Workshop Schedule

Events for:
Monday, May 3rd - Friday, May 7th

Monday, May 3rd

9:00am **Fangyaun Yang**

Title: Quantitativeanalysis of quantum Hall liquids and electronsolids in graphene from direct measurement of chemical potential

Abstract: Fangyuan Yang, Alexander A. Zibrov, Ruiheng Bai, KenjiWatanabe, TakashiTaniguchi, Mark O. Goerbig, Mike P. Zaletel, Andrea F. Young

We developed an experimental technique to mapout the evolution of chemical potential in graphene monolayer with carrierdensity up to the N=4 Landau level (LL). By integrating thechemical potential over the filling factor, we obtain the ground state energyper flux quantum, which can be directly compared with numerical calculations. Thecomparison leads to exceptional agreement in the N=0 LL if an RPA-screenedCoulomb interaction is accounted for. In the N=1 LL, thecomparison reveals the importance of valley anisotropic interaction and thepresence of valley-textured electron solids near odd integer fillings. Finally,in the N=2, 3 and 4 LLs, we find a series of oscillations in the chemicalpotential that match Hartree-Fock calculations based on single- and mixedphases of multi-electron bubble states.

9:30am **Glenn Wagner**

Title: s-wave paired composite-fermion-electron composite-fermion-hole trial state for quantum Hall bilayers with \nu=1

Abstract: We show that the \nu=1 quantum Hall bilayer, at large and intermediate distances between the layers, can be well described by s-wave BCS pairing of composite fermions of electrons in one layer and composite fermions of holes in the opposite layer. Our trial wavefunctions numerically improve over prior approaches, naturally allow for charge imbalance between the layers, and give important insight into how the physics at large interlayer separation crosses over to the physics at small interlayer separation in a fashion analogous to the BEC-BCS crossover.

10:00am **Q&A and Break**

10:20am **David Mross**

Title: Thermal and charge signatures of competing v=5/2 states

10:50am **Jia Li**

Title: Searching for non-abelian states in 2-component quantum Hall systems

11:20am **Q&A and Break**

11:40am **Eduardo Fradkin**

Title: Duality in Quantum Hall compressible states

Abstract: It has long been known empirically that quantum Hall plateau transitions enjoy an apparent self-duality symmetry manifest in that the current-voltage (I-V) curves are nonlinear and are symmetric around their liner behavior at the quantum phase transition. This behavior was first observed in dirtier samples and is now know to occur in the compressible states at filling fractions 1/2 and 1/4. This empirical result was interpreted by Shimshoni, Sondhi and Shahar (PRB 55, 13730 (1997)) as a manifestation of a particle-vortex duality. Yet, the origin of this symmetry has been mysterious and has remained unexplained until quite recently. In a recent paper (Hart Goldman and Eduardo Fradkin, PRB 98, 165137 (2018)) we used the recently developed dualities of Dirac fermions (D. T. Son Phys. Rev X. 5, 031027 (2015); N. Seiberg, T. Senthil, C. Wang and E. Witten, Ann. Phys. 374, 3095 (2016)) to show that the mirror symmetry of the Jain sequences converging on 1/2n compressible states explain the observed self-duality as a property of the compressible states.

12:10pm **Ilya Gruzberg**

Title: Numerical evidence for marginal scaling at the integer quantum Hall transition

Abstract: The integer quantum Hall transition (IQHT) is one of the most mysterious members of the family of Anderson transitions. Since the 1980s, the scaling behavior near the IQHT has been studied in experiments and numerical simulations. It is notoriously difficult to pin down the precise values of critical exponents, which seem to vary with model details and thus challenge the principle of universality. Recently, Zirnbauer has conjectured a conformal field theory for the transition, in which linear terms in the beta-functions vanish, leading to a very slow flow in the fixed point's vicinity. In this work, we provide numerical evidence for such a scenario by using extensive simulations of various network models of the IQHT at unprecedented length scales. At criticality, we show that the finite-size scaling of the disorder averaged longitudinal Landauer conductance agrees with expectations from the field theory. Away from criticality we describe a mechanism that could account for the emergence of an effective critical exponent ?_eff, which is necessarily dependent on the parameters of the model. We further support this idea by exact numerical determination of ?_eff in suitably chosen models.

12:40pm **Paul Wiegmann**

Title: TBD

1:10pm **Q&A and Break**

Tuesday, May 4th

9:00am **Inti Sodemann**

Title: Shear Sound and Universal Shear Conductivity of Fermi Seas

9:30am **Mansour Shayegan**

Title: Puzzles in Quantum Hall and Related Phenomena

10:00am **Q&A and Break**

10:20am **Nicholas Regnault**

Title: Fractional Chiral Hinge Insulator

10:50am **Zlatko Papic**

Title: Gravitational dynamics of quantum Hall states (in real materials and in quantum computers)

11:20am **Q&A and Break**

11:40am **Hart Goldman**

Title: Exploring the non-Abelian quantum Hall landscape with duality

Abstract: It is an important open problem to understand the landscape of non-Abelian fractional quantum Hall phases accessible to physically motivated theories of Abelian composite particles. We show that progress can be made using the recently proposed family of non-Abelian boson-fermion dualities in two spatial dimensions. In the quantum Hall context, these dualities connect the dynamics of the ordinary, Abelian composite particles to dual, non-Abelian degrees of freedom, for which non-Abelian topological orders may be more transparently accessible, for example through pairing or filling of Landau levels. In this talk, we will focus on the particular example of the Fibonacci FQH state of bosons at filling ? = 2. Despite its salience as the simplest platform for a universal topological quantum computer, a dynamical picture for how this state might arise in a quantum Hall system has been lacking. By using duality with a theory of bosonic "composite vortices" coupled to an emergent U(2) gauge field, we present a construction of this state starting from a trilayer system with two trivial layers and one with the Halperin (2,2,1) topological order. The Fibonacci state is obtained when the composite vortices are clustered between the layers. We further leverage this approach to motivate the first proposal for an ideal wave function for the Fibonacci state.

12:10pm **Ziyu Liu, Ursula Wurstbauer, Lingjie Du, Ken W. West, Loren N. Pfeiffer, Michael J. Manfra , Aron Pinczuk,**

Title: Domain textures in the fractional quantum Hall effect

Abstract: Domain textures in the bulk of fractional quantum Hall liquids show great impact on macroscopic states and edge modes but remain elusive in experiments. We report large nematic liquid domains situated near the Fermi level at filling factor v = 7/3 using double resonant inelastic light scattering of plasmons. The resonant coupling of nematic plasmons to optical excitons distinguishes different types of domains. We apply this method to other filling factors including to the investigations of the ground state around v = 5/2. Such results present a profound understanding of the light scattering experiments in quantum Hall liquids and offer insights on their rich domain textures.

12:40pm **Q&A and Break**

Wednesday, May 5th

9:00am **Bernd Rosenow**

Title: Anyonic Signatures in Collisions and Braiding

Abstract: Fermions and bosons are fundamental realizations of exchange statistics, which governs the probability for two particles being close to each other spatially. Anyons in the fractional quantum Hall effect are an example for exchange statistics intermediate between bosons and fermions. We analyze a mesoscopic setup in which two dilute beams of anyons collide with each other, and relate the correlations of current fluctuations to the probability of particles excluding each other spatially. While current correlations for fermions vanish, negative correlations for anyons are a clear signature of a reduced spatial exclusion as compared to fermions. Anyonic exchange statistics can also be observed directly in quantum Hall interferometers operating in an novel regime: the intrinsic energy gap can be larger than the charging energy, and addition of flux quanta can occur without adding quasiparticles. We explain that the observation of anyonic statistical phases is possible by tuning to the transition from a regime with constant chemical potential to a regime with constant particle density, where the flux periodicity changes at a critical magnetic field strength.

9:30am **Yang Bo**

Title: Anyon dynamics in fractional quantum Hall systems and their experimental implications

Abstract: Anyons are topological objects with fractionalised charge and exotic statistics that can emerge from two-dimensional strongly correlated systems. We show that with fractional quantum Hall (FQH) effect, there are rich dynamics of anyons hosted by even the simplest topological phases. The analytic tools we developed, combined with large scale numerical calculations, show that anyons can undergo fractionalisation near the critical point between the nematic FQH state and the fully gapped FQH state. This leads to a BKT-type phase transition for the low-lying excitations of the Laughlin phase, even when the topological properties of the ground state remain the same. In addition, we show that anyons in FQH systems can be bosonized, and the microscopic interaction Hamiltonians capturing the statistical interactions between anyons can be explicitly derived. The duality from this bosonization scheme leads to previously unexplored families bosonic single-component FQH states at integer filling factors, with explicit microscopic model Hamiltonians. We will also discuss several experimental ramifications from our results.

10:00am **Q&A and Break**

10:20am **Dmitri Feldman**

Title: Thermal equilibration on the edges of topological liquids

Abstract: Thermal conductance has emerged as a powerful probe of topological order in the quantum Hall effect and beyond. The interpretation of experiments crucially depends on the ratio of the sample size and the equilibration length, on which energy exchange among contra-propagating chiral modes becomes significant. We show that at low temperatures the equilibration length diverges as $1/T^2$ for almost all Abelian and non-Abelian topological orders. A faster 1/T? divergence is present on the edges of the non-Abelian PH-Pfaffian and negative-flux Read-Rezayi liquids. We address experimental consequences of the $1/T^2$ and 1/T? laws in a sample, shorter than the equilibration length.

10:50am **Mitali Banerjee**

Title: TBD

11:20am **Q&A and Break**

11:40am **Biao Lian**

Title: Quantum chaos of chiral edge states

Abstract: nbsp;chiral edge states arise on the edges of 2+1D chiral topological phases. Interacting chiral edge states at low energies are usually believed to be described by integrable chiral Luttinger liquid theories, which allows the study of their coherent interferences. We show that marginal interactions can lead to quantum chaos in chiral edge states at low energies. For N identical chiral Majorana fermion modes with generic 4-fermion interactions, we find the system is integrable when N<=6, while is quantum chaotic when N>=7. In the large N limit, the system defines a chiral SYK model, the chaos exponent of which can be solved analytically. We further discuss interacting models hosting Abelian anyons which show quantum chaos. In particular, we show that the chaotic correlation of Abelian anyons decomposes into a statistical factor times a fermion correlator.

12:10pm **Hugo Bartolomei**

Title: TBD

12:40pm **Q&A and Break**

Thursday, May 6th

9:00am **Moty Heiblum**

Title: Does shot noise measure always the quasiparticle charge?

Abstract: We demonstrate that the Fano factor of partitioned shot noise (F=1 for integers), stemming from either weakly backscattered partitioned charges (by a QPC), purely from neutral modes, or both effects, depends only on the bulk filling and not on the structure (and conductance) of the edge modes or the filling inside the QPC constriction.

9:30am **Andrea Cappelli**

Title: "W-infinity Symmetry in the Quantum Hall Effect Beyond the Edge"

Abstract: The description of chiral quantum incompressible fluids by the W-infinity symmetry can be extended from the edge, where it encompasses the conformal field theory approach, to the non-conformal bulk. The two regimes are characterized by excitations with different sizes, energies and momenta within the disk geometry. In particular, the bulk quantities have a finite limit for large droplets. We obtain analytic results for the radial shape of excitations, the edge reconstruction phenomenon and the energy spectrum of density fluctuations in Laughlin states.

10:00am **Q&A and Break**

10:20am **Loren Pfeiffer**

Title: “Progress on improving the MBE sample quality of GaAs and AlAs quantum wells”.

10:50am **Dung Nguyen**

Title: TBD

11:20am **Q&A and Break**

11:40am **James Nakamura**

Title: Evidence for anyonic statistics in the fractional quantum Hall regime through Fabry-Perot interferometry

Abstract: Fractional quantum Hall states have been predicted to host exotic quasiparticles which carry fractional charge and obey anyonic braiding statistics. Fabry-Perot interferometers have been proposed as a tool for observing these fractional properties. We have fabricated interferometers in which the bulk-edge coupling is suppressed by screening layers. At the ?= 1/3 state we observe Aharonov-Bohm interference interrupted by discrete jumps in phase, which provides experimental evidence for anyonic braiding statistics.

12:10pm **Smitha Vishveshwara**

Title: Probing anyon correlations and blackhole-like dynamics in the quantum Hall bulk

Abstract: The recent interferometric and beam-splitter experiments signaling the presence of anyons in quantum Hall systems has created of resurgence of interest in the topic. Here, I will present a theoretical description of coherent state bulk anyons and their signatures in two particle correlators. I will demonstrate how a saddle potential, for instance created in a pinched point contact geometry, can model a beam-splitter. Anyon dynamics in such a potential reflects Hanbury-Brown Twiss correlations that can directly probe fractional statistics. I will also illustrate how the same setting can probe dynamics akin to that found in the astrophysical realm of black holes. Specifically, point-contact geometries can exhibit phenomena parallel to Hawking-Unruh radiation and black hole quasinormal modes associated with ringdowns in gravitational wave detection.

12:40pm **Q&A and Break**

Friday, May 7th

9:00am **Jainendra Jain**

Title: An exactly solvable model for FQHE

9:30am **Kun Yang**

Title: Interplay of Geometry and Topology in Quantum Hall Liquids

10:00am **Q&A and Break**

10:20am **Semyon Klevtsov**

Title: Geometric test for topological states of matter

Abstract: We generalize the flux insertion argument due to Laughlin, Niu-Thouless-Wu and Avron-Seiler to the higher-genus surface. We propose this setting as a test to characterise whether the quantum state of matter is "topological" and apply our test to the Laughlin states. We compute the Chern classes of bundles of Laughlin states over the space of Aharonov-Bohm fluxes through the holes of the surface (Laughlin bundles), the degeneracy of the Laughlin states on higher genus Riemann surfaces with any number of quasi-holes, settling the Wen-Niu conjecture, as well as the dimensions of the corresponding Hilbert spaces. We then show that the Laughlin bundles without the localized quasi-holes are not projectively flat. Based on the upcoming paper with D. Zvonkine.

10:50am **Michael Zaletel**

Title: Skyrmion pairing: DMRG evidence for a topological route to superconductivity

11:20am **Q&A and Break**

11:40am **Gabor Csathy**

Title: Paired and Stripe Phases in the Two-dimensional Electron Gas

Abstract: Electronic stripe phases are ubiquitous at half filling in high Landau levels. Most recently, stripe phases were also observed in the second Landau level, leading to a richer phase diagram in this region of the phase space. In this talk I will discuss the observation of a pressure-driven direct phase transition between even denominator fractional quantum Hall states and the stripe phase that occurs in the second Landau level. The special properties and the driving forces of this phase transition will be discussed.

12:10pm **Ramanjit Sohal**

Title: Emergence of Clustered non-Abelian Quantum Hall States from non-Abelian duality

Abstract: The vast majority of experimentally observed fractional quantum Hall states can be reliably explained within the framework of composite fermion and composite boson field theories. However, such composite particle theories have proved less successful in describing the emergence of exotic non-Abelian FQH states, such as the Read-Rezayi sequence. In this talk, I will show how Landau-Ginzburg theories for a large class of non-Abelian FQH states, including the Read-Rezayi and non-Abelian spin singlet sequences, can be formulated by making use of recently proposed Chern-Simons-matter theory dualities. These dualities roughly take the form of a non-Abelian version of flux attachment and allow for accessing regions of the FQH phase diagram which are not so easily seen in the standard composite fermion and boson pictures. Our construction employs the condensation of clusters of composite vortex objects in parent multilayer Abelian states. As I will emphasize, this closely mirrors the structure of ideal wave functions proposed for these states. To conclude, I will briefly discuss how an extension of our analysis to the formulation of an effective field theory for a novel Fibonacci FQH state can be used to motivate a trial wave function for this state.

12:40pm **Q&A and Break**