The 17th Capri Spring School on Transport in Nanostructures 2023

	Sunday 07.05.2023	**Monday 08.05.2023**	**Tuesday 09.05.2023**	**Wednesday 10.05.2023**	**Thursday 11.05.2023**	**Friday 12.05.2023**	**Saturday 13.05.2023**
Chair		Schönenberger	De Martino	Tagliacozzo	Fazio	Egger	
9:00-9:55		Glattli (1)	Splettstoesser (1)	Fève (3)	Rosenow (3)	Gefen (3)	
10:00-10:55		Rosenow (1)	Glattli (2)	Hasan	Splettstoesser (3)	Martin	
11:00-11:30		Coffee Break & Poster Session					
11:30-12:25		Manfra (1)	Rosenow (2)	Splettstoesser (2)	Banerjee	Gornyi	
13:00-16:00		Lunch Break					
Chair		Egger	Bercioux	Bercioux		De Martino	
16:00-16:55		Gefen (1)	Fève (2)	Gefen (2)		Glattli (3)	
17:00-17:30		Coffee Break & Poster Session			Free Afternoon	Coffee Break & Poster Session	
17:30-18:25	Registration Hotel Senaria	Fève (1)	Manfra (2)	Manfra (3)		Participant talk	
18:30-19:30	19:00-19:40	Poster presentation and official poster session	Participant talk	Participant talk		Concluding remarks	
20:00 Dinner	Le Arcate	Le Arcate	Le Arcate	Free dinner	Le Arcate	Le Arcate	

School excursion to Pompeii/ Sorrento (if weather permits) Start at 9 am, Capri Harbour Return by 6 pm

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M. Banerjee	Thermal conduction of fractional quantum Hall channels
G. Féve	Two-particle interferometry in integer and fractional quantum Hall conductors
Y. Gefen	Anyonic colliders
C. Glattli	AC quantum transport, noise and 2-particle dynamical interferometry of integer and fractional quasi-particles
I. Gornyi	Statistics-induced entanglement in a Hong-Ou-Mandel interferometer
Z. Hasan	Kagome quantum matter
M. Manfra	FQHE in AlGaAs/GaAs heterostructures: charge fractionalization and statistics via interferometric measurements
T. Martin	Anyonic statistics and scaling dimension revealed by the Hong-Ou-Mandel dip and photo-assisted transport in the fractional quantum Hall effect
B. Rosenow	Correlation effects in interferometric set-ups
J. Splettstößer	Interference effects for controlling/exploiting heat in electronic systems

Poster presentation (2 min) & poster session

Monday Session (18:30 - 19:30)	Charles Boudet	Prasoon Kumar
	Mario Di Luca	Sourav Manna
	Marcel Hild	Carolina Martinez Strasser
	Yi-Ju Ho	Alexandra Mestre Tora
	Erwin Mönch	Henry Mullineaux Sanders
	Maria Chiara Paolozzi	Elina Pavlovska
	Smriti Prakash Suman	Christian Prosko
	Felix Puster	Eusebio Jesús Rodríguez Fernández

Participant Talks

Tuesday Session (12+3)	Matteo Acciai	Channel mixing in a quantum Hall two-particle interferometer
	Chun-Chia Chen	Chiral Andreev Edge States at the Quantum Hall / Superconductor Interfaces
	Marco Coraiola	Hybridizing Andreev states in three-terminal Josephson junctions
	Mélanie Ruelle	Comparing fractional quantum Hall Laughlin and Jain topological orders with the anyon collider
Thursday Session (12+3)	Ankur Das	Shot Noise as a Diagnostic in the Fractional Quantum Hall Edge Zoo
	Robert Garbrecht Larsen	Towards controllable anyonic brading statistics in an interferometer
	James Nakamura	Interference measurements of the fractional quantum Hall state
	Noam Schiller	Anyon statistics through conductance measurements of time-domain interferometry
Friday Session (12+3)	Emanuele Di Salvo	Plasmonic contributions to shear viscosity in graphene
	Elric Frigerio	Tunable Edge Magnetoplasmon Resonator
	Sungguen Ryu	Beating Carnot efficiency with periodically driven chiral conductors
	Eusebio Jesús Rodríguez Fernández	Nonmonotonic quantum phase gathering in curved spintronic circuits
	Sofieke ten Kate	Flip-chip-based fast parity readout of a superconducting island
	Simon Wozny	Noise calculations for transport through quantum dot systems and applications in charge sensing and thermodynamic uncertainty relations
	Drilon Zenelaj	Microwave power harvesting using cavity-coupled double quantum dot photodiode
	Dario Bercioux	Information regarding the excursion to Pompeii & Sorrento

Short talks abstracts: Tuesday Session

From 18:30 to 19:30

Matteo Acciai (Chalmers University of Technology) — *Channel mixing in a quantum Hall two-particle interferometer*

We consider a two-particle interferometer, where voltage sources inject electronic excitations into a pair of copropagating quantum Hall edge channels. Such excitations then interfere at a quantum point contact. For an ideal scenario, the output noise of this interferometer is completely suppressed when the incoming excitations are synchronized. However, recent experiments an incomplete reduction of the noise, which cannot be explained by Coulomb interactions. Here, we show that channel mixing due to inter-edge tunneling can be responsible for an incomplete suppression of the noise, thereby reducing the visibility of the interference.

Chun-Chia Chen (Duke University) — *Chiral Andreev Edge States at the Quantum Hall / Superconductor Interfaces*

When quantum Hall edge states approach an interface with a superconductor, they undergo successive Andreev reflections. This results in the formation of Chiral Andreev edge states (CAES) - hybridized states of electrons and holes. The presence of the CAES can be detected by measuring the non-local resistance downstream of the superconducting contact. In this study, we examined different factors that influence CAES interference and manipulated the CAES by moving vortices in superconducting contacts. Our results may facilitate the understanding and design of chiral quantum states in proximity-based devices.

Marco Coraiola (IBM Research Europe, Zurich) — *Hybridizing Andreev states in three-terminal Josephson junctions*

In hybrid multiterminal Josephson junctions—devices with three or more superconducting terminals coupled to a semiconducting region—Andreev bound states (ABSs) may form unconventional energy band structures, engineered by controlling superconducting phase differences between the individual terminals. We present tunneling spectroscopy of three-terminal Josephson junctions realized in an InAs/Al heterostructure. By accessing the 2D phase space, we demonstrate an Andreev molecule originating from two discrete ABSs that spatially overlap and hybridize. Signatures of hybridization are observed in the form of avoided crossings in the spectrum and band structure anisotropies in the phase space, all well explained by a numerical model.

Mélanie Ruelle (Stanford University) — *Comparing fractional quantum Hall Laughlin and Jain topological orders with the anyon collider*

Anyon collision experiments have recently demonstrated the ability to discriminate between fermionic and anyonic statistics. However, only one type of anyons associated with the simple Laughlin state at filling factor $\nu = 1/3$ has been probed so far. It is now important to establish anyon collisions as quantitative probes of fractional statistics for more complex topological orders, with the ability to distinguish between different species of anyons with different statistics. In this work, we use the anyon collider to compare the Laughlin $\nu = 1/3$ state, which is used as the reference state, with the more complex Jain state at $\nu = 2/5$, where low energy excitations are carried by two co-propagating edge channels. We demonstrate that anyons generated on the outer channel of the $\nu = 2/5$ state (with a fractional charge e^*=e/3) have a similar behavior compared to $\nu = 1/3$, showing the robustness of anyon collision signals for anyons of the same type. In contrast, anyons emitted on the inner channel of $\nu = 2/5$ (with a fractional charge e^*=e/5) exhibit a reduced degree of bunching compared to the ν=1/3 case, demonstrating the ability of the anyon collider to discriminate not only between anyons and fermions, but also between different species of anyons associated with different topological orders of the bulk. Our experimental results for the inner channel of $\nu = 2/5$ also point towards an influence of interchannel interactions in anyon collision experiments when several co-propagating edge channels are present.

Short talks abstracts: Thursday Session

From 17:30 to 18:30

Ankur Das (Weizmann Institute of Science) — *Shot Noise as a Diagnostic in the Fractional Quantum Hall Edge Zoo*

Edge modes in a fractional quantum Hall state can be in coherent or equilibrated regimes, where different degrees of thermal equilibration can be reached while the charge is fully equilibrated, giving rise to a zoo of intriguing models. Classifying them based on a diagnosis in a single experimental device is an outstanding problem. We show that the electrical shot noise can serve the purpose of a quantum point contact conductance plateau. We consider $\nu = 2/3$ FQH state and show that different inequalities among the auto- and cross-correlation shot noise hold for different edge models, including recently observed $e^2/2h$ QPC conductance plateau.

Robert Garbrecht Larsen (Niels Bohr Institute, University of Copenhagen) — Towards controllable anyonic brading statistics in an interferometer

Recent work in the field of quantum Hall interferometry has led to the direct observation of phase slips indicating anyonic braiding statistics of the interfering quasiparticles. However these experiments have relied on local disorder to change the number of encircled quasiparticles. My work focuses on implementing an electronic interferometer in a FQH regime with an antidot structure that can tune the number of enclosed quasiparticles.

James Nakamura (Purdue University) — Interference measurements of the $\nu = 2/5$ fractional quantum Hall state

Electronic Fabry-Perot interferometry can be used to probe charge and statistics of quasiparticles in the fractional quantum Hall regime. We have used this technique to probe the $\nu = 2/5$ state, which in the composite fermion picture consists of two filled Landau levels and thus has two separate edge channels. Measurements of conductance versus gate voltage on quantum point contacts supports this picture. We present measurements of interference for the inner and outer edge modes at $\nu = 2/5$.

Noam Schiller (Weizmann Institute of Science) — *Anyon statistics through conductance measurements of time-domain interferometry*

We propose a method to extract the mutual exchange statistics of the anyonic excitations of a general Abelian fractional quantum Hall state, by comparing the tunneling characteristics of a quantum point contact in two different experimental conditions. In the first, the tunneling current between two edges at different chemical potentials is measured. In the second, one of these edges is strongly diluted by an earlier point contact. We describe the case of the dilute beam in terms of a time-domain interferometer between the anyons flowing along the edge and quasiparticle-quasihole excitations created at the tunneling quantum point contact. In both cases, temperature is kept large, such that the measured current is given to linear response. Remarkably, our proposal does not require the measurement of current correlations, and allows us to carefully separate effects of the fractional charge and statistics from effects of intra- and inter-edge interactions.

Short talks abstracts: Friday Session

From 18:30 to 19:30

Emanuele Di Salvo (Utrecht University) — *Plasmonic contributions to shear viscosity in graphene*

One of the hallmark properties of fluids is their shear viscosity which is, among other things, responsible for parabolic flow profiles through tubes. In recent years there has been a growing number of observations of said flow profiles in electronic transport measurements in a variety of material systems, with graphene taking the position of a frontrunner. We investigate the shear viscosity of interacting graphene from a theoretical point of view. We study both a phenomenological as well as a microscopic model and find excellent agreement between the two. Furthermore, we find that interactions make a sizeable contribution to the viscosity, which can on equal footing with or even outweigh the electronic contribution that is usually assumed dominant.

Elric Frigerio (LPENS) — *Tunable Edge Magnetoplasmon Resonator*

Edge magnetoplasmons (EMPs) are the low-energy excitations of a 2DEG in the Quantum Hall regime. These chiral collective excitations propagate along the electrostatic edge of the 2DEG. In an isolated Hall island, EMPs trajectories are closed loops, making it possible to create a resonant cavity. The resonance will depend on the perimeter of the Island and the velocity of EMPs. With a few gates, it is possible to tune the resonant frequency by changing the perimeter of the resonator. In this work, we will show that it is possible to create such cavities, mesure and tune their resonant frequencies.

Sungguen Ryu (Institute for Cross-Disciplinary Physics and Complex Systems) — *Beating Carnot efficiency with periodically driven chiral conductors*

Efficiencies of macroscopic engines are bounded by Carnot limit, originated from the second law of thermodynamics. Is this bound is still valid for microengines operating far from equilibrium? Here, we demonstrate that a quantum chiral conductor driven by AC voltage can indeed work with efficiencies much larger than the Carnot bound. Nonetheless, with the proper definition, entropy production is always positive and the second law is preserved. The crucial ingredients for surpassing the Carnot limit are: i) irreversible entropy production by the photoassisted processes due to the AC field and ii) absence of power injection thanks to chirality.

Eusebio Jesús Rodríguez Fernández (University of Sevilla) — *Nonmonotonic quantum phase gathering in curved spintronic circuits*

Spin carriers propagating along quantum circuits gather quantum spin phases which typically grow monotonically with the SOC strength, as found in Rashba quantum wires and rings. In this work we show that the spin-phase gathering can be engineered by geometric means, viz., by the geometric curvature of the circuits, to be nonmonotonic. The complex interplay between dynamic and geometric spin-phase components—triggered by a series of emergent spin degeneracy points—leads to bounded, global spin phases. Moreover, we show that the particulars of the spin-phase gathering have observable consequences in the Aharonov-Casher conductance of Rashba loops.

Short talks abstracts: Friday Session

From 18:30 to 19:30

Sofieke ten Kate (IBM Research - Zurich) — *Flip-chip-based fast parity readout of a superconducting island*

The charge parity of a superconducting island is measured by monitoring the response of a resonator, inductively coupled to a superconducting loop, into which the island is incorporated. The strength of the parity effect could be controlled by electrostatically tuning the energy of a single Andreev bound state, co-localized on the same island. Using our detection circuit we estimated parity detection signal-to-noise ratio (SNR) exceeding 3 for integration time below 30 μs. Time-resolved studies of parity-flips allowed to estimate parity lifetime in excess of 100 μs. We elaborate on the role of Andreev bound states enabling this readout approach.

Simon Wozny (Lund University) — *Noise calculations for transport through quantum dot systems and applications in charge sensing and thermodynamic uncertainty relations*

Using full counting statistics we calculate the current and current noise through quantum dot (QD) systems. We apply the calculations to investigate the use of a parallel double QD as a charge sensor that uses interference effects. We show that this system can outperform a single-dot charge sensor. Access to the noise also allows us to investigate the so called thermodynamic uncertainty relations (TURs) in QD thermoelectric engines, that give a trade-off between power, fluctuations and efficiency. Violations indicate the presence of quantum effects, e.g., in an interacting sequential double QD coherences can lead to violations.

Drilon Zenelaj (Lund University) — *Microwave power harvesting using cavity-coupled double quantum dot photodiode*

We demonstrate a microwave power conversion engine based on a cavity-coupled double quantum dot system. We realize the photon-to-electron conversion process in an asymmetrically tunnel-coupled double-dot and theoretically model the device operation. The photodiode is then operated with a bias voltage applied against the photocurrent to extract the electrical power. The device attains a maximum power harvesting efficiency of 2%, with the photon-to-electron con- version efficiency reaching 12%. We discuss the device operation and efficiencies in the linear and nonlinear response regimes.

Dario Bercioux (Donostia International Physics Center) — Information regarding the excursion to Pompei & Sorrento

Important information for the excursion on Saturday to Pompeii and Sorrento.

Poster sessions

On Monday w/ presentation & daily parallel to coffee breaks

1. Charles Boudet (C.E.A. Saclay) — *Design of a single shot electron detector with sub-electron sensitivity for electron flying qubit operation*
2. Mario Di Luca Day (EPFL Lausanne) — *Fabry-Perot interferometer in bilayer-graphene*
3. Marcel Hild (University of Regensburg) — *Terahertz spin-ratchet in magnetic metamaterials*
4. Yi-Ju Ho (University of Würzburg) — *Heat transport in HgTe 3DTI devices*
5. Prasoon Kumar (CEA Grenoble) — *Towards the Quantum hall interferometry in FQHE : using Composite fermions*
6. Sourav Manna (Weizmann Institute of Science) — *Full Classification of Transport on an Equilibrated $\nu = 5/2$ Edge via Shot Noise*
7. Carolina Martinez Strasser (DIPC) — *Non-Hermitian diamond chain*
8. Alexandra Mestre Tora (ETH Zurich) — *Gate-defined ring in MATBG*
9. Erwin Mönch (University of Regensburg) — *Circular polarization immunity of the cyclotron resonance photoconductivity in two-dimensional electron systems*
10. Henry Mullineaux Sanders (University of St. Andrews) — *Topology in Chiral Edges*
11. Maria Chiara Paolozzi (Sapienza University of Rome) — *Extraordinary Optical Transmittance Generation on Si_3N_4 Membranes*
12. Elina Pavlovska (University of Latvia) — *Mesoscopic Coulomb collisions of on-demand electrons as a nonlinear quantum optics effect*
13. Smriti Prakash Suman (University of Würzburg) — *Interferometry in quantum point contacts fabricated with HgTe quantum wells*
14. Christian Prosko (TU Delft) — *Flux-Tunable Hybridization in a Double Quantum Dot Interferometer*
15. Felix Puster (Leipzig University) — *Dynamical breaking of the electron-hole symmetry in non-equilibrium chiral quantum channel*
16. Eusebio Jesús Rodríguez Fernández (University of Sevilla) — Magnetic switching of spin-scattering centers in Dresselhaus [110] circuits