Journal Club

A. Kobayashi, Y. Suzumura, F. Pichon, G. Montambaux

Emergence of Dirac Electron Pair in Charge Ordered State of Organic Conductor -(BEDT-TTF)$_2$I$_3$, arXiv:1107.4841

We re-examine the band structure of the stripe charge ordered state of α-(BEDT-TTF)$_2I_3$ under pressure by using an extended Hubbard model within the Hartree mean-field theory. By increasing pressure, we find a topological transition from a conventional insulator with a single-minimum in the dispersion relation at the M-point in the Brillouin zone, towards a new phase which exhibits a double-minimum. This transition is characterized by the appearance of a pair of Dirac electrons with a finite mass. Using the Luttinger-Kohn representation at the M-point, it is shown that such a variation of the band structure can be described by an effective 2×2 low energy Hamiltonian with a single driving parameter. The topological nature of this transition is confirmed by the calculation of the Berry curvature which vanishes in the conventional phase and has a double peak structure with opposite signs in the new phase. We compare the structure of this transition with a simpler situation which occurs in two-component systems, like boron-nitride.

A. Petkovic, N. M. Chtchelkatchev, V. M. Vinokur

Far-from-equilibrium superconductor in fluctuational regime, arXiv:1107.5013

We derive Ginzburg-Landau-like action for two-dimensional disordered superconductor under far-from-equilibrium conditions in a fluctuational regime. Then, utilizing it, we calculate fluctuation induced density of states, Maki-Thomson and Aslamazov-Larkin type contributions to the in-plane electrical conductivity. We apply our approach to thin superconducting film sandwiched between a gate and a substrate that have different temperatures and different electrochemical potentials.

V.V. Cheianov, I.L. Aleiner, V.I. Fal'ko

Tunable Strongly Correlated Band Insulator, arXiv:1107.4750

We introduce the notion of the strongly correlated band insulator (SCI), where the lowest energy excitations are collective modes (excitons) rather than the single particles. We construct controllable 1/N expansion for SCI to describe their observables properties. A remarkable example of the SCI is bilayer graphene which is shown to be tunable between the SCI and usual weak coupling regime.

Nathan Davies, Aavishkar A. Patel, Alberto Cortijo, Vadim Cheianov, Francisco Guinea, Vladimir I. Fal'ko

Skipping and snake orbits of electrons: singularities and catastrophes, arXiv:1107.4738

Near the sample edge, or a sharp magnetic field step the drift of two-dimensional electrons in a magnetic field has the form of skipping/snake orbits. We show that families of skipping/snake orbits of electrons injected at one point inside a 2D metal generically exhibit caustics folds, cusps and cusp triplets, and, in one extreme case, a section of the batterfly bifurcation. Periodic appearance of singularities along the $\pm B$-interface leads to the magneto-oscillations of nonlocal conductance in multi-terminal electronic devices.

Dervis C. Vural, Anthony J. Leggett

Universal Sound Absorption in Amorphous Solids: A Theory of Elastically Coupled

Generic Blocks, arXiv:1103.5530
Glasses are known to exhibit quantitative universalities at low temperatures, the most striking of which is the ultrasonic attenuation coefficient 1/Q. In this work we develop a theory of coupled generic blocks with a certain randomness property to show that universality emerges essentially due to the interactions between elastic blocks, regardless of their microscopic nature.

Rupert L. Frank and Elliott H. Lieb
Possible Lattice Distortions in the Hubbard Model for Graphene, Phys. Rev. Lett. **107**, 066801 (2011) [4 pages]
The Hubbard model on the honeycomb lattice is a well-known model for graphene. Equally well known is the Peierls type of instability of the lattice bond lengths. In the context of these two approximations we ask and answer the question of the possible lattice distortions for graphene in zero magnetic field. The answer is that in the thermodynamic limit only periodic, reflection-symmetric distortions are allowed and these have at most 6 atoms per unit cell as compared to two atoms for the undistorted lattice.

Zhongyu Zheng, Feng Wang, and Yilong Han
Glass Transitions in Quasi-Two-Dimensional Suspensions of Colloidal Ellipsoids, Phys. Rev. Lett. **107**, 065702 (2011) [4 pages]
We observed a two-step glass transition in monolayers of colloidal ellipsoids by video microscopy. The glass transition in the rotational degree of freedom was at a lower density than that in the translational degree of freedom. Between the two transitions, ellipsoids formed an orientational glass. Approaching the respective glass transitions, the rotational and translational fastest-moving particles in the supercooled liquid moved cooperatively and formed clusters with power-law size distributions. The mean cluster sizes diverge in power law as they approach the glass transitions. The clusters of translational and rotational fastest-moving ellipsoids formed mainly within pseudonematic domains and around the domain boundaries, respectively.

B. Sriram Shastry
Extremely Correlated Fermi Liquids, Phys. Rev. Lett. **107**, 056403 (2011) [5 pages]
We present the theory of an extremely correlated Fermi liquid with $U \to \infty$. This liquid has an underlying auxiliary Fermi liquid Green's function that is further caparisoned by extreme correlations. The theory leads to two parallel hierarchies of equations that permit iterative approximations in a certain parameter. Preliminary results for the spectral functions display a broad background and a distinct T dependent left skew. An important energy scale $\Delta(k, x)$ emerges as the average inelasticity of the FL Green's function, and influences the photoemission spectra profoundly. A duality is identified wherein a loss of coherence of the ECFL results from an excessively sharp FL.