List of references, CMT journal club 7.7.2015

- **Presented paper: Observation of phononic helical edge states in a mechanical topological insulator**
  R. Süsstrunk and, D. Huber,
  Science 349, 47-50 (2015)

- **Observation of the Berezinskii-Kosterlitz-Thouless Phase Transition in an Ultracold Fermi Gas**
  S. Jochim et al.
  Phys. Rev. Lett. 115, 010401 (2015)
  We experimentally investigate the first-order correlation function of a trapped Fermi gas in the two-dimensional BEC-BCS crossover. We observe a transition to a low-temperature superfluid phase with algebraically decaying correlations. We show that the spatial coherence of the entire trapped system can be characterized by a single temperature-dependent exponent. We find the exponent at the transition to be constant over a wide range of interaction strengths across the crossover. This suggests that the phase transitions in both the bosonic regime and the strongly interacting crossover regime are of Berezinskii-Kosterlitz-Thouless type and lie within the same universality class. On the bosonic side of the crossover, our data are well described by the quantum Monte Carlo calculations for a Bose gas. In contrast, in the strongly interacting regime, we observe a superfluid phase which is significantly influenced by the fermionic nature of the constituent particles.

- **Quantum fluctuations in the BCS-BEC crossover of two-dimensional Fermi gases**
  L. He, H. Lv, G. Cao, H. Hu, X.-J. Liu
  arXiv:1506.07156v1
  We present a theoretical study of the ground state of the BCS-BEC crossover in dilute two-dimensional Fermi gases. While the mean-field theory provides a simple and analytical equation of state, the pressure is equal to that of a noninteracting Fermi gas in the entire BCS-BEC crossover, which is not consistent with the features of the weakly interacting Bose condensate in the BEC limit and the weakly interacting Fermi liquid in the BCS limit. The inadequacy of the 2D mean-field theory indicates that the quantum fluctuations are much more pronounced than those in 3D. In this work, we show that the inclusion of the Gaussian quantum fluctuations naturally recovers the above features in both the BEC and BCS limits. In the BEC limit, the missing logarithmic dependence on the boson chemical potential is recovered by the quantum fluctuations. Near

the quantum phase transition from the vacuum to the BEC phase, we compare our equation of state with the known grand canonical equation of state of 2D Bose gases and determine the ratio of the composite boson scattering length a_B to the fermion scattering length a_{2D}. We find $a_B \simeq 0.56 a_{2D}$, in good agreement with the exact four-body calculation. We compare our equation of state in the BCS-BEC crossover with recent results from the quantum Monte Carlo simulations and the experimental measurements and find good agreements.

- **Fractal butterflies in buckled graphenelike materials**
  V. Apalkov, and T. Chakraborty
  Phys. Rev. B 91, 235447 (2015)
  We study theoretically the properties of buckled graphenelike materials, such as silicene and germanene, in a strong perpendicular magnetic field and a periodic potential. We analyze how the spin-orbit interaction and the perpendicular electric field influence the energy spectra of these systems. When the magnetic flux through a unit cell of the periodic potential measured in the magnetic flux quantum is a rational number, $\alpha = p/q$, then in each Landau level the energy spectra have a band structure, which is characterized by the corresponding gaps. We study the dependence of those gaps on the parameters of the buckled graphenelike materials. Although some gaps have weak dependence on the magnitude of the spin-orbit coupling and the external electric field, there are gaps that show strong nonmonotonic dependence on these parameters. For $\alpha = 1/2$, the spin-orbit interaction also opens up a gap at one of the Landau levels. The magnitude of the gap increases with spin-orbit coupling and decreases with the applied electric field.

- **Topological Nonsymmorphic Crystalline Superconductors**
  Q.-Z. Wang, C.-X. Liu
  arXiv:1506.07938v1
  Topological superconductors possess a nodeless superconducting gap in the bulk and gapless zero energy modes, known as "Majorana zero modes", at the boundary of a finite system. In this work, we introduce a new class of topological superconductors, which are protected by nonsymmorphic crystalline symmetry and thus dubbed "topological nonsymmorphic crystalline superconductors". We construct an explicit Bogoliubov-de Gennes type of model for this superconducting phase in the D class and show how Majorana zero modes in this model are protected by glide symmetry. Furthermore, we generalize the classification of topological nonsymmorphic crystalline superconductors to the classes with time reversal symmetry, including the DIII and BDI classes, in two dimensions. Our theory provides a guidance to search for new topological superconducting materials with nonsymmorphic crystal structures.