TALKS

Alice SINATRA
Laboratoire Kastler Brossel - École normale supérieure, Paris – FRANCE

Spin squeezing, phase dynamics and coherence time in cold degenerate gases
A specific feature of ultra cold atomic gases in optical or magnetic potentials, is that they are well isolated from the environment. Added to tunable interactions, this makes the appealing possibility to generate entangled states for quantum metrology. In a bimodal Bose-Einstein condensate, useful quantum correlations in the form of spin-squeezing result from the interaction-induced phase dynamics at short times. In this frame, we explain how the first spin-squeezed states were obtained by controlling both the external and the internal degrees of freedom of the atoms at the quantum level. We present theoretical results about the fundamental limits of spin-squeezing in condensates due to finite temperature and decoherence and mention the major challenges for the future.
A second appealing feature of isolated interacting many-body systems, is that some key properties, as the coherence time, are intrinsic to the system. In the second part of the talk we address the question of the temporal coherence of a Bose-Einstein condensate, that is ruled by the phase dynamics at long times. In the case of bosons, we can very generally calculate this coherence time.
The answer to this fundamental question discloses a very rich physics involving the interactions among quasi particles and fascinating concepts as the eigenstates thermalization" that allows to extend to a quantum system the classical notion of ergodicity. The case of fermions and our recent results for the super-diffusive phase spreading of a pair-condensed Fermi gas will be presented in the end.

Lauriane CHOMAZ
Laboratoire Kastler Brossel - École normale supérieure, Paris – FRANCE

Emergence of coherence in a uniform 2D Bose Gas
The appearance of degeneracy in a 2D Bose gas is fundamentally different from the 3D case. In this talk, I will present our new experimental results with 2D Bosons trapped in a flat bottom potential. We investigate the appearance of a bimodal distribution in time of flight measurement to enhance the appearance for a bimodal distribution while varying the thermodynamics properties of the gas under study. This can then be confronted to the appearance of fringes when two similar systems interfere. When the transition is crossed too abruptly we also observe excitations of our systems that decay rapidly in time.

Jan CHWEDENCZUK
University of Warsaw – POLAND

Cauchy-Schwarz inequality and particle entanglement
We discuss the analogy between the Glauber-Sudarshan P-representation, used in quantum optics to distinguish between classical and quantum electromagnetic fields, and separable states of identical bosons. We show that the violation of Cauchy-Schwarz inequality is a criterion for particle entanglement. The presented derivation applies to any quantum system of identical bosons, with either fixed or fluctuating number of particles, provided that there is no coherence between different number states. The violation of the Cauchy-Schwarz inequality has already been observed due to recent experimental advances in single-particle detection, and now becomes a proof of particle entanglement in correlated many-body systems.

Wolfgang MUESSEL
Kirchhoff Institute for Physics, University of Heidelberg – GERMANY

Scalable generation, verification and application of entanglement in Bose-Einstein condensates

One major area of quantum technologies is metrology, where entangled input states, such as spin squeezed states, are employed to enhance the performance of an interferometer. We present recent experimental results demonstrating that atomic squeezing generated via non-linear dynamics in Bose Einstein condensates, combined with suitable spatial traps, allows upscaling to large ensembles. We show the applicability for quantum enhanced magnetometry by swapping the squeezing to magnetically sensitive and non-interacting hyperfine levels, and find a quantum-enhanced single-shot sensitivity of 310(47) pT for dc magnetic fields in a volume as small as 90 µm. The metrological improvement using squeezed states is due to reduction of fluctuations. Even further improvement of metrological sensitivity can be obtained with non-Gaussian states which require new methods for creation and verification of entanglement in mesoscopic ensembles. We can generate non-Gaussian spin states employing unstable fixed point dynamics of internal states in our Bose-Einstein condensate. A scalable method of entanglement detection via Fisher information, which is the key parameter quantifying sensitivity in a phase estimation protocol, detects metrologically relevant entanglement of these states. The demonstrated sensitivity beyond the standard quantum limit in a Bayesian phase estimation protocol is in excellent agreement with the extracted Fisher information.

Marie PIRAUD
Department für Physik, LMU München – GERMANY

Anderson localization of matter waves in 3D anisotropic disordered potentials

We study quantum transport and Anderson localization of matter-waves in 3 dimensional correlated disorder, focusing on the effects of the anisotropy. Understanding the anisotropy effects is fundamental in several systems, such as electrons in MOSFETs, light in biological medium, liquid crystals, as well as in ultracold atoms. A major challenge is to understand whether the anisotropy of the diffusion tensor is altered by the interference terms at the origin of Anderson localization. In particular, its anisotropy at the mobility edge remains to be investigated. So far, all theoretical analysis have assumed - more or less implicitly - that the anisotropy of the diffusion tensor is preserved by interference effects, and have focused on the vanishing of diffusion as a whole. Here, we present a method to go beyond the standard self-consistent theory, which includes in particular the full anisotropic structure of the spectral function. It thus avoids the infrared divergence of the usual self-consistent theory and, most importantly, does not make any assumption on the anisotropy of the renormalized diffusion tensor when including quantum interference terms. Using a generic model of disorder with elongated correlations, we find that the diffusion tensor is strongly affected by the quantum interference terms and that the anisotropy strongly diminishes in the vicinity of the mobility edge. Our work paves the way to further investigation with speckle potentials, which are directly relevant to ultracold-atom experiments. It will permit comparison with previous predictions for the mobility edge and shed new light on ongoing experiments in the field of ultracold atoms.

Immanuel BLOCH
Max Planck Institute of Quantum Optics, München – GERMANY

Strong Correlation Physics with Ultracold Atoms in Optical Lattices
Ultracold atoms in optical lattice form an ideal test bed to realize and explore strongly correlated quantum many-body systems. In particular recent high-resolution imaging and control techniques probe and control quantum many-body systems in an unprecedented way. In the talk, I will give and introduction to these new and powerful detection and preparation techniques that have emerged over the past three years. In particular I will focus on several examples regarding quantum magnetism: 1) the direct detection of a more than 80 year old prediction by Hans Bethe on bound-magnon states in the Heisenberg model, 2) the observation of the propagation of single spin impurities in the Heisenberg model and the direct measurement of entanglement generation during their propagation and 3) the realization of novel long-range interacting quantum spin models using Rydberg atoms.

Michael KNAP
Harvard University, Massachussetts – UNITED STATES

Interferometric probes of strongly-correlated quantum matter
Interferometric probes, such as Ramsey and Hahn spin-echo protocols, are very useful to explore synthetic many-body systems. In this talk, I will discuss how interferometric protocols can be used to study dynamic correlation functions and to characterize exotic many-body phases. In order to illustrate the power of these techniques, we consider two examples of quantum magnetism: the Heisenberg antiferromagnet and the long-range transverse field Ising model which can be realized for example with cold atoms and trapped ions. We further discuss generalizations of these protocols to detecting and probing the many-body localized (MBL) phase in disordered spin systems. This exotic phase is characterized by a vanishing conductivity in the presence of many-body interactions even at finite temperatures.

Nir NAVON
Cavendish Laboratory, University of Cambridge – UNITED KINGDOM

Thermodynamics and dynamics of Bose condensation in a quasi-homogeneous gas
I will present our experimental study of the thermodynamics and dynamics of Bose-Einstein condensation (BEC) in an optical-box trap. We characterized the critical point for BEC, and observed saturation of the thermal component in a partially condensed cloud, in agreement with Einstein's textbook picture of a purely statistical phase transition. We also observed the quantum Joule-Thomson effect, namely isoenthalpic cooling of a non-interacting gas. In the limit of low temperatures, we measured via Bragg spectroscopy the Heisenberg-limited momentum distribution of the ground state, consistent with a fully coherent macroscopic BEC spanning the whole box. I will present our recent effort to address the dynamics of Bose condensation in the box potential following a rapid temperature quench through the phase transition.

Luca TAGLIACOZZO
ICFO, Barcelona – SPAIN

Physics of the 1D long range Ising model in a transverse field

Long range interacting systems can show different behaviour from their short range versions.
Recent experiments with trapped ions have started to investigate them. Among them the simplest is the long range Ising model in a transverse field in 1D. The ground state and low energy excitations will be discussed with special focus on the complexity of the ground state wave function in terms of entanglement and more traditional spin correlation functions. We will also illustrate that, out of equilibrium, long range interacting systems could display violations of causality when the long range interactions decay sufficiently slow with the distance. These predictions have been confirmed by recent experiments with trapped ions.

Christian TREFZGER
Laboratoire Kastler Brossel - École normale supérieure, Paris – FRANCE

Energy, decay rate, and effective masses for a moving polaron in a Fermi sea: Explicit results in the weakly attractive limit

We study the properties of an impurity of mass M moving through a spatially homogeneous three-dimensional fully polarized Fermi gas of particles of mass m. In the weakly attractive limit, where the effective coupling constant $g \to 0^-$ and perturbation theory can be used, both for a broad and a narrow Feshbach resonance, we obtain an explicit analytical expression for the complex energy $\Delta E(\mathbf{K})$ of the moving impurity up to order two included in g. This also gives access to its longitudinal and transverse effective masses $m_{\mathrm{long}}^*(\mathbf{K})$, $m_{\mathrm{trans}}^*(\mathbf{K})$, as functions of the impurity wave vector **K**. Depending on the modulus of **K** and on the impurity-to-fermion mass ratio M/m we identify four regions separated by singularities in derivatives with respect to **K** of the second-order term of $\Delta E(\mathbf{K})$, and we discuss the physical origin of these regions. Remarkably, the second-order term of $m_{\mathrm{long}}^*(\mathbf{K})$ presents points of non-differentiability, replaced by a logarithmic divergence for $M=m$, when **K** is on the Fermi surface of the fermions. We also discuss the third-order contribution and relevance for cold atom experiments.

Nigel COOPER
Cavendish Laboratory, Cambridge – UNITED KINGDOM

Artificial Gauge Fields for Cold Atoms

I shall give an overview of methods that can be used to create artificial gauge fields (and synthetic magnetic fields) for neutral atoms, in optical lattices and in the continuum.

Monika AIDELSBURGER
Max Planck Institute of Quantum Optics, München – GERMANY

Implementation of uniform artificial magnetic fields in optical lattices and observation of a Meissner-like effect with bosonic atoms in ladders

The quantum simulation of electrons moving in a periodic potential exposed to a large magnetic field is currently a major topic in cold-atom research. The direct simulation is, however, hindered by the charge neutrality of atoms. In this talk, I will present a new experimental technique that allows for the generation of large homogeneous and tunable artificial magnetic fields in an optical square lattice. Using laser-assisted tunneling in a tilted lattice, we engineer spatially dependent complex tunneling amplitudes. Thereby, atoms hopping in the lattice accumulate a phase shift equivalent to the Aharonov-Bohm phase of charged particles in a magnetic field. The local distribution of fluxes is determined experimentally through cyclotron orbits of the atoms on isolated lattice plaquettes. Furthermore, we show, that for two atomic spin states with opposite magnetic moments, our system naturally realizes the time-reversal-symmetric Hamiltonian underlying the quantum spin Hall effect; i.e., two different spin components experience opposite directions of the magnetic field. In ladder systems the presence of such an artificial magnetic field leads to a Meissner-like effect for bosonic atoms. For large coupling strengths along the rungs of the ladder, we find a saturated maximum chiral current, which is analogue to the surface currents in the Meissner effect. Below a critical coupling strength, the chiral current decreases in good agreement with expectations of a vortex lattice phase. The currents on each side of the ladder are measured by suddenly decoupling the ladders and projecting into isolated double wells. This work marks the first realization of a low-dimensional Meissner-like effect and spin-orbit coupling in one dimension.

Giovanni MARTONE
INO-CNR BEC Center and Università di Trento – ITALY

Static and dynamic properties of spin-orbit-coupled Bose gases

Artificial gauge fields allow for the realization of a wide class of interesting and non-trivial configurations, in particular spin-orbit-coupled quantum gases. In my talk I shall illustrate the properties of a Bose-Einstein condensate with equal Rashba and Dresselhaus spin-orbit coupling. This system presents a rich phase diagram, which exhibits a tricritical point separating a zero-momentum phase, a spin-polarized plane-wave phase, and a stripe phase. In the stripe phase translational invariance is spontaneously broken, in analogy with supersolids. Spin-orbit coupling also strongly affects the dynamics of the system. In particular, the excitation spectrum exhibits intriguing features, including the quenching of the sound velocity, the emergence of a roton minimum in the plane-wave phase, and the appearance of a double gapless band structure in the stripe phase.

Enrique Rico ORTEGA
Institute for Quantum Information Processing, Ulm University – GERMANY

Atomic Quantum Simulation of dynamical lattice gauge models

In this talk, we will see how to quantum simulate models with gauge symmetry in the lattice using atomic and quantum optics tools. We will construct a quantum simulator for an abelian gauge theory coupled to fermionic matter. This will allow us to investigate the phenomena of string breaking due to the creation of a pair particle-antiparticle.

Juliette SIMONET
Institut für Laser-Physik, Universität Hamburg – GERMANY

Artificial gauge fields in periodically driven optical lattices

Atomic quantum gases are neutral, and therefore, not affected by external electromagnetic fields in the way electrons are. This constitutes a central issue towards the quantum simulation of solid state models involving an external magnetic field, e.g. the Quantum Hall Effect. In the presence of complex hopping parameters on a lattice, the atomic gas can mimic the dynamics of an electron gas subjected to an external magnetic field. Indeed an effective Aharonov-Bohm phase can be engineered if the atomic wave function acquires a nontrivial phase while tunneling around a single plaquette of the lattice. Periodically driven optical lattices constitute a versatile tool, which allows controlling both phase and amplitude of the tunneling parameters. Ultracold atoms in optical lattices, which are periodically forced with frequencies on the order of a few to tens of kilohertz, might appear as typical examples of non-equilibrium systems. On the contrary, Floquet theory allows demonstrating that under high frequency periodic driving, the driven system behaves as the undriven system, but with renormalized matrix element. We have experimentally realized tunable artificial staggered magnetic fluxes on a periodically driven triangular lattice. The phase distribution of a superfluid state submitted to these staggered fluxes shows strong analogy with a two-dimensional spin-chirality system. We observe a thermally driven Ising-type phase transition from an ordered, ferromagnetic to an unordered, paramagnetic state. Both the experimental and theoretical analysis of the coherence properties of the ultracold gas demonstrates the strong influence of the Ising symmetry onto the condensed phase.

Ferdinand SCHMIDT-KALER
Institut für Physik, Uni Mainz –GERMANY

Fast ion transports and splitting operations in a segmented trap and the deterministic extraction of single ions for nm-microscopy and doping

Ions confined in a Paul trap arrange in linear crystals and allow for a unique control and analysis. Segmented traps provide the promising architecture for a future quantum computer, supposed that transport and the splitting of ion crytsals can be performed faster than quantum logic gate operations while the ion's motional state still allows for high-quality gates. I report experiments of ultra-fast transport, theory and experiments of fast splitting operations. The ions may be transported inside the trap, or even extracted in free space via pierced endcap electrodes, focused by a electrostaic Einzel lens and used for single-ion microscopy. We observe a 8.6nm focal spot which we scan over transmission objects . Further applications such as deterministic doping at a nm scale or ion interferometry are also discussed.

Alejandro BERMUDEZ
Instituto de Fìsica Fundamental, Madrid – SPAIN

Spin-boson quantum simulators on the lattice: hybrid magnetism and spread of correlations

In this talk, I will present our results on the study of hybrid lattice models composed spins and bosons interacting with each other. In particular, I will address two topics: (i) The possibility of deriving fundamental limits for the speed of propagation of spin-spin correlations (i.e. Lieb-Robinson bounds). (ii) The existence of a quantum phase transition in the Ising universality class that involves spins and boson on the same footing.

Jacopo CATANI
INO-CNR and LENS, Florence – ITALY

Liquids of Fermions with tunable spin: beyond the spin 1/2 Luttinger model

I will report on recent experiments performed at LENS with ultracold degenerate ^{173}Yb Fermi gases in 1D. This two-electron system is characterized by a large nuclear spin and highly-symmetric atom-atom interactions in the ground level manifold, which result in the possibility of performing quantum simulation of systems with intrinsic SU(N) symmetry with high N that have no analogous in solid state systems. Our observations show that, as the number of sin components is increased up to 6, significant deviations from the predictions of spin 1/2 Luttinger model are observed in the energetic and dynamical properties of the system. Interestingly, for very high spin number, the system behaves mostly as a bosonic spinless system, as the constraints of the Pauli exclusion principle appear to be less stringent. Beyond providing a powerful testbench for large-spin models, the specific features of our system should also allow for the realization of spin-orbit coupling in high-spin systems. In the second part of the talk, I will briefly report on the work in progress regarding the physics of a spin-orbit coupled multicomponent Fermi gas. By engineering opportunely Raman couplings between the nuclear spin components of ^{173}Yb we are able to create a coherent coupling among three or six spin components. I will show preliminary results on spin dynamics and the perspectives about this physical system.

Daniel GREIF
Institute for Quantum Electronics, ETH Zurich – SWITZERLAND

Quantum Magnetism and the Haldane model with Ultracold Fermions in an Optical Lattice

Ultracold fermionic atoms in optical lattices have long been proposed as a general platform for studying various model systems in condensed matter physics, ranging from geometries that give rise topological bands with non-zero Chern numbers, to magnetically ordered phases. Of particular interest are models for quantum magnetism, which originates from the exchange coupling between quantum-mechanical spins. Yet, reaching the low temperatures required for entering the quantum magnetism regime has proven to be challenging, and has hindered progress for systems based on ultracold fermions in optical lattices. In our experiment we designed a scheme that enabled us to locally redistribute entropy, such that a subset of lattice bonds reaches temperatures below the exchange energy. The key to this scheme is a novel type of optical lattice with tunable geometry. Using this lattice, we observe quantum magnetism emerging in the many-body state of a thermalized Fermi gas with repulsive interactions. For the lowest experimental temperatures, we observe antiferromagnetic spin correlations on neighbouring sites in an anisotropic lattice geometry. Beyond that, the same lattice is also the enabling tool for the experimental realization of the Haldane model. Our approach is based on circular modulation of a honeycomb lattice, which is filled with a non-interacting gas of ultracold fermions. We characterize the lowest topological band with a non-zero Chern number by measuring the effects of the Berry curvature distribution from momentum resolved Bloch oscillations - in close analogy to the anomalous quantum Hall effect. Furthermore, we directly map out the topological phase diagram of the Haldane model in our experiment.

Christina KRAUS
IQOQI, Innsbruck – AUSTRIA

Quantum Simulation of SU(N) physics in an optical lattice clock

Quantum simulation of fermionic many-body systems is complicated by the lack of efficient cooling schemes that would allow to reach the temperature regime where many interesting quantum mechanical effects arise. One important class of such systems are SU(N) spin models that are expected to describe transition metal oxides, heavy fermion materials or spin liquid phases. In search to overcome the notorious cooling problem we propose the possibility to use an optical lattice clock based on Alkaline Earth atoms operated at µK temperature as a finite temperature quantum simulator of two-orbital SU(N) physics, and explain how the SU(N) physics can be probed in a Ramsey-type experiment.

Tilman PFAU
Universität Stuttgart – GERMANY

Dipolar quantum gases

Abstract If atoms (or molecules) exhibit a significant dipole moment, the long range dipolar interaction will lead to a significant change in the collective behaviour. The anisotropy of the dipolar interaction can lead to deformations and instabilities, which will be discussed in some detail. Experimental data on the dipolar stability diagram and the dipolar collapse will be presented in single traps and in optical lattices. Perspectives for future experiments include the rotonization, self organized structure formation and the spin-orbit coupling via the Einstein-de Haas effect.

Kiyotaka AIKAWA
Institut für Experimentalphysik and Zentrum für Quantenphysik, Universität Innsbruck – AUSTRIA

Dipolar quantum gases of erbium atoms

Erbium atoms, belonging to lanthanide series, have a large magnetic moment of 7 Bohr magneton and provide an ideal system for investigating the impact of magnetic dipole-dipole interaction (DDI) in the quantum degenerate regime. We bring both bosonic and fermionic isotopes of erbium to quantum degeneracy. For bosons, we reveal the strongly dipolar nature of a Bose-Einstein condensate by decreasing the s-wave interaction via a Feshbach resonance. For fermions, we demonstrate a new cooling strategy for reaching Fermi degeneracy, which relies solely on universal dipolar scattering. Finally, we report on a quantum chaotic behavior observed in the collisional spectra of erbium.

Luca BARBIERO
Università di Padova – ITALY

Dipolar Fermions in a one dimensional optical lattice

In this talk I'll briefly review the peculiarities of quantum physics in one dimension and the available techniques to accurately study such a systems. After that I will focus on the specific case of dipolar fermions in a one dimensional optical lattice showing that this kind of system is particularly suitable to observe exotic many-body quantum phases. In particular I'll explain how the competition between short- and long-range interactions gives rise to frustrating effects which lead to the stabilization of spontaneously dimerized phases characterized by a bond-ordering. In conclusion I'll prove this genuine quantum order can be unambiguously probed by measuring non local order parameters via in-situ imaging techniques.

Tommaso MACRÌ
Max Planck Institute for the Physics of Complex Systems, Dresden – GERMANY

Quantum simulation of correlated solid phases with Rydberg gases

The realization and the control of long-range interactions in atomic systems at very low temperatures opens up a whole new realm of many-body physics that has recently become a central focus of research. In this respect Rydberg gases are very well-suited to achieve this goal, as the van der Waals forces between them are many orders of magnitude larger than for ground state atoms. When the electronic ground state is off-resonantly coupled to a highly excited state with strong binary interactions, the two body interaction is modified into a soft core potential. Importantly, despite the strong repulsion between the admixed Rydberg states, the dressing of the ground state does not lead to atomic trap-loss, both in free space and in optical lattices. At the many body level these non-local interactions can provide an optimal playground for the engineering of exotic many body phases. The ability to control and tune interactions and particle numbers in such systems allows the creation of superfluids, crystalline states as well as the long sought supersolid phase. At high densities and weak interactions the ground state breaks translational invariance and global gauge symmetry creating coherent density waves. For low particle densities, the system is shown to feature a solid phase in which zero-point vacancies emerge spontaneously and give rise to superfluid flow of particles through the crystal. This provides the first example of defect-induced, continuous-space supersolidity consistent with the Andreev-Lifshitz-Chester scenario.

Natalia MATVEEVA
INO-CNR BEC Center and Università di Trento – ITALY

Dipolar fermions in two dimensions: a quantum Monte Carlo study

Ultracold gases with dipolar interactions became a hot topic in the field of ultracold atoms due to the recent experimental progress towards the creation of polar molecules in the quantum degenerate regime. Two dimensional geometry has been proven to greatly suppress the chemical reaction rate of molecules, thereby enhancing their lifetime. In the strongly interacting regime the beyond mean-field effects can play an important role, therefore the use of numerical techniques, such as quantum Monte Carlo methods, becomes preferable. In my talk I present the results of the Fixed-Node Diffusion Monte Carlo study of dipolar fermions in single layer and bilayer configurations at zero temperature. I discuss the liquid-crystal phase transition, the impurity problem and BCS-BEC crossover phenomenon.

POSTERS

(May 30th – afternoon session)

Marta ABAD GARCIA – Alberto SARTORI
INO-CNR BEC Center and Università di Trento – ITALY

Stability of persistent currents in two-component condensates

We discuss the stability of persistent currents in a two-component Bose-Einstein condensate confined in a toroidal trap. We relate the instabilities shown by Bogoliubov excitations to the decay of persistent currents in the miscible regime of the binary mixture, finding a very good agreement with numerical simulations of the Gross-Pitaevskii equations. In particular, we analyze the presence of a partially stable region, where the superflow in the minority component decays while it remains stable in the majority component. The existence of this region could point out in the right direction to explain the experimental results of [PRL 110, 025301 (2013)]. In addition, we study the behaviour of the system when a velocity difference between the two components drives a dynamical instability. On the other hand, we discuss the stability of the currents in the phase separated regime of the binary mixture and the effect that a coherent coupling between the two components has on the persistent currents.

Tomas ANDRIJAUSKAS
Vilnius University – LITHUANIA

Design of laser-coupled honeycomb optical lattices supporting Chern insulators

We introduce an explicit scheme to realize Chern insulating phases employing cold atoms trapped in a state-dependent optical lattice and laser-induced tunneling processes. Chern insulating bands emerge if we add an auxiliary lattice that perturbs the lattice structure, effectively turning it into a realization of the Haldane model. We investigate the tight-binding parameters using first-principles band-structure calculations to estimate the relevant regime for experimental implementation.

Jogundas ARMAITIS
Vilnius University – THE NETHERLANDS

A Bose-Einstein condensate of dipolar molecules as a quantum rotor

We show that a Bose-Einstein condensate of heteronuclear molecules in the regime of small and static electric fields is described by a quantum rotor model for the macroscopic electric dipole moment of the molecular gas cloud. We solve this model exactly and find the symmetric, i.e., rotationally invariant, and dipolar phases expected from the single-molecule problem, but also an axial and planar nematic phase due to many-body effects.

Sadi AYHAN
Bilkent University – TURKEY

Kibble-Zurek Scaling for Non-equilibrium Dynamics of the Bose Gas

We used the theory of coarsening in statistical mechanics to make a connection between sudden quench of a Bose gas and time dependent condensate growth below its critical temperature. We define a Kibble-Zurek scaling law with a critical exponent combined with growth rate and estimate its value by numerical simulations.

Simone BARBARINO
Scuola Normale Superione, Pisa – ITALY

Strongly interacting Rashba wires
Rashba 1d wires in presence of a Zeeman field and Coulomb interaction have been widely studied. Using the bosonization technique, Oreg et al. have predicted the existence of fractional excitations in Rashba wires if the interaction is strong enough. Here I investigate these systems using an MPS algorithm. Very interesting features emerge due to the combined effect of the Zeeman field with interaction. Interesting analogies can be found out between Rashba wires and cold atom systems.

Markus BARTH
Technical University Munich – GERMANY

Pairing effects in the non-degenerate limit of the two-dimensional Fermi gas
The spectral function of a spin-balanced two-dimensional Fermi gas with short-range interactions is calculated by means of a quantum cluster expansion. The effects of pairing are clearly visible in the density of states, which displays a suppression of spectral weight due to the formation of a two-body bound state. In addition, the momentum distribution and the rf spectrum are derived, which are in excellent agreement with exact universal results.

Nicola BARTOLO
Lab. C. Coulomb, Montpellier – FRANCE

Matter Waves in Atomic Artificial Graphene
We present a model to realize Atomic Artificial Graphene: a 2D-confined atomic matter wave is scattered by atoms of a second species trapped around the nodes of a honeycomb optical lattice. The matter wave band structure and density of states are derived for an infinite system. Remarkable features emerge: tunable multi-gaps, Dirac cones for bound states, reduced group velocity, and completely flat and isolated bands. Finite-size and vacancy effects are numerically investigated.

Alexandra BEHRLE
University of Bonn – GERMANY

Unconventional pairing of ultracold fermions in two dimensions
We are setting up a new Sodium-Lithium experiment aiming to study unconventional pairing in two dimensional fermionic systems. Our experiment goes beyond the state of art of other experiments aiming for higher atom numbers in the magneto optical trap leading to colder samples in a lattice (T/T_F 10^7). Our main goal is to study the repulsive branch of the Feshbach resonance of Lithium 6, where theoreticians are uncertain whether antiferromagnetism or ferromagnetism occurs.

Dany BEN ALI
Laboratoire de Physique des Lasers, Paris – FRANCE

Magnetic transport in a cold sodium atom experiment
A new experiment relying on sodium atoms is being set up at the Laboratoire de Physique des Lasers. We aim to study the out-of-equilibrium dynamics of degenerate Bose gases, in particular the Kibble-Zurek mechanisms. In our setup, the atoms will be magnetically transported from the MOT chamber to an atom chip 65cm apart. We apply the procedure developed by M. Greiner et al. who demonstrated the efficient transport of atoms over a large distance using several pairs of coils.

Gianluca BERTAINA
Università di Milano – ITALY

Momentum distributions in Bose-Fermi mixtures
We study a Bose-Fermi mixture with interspecies resonant interaction, by means of Quantum Monte Carlo methods. For a boson density smaller or equal to the fermion density, we observe the role of interspecies interaction in the depletion of the bosonic condensate. In the molecular limit we show the occurrence of an indirect Pauli exclusion effect on the bosonic momentum distribution function.

Isabelle BOUCHOULE
Institut d'Optique, Paris – FRANCE

Breathing mode breathing mode of one-dimensional Bose gases
We measure position- and momentum- space breathing dynamics of trapped one-dimensional Bose gases at finite temperature. The breathing frequency varies continuously through the quasicondensate to ideal Bose gas crossover. A comparison with theoretical models is provided. In momentum space, we report the first observation a frequency doubling, corresponding to a self-reflection mechanism and we monitor its disappearance through the quasicondensation crossover.

Mohamed Shahid CHERUKATTIL
LENS, University of Florence – ITALY

Coherent control and realization of Quantum Zeno Dynamics on an atom chip
The control of quantum dynamics is crucial to quantum information processing. We theoretically and experimentally apply recently developed quantum optical control tools to steer the coherent evolution of ^{87}Rb BEC realized on an atom chip. Further, we harness measurements and strong couplings to dynamically disconnect different groups of quantum states and constrain the atoms to coherently evolve inside a two - level subregion experimentally realizing Quantum Zeno Dynamics.

Alessio CIAMEI
Institute of Physics, University of Amsterdam – THE NETHERLANDS

Quantum degenerate mixtures of strontium and rubidium atoms
Our goal is the creation of RbSr ground-state molecules. These polar molecules will experience strong dipole-dipole interactions which, together with the unpaired electron's spin, allow to simulate strongly interacting many-body quantum systems, e.g. lattice-spin models. We will show the creation of a double BEC of Sr and Rb. Moreover, we will present our recent results on 1 and 2-colour photo-association spectroscopy and on the realization of a dual Mott insulator in a 3D optical lattice.

Marco COMINOTTI
LPMMC (Université Joseph Fourier, Grenoble - CNRS) – FRANCE

Optimal persistent currents for ultracold bosons stirred on a ring
We study persistent currents for interacting one-dimensional bosons on a tight ring trap, subjected to a rotating barrier potential, which induces an artificial U(1) gauge field. We show that, at intermediate interactions, the persistent current response is maximal, due to a subtle interplay of effects due to the barrier, the interaction and quantum fluctuations. These results are relevant for ongoing experiments with ultracold atomic gases on mesoscopic rings.

Vincent CORRE
Laboratoire Kastler Brossel - École normale supérieure, Paris – FRANCE

Antiferromagnetism with ultracold spin-1 bosons

We experimentally study the behavior of a Sodium spin-1 Bose-Einstein condensate with antiferromagnetic interactions at small magnetic fields and small magnetization where mean-field theory breaks down and anomalously large fluctuations are observed. We show that they can be explained by collective spin fluctuations, that would vanish in the thermodynamic limit but are important due to the small size of the sample. This illustrates how fluctuations in small systems can counter symmetry breaking.

Camilla DE ROSSI
Université Paris 13 – FRANCE

Superfluidity of a 2D Bose gas in a ring geometry

Our experiment aims at studying persistent flows in a two-dimensional superfluid Bose gas. The Bose quantum gas will be confined in a ring trap obtained by the combination of an adiabatic potential based on rf-dressed atoms, setting the ring radius and radial frequency, and a dipole potential for the confinement to two dimensions. Dimensionality and geometry will be varied by adjusting the rf and optical field parameters. A rotating repulsive focused laser spot will put the fluid into rotation.

Nicolò DEFENU
International School for Advanced Studies, Trieste – ITALY

Long Range Ising model: a functional Renormalization Group approach

We show that the critical behaviour of the *n*-vector models with long range interactions can be inferred from the behaviour of the short range ones in fractional dimension at least for the universality classes. The mapping do not hold for the numerical values of the critical exponents that can be mapped only in an approximated way. The behaviour of those exponents for the LR system is discussed in details.

Marion DELEHAYE
Laboratoire Kastler Brossel,Paris – FRANCE

Bose-Fermi Superfluid Mixture

We produce a superfluid mixture of fermionic ^{6}Li and bosonic ^{7}Li in an optical dipole trap. We use collective oscillations to measure the coupling between the two superfluids across the Feshbach resonance at zero temperature and find very good agreement with mean-field theory.

Marco DI LIBERTO
Utrecht University – THE NETHERLANDS

η-pairing superconductivity in optical lattices

We propose a method to simulate correlated hopping models with fermionic atoms which show η-pairing superconductivity in the ground state. We use Feshbach resonances to modulate interactions in time and the Floquet formalism to generate an effective extended Hubbard model. We discuss the symmetries of the model, a phase diagram in 1D and quantum Monte Carlo results.

Simone DONADELLO – Simone SERAFINI – Marek TYLUTKI
INO-CNR BEC Center and Università di Trento – ITALY

Kibble-Zurek mechanism and solitonic vortices observed in elongated BECs
We observe solitonic vortices in an atomic Bose-Einstein condensate after free expansion. Clear signatures of the nature of such defects are the twisted planar density depletion around the vortex line, observed in absorption images, and the double dislocation in the interference pattern obtained through homodyne techniques. Both methods allow us to determine the sign of the quantized circulation. Experimental observations agree with numerical simulations. These solitonic vortices are the decay product of grey solitons spontaneously created via the Kibble–Zurek mechanism after a rapid quench across the BEC transition in a cigar-shaped harmonic trap and are shown to have a very long lifetime.

Matthew EDMONDS
Newcastle University – UNITED KINGDOM

Modelling two component condensates at finite temperature with dynamical thermal clouds
We develop a fully-dynamical finite temperature model for a mixture of 2 interacting condensates. Within this extended 'ZNG' formalism, the two-component system is modelled as 2 distinct co-existing condensates, coupled via dissipative Gross-Pitaevskii equations to 2 thermal clouds, which are in turn described by mutually-coupled Quantum Boltzmann equations. By deriving the appropriate conservation laws, we discuss the analogous Landau-Khalatnikov theory for the condensate mixture.

Guillem FERRÉ
Departament de Física i Enginyeria Nuclear, UPC – SPAIN

Finite temperature properties of a one-dimensional Coulomb gas
We present the results of a Path Integral Monte Carlo simulation of a one-dimensional Coulomb gas at low temperature. In the limit of zero temperature we confront the findings with the predictions of diffusion Monte Carlo method. The analysis is mainly focused on the determination of the energetic and structural properties. At low densities the system is described by a Wigner crystal theory while at large densities regime corresponds to an ideal Fermi gas.

Igor FERRIER-BARBUT
Laboratoire Kastler-Brossel, Paris – FRANCE

A double Bose-Fermi Superfluid
We demonstrate the experimental realization of a mixture of Bose-Fermi Superfluids. This mixture is realized using the two isotopes of Lithium. The Fermi superfluid is a strongly interacting gas in the BEC-BCS crossover while the bosonic superfluid is a Bose-Einstein Condensate in the mean-field regime. By a precise spectroscopy of the dipole collective modes we experimentally determine the interaction between these superfluids, and compare it with a simple coupled oscillator model.

Andreas FINKE
University of Nottingham – UNITED KINGDOM

Non-equilibrium Bose-Einstein Condensates and their application to cosmology
We study a weakly interacting homogeneous Bose gas undergoing a forced variation of the interaction strength during a finite time region at finite T. Excited modes of opposite momenta are correlated stronger than classically at sufficiently low temperature or strong (e.g. resonant parametric) excitation; the non-classical behavior is an observable accessible in experiment. We verify our results and investigate its time-dependence and the thermalization of the system with TWA-simulations.

Elisa FRATINI
Abdus Salam ICTP, Trieste – ITALY

Zero-Temperature Equation of State and Phase Diagram of Repulsive Fermionic Mixtures

We compute the zero-temperature equation of state of a mixture of two fermionic atomic species with repulsive interspecies interactions using second-order perturbation theory. We vary the interaction strength, the population and the mass imbalance, and we analyze the competition between different states: homogeneous, partially separated and fully separated. The canonical phase diagrams are determined for various mass ratios, including the experimentally relevant case of the Li-K mixture.

Albert GALLEMÌ
Universitat de Barcelona – SPAIN

The role of anisotropy in dipolar bosons in triple-well potentials

Mesoscopic samples of polarized dipolar atoms confined in three separated traps conform an extended Bose-Hubbard Hamiltonian in which different quantum phases appear depending on the competition between tunneling, on-site and long range inter-site dipole-dipole interactions. By choosing an appropriate configuration of triple-wells, we analyze the role played by the anisotropic character of the dipolar interaction in the phase diagram of the system. We also characterize entanglement properties.

Matthias GERSTER
Institut für Quanteninformationsverarbeitung, Ulm – GERMANY

Tree Tensor Network study of the bilinear-biquadratic spin-1 chain

We study the spin-1 chain with bilinear and biquadratic interactions which emerges, for instance, from confining spinor atoms to an optical lattice. In 1D this model has a rich phase diagram, including a much disputed hypothesized nematic phase between the dimerized and ferromagnetic phases. By means of a Tree Tensor Network simulation, we numerically substantiate a recent derivation of the scaling of the dimerization parameter and corroborate the predicted absence of the nematic phase.

Andrea GUIDINI
Università di Camerino – ITALY

Bose-Fermi mixture in the molecular limit

We consider a homogeneous Bose-Fermi mixture in the molecular limit of the attractive interaction between fermions and bosons. For a boson density smaller or equal to the fermion density, we show analytically how a T-matrix approach for bosons and fermions recovers the expected physical limit of a Fermi-Fermi mixture of dimers and atoms. We derive simple expressions for self-energies, momentum distribution functions, and chemical potentials. These equations will be extended to trapped systems.

Timothy HARRISON
University of Bonn – GERMANY

Unconventional Pairing in Ultracold Fermi Gases

We are constructing a new experiment, utilising ^{23}Na and ^{6}Li, which will allow a previously unattained ability to create, manipulate and probe a degenerate fermi gas. By controlling the magnetic fields and the optical lattice, we can tune to a strongly repulsive system where unconventional pairing is expected to dominate. Utilising ARPES, Bragg Spectroscopy and susceptibility measurements, we will investigate the interplay between superconductivity and magnetic order at low temperatures (T/T_F<0.05).

Daniel HUERGA
Instituto de Estructura de la Materia, CSIC, Madrid – SPAIN

Hierarchical mean field theory for spin and bosons in 2D lattices
I will introduce the Hierarchical mean field theory scheme and recent results of its application to two-dimensional spin and bosonic systems. In particular, I will discuss the J-K spin model and Bose-Hubbard models. I will show how this method allows for the description of novel chiral valence bond-solid phases, in the former case, and low-lying Higgs and Goldstone excitation modes along the particle-hole symmetry line crossing the Mott-superfluid transition, in the latter.

Krzysztof JACHYMSKI
Faculty of Physics, University of Warsaw – POLAND

Fast quantum gate via Feshbach-Pauli blocking in a subwavelength trap
We propose a simple idea for realizing a quantum gate with two identical fermions in a double well trap via external optical pulses without addressing the atoms individually. The key components of the scheme are Feshbach resonance and Pauli blocking, which decouple unwanted states from the dynamics. As a physical example we study atoms in the presence of a magnetic Feshbach resonance in a nanoplasmonic trap.

Rhys JENKINS
Swansea University, UNITED KINGDOM

Tapered Optical Nanofibers as a Detection method for Quantum Gases
We are working toward the production of a quantum gas and a single atom sensitivity detection method using optical tapered nanofibers (TNFs). Currently we are incorporating a hybrid 'dimple' trap technique into the experiment that will result in the production of a ^{87}Rb BEC. Our short term goal is to detect trapped atoms with TNFs utilising their evanescent field properties. We present a progress report of our atom trapping and detection methods to date, along with future concepts.

Vipin KERALA VARMA
International Centre for Theoretical Physics, Trieste – ITALY

Thermodynamics and criticality of hardcore bosons on the kagome lattice
We study the thermodynamics and criticality of interacting hardcore bosons on the kagome lattice as relevant to realizations in optical lattices. At low densities in the Ising limit we find that, as the temperature is lowered, the instability of these dilute kagome systems decreases as a finite intersite boson tunneling is applied. In the strong coupling limit, using Grueneisen parameter scaling, we find no strong evidence for a quantum critical point at the tip of the valence bond solid phase.

Christine KHRIPKOV
Ben-Gurion University of the Negev – ISRAEL

Coherence dynamics of kicked Bose-Hubbard dimers: Interferometric signatures of chaos
We study the coherence dynamics of a kicked two-mode Bose-Hubbard model starting with an arbitrary coherent spin preparation. Preparations in the chaotic regions of phase space have a generic behavior with Floquet participation numbers that scale as the entire N-particle Hilbert space, leading to a rapid loss of single-particle coherence. This is contrasted with the low log(N) participation that is responsible for the revivals in the vicinity of isolated hyperbolic instabilities.

Anna KOWALCZYK
University of Birmingham – UNITED KINGDOM

Towards experimental realisation of dipolar quantum magnets
Ultracold atoms can simulate quantum systems. We aim to exploit spinor BEC in an optical lattice at ultralow magnetic field to study magnetism. In such regime magnetic dipole interactions dominate the system and allow creating dipolar quantum magnets. Ferromagnetic contact interactions coupled with cigar-shaped trap geometry cause multiple spins to couple to each other resulting in a single large spin for the whole atomic ensemble. We want to use it to study dipolar quantum phases and dynamics.

Manuele LANDINI
CNR-INO, Florence – ITALY

Measurement of the mobility edge for 3D Anderson localization
The localization of single-particle states in disorder, or Anderson localization (AL), determines the behavior of many real materials. In 3D, a transition to localization occurs when the energy goes below the mobility edge Ec, whose value depends on the disorder properties. We employ an ultracold gas with tunable interactions to measure Ec associated to a controlled speckle disorder. These results offer the opportunity of an unprecedented quantitative comparison with existing theories of AL.

Pierre-Élie LARRÉ
INO-CNR BEC Center and Università di Trento – ITALY

Sonic black holes and Hawking radiation in BECs
Simple sonic analogues of black holes can be realized in the flow of a liquid through a pipe. If the flow is supersonic in some region of space, a sound wave issued from this region is dragged away and cannot propagate upstream. One speaks of acoustic black holes or dumb holes. Dumb holes have been considered as potential tools for studying the elusive black-hole radiation predicted by Hawking in the 70's. This domain has recently gained interest in the BEC community because of the extraordinary experimental control over BEC systems and also thanks to an idea of two Italian groups (Trento and Bologna) who proposed to use density correlations as probes of Hawking radiation. I will present several black-hole configurations of experimental interest and will discuss some analytical and numerical predictions obtained during my PhD in France.

To Chun Johnathan LAU
University of Southampton – UNITED KINGDOM

Non interacting spin polarised Fermi gas
A non interacting gas of spin polarised 6Li Fermi gas in a magnetic quadrupole trap which is not in thermal equilibrium can nevertheless show thermal signatures in some cases. This puzzling behaviour can be seen by measuring the doubly integrated momentum distribution along a particular axis. This distribution can be extremely close to a Gaussian from which we can extract a temperature. However, we show, using simulations that the temperature thus measured is different along different axis.

Yun LI
Centre for Quantum Technologies - SINGAPORE

Spin-orbit coupled Bose-Einstein condensate

We consider a spinor BEC with equal Rashba and Dresselhaus spin-orbit coupling. We show the ground state phase diagram of the system calculated based on the mean-field framework. At T=0 it contains three different quantum phases: the strip phase, the plane-wave phase, and the zero momentum phase. Corresponding excitation spectrum in each quantum phase is studied. For the trapped case, we find the dipole oscillation is deeply influenced by the spin degree of freedom, and the frequency deviates from the harmonic trap frequency. In the bulk, the Bogoliubov spectrum exhibits a roton structure in the plane-wave phase, while in the stripe phase it shows a supersolid like double gapless band structure. The sound velocities are also obtained, and a new relation between the sound velocity, the compressibility and the spin polarizability is pointed out.

Eleonora LUCIONI
INO-CNR & LENS, University of Florence – ITALY

Observation of a disordered insulator from weak to strong interactions

Understanding the behavior of disordered, interacting systems is a challenge of quantum physics. We study bosons in 1D with controlled disorder and interactions combining coherence, transport and excitation measurements. We detect a conductive regime surrounded by an insulator in the disorder-interaction plane with contrasting effects of weak and strong interactions. We compare our findings with theoretical models and simulations finding a general agreement with the established low-T theory.

Francesc MALET GIRALT
VU University Amsterdam – THE NETHERLANDS

Density functional theory for strongly-correlated ultracold dipolar gases

We address quasi-one-dimensional strongly-correlated dipolar ultracold gases by means of density functional theory. We make use of an approximation for the Hartree-exchange-correlation that has been shown to be very accurate for electronic systems with coulombic interactions. We show that this approach allows to treat systems with very large particle numbers at relatively very low computational cost.

Daniele MALPETTI
Ecole Normale Supérieure de Lyon – FRANCE

Gutzwiller Monte Carlo: a new approach to the thermodynamics of optical lattice bosons

We perform a numerical study of interacting bosons in a square optical lattice. We use the Gutzwiller theory in its cluster version, in order to keep account of quantum fluctuations. We concentrate on the behaviour of the system at finite temperature and use a Monte Carlo approach, in order to be able to describe thermal fluctuations. The aim is to describe the behaviour of the system using a fairly inexpensive computation.

Marco MANCINI
Università di Firenze – ITALY

A one-dimensional liquid of fermions with tunable spin
We report on the realization of 1D, strongly correlated liquids of ultracold fermions interacting repulsively within SU(N) symmetry, with a tunable number N of spin components. We observe that static and dynamic properties of the system deviate from those of ideal fermions and, for N>2, from those of a spin-1/2 Luttinger liquid. In the large-N limit, the system exhibits properties of a bosonic spinless liquid. Our results provide a testing ground for many-body theories.

Mirosław MARZAŁEK
Institut für Experimentalphysik, Univ. Innsbruck – AUSTRIA

Towards a K-Cs/KCs quantum gas experiment with high resolution imaging
The aim of our experiment is to investigate Bose-Fermi K-Cs quantum gas mixtures and ultracold fermionic ground-state KCs molecules with long-range dipolar interactions in optical lattice potentials for quantum simulation purposes. The molecules will be obtained by associating K-Cs pairs in band resp. Mott insulators by means of Feshbach resonances and transfering them to ground-state via the STIRAP technique. We will implement sub-micrometer resolution single-site imaging of both species.

Ali Ihsan MESE
Trakya Üniversity – TURKEY

The Importance of Interactions in the Formation of Wigner crystal at Two-Dimensional Anyonic System
In this work, we investigate the anionic systems regime and to seek fort he effect of interaction potential on the formation of Wigner Crystal. Next we investigate the effect of statistical interactions, the effects of particle number and the effect of the range of the interaction potential will be explored. The effect of the anionic defination on the Wigner Crystalization is investigated by a phase factor that is added.

Bruno NAYLOR
Université Paris 13 – FRANCE

A double well trap to study dipolar physics
We load a chromium BEC into a double well trap. We prepare the atoms of each well in opposite spin states and study spin dynamics driven by dipolar interactions between atoms of each well. In contrast to our previous measurements in optical lattices, here we find that the spin state is practically frozen. No spin dynamics is observed. Our interpretation is that the collective spins of atoms in both wells behave like a classical giant spin, for which spin fluctuations are strongly reduced.

Giuliano ORSO
Université Paris Diderot – FRANCE

Mobility edge for atoms in laser speckle potentials
Based on the transfer matrix method, we have calculated the exact mobility edge for cold atoms in disordered laser speckle potentials. Our results deviate significantly from previous approximate estimates based on the self-consistent approaches to Anderson localization.

Tomoki OZAWA – Hannah PRICE – Grazia SALERNO
INO-CNR BEC Center and Università di Trento – ITALY

Berry curvature and artificial gauge fields in electronic, atomic, photonic, and mechanical systems

We explore the concept of artificial gauge fields in various systems paying particular attention to the relation with the Berry connection. The Berry connection is known to serve as an analogue of a magnetic field in parameter space. Making use of this analogy, we construct a model where a uniform magnetic field is realized in momentum space, and characterize the energy spectrum and wavefunction in terms of Landau levels on a torus. We also discuss the occurrence of a non-trivial coupling phase in a mechanical system, consisting of a pair of coupled pendulums subject to a periodic temporal modulation of their oscillation frequency. Using these ideas, we explore possibilities to generate more exotic types of artificial gauge fields in various systems.

Thomas PICHLER
Institut für QIV, Ulm university – GERMANY

Optimal control in cold atomic systems

Optimal control theory has been applied in many fields of quantum physics so far. It has shown to successfully improve the fidelity of engineered quantum states. On this poster we show two examples of optimized cold atomic systems. The first concerns the crossing of the SF-MI quantum phase transition with reduced defects at the quantum speed limit. The second example shows improved spin squeezing results with respect to decoherence processes.

David PAPOULAR
INO-CNR BEC Center and Università di Trento – ITALY

Fast thermalization and plasma oscillations of an ultracold Bose gas

We analyze theoretically the transport properties of a weakly interacting ultracold Bose gas enclosed in two reservoirs connected by a constriction. We assume that the transport of the superfluid part is hydrodynamic, and we describe the ballistic transport of the normal part using the Landauer-Büttiker formalism. Modeling the coupled evolution of the phase, atom number, and temperature mismatches between the reservoirs, we predict that plasma oscillations, induced by an initial imbalance in atom numbers, can be observed at non zero temperatures below Tc. We show that, because of its strong compressibility, the ultracold Bose gas is characterized by a fast thermalization compared to the damping time. This important difference with respect to the fermionic case can be revealed by observing the response of the gas to an initial temperature imbalance, both below and above Tc.

Marcin PLODZIEN
Jagiellonian University, Krakow – POLAND

Matter-wave interference versus spontaneous pattern formation in spinor Bose-Einstein condensates

We describe effects of matter-wave interference of spinor states in the ^{87}Rb Bose-Einstein condensate. The components of the F=2 manifold are populated by forced Majorana transitions and then fall freely due to gravity in an applied magnetic field. Weak inhomogeneities of the magnetic field, present in the experiment, impose relative velocities onto different mF components, which show up as interference patterns upon measurement of atomic density distributions with a Stern-Gerlach imaging method. We show that interference effects may appear in experiments even if gradients of the magnetic field components are eliminated but higher-order inhomogeneity is present and the duration of the interaction is long enough. In particular, we show that the resulting matter-wave interference patterns can mimic spontaneous pattern formation in the quantum gas.

Tadeusz PUDLIK
Boston University, Massachussetts – UNITED STATES

The dynamics of a (dissipative) Bose-Hubbard dimer
Some of the simplest systems accessible to experiments with ultracold gases in optical lattices are dimers: atoms in a double-well optical lattice, or atoms in a single optical trap, but with two interacting spin states. These systems are very accurately represented by the Bose-Hubbard dimer. We study how much of the quantum system's behavior is captured by the classical mean-field picture and its semiclassically quantized variant.

Alexey PYRKOV
IPCP RAS – RUSSIA

Entanglement propagation in an artificial chain of BEC qubits
We consider an artificial chain of macroscopic BEC qubits mutually connected by optical fiber in the short fiber limit and investigated entanglement between the ends of the chain depends on length of the chain and measurement results of the qubits in between. We showed that entanglement decays slow with number of sites for the most probable measurement results. We investigated fidelity of the entanglement propagation protocol.

Maurizio ROSSI
Università di Padova – ITALY

Monte Carlo Simulations of the Unitary Bose Gas
We investigate the T=0K properties of a diluted homogeneous Bose gas made of N=500 particles by performing Monte Carlo simulations. We tune the scattering length and compute the energy per particle E/N and the condensate fraction N_0/N by using a many-body wave function which avoids the formation of the self-bound ground state and describes a (metastable) gaseous state with uniform density. In the unitarity limit (a infinite) we find a finite E/N and a quite large condensate fraction (83%).

Arko ROY
Physical Research Laboratory, Gujarat – INDIA

Goldstone modes and bifurcations in segregated Bose-Einstein condensates at finite temperature
The third Goldstone mode, which emerges in two-species BEC at phase-separation, persists to higher inter-species interaction for sandwich type density profiles. This is not the case with side-by-side density profiles. We use Hartree-Fock-Bogoliubov theory with Popov approximation to examine the mode evolution at finite temperature and show the existence of mode bifurcation near the critical temperature.
Ref: A. Roy, S. Gautam, and D. Angom, Phys. Rev. A, 89, 013617 (2014).

Luigi SAMTAMARIA AMATO
INO-CNR, Napoli – ITALY

Exploring fundamental physics by precision spectroscopy/interferometry with cold stable molecules
We report on the realization and characterization of a cold and slow molecular beam extracted from a buffer-gas-cooling source and then collimated by means of an electrostatic hexapole lens. Prospects are then discussed for fundamental physics applications, including the spectroscopic assessment of the time constancy of the proton-to-electron mass ratio as well as the interferometric detection of nuclear spin-dependent parity violation.

Bruno SCIOLLA
Bonn University – GERMANY

Two-times correlations in the dissipative Bose-Hubbard model with phase noise

We study the dynamics of a many-body system with strong dissipation and interactions. To do so, we extend the methods developed in [PRL 109, 045302] to compute two-times correlations, a quantity which allows for a detailed characterization of the out-of-equilibrium dynamics.

Taking the example of the Bose-Hubbard model with phase noise, we show that the density-density correlations follow a slow power law dynamics, whereas the single particle correlations are exponentially suppressed by decoherence. Generalizing the arguments, we show that depending on the model and the observables of interest, the dynamics can take place either on the fast timescale of the dissipation or on a slower, interaction impedded Zeno timescale. These results indicate that the strong dependence of the dynamics on the observable may be among salient feature of many-body dissipative systems.

Tapio SIMULA
Monash University, AUSTRALIA

Emergence of Onsager vortices via evaporative heating in a turbulent quasi-two-dimensional Bose gas

We have studied non-equilibrium dynamics of realistic quasi-two-dimensional quantum turbulent Bose-Einstein condensates. Starting with a random distribution of quantized vortices and antivortices, we have observed the emergence of coherent clusters of like-signed "Onsager vortices" in this conservative system, corresponding to absolute negative temperature states. We explain the obtained results in terms of an intrinsic evaporative heating mechanism of the vortex gas.

Mingyuan SUN
École normale supérieure, Paris - FRANCE

Pseudogap in the unitary Fermi gas

We study the pseudogap problem in the unitary Fermi gas with contact interactions at finite temperatures. Feynman diagrammatic method is employed to calculate the self-energy in the high-temperature virial expansion at the second and third order. This contains non-trivial three-body physics. At the second order, the spectral function displays some features of a pseudogap. We will present some preliminary numerical results for the third-order contributions.

Edina SZIRMAI
BUTE - Budapest University of Technology – HUNGARY

Diversity of superfluidity in one-dimensional high spin ultracold atomic systems

We investigate high spin chains to describe the competition of various superfluid states. We show that with ^{87}Sr isotopes an FFLO-like state can be stabilized without spin- or bare mass imbalance when the particles in their electronic ground state and their metastable optically excited states are coupled. We also show that for spin-3/2 system an unusual phase separation emerges where spin-carrier Cooper pairs and fourparticle SU(4) singlet quartets coexist forming a domain structure.

Gergely SZIRMAI
Wigner Research Centre for Physics – *HUNGARY*

Spin liquid phases and elementary excitations of high-spin fermions on optical lattices

We describe the spin dynamics of the antiferromagnetic Mott insulator state of high spin fermions on a 2-dimensional hexagonal lattice at finite temperatures. We calculate the spectrum of elementary excitations above the mean-field spin liquid solutions. The excitation provide information about the dynamical stability of the spin-liquid phases. We also determine the measurable spin-spin correlation functions.

Filippo TRAMONTO
Università di Milano – ITALY

Bose systems: dynamic properties from the weak to the strong interaction regime

In a recent work [PRB 88,214505(2013)], we studied the dynamics of hard-sphere Bose gases at T=0 from dilute regimes up to the density corresponding to superfluid ^{4}He. We compute the dynamic structure factor performing analytic continuations via a numerical algorithm (GIFT) of imaginary time correlation functions computed via an exact Path Integral method. We observe a crossover of the dispersion of elementary excitations from a Bogoliubov-like spectrum to a phonon-maxon-roton curve.

Andreas TRENKWALDER
LENS and CNR-INO, Università di Firenze – ITALY

Atom interferometry of trapped BECs with tunable interactions

In this poster we present a new atom interferometry experiment with BECs of ^{39}K atoms with tunable interactions. The setup consists of an array of double-well potentials which we can operate in parallel. The tunability of interactions allows to obtain long coherence times and the possibility of using entangled states bares the potential to increase the sensitivity beyond shot noise towards the Heisenberg limit.

Fatma Nur ÜNAL
Bilkent University - TURKEY

Pairing of Fermions with Unequal Charges

We study the low-temperature behavior of a Fermi gas of up and down spin components with different effective charges. By following mean-field approximation we obtain the gap equation. When the components of Cooper pairs have different cyclotron frequencies, as temperature decreases the pairing susceptibility makes a rounded peak and saturates to some finite value, instead of diverging. Due to this peak, there are two critical temperatures for superconducting state, with an addition of lower cut-off.

Anne-Maria VISURI
Aalto University – FINLAND

Moving perturbation in a one-dimensional Fermi gas

Using the time-evolving block decimation method, we distinguish two velocity regimes of a perturbation moving through a two-component Fermi gas in a one-dimensional lattice. In the slow regime, the particle densities deform and the pair correlations show that the initial superfluid state is broken. In the fast regime, the densities are not considerably deformed and the correlations are preserved. This is in contrast with the concept of a superfluid critical velocity in higher dimensions.

Davide VODOLA
Dipartimento di Fisica e Astronomia, Bologna – ITALY

Kitaev chains with long range pairing

We study a generalization of the Kitaev Ising chain with long-range paring, both with periodic and open boundary condition. The model is exactly solvable in terms of Bogoliubov excitations. We identify a standard regime where the system behaves similarly to the usual Ising spin-chain, an intermediate zone where exponential and power-law decay coexist and an exotic long-range regime where the correlation functions are power-law decaying also in presence of the mass gap.

Valentin VOLCHKOV
Institut d'optique, Paris – FRANCE

Breaking and the revival of the time reversal symmetry in coherent backscattering
Time reversal (TR) symmetry lies at heart of the weak localization phenomenon since it is responsible for the coherent backscattering (CBS) in quantum transport in disorder. Here, we study experimentally the phase-coherence of a Rb condensate propagated in a disorder potential. In particular, we break the TR symmetry by applying a phase kick to the atoms and observe the following decrease of the CBS signal. At a specific time the TR symmetry is restored, indicated by an echo of the CBS signal.

Artem VOLOSNIEV
Aarhus University – DENMARK

Exact solution of strongly interacting confined quantum systems in one dimension
We demonstrate that one-dimensional strongly interacting systems in any confining geometry can be approached analytically in the limit of large zero-range interactions.

Klejdja XHANI
LENS, University of Florence – ITALY

Experiments with fermionic 6Li atoms at LENS
I present our experimental apparatus aiming at studying strongly-correlated 6Li fermions. We produce a molecular BEC of 300000 molecules and a Fermi gas of 400000 atoms at T/TF=0.2. We are presently implementing on the degenerate clouds a thin-barrier potential (~2 um) to study both spin and superfluid pairs dynamics at the BEC-BCS crossover. In the former case this may reveal the presence of a ferromagnetic state, while in the latter one we expect Josephson tunnelling through the barrier.

Yariv YANAY
Cornell University, New York – UNITED STATES

Heating from Number Density Measurements in Optical Lattices
We calculate the dynamics of a Bose Hubbard system when a weak local probe continuously measures local number density. This process drives the system towards a thermodynamic distribution with high entropy. We find exponential decay of correlations over time in the weakly-interacting regime and a two-stage decay with two distinct time scales in the strongly-interacting regime. For low-spatial-resolution measurements, we find that the heating rate is proportional to the information gain.

Alessandro ZENESINI
Institute für Quantenoptik, Hannover – GERMANY

Dipolar gases of ground state molecules: NaK in Hannover
In the coming years, dipolar interactions will be the most promising tools in the field of ultracold atoms to study long-range interactions, anisotropy, exotic phase transitions and other peculiar phenomena. I will update you on our work in Hannover, where we are completing the construction of a new experimental apparatus for the realization of NaK molecules in their rovibrational groundstate.
