magnetic fields, the competition between quantum fluctuations and disorder is responsible for the resilience of superconductivity at the lowest temperatures, supporting a glassy state that persists above the upper critical field.We provide the entire phase diagram of the disorder and magnetic-field-tuned transition to reveal the role of quantum phase fluctuations in 2D superconducting systems.

3. **Hidden spin polarization in inversion-symmetric bulk crystals**
   Xiuwen Zhang, Qihang Liu, Jun-Wei Luo, Arthur J. Freeman, and Alex Zunger
   Nature physics, 10, 387, (2014)

   Spinorbit coupling can induce spin polarization in nonmagnetic 3D crystals when the inversion symmetry is broken, as manifested by the bulk Rashba and Dresselhaus effects. We establish that these spin-polarization effects originate fundamentally from specific atomic site asymmetries, rather than, as generally accepted, from the asymmetry of the crystal space group. This understanding leads to the recognition that a previously overlooked hidden form of spin polarization should exist in centrosymmetric crystals. Although all energy bands must be doubly degenerate in centrosymmetric materials, we find that the two components of such doubly degenerate bands could have opposite polarizations, each spatially localized on one of the two separate sectors forming the inversion partners. We demonstrate such hidden spin polarizations in particular centrosymmetric crystals by first-principles calculations. This new understanding could considerably broaden the range of currently useful spintronic materials and enable the control of spin polarization by means of operations on the atomic scale.

4. **Electron-hole imbalance and large thermoelectric effect in superconducting hybrids with spin-active interfaces**
   Mikhail S. Kalenkov and Andrei D. Zaikin
   arXiv:1405.3858

   We argue that spin-sensitive quasiparticle scattering may generate electron-hole imbalance in superconducting structures, such as, e.g., superconducting-normal hybrids with spin-active interfaces. We elucidate a transparent physical mechanism for this effect demonstrating that scattering rates for electrons and holes at such interfaces differ from each other. Explicitly evaluating the wave functions of electron-like and hole-like excitations in superconducting-normal bilayers we derive a general expression for the thermoelectric current and show that in the presence of electron-hole imbalance this current can reach maximum values as high as the critical current of a superconductor.

5. **Non-Fermi liquid behaviour at the onset of incommensurate 2kF charge or spin density wave order in two dimensions**
   Tobias Holder and Walter Metzner
   arXiv:1405.3589

We analyze the influence of quantum critical fluctuations on single-particle excitations at the onset of incommensurate 2kF charge or spin density wave order in two-dimensional metals. The case of a single pair of hot spots at high symmetry positions on the Fermi surface needs to be distinguished from the case of two hot spot pairs. We compute the fluctuation propagator and the electronic self-energy perturbatively in leading order. The energy dependence of the single-particle decay rate at the hot spots obeys non-Fermi liquid power laws, with an exponent 2/3 in the case of a single hot spot pair, and exponent one for two hot spot pairs. The prefactors of the linear behavior obtained in the latter case are not particle-hole symmetric.

6. **Generation of magnonic spin wave traps**
Frederik Busse, Maria Mansurova, Benjamin Lenk, Marvin Walter, and Markus Munzenberg
arXiv:1405.3470

Spatially resolved measurements of the magnetization dynamics induced by an intense laser pump-pulse reveal that the frequencies of resulting spin wave modes depend strongly on the distance to the pump center. This can be attributed to a laser generated temperature profile. On a CoFeB thin film magnonic crystal, Damon-Eshbach modes are expected to propagate away from the point of excitation. The experiments show that this propagation is frustrated by the strong temperature gradient.

7. **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.

8. **Exotic electronic states in the world of flat bands: from theory to material**
Zheng Liu, Feng Liu, Yong-Shi Wu
arXiv:1404.1131

It has long been noticed that special lattices contain single-electron flat bands (FB) without any dispersion. Since the kinetic energy of electrons is quenched in the FB, this highly degenerate energy level becomes an ideal platform to achieve strongly correlated electronic states, such as magnetism, superconductivity and Wigner crystal. Recently, the FB has attracted increasing interests, because of the possibility to go beyond the conventional symmetry-breaking phases, towards topologically ordered phases, such as lattice versions of fractional quantum Hall states. This article reviews different aspects of FBs in a nutshell. Starting from the standard band theory, we aim to bridge the frontier of FBs with the textbook solid-state physics. Then, based on concrete examples, we show the common origin of FBs in terms of destructive interference, and discuss various many-body phases associated with such a singular band structure. In the end, we demonstrate real FBs in quantum frustrated materials and organometallic frameworks.