Third International

UQUAM

ULTRACOLD QUANTUM MATTER

Workshop

Harnack Haus - Berlin

24 October - 27 October 2016

Invited Speakers: Antoine Browaeys (CNRS, FR), Gil Refael (Caltech, USA), Hui Zhai (Tsinghua University, China), Nathan Goldman (ULB, Belgium), Selim Jochim (Heidelberg University,GER), Jürgen Berges (Heidelberg University, GER), Daniel Greif (Harvard, USA)

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European Research Council
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UQUAM
ultracold quantum matter

Project Number: 319278

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General Information

Arrival and registration

The registration will take place on Monday, from 09:45 o'clock until 10:15 o'clock (for participants joining the conference later, registration will take place upon arrival). Moreover, for people arriving early on Sunday, we plan to have an informal Get-Together at a restaurant close by the conference venue (the costs for this dinner will have to be covered by your own expenses). For those who would like to join for dinner, the meeting point will be at 18:30 o'clock in the entrance hall of the Harnack House.

Conference dinner:

The conference dinner will take place on Wednesday evening at the Italian restaurant 12-Apostel (http://www.12-apostel.de/) at 19:30 o'clock. The restaurant is located approximately 10 minutes away from the U- and S-Bahn Station Friedrichstraße (walking distance). You can reach the restaurant from the conference venue by metro (U3), S-bahn (S9) or tram. The dinner will include a three course menu as well as a vegetarian option. You can find a map guiding you to the restaurant on the next pages.

Meals:

The stay at the hotel and the Harnack house includes all breakfasts and a lunch buffet on Monday and Wednesday.
For non-included meals: In case you still feel hungry, or on days when lunch or dinner is not included, there are several restaurants close by. The city center is only 20 minutes away by public transport.

Activities free afternoon Tuesday:

Free guided city tour Sandemans:
In case you would like to get a first impression of the historic city center of Berlin, there are free English speaking guided city tours which start daily at 14 o'clock in front of the Brandenburg gate and are highly recommended.
http://www.neweuropetours.eu/berlin/en/tours/tour-view?Tour=418&date=17/10/2016#

Visit Bundestag/Reichtagskuppel:
In addition to that, a visit to the Bundestag building will be organized on Tuesday night at 21:45 o'clock for which you should have registered in advance.

Sports:
For the runners amongst you, running will be organized starting at the Harnack house (we'll keep you informed about the details).

WLAN

Useful phone numbers

Frauke:

Workshop venue

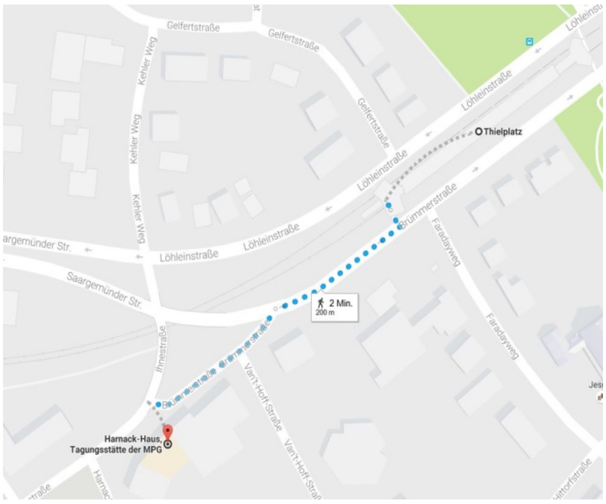
Harnack Haus
Ihnestr. 16-20
14195 Berlin

Phone: +49 30 8413-3800
Fax: +49 30 8413-3801
Homepage: http://www.harnackhaus-berlin.mpg.de

Map & Directions

Harnack Haus by public transport:

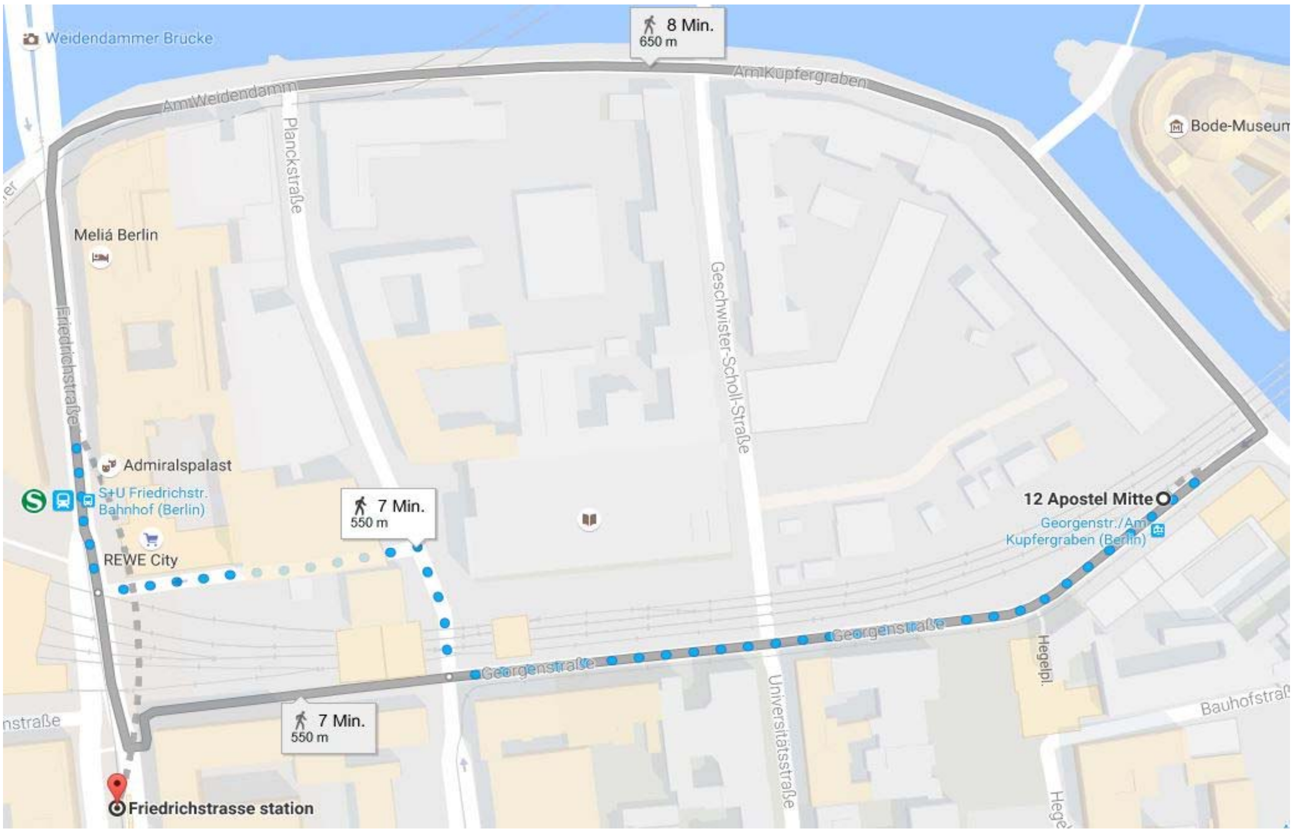
Closest metro station: Thielplatz



Seminaris Campus Hotel:

Closest metro station: Dahlem Dorf

Social Dinner: 12-Apostel



Talks

Invited Speakers: Antoine Browaeys (CNRS, FR), Gil Refael (Caltech, USA), Hui Zhai (Tsinghua University, China), Nathan Goldman (ULB, Belgium), Selim Jochim (Heidelberg University, GER), Jürgen Berges (Heidelberg University, GER), Daniel Greif (Harvard, USA)

Monday 24.10.2016

Mikhail Baranov

Nano-Scale 'Dark State' Optical Potentials for Cold Atoms

Time: 10:15-10:45

Monika Aidelsburger

Near-resonant light scattering in a dense quasi-2D Bose gas

Time: 10:45-11:30

Sylvain Nascimbène

Creating fractional quantum Hall states with atomic clusters using light-assisted insertion of angular momentum

Time: 12:00-12:30

Guillaume Salomon

Microscopy of antiferromagnetic correlations in the Fermi-Hubbard model

Time: 12:30-13:15

Invited Talk: Nathan Goldman

Instability rates in periodically-driven band systems

Time: 15:00-15:45

Monday 24.10.2016

Lukas Sieberer

Quantum annealing of highly connected spin glass models

Time: 15:45-16:15

Invited Talk: Jürgen Berges

Addressing fundamental particle-physics problems with ultracold atoms

Time: 16:45-17:30

Tuesday 25.10.2016

Invited Talk: Daniel Greif

Exploring Quantum Antiferromagnets with single-site resolution

Time: 09:00-09:45

Benoit Vermersch

Noisy quantum network

Time: 09:45 – 10:15

Marcello Dalmonte

Measuring entanglement spectra of many-body systems via modular Hamiltonians

Time: 10:45-11:30

Eyal Leviatan

Is the long-time quantum dynamics of a many-body system computable?

Time: 11:30-12:00

Wednesday 26.10.2016

Invited Talk: Antoine Browaeys

Implementation of spin hamiltonians in arrays of individual Rydberg atoms

Time: 09:00-09:45

Karina Jiménez-Garcia

One-dimensional spinor Bose gases: Quantum Phase Transitions and Non-equilibrium Dynamics

Time: 09:45 -10:15

Invited Talk: Hui Zhai

Out-of-Time-Order Correlation: From Holographic Duality to Many-Body Localization

Time: 10:45 – 11:30

Alexander Glätzle

A Coherent Quantum Annealer with Rydberg Atoms

Time: 11:30 -12:00

Invited Talk: Gil Refael

Persistent Hall response in a quantum quench

Time: 15:00-15:45

Christian Schweizer

Spin pumping and measurement of spin currents in optical superlattices

Time: 15:45 -16:15

Mark Fischer

Dynamics of a Many-Body-Localized System Coupled to a Bath

Time: 16:45 – 17:30

Ionut-Dragos Potirniche

Engineering Floquet phases of matter

Time: 17:30 – 18:00

Thursday 27.10.2016

Invited Talk: Selim Jochim

Can we assemble complex many-body states from individual building blocks?

Time: 09:00-09:45

Jae-Yoon Choi

Exploring many-body localization transition in two dimensions

Time: 09:45 -10:15

Leonid Sidorenkov

Narrow-line magneto-optical trapping of ultracold Dysprosium: role of spin polarization and light-induced collisions

Time: 10:45 -11:15

Christoph Gohle

> 23Na40K ground state dipolar molecules with detuned STIRAP

Time: 11:15-11:45

Posters

The Poster Session will take place on Monday (24th) at 18.00 o'clock and start with a one-minute "flash presentation" of each poster.

Group: Immanuel Bloch

Heating rates of interacting Bosons a shaken 1D optical lattice

Martin Reitter, Jakob Näger, Karen Wintersperger, Christoph Sträter3, Ulrich Schneider, André Eckardt, and Immanuel Bloch

Periodically driven systems have been successfully used to implement topological band structures with non-zero Chern numbers for non-interacting neutral particles. The extent to which the engineered topological properties survive in the presence of interactions, and which many-body phases result, remains, however, a largely open question. We systematically explore the heating mechanisms in a shaken 1D lattice for different driving frequencies, driving strengths and interactions, and theoretically explain which channels have the main contributions. We will present first results as well as future prospects of the experiment.

23Na40K ground state molecules with detuned STIRAP

Frauke Seeßelberg, Nikolaus Buchheim, Zhenkai Lu, Tobias Schneider, Xin-Yu Liu, Immanuel Bloch and Christoph Gohle

Dipolar long-range interactions promise exciting new possibilities for quantum simulation of strongly interacting many-body systems, eg. supersolid phases. We report on the creation of several thousands of polar 23Na40K molecules in their electronic and rovibronic ground state. Starting with an ultracold mixture of sodium and potassium at high phase space density we first associate weakly bound Feshbach molecules. Utilizing the technique of stimulated Raman adiabatic passage (STIRAP) we transfer those molecules via an intermediate, electronically excited level in the d/D potential manifold to their electronic and rovibronic ground state. This intermediate level does not exhibit resolved hyperfine structure. To enable efficient population transfer to the ground state anyway we successfully implemented a two-photon detuned STIRAP scheme. By applying external electric fields we can polarize the ground state molecules and induce a dipole moment.

Towards quantum many-body physics with Sr in optical lattices

André Heinz, Annie Jihyun Park, Stephan Wissenberg,
Stepan Snigirev, Jean Dalibard, Immanuel Bloch, Sebastian Blatt

Within the last decade, fermionic alkaline earth atoms in optical lattices have become a platform for precision measurements, culminating in the realization of an atomic clock with the currently highest stability and accuracy at the 2e-18 level. In the meantime, quantum degenerate gases of all bosonic and fermionic isotopes of Sr have been realized. With the extension of the quantum gas microscopy technique to fermionic alkali metal atoms, experiments with quantum degenerate gases in optical lattices have taken another step towards full control over the internal and external degrees of freedom of fermions in optical lattices. Here, we report on the construction of a new experiment with quantum degenerate gases of Sr in optical lattices. Our experiment aims to combine the high spatial control over the atomic degrees of freedom from quantum gas microscopy with the precision control over the internal degrees of freedom enabled by optical lattice clock techniques.

Exploring the many-body localization transition in two dimensions

Choi, J.-y.; Hild, S.; Zeiher, J.; Schauß, P.; Rubio-Abadal, A.;
Yefsah, T.; Khemani, V.; Huse, D. A.; Bloch, I. & Gross, C

Thermalization of isolated quantum many-body systems under their own dynamics is a fundamental assumption in statistical physics. While general conditions for the thermalization of isolated quantum many-body system are not well established, the many-body localization has been considered as a general system that breaks the thermalization, which could extend our understandings of the connection between statistical physics and quantum mechanics. In this presentation we report on the observation of many-body localization transition in two-dimensional disordered optical lattice. Using single-site resolved imaging system, we prepare a high energy density state far from equilibrium and trace its dynamical evolution under disorder potential. We observe the system does not thermalize above a nonzero disorder and find strong evidence for a diverging length scale when approaching the localization transition.

Tailoring long-range interactions via Rydberg dressing

Johannes Zeiher, Simon Hollerith, Sebastian Hild , Antonio Rubio Abadal, Jae-yoon Choi, Peter Schauß, Rick van Bijnen, Thomas Pohl, Immanuel Bloch, Christian Gross

Rydberg atoms offer the possibility to study long range interacting systems of ultracold atoms due to their strong van der Waals interactions. Admixture of a Rydberg state to a ground state, known as Rydberg dressing, allows for increased experimental tunability of these interactions and promises to study novel phases of matter. Here we report on our results of the realization of Rydberg dressing in a many- body spin system. Starting from a two-dimensional spin-polarized Mott insulator of an ultracold gas of rubidium-87, we optically couple one spin component to a Rydberg p-state on a single photon ultra-violet transition at 297 nm. Using microwave Ramsey interferometry in the ground state manifold, we measure the spin-spin correlations emerging due to the admixture of long range interactions to the ground state. We furthermore discuss loss processes affecting our dressed ensembles and present initial indications of improved lifetimes in our system. Our results constitute an important step towards the realization of novel spin models with Rydberg dressed interactions

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Spin and Charge Resolved Quantum Gas Microscopy of Antiferromagnetic Order in Hubbard Chains

Guillaume Salomon, Martin Boll, Timon Hilker, Ahmed Omran, Immanuel Bloch & Christian Gross

Ultracold fermions in optical lattices allow for the simulation of the Hubbard Hamiltonian with a unique control over kinetic energy, interactions and dimensionality. However the study of the onset of magnetic ordering at low temperature turns out to be challenging when looking at trap averaged quantities. We will present our recent experimental study of spin correlations in spin 1/2 Hubbard chains using a quantum gas microscope. We revealed antiferromagnetic correlations at distances up to three sites corresponding to a local entropy well below ln(2). Our ability to measure both charge and spin opens exciting perspectives for studying the interplay between magnetic ordering and doping in ultracold fermion systems.

A new experiment to explore long-range interactions via Rydberg Dressing

Lorenzo Festa, Marcel Duda and Christian Gross

We present our plans for the design of a new experiment aiming to study long-range interacting ultracold quantum systems. The interaction will be induced by laser coupling to Rydberg states and thus can be controlled both in time and space. A first goal is the study of designed quantum magnetism with single atom resolution. In this context, we will also explore new preparation possibilities based on the collisional blockade to prepare a unity filled atomic array.

Spin pumping and measurement of spin currents in optical superlattices

C. Schweizer, M. Lohse, R. Citro, I. Bloch

We report on the experimental implementation of a spin pump with ultracold bosonic atoms in an optical superlattice. In the limit of isolated double wells it represents a 1D dynamical version of the quantum spin Hall eect. Starting from an antiferromagnetically ordered spin chain, we periodically vary the underlying spin-dependent Hamiltonian and observe a spin current without charge transport. We demonstrate a novel detection method to measure spin currents in optical lattices via superexchange oscillations emerging after a projection onto static double wells. Furthermore, we directly verify spin transport through in-situ measurements of the spins' center of mass displacement.

Many-Body Localization in Open and Driven Quantum Systems

Pranjal Bordia, Henrik Lüschen, Sebastian Scherg, Ulrich Schneider and Immanuel Bloch

Many-Body Localization describes a phase in which a closed and isolated quantum system can fail to thermalize. However, dissipative couplings which are present in all experiments will result in an eventual thermalization of the system. Hence, in order to investigate MBL in real experiments, it is crucial to understand how such couplings affect the many-body dynamics. Here we present our experimental results on studying open MBL systems implemented via i) light scattering and ii) coupling many identical MBL systems to one-another. We find increasingly faster thermalization dynamics close to the phase transition point. Further, by periodically modulating the disorder strength, we create a Floquet-MBL phase which fails to heat to infinite temperature above a critical frequency.

Probing Critical Dynamics at the Many-Body Localization Transition in One and Two Dimensions

Henrik Lüschen, Pranjal Bordia, Sebastian Scherg, Ulrich Schneider and Immanuel Bloch

The phenomenon of Many-Body Localization (MBL) describes a generic non-thermalizing phase in which quantum information can persist locally up to infinite times. This phase is separated from a phase obeying the Eigenstate Thermalization Hypothesis via a disorder driven, dynamical phase transition, which happens not only in the ground state but over an extended range of excited states. While the dynamical structure deep in the MBL phase is arguably well understood in one dimension, there is a paucity of results close to the critical point and in higher dimensions. In this work, we report on the observation of MBL in one and two dimensions. We directly probe the transition points finding critically slow relaxation below the critical disorder strength in both 1D and 2D. The slow dynamics in 1D can be attributed to Griffiths type effects. We highlight the importance of interactions, which strongly govern the behavior around the critical point.

Quantum gases with orbital degrees of freedom using fermionic ytterbium

M. Höfer, L. Riegger, N. Darkwah Oppong, C. Hofrichter, D. Rio Fernandes, I. Bloch and S. Fölling

Degenerate ensembles of more complex atoms with Alkaline-earth-like electronic structure, such as ytterbium, allow for novel many-body systems to be modeled and probed, due to their more complex internal structure. We use ytterbium-173 to implement SU(N)-symmetric gases as well as to couple internal degrees of freedom of the atoms to the external degrees via state-dependent potentials and interactions. One motivation to use these states is to implement Kondo lattice-type physics with two orbitals. For this, we implement a state-dependent lattice and use inter-orbital interaction channels between atoms in different electronic states of fermionic Yb to implement effective spin-spin interactions. In addition, the enhanced symmetry allows for the implementation of SU(N)-symmetric hamiltonians, such as the generalized SU(N) Fermi-Hubbard model, which allows for the realization of large spin Fermi liquids and fermionic Mott insulators.

Towards Quantum Hall States with On-demand Filling Factors: the Return of Rotating Gases

Tarik Yefsah

In the recent years, several experimental and theoretical efforts were made for the creation of artificial gauge fields in ultracold atom systems. A seminal, yet simple, idea in this direction is the

rotation method, whereby atoms are set into a rotating trapping potential. In the rotating frame, each atom experiences a Coriolis force that mimics the Lorentz force exerted on a charged particle subject to a magnetic field. Building upon this mapping, pioneering experiments on Bose-Einstein condensates, led by J. Dalibard in Paris and E. Cornell in Boulder, showed for instance the formation of Abrikosov lattices of quantized vortices and the creation of quantum Hall states with high filling factor. However, this approach proved to be technically challenging for the creation of quantum Hall states with low filling factors, such as the celebrated fractional ½ Laughlin state or the enigmatic 5/2 state. Here, we propose to resurrect the quest for fractional quantum Hall states via fast rotation by combining the use of Fermi gases with tunable interactions and a quantum gas microscope, allowing for the detection of small clusters of atoms. The favorable fermionic statistics, the ability to quickly sweep interactions through a Feshbach resonance and single atom detection, represent valuable additions to the "rotation route" with the perspective to create quantum hall states of arbitrary filling factor

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Group: Jean Dalibard

Rabi oscillations and interactions in a 2-level ytterbium BEC

A. Dareau, M. Scholl, M. Bosch Aguilera, R. Bouganne, Q. Beaufils, J. Beugnon and F. Gerbier

We present our recent experimental advances towards the realization of artificial gauge fields on an optical lattice (OL), following an early proposal [1]. We plan to engineer gauge fields on a 174-Yb Bose-Einstein condensate (BEC) loaded in a 2D state-dependent OL, according to the scheme described in [2]. This protocol requires coherent control of Yb atoms on the doubly forbidden ultranarrow 1S_0 --> 3P_0 spontaneous emission-free transition [3] (clock transition). A description of our experimental apparatus can be found in [4]. Here we demonstrate a coherent control of an 174-Yb BEC loaded in a 1D OL at a magic wavelength. We are able to drive Rabi oscillations on the clock transition. Dynamics are strongly influenced by the effects of interactions in our system. Hence this ultranarrow transition enables us to study interaction properties of Yb atoms that are nowadays still to be unveiled [5], e.g. scattering lengths for the excited state. We believe the damping of these oscillations to be a cause of interactions. Nonetheless, we are currently studying the many possible sources of dephasing: inhomogeneous density, inelastic losses, possible laser frequency fluctuations, atomic motion, etc. A Gross-Pitaevskii equation simulation and fits should allow us to extract interesting interaction properties of Yb atoms (scattering lengths, inelastic coefficients).

Narrow-line magneto-optical trapping of ultracold Dysprosium: role of spin polarization and light-induced collisions"

L. Sidorenkov

Creating fractional quantum Hall states with atomic clusters using light-assisted insertion of angular momentum

S. Nascimbène

Non-Equilibrium 8pi Josephson Effect in Atomic Kitaev Wires

C. Laflamme, J.C. Budich, P. Zoller, M. Dalmonte

In this poster we will present a new signature of Majorana quasi-particles, qualitatively different from the behaviour of a conventional superconductor, which can be detected in cold atom systems using alkaline-earth-like atoms. The system studied is a Kitaev wire interrupted by an extra site, which gives rise to super exchange coupling between two Majorana bound states. We show that this system hosts a tunable, non-equlibrium Josephson effect with a characteristic 8pi periodicity of the Josephson current. We further show the robustness of this effect in the presence of imperfections, in the form of dephasing and particle loss.

One-dimensional spinor Bose gases: Quantum Phase Transitions and Elementary Excitations

Andrea Invernizzi, Karina Jiménez-García, Camille Frapolli,
Bertrand Evrard, Jean Dalibard, Fabrice Gerbier

Ultracold atom systems are excellent candidates to investigate the underlying physical mechanisms of spatial organization in quantum phases of matter. Spatial order typically arises when the system undergoes a phase transition at sufficiently low temperatures, and eventually determines the macroscopic properties of materials. Ultracold spinor gases (systems with an internal spin degree of freedom) exhibit a rich landscape of quantum phases. In such systems, the competition between the spin dependent interaction energies and the hyperfine Zeeman energies, gives rise to a quantum phase diagram of generalized magnetic phases [1]. Spinor Bose gases in reduced dimensions are particularly interesting to study non- equilibrium phenomena across such magnetic quantum phase transition. Here we present the experimental study of one-dimensional spin-1 Bose gases of Na atoms across a magnetic quantum phase transition, and the experimental progress toward the observation of their non-equilibrium dynamics. By quenching the system we expect to observe defects, manifested as axial spin domains, arising from the Kibble-Zurek mechanism. The introduction of an external periodic potential will further allow us to investigate magnetically ordered phases in a lattice.

Two-dimensional quantum gas in a dynamically tunable optical accordion

Jean-Loup Ville, Tom Bienaimé, Raphaël Saint-Jalm, Monika Aidelsburger, Laura Corman, Jérôme Beugnon, Sylvain Nascimbène, and Jean Dalibard

We demonstrate the realization of a uniform two-dimensional (2D) quantum gas of 87Rb atoms in an optical accordion: a one-dimensional lattice of blue-detuned light with tunable spacing. The atoms are first loaded in a single fringe of the accordion lattice, corresponding to a spacing of 10 µm between two bright fringes. The interference pattern can then be compressed down to a spacing of 2 µm between two fringes. This corresponds to an increase of the trapping frequency from 2 to 10 kHz with our current parameters. This enables the realization of 2D gases with large interaction parameter $\tilde{g}$ =0,22. We study the adiabaticity of the compression based on precise temperature measurements.

Scattering of near-resonant photons in a dense bidimensional ensemble of cold atoms

Jean-Loup Ville, Tom Bienaimé, Raphaël Saint-Jalm, Monika Aidelsburger, Laura Corman, Jérôme Beugnon, Sylvain Nascimbène, and Jean Dalibard

Typical cold atomic experiments are performed in the dilute regime, where the response to quasi-resonant light is well described by a lorentzian shape as the detuning is varied. This shape corresponds to the response of a single-atom. With increasing atomic density, dipole-dipole interactions become more important and as the distance between neighbouring atoms becomes as small as the wavelength, strong collective effects are expected. Here we present experiments using a dense two-dimensional atomic cloud with tunable density, allowing us to observe a broadening, a blue shift and a non-lorentzian behaviour at large detunings for the resonance shape. Another interesting aspect of this phenomenon is the transport of photons in such a medium: how far can a photon propagate before escaping a two-dimensional slab of scatterers? We study this experimentally for various atomic densities and compare our findings to classical and quantum models.

Cooling and trapping highly magnetic atoms: the benets of a spontaneous spin polarization

Chayma Bouazza, Thomas Chalopin, Davide Dreon, Leonid A. Sidorenkov, Jean Dalibard, and Sylvain Nascimbène

Narrow-line magneto-optical trapping is an essential step for preparing dipolar quantum gases of Lanthanide atoms. We present an extensive experimental study of Dysprosium gases loaded in a magneto-optical trap operated on the 626-nm optical transition. Far from resonance, we observe a spontaneous polarization of the electronic spin, induced by gravity. In this regime, a simple theoretical model accounts well for the gas properties determined experimentally. We also measure density-dependent atom loss rates in the range 2 10⍰11 cm3/s, in reasonable agreement with a model based on light-induced Van der Waals forces. In the optimal conguration, we prepare spin-polarized samples of about 5 108 atoms at a temperature of 20 K, leading to high phase space densities after transferring the atoms into an optical dipole trap

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Group: Peter Zoller

Adiabatic state preparation of stripe phases with magnetic dipoles

Azadeh Mazloom , Mikhail Baranov , Marcello Dalmonte , Benoit Vermersch and Peter Zoller

We propose a protocol for the realization of magnetic stripe phases with dipoles trapped in a square lattice. Our protocol is based on the study of the adiabatic state preparation of two spin models which can be realized by encoding spin states in Zeeman sublevels of magnetic atoms. We simulate the dynamics of the system within a time dependent variational approach showing the time required to prepare the stripe phase is compatible with an experimental realization

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A sub-wavelength non-destructive microscope for cold atoms

D. Yang, C. Laflamme, P. Hauke, P. Zoller

Despite their huge success, current quantum gas microscopes have two limitations. First, they are fully destructive. Second, their resolution is constrained by the far-field diffraction limit. Here, we propose a new microscope that monitors continuously the atomic position, at a resolution of sub-wavelength scale. This is achieved by exploiting the idea of position-dependent adiabatic passage and coupling the internal transition of the atoms dispersively to an optical cavity. Depending on the location of the atoms, the refraction index of the cavity is modulated, which can be monitored continuously by homodyne detection of the photons leaking out of the cavity. The atoms modify the cavity response only when they enter certain nano-scale zones in space, thus achieving sub-wavelength resolution.

A 'dark state' optical lattice for cold atoms

Mateusz Łącki, Mikhail Baranov, Hannes Pichler, and Peter Zoller

We describe a new way to construct an optical lattice. In the standard setting one uses a a second order process, an AC Stark shift from a far-detuned excited state. The new way is based on different paradigm: a position-dependent dark state generated by a Lambda-type resonant coupling with Raman-type standing wave beams. An atom in the dark state feels an effective potential which is a comb of Dirac-delta like potentials, with distinctively sub-wavelength width. The setup allows for including of the spin-orbit coupling. We present a detailed single-particle description of the model such as band structure, but also discuss in detail losses due to violation of the adiabatic condition and coupling by motion between the dark and bright states and resulting spontaneous emission creation of "domain wall molecules" of subwavelength extent and construction of unconventional Hubbard models. Finally, we show the extension to the many-body case where the atoms carry an dipolar moment, which leads to a situation where the inter-atom interaction is modulated in space, and the also-present single particle potential is relatively weaker. This allows for creation of "domain wall molecules" of subwavelength extent and construction of unconventional Hubbard models.

Chiral quantum optics with V-level atoms and coherent quantum feedback

Pierre-Olivier Guimond, Hannes Pichler, Arno Rauschenbeutel, and Peter Zoller

We study the dissipative dynamics of an atom in a V-level configuration driven by lasers and coupled to a semi-infinite waveguide. The coupling to the waveguide is chiral, in that each transition interacts only with the modes propagating in a given direction, and this direction is opposite for the two transitions. The waveguide is terminated by a mirror which coherently feeds the photon stream emitted by one transition back to the atom. We are first interested in the dynamics of the atom in the Markovian limit where the time-delay in the feedback is negligible. We study the conditions under which the atom evolves towards a pure "dark" stationary state, where the photons emitted by both transitions interfere destructively thanks to the coherent feedback, and the overall emission vanishes. We extend our study to non-Markovian regimes and investigate the effect of the feedback retardation on

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A Coherent Quantum Annealer with Rydberg Atoms

R. van Bijnen, A. W. Glaetzle, P. Zoller, and W. Lechner

There is a significant ongoing effort in realizing quantum annealing with different physical platforms. The challenge is to achieve a fully programmable quantum device featuring coherent adiabatic quantum dynamics and capable of emulating an infinite-range spin-glass. We show that combining the extensive quantum simulation toolbox for Rydberg atoms with the recently proposed parity architecture [1] allows one to build a prototype for a coherent adiabatic quantum computer with all-to-all Ising interactions and, therefore, a novel platform for quantum annealing. In the parity architecture the infinite-range spin-glass is mapped onto a spin-1/2 lattice gauge theory for an enlarged number of qubits and with quasi-local 4-body parity constraints. This spin model can be emulated in a natural way with Rubidium and Cesium atoms in a bipartite optical lattice involving laser-dressed Rydberg-Rydberg interactions, which are several orders of magnitude larger than the relevant decoherence rates. This makes the exploration of coherent quantum enhanced optimization protocols accessible with state-of-the-art atomic physics experiments.

List of Participants

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Programme 3rd UQUAM Workshop Berlin 24th-27th of October 2016

	Monday, Oct 24	**Tuesday, Oct 25**	**Wednesday, Oct 26**	**Thursday, Oct 27**
9:00-9:45		Invited Talk 3 Daniel Greif	Invited Talk 4 Antoine Browaeys	Invited Talk 7 Selim Jochim
9:45-10:15	Registration	Short Talk 4 Benoit Vermersch	Short Talk 6 Karina Jiménez-Garcia	Short Talk 10 Jae-Yoon Choi
10:15-10:45	Short Talk 1 Mikhail Baranov	Coffee Break	Coffee Break	Coffee Break
10:45-11:30	Long Talk 1 Monika Aidelsburger	Long Talk 3 Marcello Dalmonte	Invited Talk 5 Hui Zhai	Short Talk 11 (10:45-11:15) Leonid Sidorenkov
11:30-12:00	Coffee Break	Short Talk 5 Eyal Leviatan	Short Talk 7 Alexander Glätzle	Short Talk 12 (11:15-11:45) Christoph Gohle
12:00-12:30	Short Talk 2 Sylvain Nascimbène		Lunch Break (12:15-13:15)	Closing Remarks
12.30-13.15	Long Talk 2 Guillaume Salomon			
13.15-14:15	Lunch Break		Open Discussion	
14.15-15:00	Open Discussion			
15:00-15:45	Invited Talk 1 Nathan Goldman		Invited Talk 6 Gil Refael	
15:45-16:15	Short Talk 3 Lukas Sieberer		Short Talk 8 Christian Schweizer	
16:15-16:45	Coffee Break	Free Afternoon	Coffee Break	
16:45-17:30	Invited Talk 2 Jürgen Berges		Long Talk 4 Mark Fischer	Departure
17:30-18:00	Poster Flash Presentation		Short Talk 9 Ionut-Dragos Potirniche	
18:00-19:30	Poster Session			
19:30			Conference Dinner	