Rotating Bose-Einstein condensates: Closing the gap between exact and mean-field solutions
J. C. Cremon et al., arXiv:1501.05543v1
When a Bose-Einstein condensed cloud of atoms is given some angular momentum, it forms vortices arranged in structures with a discrete rotational symmetry. For these vortex states, the Hilbert space of the exact solution separates into a primary space related to the mean-field Gross- Pitaevskii solution and a complementary space including the corrections beyond mean-field. Considering a weakly-interacting Bose-Einstein condensate of harmonically-trapped atoms, we demonstrate how this separation can be used to close the conceptual gap between exact solutions for systems with only a few atoms and the thermodynamic limit for which the mean-field is the correct leading-order approximation. Although we illustrate this approach for the case of weak interactions, it is expected to be more generally valid.

Magnetoresistance in 3D Weyl Semimetals
Navneeth Ramakrishnan, Mirco Milletari, Shaffique Adam, arXiv:1501.03815
We theoretically investigate the transport and magneto-transport properties of three-dimensional Weyl semimetals. Using the RPA-Boltzmann transport scattering theory for electrons scattering off randomly distributed charged impurities, together with an effective medium theory to average over the resulting spatially inhomogeneous carrier density, we smoothly connect our results for the minimum conductivity near the Weyl point with known results for the conductivity at high carrier density. In the presence of a non-quantizing magnetic field, we predict that for both high and low carrier densities, Weyl semimetals show a transition from quadratic magnetoresistance (MR) at low magnetic fields to linear MR at high magnetic fields, and that the magnitude of the MR10 for realistic parameters. Our results are in qualitative agreement with recent unexpected experimental observations on the mixed-chalcogenide compound TlBiSSe.

Many-body mobility edge due to symmetry-constrained dynamics and strong interactions
Ian Mondragon-Shem, Arijeet Pal, Taylor L. Hughes, Chris R. Laumann, arXiv:1501.03824
We provide numerical evidence combined with an analytical understanding of the many-body mobility edge for the strongly anisotropic spin-1/2 XXZ model in a random magnetic field. The system dynamics can be understood in terms of symmetry-constrained excitations about parent states with ferromagnetic and anti-ferromagnetic short range order. These two regimes yield vastly different dynamics producing an observable, tunable many-body mobility edge. We compute a set of diagnostic quantities that verify the presence of the mobility edge and discuss how weakly correlated disorder can tune the mobility edge further.

Kohn-Luttinger superconductivity in monolayer and bilayer semimetals with the Dirac spectrum
M.Yu. Kagan, V.A. Mitskan, M.M. Korovushkin,arXiv:1501.03947
The effect of Coulomb interaction in an ensemble of Dirac fermions on the formation of superconducting pairing in monolayer and bilayer doped graphene is studied using the Kohn-Luttinger mechanism disregarding the Van der Waals potential of the substrate and impurities. The electronic structure of graphene is described using the Shubin-Vonsovsky model taking into account the intratomic, interatomic, and interlayer (in the case of bilayer graphene) Coulomb interactions between electrons. The Cooper instability is determined by solving the Bethe-Saltpeter integral equation. The renormalized scattering amplitude is obtained with allowance for the Kohn-Luttinger polarization contributions up to the second order of perturbation theory in the Coulomb interaction. It plays the role of effective interaction in the Bethe-Salpeter integral equation. It is shown that the allowance for the Kohn-Luttinger renormalizations as well as intersite Coulomb interaction noticeably affects the competition between the superconducting phases with the fwave and d+idwave symmetries of the order parameter. It is demonstrated that the superconducting transition temperature for an idealized graphene bilayer with significant interlayer Coulomb interaction between electrons is noticeably higher than in the monolayer case.

On the particle entanglement spectrum of the Laughlin states *B. Majidzadeh Garjani, B. Estienne, E. Ardonne, arXiv:1501.04016* The study of the entanglement entropy and entanglement spectrum has proven to be very fruitful in identifying topological phases of matter. Typically, one performs numerical studies of finite-size systems. However, there are few rigorous results for finite-size systems. We revisit the problem of determining the rank of the "particle entanglement spectrum" of the Laughlin states. We reformulate the problem into a problem concerning the ideal of symmetric polynomials that vanish under the formation of several clusters of particles. We give an explicit generating family of this ideal, and we prove that polynomials in this ideal have a total degree that is bounded from below. We discuss the difficulty in proving the same bound on the degree of any of the variables, which is necessary to determine the rank of the particle entanglement spectrum.

Quantum transport in Dirac materials: signa-

tures of tilted and anisotropic Dirac and Weyl cones *Maximilian Trescher, Bjrn Sbierski, Piet W. Brouwer, Emil J. Bergholtz, arXiv:1501.04034* We calculate conductance and noise for quantum transport at the nodal point for arbitrarily tilted and anisotropic Dirac or Weyl cones. Tilted and anisotropic dispersions are generic in absence of certain discrete symmetries, such as particle-hole and lattice point group symmetries. Whereas anisotropy affects the conductance g, but leaves the Fano factor F (the ratio of shot noise power and current) unchanged, a tilt affects both g and F. Since F is a universal number in many other situations, this finding is remarkable. We apply our general considerations to specific lattice models of strained graphene and a pyrochlore Weyl semi-metal.

Topological Polaritons in a Quantum Spin Hall Cavity
Alexander Janot, Bernd Rosenow, Gil Refael, arXiv:1501.04092
We study the topological structure of mixed matter-light particles, so called polaritons, in a quantum spin Hall insulator coupled to photonic cavity modes. We identify a topological invariant in the presence of time reversal symmetry, and find protected helical edge states with energies below the lower polariton branch. Applying a Zeeman field allows us to relate our topological index to a different index defined for an effective pseudospin model for polaritons. A nontrivial phase is characterized by a pseudospin which covers the entire Bloch sphere twice. Both, helical edge states and the topologically nontrivial polariton pseudospin structure can be probed directly by optical techniques.

Effective response theory for zero energy Majorana bound states in three spatial dimensions
Pedro L. S. Lopes, Jeffrey C. Y. Teo, Shinsei Ryu, arXiv:1501.04109
We propose a gravitational response theory for point defects (hedgehogs) binding Majorana zero modes in (3+1)-dimensional superconductors. Starting in 4+1 dimensions, where the point defect is extended into a line, a coupling of the bulk defect texture with the gravitational field is introduced. Diffeomorphism invariance then leads to an $SU(2)_2$ Kac-Moody current running along the defect line. The SU(2)2 Kac-Moody algebra accounts for the non-Abelian nature of the zero modes in 3+1 dimensions. It is then shown to also encode the angular momentum density which permeates throughout the bulk between hedgehog-anti-hedgehog pairs.

Assembling Fibonacci Anyons From a Z_3 Parafermion Lattice Model
E.M. Stoudenmire, David J. Clarke, Roger S. K. Mong, Jason Alicea, arXiv:1501.05305
Recent concrete proposals suggest it is possible to engineer a two-dimensional bulk phase supporting non-Abelian Fibonacci anyons out of Abelian fractional quantum Hall systems. The low-energy degrees of freedom of such setups can be modeled as Z_3 parafermions "hopping" on a two-dimensional lattice. We use the density matrix renormalization group to study a model of this type interpolating between the decoupled-chain, triangular-lattice, and square-lattice limits. The results show clear evidence of the Fibonacci phase over a wide region of the phase diagram, most notably including the isotropic triangular lattice point. We also study the broader phase diagram of this model and show that elsewhere it supports an Abelian state with semionic excitations.

Plasmon signature in Dirac-Weyl liquids
Johannes Hofmann, S. Das Sarma, arXiv:1501.04636
We consider theoretically as a function of temperature the plasmon mode arising in three-dimensional Dirac liquids, i.e., systems with linear chiral relativistic single-particle dispersion, within the random phase approximation (RPA). We find that whereas no plasmon mode exists in the intrinsic (undoped) system at zero temperature, there is a well-defined finite-temperature plasmon with linear temperature dependence, rendering the plasmon dispersion widely tunable with temperature. The plasmon dispersion has an additional logarithmic correction due to the ultraviolet-logarithmic renormalization of the electron charge, manifesting a fundamental new many-body interaction effect as in quantum electrodynamics. The plasmon dispersion of the extrinsic (doped) system displays a minimum at finite temperature before it crosses over to the linear intrinsic behavior at higher temperature. This striking characteristic linear temperature dependence of intrinsic Dirac plasmons along with the logarithmic renormalization is a unique manifestation of the three-dimensional relativistic Dirac nature of quasiparticle excitations and serves as an experimentally observable signature of three-dimensional Dirac materials.

Optical absorption of semiconductor 2D Majorana nanowires
Daniel Ruiz, Javier Osca, Llorens Serra, arXiv:1501.05811
We calculate the cross section for optical absorption of planar 2D Majorana nanowires. Light is described in the dipole approximation. We discuss the signatures on the cross section of a near-zero-energy mode. A low energy peak for transverse polarization, absent in longitudinal one, reveals the presence of the Majorana-like state. This peak is relatively robust against thermal smearing of the level occupations. We consider the influence of optical masks hiding parts of the nanowire from the light.