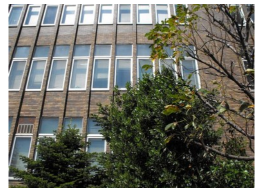
Trieste Quantum Days 2017

SISSA, Trieste, 20-24 February 2017



Monday 20 February 2017 – *Many body Quantum Systems, Unitary Gases*

9:20 ***opening***
9:30 A. Michelangeli • *Quantum systems with zero-range interactions: a math-phys propaganda*
10:30 ***coffee break***
11:00 G. Roati • *Experiments with strongly interacting atomic Fermi gases*
12:05 J. Hofmann • *Deep inelastic scattering on ultra-cold gases*

lunch

15:00 A. Bassi • *Collapse models and many-body quantum systems*
16:00 ***coffee break***
16:30 A. Teta • *Efimov effect for a three-particle system with two identical fermions*
17:35 L. Pitaevskii • *Magnetic solitons in BEC mixtures*

Tuesday 21 February 2017 – *Ultra-cold Atoms, Many-body Quantum Systems*

9:30 S. Stringari • *Superfluidity of spin-orbit coupled Bose gases*
10:30 ***coffee break***
11:00 M. Dalmonte • *Lattice gauge theories in AMO systems: from spin Ices to SU(N)*
12:05 M. Pulvirenti • *From N-Body Schrödinger to Hartree: Uniformity in the Planck constant*

lunch

15:00 G. Semeghini • *3D Anderson localization and liquid quantum droplets with ultra-cold atoms*
16:00 ***coffee break***
16:30 S. Cenatiempo • *Analysis of fluctuations around non linear Schrödinger dynamics*
17:35 A. Trombettoni • *Tunneling-based quantum devices with ultra-cold strongly interacting atoms*

Wednesday 22 February 2017 – *Geometrical and Topological Methods in Solid State Quantum Physics*

9:30 H. Cornean • *On the multiple-logarithm method in constructing exponentially localized composite Wannier functions*
10:30 ***coffee break***
11:00 R. Bianco • *Orbital magnetization in insulators: bulk versus surface*
12:05 D. Monaco • *Localization dichotomy for gapped periodic quantum systems*

lunch

15:00 V. Mastropietro • *Localization of interacting fermions with quasi-random disorder*
16:00 ***coffee break***
16:30 A. Scardicchio • *Many body localization and the glass phase*
17:35 G. Landi • *Sigma-models and the Schrödinger representation*

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Thursday 23 February 2017 – *Quantum Information Technologies*

9:30 F. Benatti • *Hybrid mesoscopic dissipative dynamics on quantum spin chains*
10:30 ***coffee break***
11:00 S. Maniscalco • *Quantum simulators of non-Markovian dynamics*
12:05 N. Datta • *Second-order asymptotics for quantum hypothesis testing in settings beyond i.i.d.*

lunch

15:00 M. Campisi • *(Quantum) Volume Entropy*
16:00 ***coffee break***
16:30 J. Goold • *Daemonic ergotropy: enhanced work extraction from quantum correlations*

Friday 24 February 2017 – *Quantum Transport*

9:30 V. Ros • *Remanent magnetization: signature of many-body localization in quantum antiferromagnets*
10:30 ***coffee break***
11:00 T. Prozen • *Strongly correlated nonequilibrium steady states with currents – classical and quantum*
12:05 R. Fazio • *Topological fractional pumping with alkaline-earth(-like) ultracold atoms*

lunch

15:00 S. Lepri • *The discrete nonlinear Schroedinger equation out of equilibrium*
16:00 ***coffee break***
16:30 M. Porta • *Topological phase transitions in the Haldane-Hubbard model*
17:35 ***closing***

Collapse models and many-body quantum systems

Angelo Bassi
University of Trieste

To make quantum theory consistent, models of spontaneous wave function collapse (collapse models) propose to modify the Schrödinger equation by including non-linear and stochastic terms, which describe the collapse of the wave function in space. These spontaneous collapses are "rare" for microscopic systems, hence their quantum properties are left almost unaltered. At the same time, since these effects add coherently in composite systems, macroscopic spatial superpositions of macro-objects are rapidly suppressed. I will review the main features of collapse models, by presenting the GRW (Ghirardi-Rimini-Weber) collapse model. In particular, I will distinguish the case of "rigid objects" from typical many-body quantum systems, and show how this difference reflects on the possibility of testing collapse models. I will present an update of the most promising ways of testing them in interferometric and non-interferometric experiments.

Hybrid mesoscopic dissipative dynamics on quantum spin chains

Fabio Benatti
University of Trieste

Given a quantum spin chain with a mean-field dissipative microscopic dynamics of Lindblad type, we study the large N limit of the time-evolution of quantum fluctuations, that is of many-body observables that scale as the inverse of the square-root of the number of particles. We show that, when the microscopic state of the quantum spin chain is not invariant under the dissipative dynamics, the fluctuations evolve according to a dissipative dynamics given by completely positive maps with a generator which is of hybrid type and consists of both classical, quantum and mixed classical-quantum parts.

Orbital magnetization in insulators: bulk versus surface

Raffaello Bianco
University of Rome "La Sapienza"

The magnetic moment of a macroscopic piece of insulating matter is the sum of two terms, due to states in the bulk and at the boundary of the system, respectively. Using a common formalism for crystalline and non-crystalline insulators, the two terms are expressed in terms of a marker localized in the corresponding regions of the sample [1]. A key aspect of this approach is that it is free from the drawbacks related to the use of currents. The surface term occurs when transverse conductivity is non-zero and it is expressed in terms of the local marker related to the Chern invariant [2].

References

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[2] R. Bianco and R. Resta, Mapping topological order in coordinate space, *Phys. Rev. B*, 84:241106, Dec 2011.

(Quantum) Volume Entropy

Michele Campisi
Scuola Normale Superiore Pisa

Motivated by the recent attention to the volume entropy (aka Gibbs entropy, aka Hertz entropy) in the context of many-body quantum physics (both for its role in in the ongoing debate on negative temperatures [1, 2], and as well as for its role as a quantifier of irreversibility [3]), I will review its mathematical foundations [4, 5, 6], discuss its quantum version [7], and illustrate some of its properties [8, 9, 10].

References

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Analysis of fluctuations around non linear Schrödinger dynamics

Serena Cenatiempo
GSSI L'Aquila

Since the early experiments on Bose condensation in cold atoms, the success of the Gross-Pitaevskii equation in the description of the dynamics of initially trapped Bose-Einstein condensates has attracted researchers both in the physics and mathematics communities. From a mathematical point of view, the derivation of the Gross-Pitaevskii equation from the many body dynamics of a system of N bosons interacting through the Gross-Pitaevskii potential $N^2V(N(x))$ has been fully understood in the sense of convergence of reduced density matrices. Beyond this results, there is some interest in studying fluctuations around the effective dynamics described by the Gross-Pitaevskii equation. This is a particularly challenging issue, due to the singular correlation structure generated by the Gross-Pitaevskii interaction. Motivated by this problem, in collaboration with C. Boccato and B. Schlein, we studied fluctuations around the non linear Schrödinger dynamics which approximates the dynamics of a system of N bosons interacting through a two body potential $N^{3\beta-1}V(N^\beta x)$, obtaining for any $0 < \beta < 1$ a norm approximation of the evolution of an appropriate class of data on the Fock space. While we are not able to treat the $\beta = 1$ case, the regime we considered already contains some of the difficulties that should be addressed to prove an analogous result for the physically relevant Gross-Pitaevskii case. In this talk I will present this result, discuss the obstructions to the extension to the Gross-Pitaevskii regime and outline some perspectives of this work.

On the multiple-logarithm method in constructing exponentially localized composite Wannier functions

Horia D. Cornean
University of Aalborg

We consider a finite-rank family of orthogonal projections $P(\cdot)$ which is smooth, $\mathbb{Z}^d$-periodic, and time reversal symmetric. The main issue is whether one can construct an orthonormal basis of the range of $P(\cdot)$ which consists of vectors which are simultaneously smooth, periodic, and compatible with the time reversal symmetry. It turns out that this problem is equivalent with proving that a certain family of unitary matching-matrices is null-homotopic. We will identify under which conditions one can construct a homotopy which preserves periodicity, smoothness and time reversal symmetry, and if these conditions are met, we will give a constructive algorithm for it. This is joint work with I. Herbst and G. Nenciu in the 'bosonic' case, and with D. Monaco and S. Teufel in the 'fermionic' case.

Lattice gauge theories in AMO systems: from spin Ices to SU(N)

Marcello Dalmonte
ICTP Trieste

Lattice gauge theories constitute a fully non-perturbative framework for the investigation of gauge theories. It has lead to impressive progresses on the way towards the understanding of basic interactions underlying the standard model, and to the interpretation of fractionalized states of matter in strongly correlated electronic systems. However, paradigmatic phenomena such as the real-rime dynamics and finite-density regimes of cornerstone theories such as quantum chromodynamics are not amenable to efficient classical algorithms, which are usually biased by the so-called sign problem affecting Monte Carlo simulations. In the last few years, quantum simulators have been proposed as an alternative route to tackle such problems. In this talk, I will review the basic idea of quantum simulation, following the original intuition by Feynman tracking back to the eighties, and discuss its main properties and differences with respect to classical simulations. Against this background, I will then illustrate our recent progresses regarding the quantum simulation of lattice gauge theories using ultra-cold atoms: after introducing the specific Abelian and non-Abelian cases we are interested in, I will discuss some basic strategies to implement gauge symmetries in synthetic quantum systems, focusing on the co-called quantum link formalism. From the cold atom side, the discussion will involve a variety of systems, ranging from Bose-Fermi mixtures, to Rydberg atoms in optical lattices. Finally, I will also briefly discuss how DMRG-inspired methods can now be adapted to the investigation of gauge theories, discussing as a concrete example string-breaking in U(1) theories.

Second-order asymptotics for quantum hypothesis testing in settings beyond i.i.d.

Nilanjana Datta
University of Cambridge

Quantum Steins Lemma is a cornerstone of quantum statistics and concerns the problem of correctly identifying a quantum state, given the knowledge that it is one of two specific states (ρ or σ). It was originally derived in the asymptotic i.i.d. setting, in which arbitrarily many (say, n) identical copies of the state are considered to be available. In this setting, the lemma states that, for any given upper bound on the probability of erroneously inferring the state to be σ, the probability of erroneously inferring the state to be decays exponentially in n, with the rate of decay converging to the relative entropy of the two states. The second order asymptotics for quantum hypothesis testing, which establishes the speed of convergence of this rate of decay to its limiting value, was derived in the i.i.d. setting independently by Tomamichel and Hayashi, and Li. We extend this result to settings beyond i.i.d.. Examples of these include Gibbs states of quantum spin systems (with finite-range, translation-invariant interactions) at high temperatures, and quasi-free states of fermionic lattice gases. Our analysis employs the useful framework of relative modular operators. This is joint work with Yan Pautrat (Orsay) and Cambyse Rouzé (Cambridge).

Topological fractional pumping with alkaline-earth(-like) ultra-cold atoms

Rosario Fazio
Scuola Normale Superiore Pisa, ICTP Trieste

Since the invention of the Archimedean screw, it has been known that matter and energy can be transported, or pumped , without imposing any external bias, by a periodic modulation of some system parameters. Investigations of pumping in quantum systems encompass a wide range of phenomena and applications, from the definition of novel current standards. In his pioneering work, Thouless showed that in some one-dimensional insulating systems the pumped charge may be quantised to an integer number. The experimental demonstration of such pump had to wait for three decades till its realisation with cold atoms. In my presentation I will discuss a proposal to realise fractional topological pumps with alkaline-earth gases.

Daemonic ergotropy: enhanced work extraction from quantum correlations

John Goold
ICTP Trieste

We investigate how the presence of quantum correlations can influence work extraction in closed quantum systems, establishing a new link between the field of quantum non-equilibrium thermodynamics and the one of quantum information theory. We consider a bipartite quantum system and we show that it is possible to optimise the process of work extraction, thanks to the correlations between the two parts of the system, by using an appropriate feedback protocol based on the concept of ergotropy. We prove that the maximum gain in the extracted work is related to the existence of quantum correlations between the two parts, quantified by either quantum discord or, for pure states, entanglement. We then illustrate our general findings on a simple physical situation consisting of a qubit system.

Deep inelastic scattering on ultra-cold gases

Johannes Hofmann
Cavendish Laboratory Cambridge

In my talk, I will discuss the dynamic structure factor of an ultra-cold quantum gas in the deep inelastic scattering limit of large wave vector transfer, where it is dominated by a resonance near the single-particle energy. In this limit, it turns out that the dynamic structure factor shows a surprisingly rich scaling behaviour which is captured by two distinct and complementary scaling regimes: first, close to the resonance, the impulse approximation by Hohenberg and Platzman applies. Second, away from the resonance, where multi-particle excitations must be taken into account, the dynamic structure factor scaling function is derived from an operator product expansion of the density response function. I will also discuss an exact result for the resonance position that extends older work by Beliaev to arbitrary interaction strengths and is consistent with recent measurements of the Bose gas structure factor at JILA and Cambridge.

Sigma-models and the Schrödinger representation

Giovanni Landi
University of Trieste

We use results from the Schrödinger representation and time-frequency analysis to construct sigma-model solitons over the Moyal plane and over the irrational rotation algebra. These satisfy a self-duality equation for projections into the corresponding 'algebras of functions and have a non-trivial topological number (a Chern number for the projection). A crucial role is played by Morita equivalence bi-modules endowed with a holomorphic connection, with complex structures given via positive Hochschild cocycles.

The discrete non-linear Schrödinger equation out of equilibrium

Stefano Lepri
ISC-CNR Florence

We discuss the non-equilibrium properties of the one-dimensional discrete non-linear Schrödinger equation. Due to the presence of two conserved quantities, energy and norm (or number of particles), the model displays coupled transport in the sense of linear irreversible thermodynamics. Monte Carlo and Langevin thermostats are implemented to impose a temperature and/or chemical potential gradients. At high-enough temperature Onsager coefficients are finite in the thermodynamic limit, i.e. transport is normal. At lower temperatures signatures of anomalous transport are observed. Application of the model to macrospin system is discussed throughout.

Quantum simulators of non-Markovian dynamics

Sabrina Maniscalco
Turku Centre for Quantum Physics

The time evolution of open quantum systems can be characterised by the way in which they exchange information with their surrounding environment [1]. One says that the dynamics is memory-less or Markovian if information is continuously and monotonically lost into the environment. Non-Markovian open system dynamics, on the contrary, presents a partial regain of information due to memory effects and long-living system-environment correlations. It is a current open problem whether back-flow of information in non-Markovian systems can be used as a resource for quantum technologies. While there is evidence that memory effects are useful for quantum communication protocols (quantum key-distribution, superdense coding, quantum teleportation) [2] and for precision measurements [3], there exist important tasks, such as quantum error correction and quantum metrology, where memory effects do not actually play a crucial role and may even hinder the efficiency of the protocols [4]. From a fundamental perspective it is, however, important to study theoretically and experimentally whether fundamental properties of complex quantum systems, acting as environments, can be mapped into specific dynamical features of the open system decoherence, such as its Markovian/Non-Markovian character. After giving an overview of the information-theoretic approach to non-Markovian open quantum systems, I will present some relevant examples showing that this is indeed the case. In particular I will provide evidence of the existence of a strong connection between quantum phase transitions in many-body systems and a crossover in the Markovian character of the open system dynamics. I will also present preliminary results on the connection between localisation and non-Markovianity. Finally, in the spirit of quantum reservoir engineering, I will speculate on the possibility of describing theoretically certain relativistic phenomena, such as the Unruh effect or Hawking radiation, in terms of information flow and non-Markovianity.

References

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Localization of interacting fermions with quasi-random disorder

Vieri Mastropietro
University of Milan

We consider interacting electrons in a one dimensional lattice with an incommensurate Aubry-André potential in the regime when the single-particle eigenstates are localized. We rigorously establish persistence of ground state localization in presence of weak many-body interaction.The proof uses a quantum many body extension of methods adopted for the stability of tori of nearly integrable Hamiltonian systems, and relies on number-theoretic properties (Diophantine conditions) of the potential incommensurate frequency and phase.

Quantum systems with zero-range interactions: a math-phys propaganda

Alessandro Michelangeli
SISSA Trieste

This is a (partial) survey of the history and of the current research activity in the mathematical physics of quantum systems of particles with a pair interaction whose range is essentially zero: physical heuristics and motivations from experiments, main mathematical problems, tools, open questions, perspectives.

Localization dichotomy for gapped periodic quantum systems

Domenico Monaco
University of Tübingen

Since the discovery of the quantum Hall effect, there has been an increasing interest in the study of dissipation-less currents of topological origin in crystalline band insulators, that is, in gapped periodic quantum systems. This is best illustrated by the Kubo-Chern formula, relating the quantization of the transverse Hall conductivity to the Chern number of the Bloch bundle. The vanishing of the Chern number is also known to characterize the existence of a set of exponentially localized Wannier orbitals, describing the insulating state. In this talk, based on joint work with G. Panati, A. Pisante and S. Teufel, we compute the optimal decay of Wannier functions in the topologically non-trivial regime, proving in particular that whenever the variance of the position operator (or equivalently the Marzari-Vanderbilt localization functional) is finite in a Wannier state, then the Bloch bundle must be trivial, and the expected Hall conductivity vanishes. Thus, no intermediate regimes of localization are allowed for Wannier orbitals, between those having finite second moment of the position operator and those which are exponentially localized.

Magnetic solitons in BEC mixtures

Lev P. Pitaevskii
INO-CNR BEC Center Trento

We investigate a new type of soliton, magnetic soliton, in a two-component spinor Bose gas, which manifests itself as a localized spin polarization n_1-n_2, where n_1 and n_2 are the densities of the two components, and resides in a spin balanced density background. To construct an analytic solution, we take advantage of the fact that typical experimental mixtures of hyperfine states of bosonic alkali atoms are near the boundary of phase separation instability. Then the total density is practically unperturbed in the region of the soliton. The width and the velocity of magnetic solitons are explicitly related to the spin healing length and the spin sound velocity of the mixture, respectively. We calculate the profiles, the energy, and the effective mass of the solitons and investigate their oscillation in a harmonic trap. We also studied magnetic solitons in binary BEC in the same conditions in the presence of the Rabi coupling. Then the system exhibits two types of magnetic solitons, called 2π and 0π solitons. 2π solitons exhibit a 2π jump of the relative phase, independent of their velocity. The static domain wall explored by Son and Stephanov is a particular case of such 2π solitons with vanishing velocity and magnetization. 0π solitons do not instead exhibit any asymptotic jump in the relative phase. Numerical calculations in the presence of a one dimensional harmonic trap reveal that a 2π soliton evolves in time into a 0π soliton, and vice versa, oscillating around the centre of the trap. Results for the effective mass, the Landau critical velocity and the role of the transverse confinement are discussed.

Topological phase transitions in the Haldane-Hubbard model

Marcello Porta
University of Zurich

The Haldane model is a paradigmatic example of topological insulator. It describes fermions on the honeycomb lattice, in the presence of a zero flux magnetic field and of a staggered on site potential. In the absence of interactions, the model displays a non-trivial topological phase diagram, corresponding to different values of the Hall conductivity. I will present a theorem about the topological phase diagram of the interacting Haldane model. We prove that weak interactions induce a deformation the transition curves, and do not produce any new topological phase. Moreover, we prove the universality of the longitudinal conductivity at criticality. The proof is based on a combination of renormalization group techniques and Ward identities. Joint work with A. Giuliani, I. Jauslin and V. Mastropietro.

Strongly correlated non-equilibrium steady states with currents — classical and quantum picture

Tomaž Prosen
University of Ljubljana

In my talk I will introduce several explicit models of strongly correlated stationary states of conservative systems in one dimension that are driven out of equilibrium with the dissipative couplings at the system boundaries. All these models share a simple algebraic matrix product structure of the exact solution. In the framework of quantum physics, the main examples of such models are integrable spin chains, e.g. the XXZ model, or Fermi-Hubbard model, while in the realm of classical physics we have an example of a reversible and integrable cellular automaton. I will outline general features of solving non-equilibrium stationary states in terms of matrix product Ansatz and its generalizations and stress some of the most interesting and outstanding open problems.

From N-Body Schrödinger to Hartree: Uniformity in the Planck constant

Mario Pulvirenti
University of Rome "La Sapienza"

In this talk I review the problem of the derivation of the Hartree equation from quantum particle systems, in the mean-field limit. The problem is to obtain convergence estimates independent of the Plank constant. The talk is based on a work in collaboration with F. Golse and T. Paul.

Experiments with strongly interacting atomic Fermi gases

Giacomo Roati
INO-CNR BEC Center Trento, LENS Florence

We will present two experimental studies, exploiting strongly interacting ultra-cold Fermi gases of 6Li atoms confined in optical potentials. In a first experiment, we create the analogous of a Josephson junction by bisecting BEC-BCS crossover superfluids with a thin optical barrier. We observe coherent dynamics in both the population and in the relative phase between the two superfluid reservoirs, extracting the Josephson coupling energy, which appears to be maximum for unitary superfluids. For critical parameters, we see how the Josephson dynamics is affected by the presence of topological defects entering the superfluid bulk [1]. In a second experiment, we create an artificial ferromagnetic state by segregating degenerate spin mixtures into two initially disconnected reservoirs [2]. We study the spin dynamics for different interaction strengths and temperatures. For sufficiently high values of the inter-spin repulsive interactions and sufficiently low temperatures, we observe a softening of the spin dipole mode connected to a time window during which spin diffusion is zeroed. We interpret our data as pointing to of the Stoner instability in our system for critical values of repulsive interactions. Our measurements provide exciting new insights into the physics of attractive and repulsive Fermi gases.

References

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Remanent magnetization: signature of many-body localization in quantum antiferromagnets

Valentina Ros
CEA Saclay

For a quantum system to be permanently out of equilibrium, some non-trivial mechanism must be at play, to counteract the general tendency of entropy increase and flow toward equilibration. Among the possible ways to protect a system against local thermalization, the phenomenon of localization induced by quenched disorder appears to be one of the most promising. In this talk, I will discuss the underlying "integrable" structure of many-body localized systems, i.e., the existence of non-trivial conservation laws that prevent ergodicity and thermalization. I will briefly review how such operators can be constructed explicitly, by dressing perturbatively the non-interacting conserved quantities. I will then discuss how they can be exploited to compute the long time limit of the remanent magnetization in antiferromagnetic, many-body localized quantum spin chains initialized in a fully magnetized state. The remanent magnetization is an order parameter for the localization transition, which is a magnetic analogue of the remanent density modulation measured in recent cold-atom experiments.

Many body localization and the glass phase

Antonello Scardicchio
ICTP Trieste

I will discuss the interplay of the localized and glassy phase in mean field spin glasses when endowed with quantum dynamics.

3D Anderson localization and liquid quantum droplets with ultra-cold atoms

Gulia Semeghini
LENS Florence

We report on the observation of two different quantum phenomena using ultra-cold atomic gases of potassium-39, where the homo-nuclear scattering length can be finely tuned from positive to negative values using a broad magnetic Feshbach resonance. In a first experiment we have observed the well-known Anderson transition, which occurs for non-interacting matter waves when they propagate in a three-dimensional space in presence of sufficiently strong disorder [1]. The determination of the critical conditions for localization of non-interacting particles is an important result in the study of disordered systems and it paves the way to future studies about the interplay of disorder and inter-particle interactions. The second phenomenon we study is the creation of self-bound quantum droplets in Bose-Bose mixtures. We use a mixture of two hyperfine states and we tune their mutual scattering lengths such that the mean-field interaction energy and the first beyond-mean-field correction have opposite sign and perfectly compensate each other. This gives rise to a liquid-like droplet, which is bound without any external trapping. These objects are expected to have unusual properties and interesting implications, due in particular to their peculiar excitation spectrum.

References

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Superfluidity of spin-orbit coupled Bose gases

Sandro Stringari
INO-CNR BEC Center Trento

I will discuss recent results on the superfluid behaviour of spin-orbit coupled BECs. Topics include: Raman induced and Rahba spin-orbit coupled Hamiltonians. Violation of Galilean invariance, emergence of diffused vorticity, violation of the irrotationality constraint and spinor hydrodynamics. Predictions for the rotational behaviour of harmonically trapped gases will be explicitly discussed.

Efimov effect for a three-particle system with two identical fermions

Alessandro Teta
University of Rome "La Sapienza"

We consider a three-particle quantum system in dimension three made of two identical fermions of mass one and a different particle of mass m. The particles interact via two-body short range potentials. We assume that the Hamiltonians of all the two-particle subsystems do not have bound states with negative energy and, moreover, that the Hamiltonians of the two subsystems made of a fermion and the different particle have a zero-energy resonance. From the physical literature it is known that, under these conditions and for $m < m^* = (13.607)^{-1}$, the Efimov effect occurs, i.e., there are infinitely many negative eigenvalues for the three-particle Hamiltonian H. We give a rigorous proof of this fact. More precisely, we prove that: i) for $m > m^*$ the number of negative eigenvalues of H is finite, ii) for $m < m^*$ the number $N(z)$ of negative eigenvalues of H below $z < 0$ has the asymptotic behaviour $N(z) \sim \mathcal{C}(m)|\log|z||$ for $z \to 0^-$. Moreover, we give an upper and a lower bound for the positive constant $\mathcal{C}(m)$.

Tunneling-based quantum devices with ultra-cold strongly interacting atoms

Andrea Trombettoni
CNR-Democritos Trieste

After briefly reviewing the use of ultra-cold atoms for the implementation of quantum devices, I present in the first part of the talk recent results on the Josephson dynamics of two superfluid ultra-cold fermionic gases weakly linked by a controllable barrier. In the second part I discuss properties of 1D Bose gases and then presenting a discussion on the junctions of Tonks-Girardeau gases. I will also show recent results on the experimental realization of Y-geometries with holographic traps.