The Abdus Salam
International Centre
for Theoretical Physics

Conference on Long-Range Interacting Many-Body Systems: from Atomic to Astrophysical Scales (25 - 29 July 2016)

Venue: ICTP Leonardo da Vinci Building - Budinich Lecture Hall
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POSTER TITLES and ABSTRACTS

(as of 25/7/16)

Emre AKATURK:
Bilkent University , Ankara, Turkey

Density-Wave Instability and Collective Modes in a Bilayer System of Dipolar Bosons

We study dipolar bosonic and fermionic systems at T=0. We investigate collective modes and density wave instabilities of bilayer dipolar bosons, studying the divergences of density-density response function. We are also utilizing Quantum Monte Carlo simulations to study properties of dipolar atomic systems in liquid and solid regimes and investigate liquid-solid phase transition.

Debarshee BAGCHI:
Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil

Sensitivity to initial conditions of d-dimensional long-range-interacting Fermi-Pasta-Ulam-like model: Universal scaling

We introduce a generalized d -dimensional Fermi-Pasta-Ulam (FPU) model in presence of long-range interactions, and perform a first-pr inciple study of its chaos for d = 1 , 2 ,3 through large-scale numerical simulations. The nonlinear interaction is assumed to decay alge- braically as d ‚àí Œ± ij (Œ± ‚â• 0), { d ij} being the distances between N oscillator sites. Starting from random initial conditions we compute the maximal Lyapunov exp onent Œª max as a function of N . Our N >> 1 results strongly indicate that Œª max remains constant and positive for Œ±/d > 1 (im- plying strong chaos, mixing and ergodicity), and that it vanish es like N ‚àí Œ∫ for 0 ‚â§ Œ±/d < 1 (hence approaching weak chaos, thus opening the possibility of bre akdown of ergodicity). The suitably rescaled exponent Œ∫ exhibits universal scaling, namely that (d +2) Œ∫ depends only on Œ±/d and, when Œ±/d increases from zero to unity, it monotonically decreases fr om unity to zero, so remaining for all Œ±/d > 1. The value Œ±/d = 1 can therefore be seen as a critical point separating the er godic regime from the anomalous one, Œ∫ playing a role analogous to that of an order parameter. This scaling law is consistent with Boltzmann-Gibbs statistics f or Œ±/d > 1, and possibly with q -statistics for 0 ,â§ Œ±/d < 1

Luca BARBIERO:
CNR-IOM Democritos Simulaton Center, Trieste, Italy

Out-of-equilibrium states and quasi-many-body localization in polar lattice gases

The absence of energy dissipation leads to an intriguing out-of-equilibrium dynamics for ultra-cold polar gases in optical lattices, characterized by the formation of dynamically-bound on-site and inter-site clusters of two or more particles, and by an e ective blockade repulsion. These e ects combined with the controlled preparation of initial states available in cold gases experiments can be employed to create interesting out-of-equilibrium states. These include quasi-equilibrated e ectively repulsive 1D gases for attractive dipolar interactions and dynamically-bound crystals.

Furthermore, non-equilibrium polar lattice gases can o er a promising scenario for the study of many-body localization in the absence of quenched disorder. This fascinating out-of-equilibrium dynamics for ultra-cold polar gases in optical lattices may be accessible in on-going experiments.

[1] L. Barbiero, C. Menotti, A. Recati, and L. Santos, Phys.

Rev. B 92, 180406 (R) (2015)

Luis BENET FERNANDEZ:
Univ. Nacional Automoma de Mexico, Cuernavaca, Mexico

ON THE LOCATION AND CONFINEMENT OF SATURN'S F RINGS

The confinement of planetary narrow rings is understood in terms of the shep-herd theory [1]. This theory proposes the existence of two shepherd moons that orbit around the ring, and involves angular momentum transfer mechanisms be-tween them and the ring particles, self-gravity, viscous damping, and assumes the existence of lower-order two-body resonance at the ring boundaries in order to con ne the ring. Saturn's F ring is a fascinating example of a narrow eccentric ring that displays a rich dynamical structure:

besides its non-zero eccentricity and sharp-edges, it has multiple components entangled in a complicated way which shows a variety of short-time features [2]. The two shepherd moons, Prometheus and Pandora, in uence importantly many of the short-time dynamical features observed. Yet, the ring is not located where the torques exerted by the shepherds balance [3]. The con nement of Saturn's F-ring thus remains unexplained. Here, I shall describe recent results [4] from our scattering approach to narrow rings [5] and present numerical results based of accurate long-time integrations on a realistic 5-body model for Saturn's F ring. Test particles that remain trapped and that ful ll and additional stability condition form a narrow elliptic ring dis- playing sharp edges, whose location and width agrees with the observations. The con nement of the ring seems to be related to the occurrence of resonances in- volving at least three-bodies. This work is in collaboration with Angel Jorba (U. Barcelona).

Mohammed BENJELLOUN:
University Mohammed 5, Rabat, Morocco

Quantum cryptography and teleportation

Nilanjan BONDYOPADHAYA:
isva-Bharati University, West Bengal, India

Study of Polychronakos like spin chains associated with polarized spin reversal operators

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Minryeong CHA:
KAIST, Daejeon, Republic of Korea

The Manning Transition Revisited

A system of a positively charged cylinder in the presence of negatively charged counterions shows binding-unbinding transition of counterions to the charged cylinder. This critical phenomenon demonstrates different properties depending on the strength of electrostatic interaction. As the system becomes charged more highly, the coupling between counterions and the charged cylinder becomes strong and the correlation of counterions becomes significant. For an extensive range of the strength of electrostatic interaction, we examine its equilibrium states, performing Monte Carlo simulation and analytic calculation. We find that characteristic phases such as complete de-condensation, partial condensation, complete condensation, and Wigner crystal. We determine the phase boundaries and discuss underlying mechanism and criticality .

Sudip CHAKRABORTY:
Tata Institute of Fundamental Research, Mumbai, India

Ordering and Phase Transition in a 2-D system of moving beads

We externally disturbed a system of beads (cylindrical and spherical), and found clustering and crystal formation in both the systems. We have also observed hysteresis in both the systems. We have investigated, both experimentally and through simulations, the crystal formation, defect propagation and phase transitions in both the systems.

CHEN Ji-Sheng:
Central China Normal University, Wuhan, P. R. CHINA

Flow field of a unitary Fermi gas for the scissors mode

Silvia CHIACCHIERA:
Centro de Fisica da Universidade de Coimbra, Portugal

Boltzmann equation with double-well potentials

L. Debora CONTRERAS-PULIDO:
National Autonomous University of Mexico, Mexico

Counting statistics in a linear triple quantum dot

Elnaz DARSHESHDAR:
University of Isfahan, Islamic Republic of Iran

Shear viscosity of quasi 2D Bose-Fermi mixture with dipole-dipole and Coulomb interactions

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Patrick DAS GUPTA:
University of Delhi, New Delhi, India

On the possibility of creating Supermassive Black holes from Bose-Einstein condensation of bosonic dark matter

Observed active galactic nuclei at redshifts of about 6 strongly suggest that supermassive black holes (SMBHs) had formed early on. Accretion of matter onto remnants of Population III stars leading to SMBHs is a very slow process, and therefore the model faces difficulties in explaining quasars detected at z >,àº 6. In this paper we invoke Bose-Einstein condensation of dark bosons to demonstrate that existence of very light spinless dark matter particles can lead to SMBHs of mass > 10 10 M at z > 6. We predict that scalar/pseudo-scalar particles with mass ,àº 10 ,àí23 eV cannot only generate SMBHs of mass >,àº 10 M at z ,àº 6 but also can masquerade as dark matter as well as dark energy.

Chitralekha DATTA:
Saha Institute of Nuclear Physics, Kolkata, India

Rational quantum integrable systems of D_N type with polarized spin reversal operators

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Himadri Shekhar DHAR:
Harish-Chandra Research Institute, Allahabad, India

Adiabatic freezing of long-range quantum correlations in spin chains

We consider a process to create quasi long-range quantum discord between the non-interacting end spins of a quantum spin chain, with the end spins weakly coupled to the bulk of the chain. The process is not only capable of creating long-range quantum correlation but the latter remains frozen, when certain weak end-couplings are adiabatically varied below certain thresholds. We term this phenomenon as adiabatic freezing of quantum correlation. We observe that the freezing is robust to moderate thermal fluctuations and is intrinsically related to the cooperative properties of the quantum spin chain. In particular, we find that the energy gap of the system remains frozen for these adiabatic variations, and moreover, considering the end spins as probes, we show that the interval of freezing can detect the anisotropy transition in quantum XY spin chains. Importantly, the adiabatic freezing of long-range quantum correlations can be simulated with contemporary experimental techniques.

Pierfrancesco DI CINTIO:
Universita di Firenze, Italy

Radial Orbit Instability in long-range interacting n-body systems with radial anisotropy

We continue to investigate the dynamics of collisionless systems of particles interacting via additive r^-Œ±interparticle forces. In this paper we study the stability of a family of radially anisotropic self-consistent spherical Hernquist models with r^‚àíŒ± forces and 1 ‚â§Œ±< 3. By means of direct N-body simulations we explore the conditions for the onset of radial orbit instability of for the radially anisotropic Osipkov-Merritt models constructed in Di Cintio, Ciotti & Nipoti (2015). We determine the minimum value of the anisotropy radius r as and correspondent initial anisotropy parameter Œæ as a function of Œ± for stability (i.e. the model maintains its spherical shape and density profile). We find that r as decreases for increasing Œ±, consistently with the fact that the amount of kinetic energy that can be stored in the radial direction relative to that stored in the tangential directions for marginally consistent models increases for decreasing Œ±. In addition, we find that the end products of the simulations of unstable systems are all markedly triaxial with minimum axial ratio c/a > 0.3 so that they are never flatter than an E7 system.

Martina ESPOSITO:
University of Trieste, Italy

Disclosing fluctiations of lattice atomic positions by non equilibrium optical experiments

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Uwe FISCHER:
Seoul National University, Republic of Korea

Condensate fragmentation as a sensitive measure of the quantum many-body behavior of bosons with long-range interactions.

Phys. Rev. A 91, 063621 (2015)

Fabio FRANCHINI:
Ruder Boskovic Institute, Zagreb, Croatia

Universal Quantum Simulator, Local Convertibility and Edge States in Many-body Systems

In some many-body systems, certain ground state entanglement (Renyi) entropies increase even as the correlation length decreases. This entanglement non monotonicity implies a stronger ``quantum nature" of the wave function and gives it a higher computational power, compared to classical manipulations.

In this work we demonstrate that such a phenomenon, known as non-local convertibility, is due to the edge state (de)construction occurring in the system.

To this end, we employ the example of the Ising chain, displaying an order-disorder quantum phase transitions.

Employing both analytical and numerical methods, we compute entanglement entropies for various system's bipartitions $(A|B)$ and consider ground states with and without Majorana edge states.

We find that the thermal ground states, enjoying the Hamiltonian symmetries, show non-local convertibility if either A or B are smaller than, or of the order of, the correlation length. In contrast, the ordered (symmetry breaking) ground state is always locally convertible.

The edge states behavior explains all these results and could disclose a paradigm to understand local convertibility in other quantum phases of matter.

The connection we establish between convertibility and non-local, quantum correlations provides a clear criterion of which features a {\it universal quantum simulator} should possess to outperform a classical machine.

John M. F. GUNN:
University of Birmingham, UK

Long range interactions and instabilities in hollow optical fibres

Instabilities are predicted for a sufficiently long hollow photonic optica fiber, or cavity", containing a one dimensional Bose - gas in the presence of a classical, far red -detuned, confined weak electromagnetic mode. We examine both a single beam with Bose gas (a type of Brillouin instability) and the case of a standing wave, or optical lattice. The instabilities of these driven systems have pronounced spatial structure, of combined modulational instabilities in the electromagnetic and Bose density fields. Near the critical wave vectors for the instability the coupled modes of the BEC and light can be interpreted as ‚Äúphonons" of the optical lattice. We conjecture these spatially - structured instabilities for the optical lattice, which we predict at weak field s, develop into the source of spatially homogeneous heating predicted for strong fields. In a simple ring - cavity model problem, I find three phases for repulsive interatomic interactions (including an angular momentum phase separation between light and atoms) and an additional ultraquantum crossover to a "nonoptical" lattice phas e for attractive interactions. This work suggests a new avenue for producing dynamical non - abelian gauge fields.

John M. F. GUNN:
University of Birmingham, UK

Condensation of composite particles when single particle excitations Mott gapped

A staggered potential which acts on two hyperfine levels with opposite signs has remarkable effects. For example it can lead to full single particle bandwidth transport of a tightly bound pair of such atomic states. This when the single particle transport is strongly suppressed and in an unstaggered lattice this would be strongly suppressed for the pair when the binding energy is bigger than the single particle bandwidth. More remarkably , this phenomenon can survive in the dense limit. For example when si ngle particle transport is Mott insulating, two - particle can be not Mott. We have shown, in principle, that one can readily construct staggered lattices where the composites are not one atom of each type but higher composites. The applications of this t o random potentials start in the mean field limit, with no bound states. There, depending on the interspecies interactions, one can have first order localisation transitions. The results, even at a mean field level, are strongly dimensionally dependent . For a strongly varying random "mirror" potential, with an attractive interaction between the two species, the single bound - state ground state is already surprising. There is a sort of dimensional reduction where the composites reside on a manifold of one d imension less.

Vahan HOVHANNISYAN:
A.I. Alikhanyan National Science Laboratory, Yerevan, Armenia

The canonical and microcanonical solutions of the long-range interaction Blume-Emery-Griffiths model

We study phase diagram properties of the mean-field Blume-Emery- Griffiths (BEG) model [1]. In Particular, we obtain equivalence and in- equivalence of the canonical and microcanonical ensembles for the some values of the model parameters. As for the infinite-range Blume-Capel model [2], inequivalence of the phase diagrams of the two ensembles be- low the tricritical point of the canonical ensemble is shown. We observe negative specific heat and temperature jumps at low temperatures in the microcanonical ensemble.

The gaps in the accessible magnetization interval are appear at low energies, which show the absence of the micro- scopic configuration in this region. By increasing biquadratic exchange interaction parameter the accessible magnetization intervals are decreas- ing.

[1] M. Blume, V.J. Emery and R.B. Griffiths, Phys. Rev. A 4, 1071 (1971).
[2] J. Bar ÃÅre, D. Mukamel and S. Ruffo, Phys. Rev. Lett. 87, 030601 (2001).

Shahid IQBAL:
National Univ. of Sciences and Technology, Islamabad, Pakistan

Quantum information approach to many-body physics: effects of composite character of cobosons

The composite bosons manifest deviations from ideal bosonic character in many physical phenomena, such as Bose-Einstein condensation, coherence-decoherence, and quantum interference. Here we discuss the quantum information approach to many body physics and probe the role of composite character of composite bosons in entanglement generation and its consequences in quantum information theory

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Kicheon KANG:
Chonnam National University, Gwangju, Republic of Korea

Quantum theory of electromagnetic interaction without a potential

It is a general consensus today that quantum mechanical treatment of electromagnetic interaction would be impossible without a potential, which is highlighted in the "Aharonov -Bohm" effect [1]. However, it is shown that this standard viewpoint is not fully consistent with the relativistic invariance when it is applied to a system composed of a charge and a fluxon in two dimension [2]. An alterna tive 'local' theory, based on without a potential, has bee n developed accordingly [2 -4]. I have investigated implications and prospects of this alter native theory.

References:
[1] M. Peshkin and A. Tonomura, "The Aharonov -Bohm Effect" (Springer 1989).

[2] K. Kang, "Aharonov -Bohm effect, local field interaction, and Lorentz invariance", arXiv:1308.2093.

[3] K. Kang, "Locality of the Aharonov -Bohm -Casher effect", Phys. Rev. A 91, 052116 (2015).

[4] K. Kang, "Aharonov -Bohm type nonlocality and sing le particle interference without a loop", arXiv:1512.02765

Rustamjon KHAKIMOV:
institute of Mathematics, Tashkent, Uzbekistan

We study the periodic and translation-invariant Gibbs measures. We give explicit formulas for solutions of corresponding translation-invariant Gibbs measures and we study their extremality. In addition, we find the exact number of periodic Gibbs measures on some invariant sets.

Ramaz KHOMERIKI:
Javakhishvili Tbilisi State University, Georgia

Moving Solitons in Long Range Oscillator Chains

Soliton existence and propagation in the long-range extension of quartic Fermi-Pasta-Ulam (FPU) chain of anharmonic oscillators has been investigated. We introduce long-range couplings in linear terms, while nonlinear terms are kept short-range. It is found that due to the non-analytical nature of long-range dispersion relation at low frequencies only the localizations characterized by high frequencies could be found: The high frequency modes can form the envelope solitons which appear to be robust as they propagate. Moreover, "magic" wavenumber kink-solitons could be created as well, although their stability properties are substantially inferior. The parameters of these solitons are analytically computed and the correspondence with the results of numerical experiments has been verified.

Hubert KLAR:
retired - University of Freiburg, Germany

Electron pair formation in two-electron-atoms

Eugene KOGAN:
Bar-Ilan University, Ramat Gan, Israel

Localized magnetic moments in a Dirac semimetal as a spin model with long--range interactions

We connect between the problem of thermodynamics of localized magnetic moments in a Dirac semimetal, the interaction with relativistic electrons leading to the effective ferromagnetic exchange between the moments, and the existing theories dealing with long{range exchange interaction. We point out that the results of high{temperature expansion for the free energy of a dilute ensemble of magnetic impurities in the semimetal performed by V. Cheianov et al. (Phys. Rev. B86, 054424

(2012)) give an indication to the existence of a new disordered xed point in such mode.

Gabor KONYA:
Wignor Research Centre, HAS, Budapest, Hungary

Damping of quasiparticles in a Bose-Einstein condensate coupled to an optical cavity

We present a general theory for calculating the damping rate of elementary density-wave excitations in a Bose-Einstein condensate strongly coupled to a single radiation eld mode of an optical cavity. Thereby we give a detailed derivation of the huge resonant enhancement in the Beliaev damping of a density-wave mode, predicted recently by Knya et al. [Phys. Rev. A 89, 051601(R) (2014)]. The given density-wave mode constitutes the polaritonlike soft mode of the self-organization phase transition. The resonant enhancement takes place, in both the normal and the ordered phases, outside the critical region. We show that the large damping rate is accompanied by a signi cant frequency shift of this polariton mode. Going beyond the Born-Markov approximation and deter-mining the poles of the retarded Green's function of the polariton, we reveal a strong coupling between the polariton and a collective mode in the phonon bath formed by the other density-wave modes.

G. Konya, G. Szirmai, and P. Domokos, Phys. Rev. A 90, 013623 (2014)

Yevhenil KURIATNIKOV:
Taras Shevchenko National Univ. of Kyiv, Ukraine

HYSTERESIS EFFECT IN STIRRED TOROIDAL BOSE-EINSTEIN AT FINITE TEMPERATURE

Ivan LATELLA:
Universitat de Barcelona, Spain

Long-range interacting systems in the unconstrained ensemble

We show that systems with long-range interactions [1] can attain equilibrium configurations in the unconstrained ensemble. In this statistical ensemble, the control parameters are the temperature, pressure and chemical potential, while the energy, volume and number of particles fluctuate. As is well known, such control parameters can not de ne equilibrium con gurations if the interactions are short-ranged, since in this case they are not a set of independent quantities. Moreover, the replica energy [2] is the appropriate free energy dening stable con gurations for these control parameters. We consider a modification of the Thirring model [3] as a concrete example of a system that achieves stable equilibria in this ensemble [4]. In addition, the unconstrained ensemble for this model is compared with the canonical and grand canonical cases. This comparison is in agreement with known results: the more the ensemble is unconstrained by allowing uctuations in energy, volume or number of particles, the smaller the space of parameters defining the equilibrium con gurations.

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L. Casseti and S. Ruffo, Phys. Rev. Lett. 114 , 230601 (2015). [3] W. Thirring, Zeitschrift ur Physik 235 , 339 (1970). [4] I. Latella, A. Perez-Madrid, A. Campa, L. Casseti and

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Wilfried MAINEULT:
Laboratoire Aime Cotton, Orsay, France

Rydberg atoms of Ytterbium

Physical properties of Rydberg atoms pave the way to experimental control of the quantum state of mesoscopic ensemble of particles. Interactions between Rydberg atoms are large for interparticle distances in the micrometer range. They can be used to induce Rydberg blockade and generate entanglement between two[1,2] or even larger ensemble [3] of atoms. Nevertheless, Rydberg atoms lack some of the ressources used with neutral atoms, especially techniques such as imaging and optical dipole traps .

In this poster, I'll describe the experimental scheme under development and present the status of the experiment. Ytterbium atoms have two valence electrons which should allow applying optical manipulation on the Rydberg states. The idea is first to promote one electron to a long lived Rydberg state. The system can then be approximated as a free electron orbiting around an ionic core. The latter has still a valence electron that can be used for optical manipulation (i.e. imaging or trapping).

We are currently able to have Ytterbium atoms held inside a magneto-optical trap on the intercombinaison transition between 1S0 and 3P1 around 556nm. We performed the spectrocopy of the ns and nd Rydberg states from n=35 to n=80, increasing by two orders of magnitude the precision of their energy levels. By means of a Multi-Channel Quantum Defect Theory (MQDT) analysis we are able to fit the levels and deduce a new value of the ionization energy. The next step will be to complete the spectroscopy and compute the Stark map of the Rydberg states.

Matteo MARCUZZI:
University of Nottingham, UK

Absorbing state phase transitions in the presence of quantum fluctuations

Absorbing state phase transitions in the presence of quantum fluctuations Stochastic processes featuring absorbing states have been extensively studied in the past and are known to display, in the presence of suitable competing dynamical processes, non - equilibrium phase transitions. Recent studies showed that in principle, under the effect of strong decoherence noise, optical lattices of laser - driven atoms can show the same universal behaviours. This opens the path to the investigation of the effects quantum fluctuations have on these otherwise fully - classical systems. S uch a scenario is addressed by studying an open quantum spin model which in its classical limit undergoes a directed percolation phase transition. Via an approximate mapping to a non - equilibrium field theory, it is shown that the introduction of quantum flu ctuations stemming from coherent, rather than statistical, spin - flips alters the nature of the transition such that it becomes first - order deep in the quantum regime. In the intermediate one, where classical and quantum dynamics compete on equal terms, a b icritical point is highlighted with different universal features from standard directed percolation.

Mariya MEDVEDYEVA:
University of Ljubljana, Slovenia

Dynamical non-extensivity in the Bose-Hubbard model

We study the Bose-Hubbard model both from a quantum and a semiclassical perspective. We consider the long- range interaction effects that are caused by the mean-field character of the model, in particular non-concavity of the microcanonical entropy and interpret it in the context of nonextensive thermodynamics. We go on with dynamical quantities and find a scaling law F (t) ,àº e N Œ± g(t) of the quantum mechanical overlap function F (t) = œà(0)|œà(t) with Œ± = 1 in contrast to what is mostly assumed in the literature, N is a particle number in the system.

David METIVIER:
Laboratoire J.A. Dieudonne, Nice, France

Trapping scaling for bifurcations in Vlasov systems

Particles,Äô systems with long range interactions are usually described over some time scale by a Vlasov-like equation. Plasmas and self-gravitating systems are the most obvious examples, but they are far from being the only ones. Vlasov equation has a huge number of stationary states. Take a non homogeneous stationary state, and perturb it; what is the fate of this perturbation? We show here how the nonlinear bifurcation analysis developed by J. D. Crawford for homogeneous states can be extended to the inhomogeneous framework and stressed the differences between the two cases (absence of resonant particles, asymmetric behaviour).

Finally we show for HMF potential numerical simulation supporting our predictions.

[1] Barr√©, J., M√©tivier, D., & Yamaguchi, Y. Y. (2015). Trapping scaling for bifurcations in Vlasov systems.

Phys. Rev. E (Accepted 7 March 2016); arXiv:1511.07645

Jiri MINAR:
University of Nottingham, UK

From Anderson to many-body localization in a disordered Rydberg chain

We study the effect of position disorder on the wavefunction properties of a chain of Rydberg atoms with van der Waals interaction. We show that, by a suitable choice of the Hamiltonian parameters, the model can be effectively described in a reduced Hilbert space by an Anderson-like Hamiltonian, where only every second site is affected by the disorder. We show by computing the Lyapunov exponents, that a single delocalized state is present, which is robust with respect to the amount of disorder. We then propose possible experimental probes of the localization by evaluating the dynamics for different initial states. Finally and importantly, we make a comparison with the existing experimental data and discuss related experimental challenges.

Jules MORAND:
National Inst. for Theoretical Physics, Stellenbosch, South Africa

Long-range interacting systems with non-hamiltonian perturbation.

Long range interactions concern numerous natural systems. A notable example is the one of gravitation which is especially relevant in the study of a stars system or a galaxy cluster. In particular, these systems does not respect the additivity of thermodynamical potential and present a dynamics dominated by collective (mean-field) effects. One of the most remarkable feature is that, after a very rapid evolution, these systems remains trapped into quasi-stationary states up to a very long time (diverging with the system size). Simulations have shown that if such systems relax to thermal equilibrium, this happens only on time scales diverging with the system size.

Quasi-stationary states are theoretically interpreted as stationary solutions of the Vlasov equation. Derived in the limit of a large number of particles, for which the two point and higher correlation function may be neglected, this kinetic equation, represents a very good approximation of the dynamics of long range systems.

This equation is valid for strictly hamiltonian system, and the quasi-stationary state are supposed to be a feature of a fixed energy dynamics.A natural question that arises is: is this states are resistant to non-hamiltonian perturbations?

In adding extra term to the Vlasov equation, we have study, how definite kind of non-hamiltonian perturbation modify the dynamics of such system. The results obtained have been derived in a perturbative limit i.e. in a limit such that the time scale of the mean-field dynamics and the one of the perturbation are separated.

Simulation of the one dimensional self-gravitating sheet model subjected to such perturbations have been performed to investigate the dynamics and to corroborated theoretical predictions made with the kinetic theory.

The main result is that quasi-stationary states are robust to such perturbations and that the system may be driven to a universal stationary state depending only on the kind of perturbation added.

Karmela PADAVIC:
Univ. of Illinois at Urbana-Champaign, USA

Gravitational Effects on Collective Modes of Superfluid Shells

We study the effects of gravity on collective excitations of shell-shaped Bose-Einstein condensates (BECs). Superfluid shells are of general interest as examples of hollow geometries that can be produced in ultracold atoms in bubble-trap potentials or optical lattices. Our approach to analyzing super uid shells is based on a Gross - Pitaevskii mean field theory and hydrodynamic equations derived from it. Considering a spherically symmetric BEC in general, there are distinct collective excitation spectra for the cases of a fully filled sphere and a very thin shell. Furthermore, an adiabatic change in the potential producing a slow transition from one geometry to the other shows a characteristic evolution. Given that in most realistic experimental conditions gravity cannot be neglected we investigate its e ects on the equilibrium profile and the collective modes in the very thin shell limit. We analyze the case in which the effects of gravity are strong and distort the shape of the condensate shell. More precisely, we obtain an estimate for the minimal number of atoms within the condensate cloud necessary for a the condensate shell to maintain its shape given fixed trap parameters. In cases when this condition is not satisfied we find that the condensate develops an extreme density depletion at the top of the shell-like geometry while the rest of the atoms pool at its bottom. These cases can be experimentally used as means of obtaining two-dimensional condensates.

For cases in which the number of atoms is sufficiently large to maintain the full shell geometry, we analytically obtain the full excitation spectrum for the thin shell con guration and account for gravity perturbatively. We find that gravity breaks spherical symmetry of the equilibrium density profile and affects the collective excitations by coupling adjacent modes in the angular direction.

Ryan PLESTID:
McMaster University, Ontario, Canada

Quantum Dynamics in the HMF model

The Hamiltonian Mean Field model was proposed approximately twenty years ago 1 as a toy model of long range interactions. It can be seen as an in nite-range XY model, or as a theory of particles on a ring interacting via a pair-wise cosine potential. The classical model has been studied ex- tensively, and its dynamics are known to exhibit quasi-stable \chevrons" 2 . These structures are not realizable in a statistical mechanical treatment, but can be predicted on general grounds by appealing to Thom's catas-trophe theory. The quantum model's statics have been well characterized for both Fermions and Bosons by Chavanis 3 , however its dynamics remain uninvestigated.

We are particularly interested in the substructure of the so-called chevrons in the quantum treatment, which should be a realization of the Percy func- tion in the immediate vicinity of the chevron's cusp. In this poster we outline the equations controlling the mean field dynamics of the model and results from numerical simulations. We emphasize the semi-classical limit as a means of comparison with the classical dynamics.

Haibo QIU:
Xi'an Univ. of Posts and Telecommunications, Shaanxi, P.R. China

Measure synchronization in quantum many-body systems

Muzaffar RAHMATULLAEV:
National Univ. of Uzbekistan, Tashkent, Uzbekistan

ON FREE ENERGIES OF THE POTTS MODEL ON THE CAYLEY TREE

Abolfazl RAMEZANPOUR:
University of Neyshabur, Islamic Republic of Iran

Characterizing the parent Hamiltonians for a complete set of orthogonal wave functions: An inverse quantum problem

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Zacharias ROUPAS
Eotvos Lorand University, Budapest, Hungary

Isotropic-nematic phase transitions in gravitational systems

Debasis SADHUKHAN:
Harish-Chandra Research Institute, Allahabad, India

Quantum discord length is enhanced while entanglement length is not by introducing disorder in a spin chain

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Auditya SHARMA:
Indian Inst. of Science Education and Research, Bhopal, India

de Almeida-Thouless line in vector spin glasses.

Gabriele SICURO:
Centro Brasileiro de Pesquisas Fisicas, Rio De Janeiro, Brazil

Working on Matching problem, Group theory and Information theory, Fractional differential equations, Generalized Leibniz triangles.

Sudipto SINGHA ROY:
Harish-Chandra Research Institute, Allahabad, India

Diverging scaling with converging multisite entanglement in odd and even quantum Heisenberg ladders

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Gergely SZIRMAI:

Damping of quasiparticles in a Bose-Einstein condensate coupled to an optical cavity

We present a general theory for calculating the damping rate of elementary density-wave excitations in a Bose-Einstein condensate strongly coupled to a single radiation eld mode of an optical cavity. Thereby we give a detailed derivation of the huge resonant enhancement in the Beliaev damping of a density-wave mode, predicted recently by Knyaet al.

[Phys. Rev. A 89, 051601(R) (2014)].

The given density-wave mode constitutes the polaritonlike soft mode of the self-organization phase transition. The resonant en-hancement takes place, in both the normal and the ordered phases, outside the critical region. We show that the large damping rate is accompanied by a signi cant frequency shift of this polariton mode. Going beyond the Born-Markov approximation and deter-mining the poles of the retarded Green's function of the polariton, we reveal a strong coupling between the polariton and a collective mode in the phonon bath formed by the other density-wave modes.

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One-dimensional chain with long-range hoppings: boson dynamics and fate of topological phases

Interactions with power - law dependence on the spatial distance hav e been introduced in trapped, low - dimensional ultracold ion gases, in which the exponent of the power -law has been demonstrated to be widely changed according to the system parameters [1] . Such inter actions with variable exponents can realize systems effectively having larger and fractional spatial dimensions. We have demonstrated that even in originally one - dimensional systems, breakdown of continuous symmetries and realization of long - range

order , forbidden in short - range models by the Mermin - Wagner - H ohenberg th eorem, is expected [2]. Here we investigate , by the time - dependent density - matrix renormalization group method , the dynamics of a Bose condensate after the long - range term is quenched [3]. T he spatial dimensionality of the system has been established as a crucial key for studying topologically nontrivial states of matter. Then, how does the topological phase behave when some degrees of freedom of the system has effectively fractional spatial dimensions , as in the systems discussed above ? Recently power - law interacting versions of the Ising chain with transverse magnetic field and the Kitaev chain have been investigated [4] , and the possibility of a novel topological phase with massive edge modes has been proposed. In this poster, we also present our r esults on the effect of the power - law kinetic term o n one - dimensional topological superconductor s with Majorana edge fermions.

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Measure synchronization in a two species bosonic Josephson junction

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Information propagation and equilibration in long-range Kitaev chains

The Lieb-Robinson bound has been a milestone in our understanding of the nonequilibrium dynamics of nonrelativistic short-range interacting quantum systems. In essence it states that the effect of a perturbation at a point A cannot be felt at another point B until a time t = r/v , with r the distance between A and B and v a characteristic velocity in the system. Even though causality is not strictly imposed on the model, it emerges as a mere consequence of the short-range nature of interactions, thereby giving rise to an e ective light cone. Recent advances in in cold-atom and trapped-ion experiments have made it possible to also study the behavior of long-range interacting quantum systems. As in these systems the Lieb-Robinson theorem ceases to hold, there is not much general that can be said about the rate at which correlations can travel through the system. New bounds on information propagation have been proposed, but they seem too loose to provide any significant insight into models of interest. Thus, is it really possible to transmit information superluminally in these systems? Or is some notion of causality still preserved, despite the long-range nature of interactions? With this work we aim at providing some insight into these elementary questions by considering an exactly solvable fermionic model with pairing interactions that decay as 1/r^alpha, known as the long-range Kitaev chain. We study the dynamics after an abrupt change of vacuum and evaluate the mutual information between two disconnected subsystems in the chain.

Surprisingly, we nd that by far most of the information in this model still propagates inside a well-de ned light cone, even for very long-range interactions (alpha< 1).

Moreover, the crucial difference with short-range interacting models lies in the fact that, counterintuitively, the dynamics can be slowed down signi cantly, rather than sped up. We illustrate that, thanks to the integrability of the model, the distribution of quasiparticle group velocities is su cient to explain these remarkable observations.

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Three-body interactions in ultracold atomic gases

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Pseudopotentials for an ultracold dipolar gas

A gas of ultracold molecules interacting via the long-range dipolar potential o ers a highly controlled environment in which to study strongly correlated phases. However, at particle coalescence the divergent 1/r3 dipolar potential and associated pathological wavefunction hinder computational analysis. For a dipolar gas constrained to two dimensions we overcome these numerical diffculties by proposing a pseudopotential that is explicitly smooth at particle coalescence. The psuedopotential delivers the scattering phase shifts of the dipolar interaction with an accuracy of 10^-6 and enables highly accurate yet radically accelerated diffusion Monte Carlo calculations of the properties of the dipolar gas.

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Core-halo structure in Hamiltonian Mean Field model with different masses

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