Veronica Ahufinger
Universitat Autonoma Barcelona

"Ultracold atoms carrying orbital angular momentum in sided coupled cylindrically symmetric potentials"

Abstract.
In this talk, we will show that ultracold atoms carrying orbital angular momentum open a very rich scenario for Atomtronics. Specifically, we will demonstrate that complex tunneling amplitudes appear naturally in the dynamics of orbital angular momentum states for a single ultracold atom trapped in two-dimensional (2D) systems of sided coupled cylindrically symmetric identical traps [1]. In a triangular ring configuration, complex tunnelings lead to the possibility of engineering spatial dark states, which allows manipulating the transport of angular momentum states via quantum interference. This triangular trapping configuration may open a myriad of possibilities when assumed to be the unit cell of a 2D lattice. In addition, we will show that robust edge-like states [2] of a single ultracold atom in a 2D optical ribbon can be engineered within the manifold of local states carrying one unit of angular momentum of the sites forming the ribbon. Finally, we will also briefly discuss the use the winding number associated to the angular momentum as a synthetic dimension.

[1] Geometrically induced complex tunnelings for ultracold atoms carrying orbital angular momentum. J. Polo, J. Mompart, V. Ahufinger, Phys. Rev. A 93, 033613 (2016).
[2] Single atom edge-like states via quantum interference. G. Pelegrí, J. Polo, A. Turpin, M. Lewenstein, J. Mompart, V. Ahufinger, Phys. Rev. A 95, 013614 (2017).

Natan Andrei
Rutgers University

"Non-equilibrium Dynamics of Quantum Integrable Systems"

Abstract.
The study of non-equilibrium dynamics of interacting many body systems is currently one of the main challenges of modern condensed matter physics, driven by the spectacular progress in the ability to create experimental systems - trapped cold atomic gases are a prime example - that can be isolated from their environment and be highly controlled. Many of the system so studied are integrable.

In this talk I will describe nonequilibrium quench and Floquet dynamics in some integrable quantum systems. I'll discuss the time evolution of the Lieb-Liniger system, a gas of interacting bosons moving on the continuous infinite line and interacting via a short range potential. Considering a finite number of bosons on the line we find that for any value of repulsive coupling the system asymptotes towards a strongly repulsive gas for any initial state, while for an attractive coupling, the system forms a maximal bound state that dominates at longer times. In the thermodynamic limit -with the number of bosons and the system size sent to infinity at a constant density and the long time limit taken subsequently- I'll show that the density and density-density correlation functions for strong but finite positive coupling are described by GGE for translationally invariant initial states with short range correlations. As examples I'll

discuss quenches from a Mott insulator initial state or a Newton's Cradle. Then I will show that if the initial state is strongly non translational invariant, e.g. a domain wall configuration, the system does not equilibrate but evolves into a nonequilibrium steady state (NESS). A related NESS arises when the quench consists of coupling a quantum dot to two leads held at different chemical potential, leading in the long time limit to a steady state current. I will also present some results on Floquet dynamics for interacting bosons. Time permitting I will discuss the quench dynamics of the XXZ Heisenberg chain.

Aidan Arnold
Department of Physics, University of Strathclyde (UK).

"Maximum contrast interferometry and coherence in Bose-Einstein condensates"

Abstract.
.P. McGilligan, R. Elvin, S.J. Ingleby, Y. Zhai, C.H. Carson, V.A. Henderson, P.F. Griffin, E. Riis & A.S. Arnold

We have laser cooled 3×10^6 ^{87}Rb atoms to 3 μK in a micro-fabricated grating magneto-optical trap (GMOT), enabling future mass-deployment in highly accurate compact quantum sensors. We magnetically trap the atoms, and use Larmor spin precession for magnetic sensing, as well as demonstrate an array of magneto-optical traps with a single laser beam – useful for future cold atom gradiometry.
We report the first observation of the spatial Talbot effect for light interacting with periodic Bose-Einstein condensate interference fringes. The Talbot effect can lead to dramatic loss of fringe visibility in images, degrading precision interferometry, however we demonstrate how the effect can also be used as a tool to enhance visibility, as well as extend the useful focal range of matter wave detection systems by orders of magnitude. We show that negative optical densities arise from matter-wave induced lensing of detuned imaging light -- yielding Talbot-enhanced single-shot interference visibility of >135% compared to the ideal visibility for resonant light.

Mikhail Baranov
Institute for Theoretical Physics, University of Innsbruck

" Nanoscale 'dark state' optical potentials for cold atoms"

Abstract.
The generation of subwavelength optical barriers on the scale of tens of nanometers, as conservative optical potentials for cold atoms, is discussed. These arise from nonadiabatic corrections to Born- Oppenheimer potentials from dressed "dark states" in atomic Λ configurations. The subwavelength optical barriers represent an optical "Kronig-Penney" potential. I discuss in details the band structure in such potentials, including decoherence from spontaneous emission and atom loss to open "bright" channels. Finally, it will be shown that inclusion of an interparticle dipole-dipole interaction leads to formation of "domain wall molecules" and to unconventional Hubbard models with modulated in space interparticle interactions.

Jerome Beugnon
Laboratoire Kastler Brossel

"Phase relaxation in a superfluid atomic ring"

Kibble-Zurek mechanism predicts the formation of supercurrents when quench cooling a ring-shaped BEC. This theory also allows one to get information about the critical exponents of the phase transition by evaluating the statistics of formation of these supercurrents. However, the relaxation dynamics of the system from the critical point to the final state, where supercurrents are detected, is challenging to study and could lead to deviation from the simple picture of Kibble-Zurek scenario. In this talk I will report experiments investigating the merging of independent BECs in a ring geometry. We measured the scaling of the typical winding number of the superfluid current with the number of BECs that are merged and studied the relaxation dynamics of the phase of such systems.

Gerhard Birkl
Technische Universität Darmstadt

Abstract.
Research on ultra-cold atomic systems has developed an important role in the investigation of fundamental quantum principles but also towards quantum technological applications. Two important fields of research can be identified in the study of quantum degenerate gases, such as Bose-Einstein condensates, as well as in quantum simulation and quantum information processing based on individual atoms. Both direction will significantly contribute to the emerging field of ATOMTRONICS.
In this presentation, recent developments in our work towards these objectives are presented: We generate samples of BECs and of single ultracold atoms and apply external potential structures created by optical fields for the manipulation of atomic matter waves and for the development of a scalable architecture for quantum computing and simulation with ultra-cold atoms.
I show the experimental investigation of Bose-Einstein condensates in external guiding potentials, such as devices based on the application of conical refraction as a new technique for creation of toroidal potentials and review the experimental progress towards quantum information processing and quantum simulation using neutral atoms in two-dimensional (2D) arrays of optical microtraps as 2D registers of qubits and individually controllable but globally interacting indiviual-atom quantum systems.

Jean-Philippe Brantut
EPFL

Abstract
We present a scanning probe microscopy technique for spatially resolving transport in cold atomic gases, in close analogy with scanning gate microscopy in semiconductor physics. The conductance of a quantum point contact connected to two atomic reservoirs is measured in the presence of a tightly focused laser beam acting as a local perturbation that can be precisely positioned in space. By scanning its position and recording the subsequent variations of conductance, we retrieve a high-resolution map of transport through a quantum point contact. We demonstrate high sensitivity and spatial resolution, in good agreement with both an analytical model and ab-initio numerical simulations. We then present the realization of mesoscopic optical lattices projected onto a single mode conductor, and observe emergence of

the band gap as a consequence of interferences. By constructing the lattice on barrier at a time, we perform a scaling analysis of the conductance at the metal to band-insulator crossover. We measure the effect of interactions and compare the experimental results with the predictions of the Tomonaga-Luttinger model.

Alessia Burchianti
INO-CNR and LENS

"Connecting phase slips and dissipation in atomic Josephson junctions "

Abstract
We have recently reported on the observation of the Josephson effect between two 6Li fermionic superfluids weakly coupled by a tunneling barrier [1]. In the limit of a small population imbalance between the two su- perfluids, Josephson plasma oscillations occur through the whole BEC-BCS crossover. For larger population imbalances, deep in the non-linear regime, the Josephson current turns into a resistive particle flow, which tends to equilibrate the two reservoirs. Here, we unveil the microscopic origin of this non-zero resistivity [2]. We find that, independently from the regime of superfluidity explored, the onset of dissipation is due to phase- slip events driven by the bias chemical potential across the junction. We show that phase-slippage takes place through vortex-excitations created nearby the barrier region and then diffusing into the superfluid bulk, where they are observed after time-of-flight expansion. In the limit of low phase-slippage rate, the coherence between the two superfluids is preserved, as proven by the occurrence, after dissipation, of Josephson plasma oscillations. In the opposite limit, the junction dynamics is irreversibly affected by phase-slips proliferation, leading to the loss of Josephson coupling. Our system provides a tunable experimental platform for investigating the compe- tition between supercurrents and dissipation in the presence of strong inter-particle interactions. Furthermore, our results pave the way to control dissipation in atomtronics devices based on the Josephson effect.

Alessio Celi
ICFO

"Synthetic topology and manybody physics in synthetic lattices"

Abstract
After a brief review of synthetic lattices, I will first discuss the topological properties of narrow Hofstadter strips, like the ones obtained by exploiting Raman-coupled N_y spin states of atoms as synthetic dimension. I will show that such narrow systems can display not only edge states but also the topological properties associated to the bulk as in large systems, even if it reduces to just one lattice point (N_y=3). In particular, I will show that by Bloch oscillations it is possible to measure the Chern number C associated to the lowest band of a large system pierced by the same flux with good accuracy, for $N_y \geq C+2$. Then, I will consider the effect of interactions, focusing on the case of bosonic synthetic Hofstadter ladder. In particular, I will describe the phase diagram of the system in the hardcore boson limit, when the lattice is dimerized in the real extended dimension. I will show by analytical and numerical means that melted vortex phases and commensurate-incommesurate transitions, already found by other authors in real and synthetic homogeneous ladders, are easily accessible and controllable by varying the amount of the dimerization.

Charles Clark
Joint Quantum Institute

"Induced density correlations in a sonic black hole condensate"

Abstract
Analog black hole/white hole pairs, consisting of a region of supersonic flow, have been achieved in a recent experiment by Jeff Steinhauer using an elongated Bose-Einstein condensate. A growing standing density wave, and a checkerboard feature in the density-density correlation function, were observed in the supersonic region. We model the density-density correlation function, taking into account both quantum fluctuations and the shot-to-shot variation of atom number normally present in ultracold-atom experiments. We find that quantum fluctuations alone produce some, but not all, of the features of the correlation function, whereas atom-number fluctuation alone can produce all the observed features, and agreement is best when both are included. In both cases, the density-density correlation is not intrinsic to the fluctuations, but rather is induced by modulation of the standing wave caused by the fluctuations.

Adolfo del Campo
Univ. of Massachusetts, (USA).

"Shortcuts to adiabaticity: tailoring quantum matter far away from equilibrium"

Abstract
Understanding the far-from-equilibrium dynamics of quantum systems is an open problem at the frontiers of physics. Yet, tailoring such dynamics is a necessity for the advancement of quantum technologies. In this context, control techniques known as shortcuts to adiabaticity (STA) have emerged as a disruptive paradigm as they reproduce the quantum adiabatic dynamics of the system and suppress excitations without the requirement of slow driving. I shall present recent developments in the development and implementation of STA in various quantum platforms including ultracold quantum gases, trapped ions, and many-body spin systems.

Rainer Dumke
Centre for Quantum Technologies/Nayang Technological University (Singapore).

"Towards Pairing Quantum Circuits with Atoms"

Abstract.
In recent years, hybrid quantum systems have become a subject of intensive research. To integrate superconducting technology for ultracold atoms promises extremely low magnetic and thermal noise compared to normal conductors. This boost in coherence time holds promising expectations for quantum information processing applications. In particular, superconducting atom chips are ideal candidates for the realization of hybrid quantum systems between atomic and superconducting solid state qubits, merging the fast gate operation times for superconducting qubits with the long coherence times of atomic qubits. In this talk I will discuss our work towards realizing this hybrid quantum system via coupling ultracold atoms and superconducting circuits

Mark Edwards
Georgia Southern University, (USA).

" Quantum Turbulence in Atomtronic Systems"

Abstract:
The appearance in the last three years of digital micro-mirror-device technologies in all-optical atom trapping has given experimentalists the ability to produce arbitrary optical potentials with arbitrary time dependences. Furthermore, the development of new evaporative cooling techniques has enabled the production of Bose-Einstein condensates (BECs) with number uncertainty below the shot-noise limit. These advances should drive new applications for atomtronic systems especially in the area of metrology. In this talk I will discuss our efforts to produce a "current source" in a "racetrack" potential atom circuit. The racetrack consists of two parallel straightaway channels connected by two semicircular endcap channels to make a closed loop. In our circuit the condensate completely fills this loop. In the process of trying to stir the BEC to produce smooth flow, we have encountered significant turbulence. This turbulence is characterized by the production of a significant number of topological excitations such as vortices and solitons. I will also present our studies of the behavior of these excitations as they migrate around the racetrack. Finally I will sketch some of our ideas for analog ammeters and voltmeters in these atom circuits.

Heng Fan
Chinese Academy od Science

“Many-body localization and the simulation in superconducting qubits”

Abstract.
Many-body localization is a phenomenon induced by disorder in intereaction or local field for non-integrable model in many-body systems. By many-body localization, the initial state can keep its initial form with strong disorder. The measure of quantum coherence can be applied in studying this phenomenon. We also investigate the possibility of exploring many-body localization in superconducting qubits.

Denis Feinberg
CNRS and Université Grenoble Alpes

“Multiterminal Josephson junctions”

Abstract.
In a junction connecting N>2 superconductors, a coherent DC multi-Cooper pair transport appears, selected by a commensurate combination of chemical potentials. It underlies a specific stationnary phase combination. With three terminals it corresponds to a three-body transport made of quartets (pairs of pairs). This generalizes the two-terminal Josephson effect and it also applies to cold atom Bose condensates under suitably chosen geometries.

Thomas Fernholz
University of Nottingham

"The Power of RF"

Abstract.
Radio-frequency (RF) dressed potentials have proven to be a very versatile tool for the generation of magnetic atom traps. Their robustness enabled the coherent splitting of trapped condensates [1], and the many degrees of freedom in terms of polarisation as well as multi-frequency settings allow for interesting and complex trap topologies [2,3]. The dependence on the atomic Landé-factor allows for hyperfine state-dependent control, which may be used to implement guided and/or fully trapped interferometers [4].
This talk will aim at conveying an intuitive geometric picture to explain a range of effects that occur in RF dressed potentials, and discuss a recent proposal for a dual, fully trapped Sagnac interferometer, which is operated like an atomic clock. A range of experimental results will address some steps towards its realization: state-dependent guiding, hyperfine-changing micro-wave transitions in dressed potentials, and dressing-enhanced, non-destructive state detection.

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[2] T. Fernholz et al., Phys. Rev. A 75, 063406 (2007)
[3] B. M. Garraway, H. Perrin, J. Phys. B: At. Mol. Opt. Phys. 49, 172001 (2016)
[4] R. Stevenson et al., Phys. Rev. Lett. 115, 163001 (2015)

Ron Folman
Ben-Gurion University

"Matter wave interferometers on atom chips: from decoherence to gravity and back"

Abstract.
Matter-wave interferometry provides an excellent tool for probing the environment and studying its coupling to isolated atoms. We will present several interferometry experiments done with a BEC on an atom chip [1] and in which different effects of the environment have been investigated. First, we will discuss fluctuations in the nearby environment probed by an interference of atoms trapped in a magnetic lattice very close (5μm) to a room temperature surface [2,3]. Here an order-of-magnitude improvement has been obtained over previous atom-surface distances for which spatial interference has been observed. Next, we will present a new interferometry of self-interfering clocks and show, in a proof-of-principle experiment, how it could probe the interplay of QM and GR [4]. We will also describe a rule for "clock complementarity", which we deduce theoretically and verify experimentally [5]. Finally, we will discuss Stern-Gerlach interferometry [6] and describe it in the context of time irreversibility [7]. To the best of our knowledge, this is the first time spatial Stern-Gerlach interferometry has been realized, and we analyze our data in the context of previous theoretical work relating the difficulties in realizing Stern-Gerlach interferometry to time irreversibility.

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[2] Shuyu Zhou, David Groswasser, Mark Keil, Yonathan Japha, Ron Folman, "Robust spatial coherence 5mm from a room temperature atom-chip", Phys. Rev. A **93**, 063615 (2016).
[3] Yonathan Japha, Shuyu Zhou, Mark Keil and Ron Folman, Carsten Henkel, Amichay Vardi, "Suppression and enhancement of decoherence in an atomic Josephson junction", New J. Phys. **18**, 055008 (2016).

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[6] Shimon Machluf, Yonathan Japha and Ron Folman, "Coherent Stern-Gerlach momentum splitting on an atom chip", Nature Communications **4**, 2424 (2013).
[7] Atom Chip group, "Probing the emergence of the arrow of time with a high visibility Stern-Gerlach interferometer", in preparation.

Joszef Fortágh
CQ Center for Quantum Science, University of Tübingen (Germany)

"Interfacing ultracold atoms and superconductors"

Abstract.
Interfacing ultra-cold atoms and superconductors promises novel quantum interfaces where electronic or magnetic degrees of freedoms may be transferred from one system to the other while preserving the quantum nature. I present experimental results on the interaction of ultra-cold atomic clouds with superconducting circuits and discuss the perspectives for quantum information processing.

Simon Gardiner
Durham University

"Atomtronic Rotational Sensing with Bose Einstein Condensates"

Abstract.
Atom interferometry potentially holds the promise of great sensitivity in precision measurements. While it might be expected that the advent of atomic Bose-Einstein condensates would produce comparable improvements in such things signal to noise as the invention of the laser did for optical interferometry, a key issue has been the ubiquity of significant atom-atom interactions, which tends to muddy any interferometric signal. Nevertheless, through some reasonably astute design, it is possible to overcome such issues, meaning that interactions need not present such a problem — specifically in the case of Sagnac interferometry for rotational sensing in ring shaped trapping configurations.

Barry Garraway
University of Southampton (UK)

"Dressed adiabatic potentials for cold atom wave-guides, shells and lattices"

Abstract.
Dressing atoms with radio-frequency and microwave radiation opens up new possibilities for cold atoms and a BEC in new types of trap and in new topologies such as spherical surfaces and in waveguide loops [1,2] as well as in lattices [3,4]. This is because of the flexibility inherent in the vector coupling of a magnetic dipole moment to electromagnetic fields which can be varied in time, frequency, orientation and space. This may in turn result in quantum technology applications to sensing (with ring traps and gyroscopes [5,6]), metrology, interferometry and atomtronics.

The presentation will give an overview of the methods of adiabatic potentials as developed for rf and microwave atom trapping. Recent work on quantifying Landau-Zener losses in dressed adiabatic traps will be included [7].

References:

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[2] Trapping atoms with radio-frequency adiabatic potentials, H. Perrin and B.M. Garraway, in Advances in Atomic, Molecular and Optical Physics, (2017), to appear.

[3] Radio-frequency dressed lattices for ultracold alkali atoms, G.A. Sinuco-León and B.M. Garraway, New J. Phys. 17, 053037 (2015); Addressed qubit manipulation in radio-frequency dressed lattices, New J. Phys. 18, 035009 (2016).

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Nathan Goldman
ULB

"Probing topology by « heating »"

Abstract.
The intimate connection between topology and quantum physics has been widely explored in solid-state physics, revealing a plethora of remarkable physical phenomena over the years. Building on their universal nature, topological properties are currently studied in an even broader context, ranging from ultracold atomic gases to photonics, where distinct observables and probes offer a novel view on topological quantum matter.

In this talk, I will start by presenting a brief overview of our recent research activities, setting the focus on the realization and detection of topological properties in ultracold atoms. I will then dedicate the main part of the talk to a very recent work [1], where we demonstrate that an intriguing topological phenomenon can be unveiled upon « heating » lattice systems.

[1] D. T. Tran, A. Dauphin, A. Grushin, P. Zoller, and N. Goldman; arXiv:1704.01990.

David Guery-Odelin
University Paul Sabatier, Tolouse (France).

"From matter wave tunneling to quantum phase transitions"

Abstract.
In this talk, I propose to give an overview of two different kind of experiments performed with Bose-Einstein condensates (BEC) placed in time-dependent optical lattices. The first experiment deals with the measurement of the time required for a wave packet to tunnel through the potential barriers of an optical lattice. In this experiment, the motion of the wave packets is triggered by a sudden displacement of the lattice by a few tens of nm. We then directly observe

in momentum space the splitting of the wave packet at the turning points of the oscillatory motion. In contrast with the methods explored in other fields to deduce the tunnel traversal time, we choose parameters so that roughly half the wave packet tunnels through the barrier. Using the packet that has not tunneled as a reference, we infer precisely the duration of the tunneling process. The tunnel barriers act therefore as beam splitters. Using such atomic beam splitter twice, we realize a chain of coherent micron-size Mach-Zehnder interferometers at the exit of which we get essentially a wave packet with a negative momentum, a result opposite to the prediction of classical physics [1].
The dynamics of Bose-Einstein condensates in phase modulated optical lattices is also very rich. One can distinguish different regimes depending on the relative time scales of the frequency of modulation and that of the tunneling rate. For low modulation frequency, the physics is dominated by the tunneling rate renormalization and the emergence of a phase order in space for which the neighbouring wells have opposite phases. We will report on our experimental results about the nucleation of this new quantum phase.

References

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Christian Miniatura
MajuLab, CNRS-UNS-NTU-NUS

“Critical properties of the Anderson transition through the looking-glass of the CBS and CFS peaks”

Abstract.
In disordered media, the absence of diffusion arising from the spatial localization of single-particle states is known as Anderson localisation (AL). In three dimensions, AL manifests itself as a phase transition which occurs at a critical energy or at a critical disorder strength (the mobility edge) separating a metallic phase where states are spatially extended, from an insulating one where states are localized. Theoretically, much efforts have been devoted to the study of the critical properties of the Anderson transition (AT), such as wave-function multifractality or critical exponents. In practice however, only a handful of experiments have found evidence for the 3D Anderson transition, among them cold atoms, and even fewer have investigated its critical features (mostly in the context of quantum-chaotic dynamical localization). In addition to the intrinsic difficulty of achieving wave localization in three dimensions, one reason for the rareness of experimental characterizations of the Anderson transition is the lack of easily measurable observables displaying criticality. In this talk, I will show that the critical properties of the AT are encoded in two emblematic interference effects observed in momentum space: the coherent backscattering (CBS) and the coherent forward scattering (CFS) peaks, the latter being a critical quantity of the transition. By a finite time scaling analysis of the CBS width and of the CFS contrast temporal dynamics, one can extract accurate values of the mobility edge and critical exponents of the transition in agreement with their best known values to this date. Furthermore, exactly at the mobility edge, the CFS peak contrast is directly related to the so-called information dimension and reflects multi-fractal properties of the wave functions.

Helene Perrin
CNRS - Université Paris 13 (France).

“Superfluidity of the two-dimensional Bose gas”

Abstract.

Nick P. Proukakis
Joint Quantum Centre (JQC) Durham-Newcastle and Newcastle University

"Non-Equilibrium Techniques for Atomtronic Modelling"

Abstract.
Although optimal atomtronic circuits should minimize the disruptive presence of fluctuations, their operation is nonetheless likely to require onset dynamics on relatively fast timescales, with some non-condensate atoms always present, and an important challenge is to balance such opposing requirements. Theoretical understanding of atomtronic devices thus requires advanced numerical simulation tools applicable in diverse experimentally-relevant conditions. In this talk, intended to act as the basis for new atomtronics collaborations during the workshop, I present two such state-of-the-art tools, and apply them to a range of non-equilibrium finite-temperature problems.

Rapid condensation in a ring trap geometry is unstable towards inducing long-lived spontaneous circulation, but once a zero-current steady-state has been established, we show that one can imprint long-lived counter-propagating dark soliton pairs whose coupled motion could conceivably prove useful as an absolute rotation sensor. Moreover, combining two rings together appears to generate non-trivial long-lived circulation patterns, whose harnessing could prove useful towards the operation of quantum switches. Such configurations will be discussed in the context of a stochastic dynamical method which fully includes fluctuations.

For slower changes, starting from a pre-formed equilibrium condensate, the coupled dynamics, such as collective modes or macroscopic excitations, are perhaps best modelled by a self-consistent kinetic theory; here we show an application of this to the recent Josephson-junctions experiments in Florence, demonstrating that actually a small amount of temperature can sometimes also have useful effects in damping out competing modes of excitation (which would always be present within Gross-Pitaevskii model). We also demonstrate, as proof-of-principle, the use of this method to ring-trap geometries with rotating barriers. This kinetic model also been recently extended to fully-coupled two-component condensates, which also emerge within the atomtronics context, and here we touch upon first dynamical applications of this method.

Matteo Rizzi
Johannes Gutenberg Universität Mainz (Germany).

"Tuning the Drude Weight of Dirac-Weyl Fermions in One-Dimensional Ring Traps"

Abstract.
We study the response to an applied flux of an interacting system of Dirac-Weyl fermions confined in a one-dimensional (1D) ring. Combining analytical calculations with density-matrix renormalization group results, we show that tuning of interactions leads to a unique many-body system that displays either a suppression or an enhancement of the Drude weight — the zero-frequency peak in the ac conductivity — with respect to the non-interacting value. An asymmetry in the interaction strength between same- and diff erent-pseudospin Dirac-Weyl fermions leads to Drude weight enhancement. Viceversa, symmetric interactions lead to Drude weight suppression. Our predictions can be tested in mixtures of ultracold fermions in 1D ring traps.

Sandro Stringari
University of Trento

" Superfluidity and Rotation of a Superfluid Spin-Orbit Coupled Bose-Einstein Condensate"

Abstract.
Spin-orbit coupling affects in a deep the superfluid behavior of BEC's. Topics that will be discussed in this talk concern the calculation of the superfluid density in uniform matter, through the evaluation of the transverse current response [1], and of the moment of inertia in harmonically trapped BECs [2]. SOC causes the emergence of diffused vorticity, thereby violating the irrotational constraint usually associated with the motion of a superfluid. Both the Raman induced 1D spin-orbit and the Rashba hamiltonians will be considered. It will be shown that, with a proper choice of the parameters and for low rotational angular velocities, the BEC system can acquire the classical rigid value of the moment of inertia even at zero temperature. Results for BECs confined in toroidal configurations will be also presented where it will be shown that SOC coupling causes the reduction of the quantum of circulation and of the value of angular momentum carried by persistent currents.

Refs:
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[2] Diffused vorticity and moment of inertia of a spin-orbit coupled Bose-Einstein condensate, Sandro Stringari, arXiv:1609.04694

Reinhold Walser
TU Darmstadt

"Technical optics with matter waves"

Abstract.
Geometrical optics and linear wave optics are core topics of physics. With the introduction of lasers and few photon states in resonators this field has expanded to non-linear optics as well as cavity-quantum electrodynamics in the last century.
The analogous creation of coherent matter waves with Bose-Einstein-condensates, its manipulation with traps, lenses, interferometers and lattices, as well as the observation of nonlinear quantum effects keep us busy today.
In this presentation, I will discuss our activities to develop a technical matter-wave optics out of the matter-wave toolbox that is available today.

Wolf von Klitzing
IESL-FORTH (Greece)

"Coherent Waveguides, Neutral Atom Accelerators and Clocks."

Abstract.
Atomtronics aims at coherently manipulating atomic matter-waves in time-dependent traps and waveguides. In the first part of this talk, I will present our accelerator for matter waves. A BEC can be accelerated, stopped or waveguided along a circular track. Dispersion controls allows us to let the condensate expand and to be re-focussed. In the second part, I will show our experimental progress towards a clock-type interferometer in adiabatic (dressed) potentials.