

UQ Quantum Gas Workshop Schedule

Sunday 18 November – Friday 30 November 2012

www.physics.uq.edu.au/people/mdavis/UQQG2012/

Matthew Davis: 0423 184082. Simon Haine: 0434 946927. Karen Kheruntsyan: 0404 753449.

Sunday 18 November 2012

5:00-7:00pm: Reception and dinner, in the new courtyard outside the Physics Annexe.

Wednesday 21 November 2012

6:30-9:30pm: Workshop dinner, Customs House, 399 Queen Street, CBD.

Sunday 25 November 2012

5:00-7:00pm: Reception and dinner, in the new courtyard outside the Physics Annexe.

Thursday 29 November 2012

6:30-9:30pm: Workshop dinner, Dell Ugo restaurant, 182 Grey St, Southbank.

To pick up your keys and get set up at your desk, you can come to the reception a bit early. Otherwise, come to level 4 of the Physics Annexe at 8:30am on Monday morning. We will then take you to the presentations. Otherwise, we'll see you at the talk.

Talks: (morning tea between, followed by lunch)

Date	Location	9:15am	11:00am
Mon 19 Nov	14-116	Kris Helmerson	John Close
Tue 20 Nov	07-222	Andy Martin	Tapio Simula
Wed 21 Nov	07-222	Chris Vale	Blair Blakie
Thu 22 Nov	07-222	Elena Ostrovskaya	Ashton Bradley
Fri 23 Nov	07-222	Hui Hu	Tod Wright
Mon 26 Nov	14-116	Craig Savage	Joachim Brand
Tue 27 Nov	14-116	Dave Kielinski	Charles Clark
Wed 28 Nov	14-217	Andre Luiten	Uli Zuelicke
Thu 29 Nov	14-116	Andrew Truscott	Simon Haine
Fri 30 Nov	14-116	TBC	Joel Corney

Talks should be 40 mins + 20 mins for questions/discussion. The purpose of this workshop is to initiate collaborations and to look towards the future, so speculation is welcome. Please refrain from summarising your research from the last five years.

Morning tea will be served outside the lecture theatre between the first and second talk.

Following the second talk there will be lunch provided at Women's College. It is about a 10-minute walk from building 14 to the college. Dietary requirements have been advised.

Afternoon (Physics Annexe): 1:30pm – 5:30pm

Collaboration, discussion, coffee drinking, etc.

Internet access

All staff and students from ANU, Monash, Massey, Swinburne should have wireless access via eduroam. **Please test at your home institution before you come to UQ.** People from the University of Otago will have temporary accounts set up for them. We expect you to bring your own computer with you, unless other arrangements have been made.

Office space

Everyone has a desk somewhere in the Physics Annexe on level 3 or 4. Pick up access card and keys either at the welcome reception, or following the first set of talks. There is a small kitchenette area near most of the offices on level 4.

Location	Places	19 – 23 Nov	26 – 30 Nov
Seminar room, 06-407	8	Tapio Simula Alberto Cetoli Andy Martin Tom Billam Hui Hu Blair Blakie Elena Ostravskaya John Close	Tapio Simula Dave Kielpinski Leo Li Stuart Szigetti Uli Zuelicke Andre Luiten Andrew Truscott Ken Baldwin
Karen Kheruntsyan, 06-402	1	Craig Savage	Craig Savage
Matthew Davis, 06-403	1	Kris Helmerson	Kris Helmerson
Joel Corney, 06-406	2	Joachim Brand Chris Vale	Joachim Brand Chris Vale
Michael Bromley	1	Ashton Bradley	Charles Clark
06-303	4	Matt Reeves Stuart Szigetti Danny Baillie Leo Li	
06-314	2	Sam Rooney Oleksandr Fialko	

Getting around

Brisbane airport is a little bit of a pain to get to/from the University of Queensland. You can take the train to Toowong if you arrive at a reasonable hour. You can then get a bus (412) from there to St Lucia. Another option is that the trains to the Gold Coast – get off at the “Boggo Rd” station. It is not far from there to UQ across the Eleanor Schonell bridge (bus 109). A taxi to UQ will probably set you back around \$60.

There is integrated ticketing system in Brisbane for which you can use a smart card. You can get a “Go Card” from newsagents and other places, and top it up with money to travel. You can also buy paper tickets on board at a significant premium. Full information here:

<http://translink.com.au/>

Useful services:

- 412 bus from Chancellor’s Place goes to the Toowong shops and train station
- 109 bus from UQ Lakes goes to Southbank / CBD in about 10 minutes.
- CityCat Ferry goes to Southbank/CBD/beyond.

There is also the CityCycle service – where you can hire bikes from stands provided by the Brisbane City Council – see <http://www.citycycle.com.au/> There are usually helmets that you can use available at the stands.

Places to eat

- Dinner will be provided at the Sunday reception from 5-7pm on 18 November and 25 November. Both are in the new courtyard just outside the Physics Annexe. We will move under the building in case of rain.
- After the seminars, we will all go to lunch at Women's College.
- There will be two workshop dinners:
 - Wednesday 21 November is at UQ Customs House in the Brisbane CBD. Take the ferry – get off at Eagle St Pier
 - Thursday 29 November at Dell Ugo Restaurant on 182 Grey St, Southbank. Take the ferry – get off at Southbank, or take the 109 bus.
- People staying at Women's College have breakfast included.

Otherwise there are a number of places to eat on campus. A summary can be found here:

<http://www.uq.edu.au/about/places-to-eat>

The local's favourite is the Schonell Pizza Café – and this is where we will be getting pizza from for the Sunday receptions. There are also a number of restaurants at the St Lucia Village shops, a five-minute walk off campus down Hawken Drive (see map).

Maps

A map of useful locations can be found here:

<http://goo.gl/maps/uH2T2>

There is also a “UQ navigation” app available on the Apple App store, or Google Play. Additionally, there is printable map on the workshop website.

Full talk schedule

Monday 19 November 9:15am, 14-116 Kris Helmerson Monash U.	Experiments with dual species BECs An apparatus capable of generating Bose-Einstein condensates of potassium and rubidium atoms is near completion at Monash. My talk will describe how the use of dual species will enable new measurement capabilities in two frontier areas of ultracold atom research – non-equilibrium dynamics in quantum systems and atomtronics.
Monday 19 November 11:00am, 14-116 John Close ANU	TBC
Tuesday 20 November 9:15am, 07-222 Andy Martin Melbourne U.	Interaction Dominated Physics This talk will cover some of the aspects concerning the properties of ultracold gases and coupled atom cavity systems in the regime where interactions dominate. Initially we will review the properties of the onsite Bose-Hubbard model and the Jaynes-Cummings Hubbard model (coupled atom cavities): examining theoretical and experimental advances in this area. We will then move onto examine the emergence of fractional quantum Hall states in ultracold gases and coupled atom cavity systems. We will then consider the properties of stationary and rotating ultracold Fermi gases in the regime of strong interactions. Finally, we will revisit these three areas and ask what are the challenges still to be addressed?
Tuesday 20 November 11:00am, 07-222 Tapio Simula Monash U.	"Vortex matter" After introducing quantized vortices as sources of synthetic electromagnetic fields, I will proceed to emphasize the fundamental role of quantized vortices in systems ranging from atomtronic circuits to quantum turbulence, Berezinskii-Kosterlitz-Thouless superfluidity, quantum-Hall effects, high-temperature superconductivity, and Majorana states and topological quantum computation. I will conclude the presentation with an attempt to argue the possibility of a zoo of topological states of matter and emergent phenomena yet to be discovered, and that controllable cold atom systems have the potential to play a significant role in such future discoveries.
Wednesday 21 November 9:15am, 07-222 Chris Vale Swinburne U.	Experiments with Fermi gases in three and two dimensions This talk will describe current and future research on ultracold Fermi gases at Swinburne. I will begin with an overview of the main ideas and motivations for our work with a focus on some outstanding questions. The majority of the talk will cover research planned in the coming years including measurements of the low momentum collective response of a Fermi superfluid and the study of superfluidity in 2D Fermi gases near a Feshbach resonance.
Wednesday 21 November 11:00am, 07-222 Blair Blakie U. Otago	Quantum Dipole Gases I will give an overview of work in my group on the meanfield theory of quantum degenerate gases with dipole-dipole interactions at zero and finite temperature. I will discuss the emergence of rotonic excitations in Bose-Einstein condensates and the properties of warm (normal) Bose and Fermi gases.
Thursday 22 November 9:15am, 07-222 Elena Ostrovskaya	Condensed exciton-polaritons in semiconductor microcavities The exciton-polariton condensate is a recently observed macroscopically-coherent quantum state with strong similarity to

ANU	the atomic Bose-Einstein condensate. Exciton-polaritons are half matter-half light bosonic quasi-particles emerging in semiconductor microcavities in the regime of strong coupling of cavity photons and excitons. I will talk about the possibilities of employing this system to study two-dimensional condensate physics, nonequilibrium effects, superfluidity, and potential applications in spinoptronics.
Thursday 22 November 11:00am, 07-222 Ashton Bradley U. Otago	Inverse energy cascade in forced two-dimensional quantum turbulence As a canonical example of a compressible superfluid, the dilute gas Bose-Einstein condensate offers a unique setting for turbulence studies. Recent work on two-dimensional quantum turbulence in BECs will be presented in this talk where I will describe the creation and characterization of an inverse energy cascade in two-dimensional quantum turbulence. The presence of the cascade is confirmed via three independent measures: merging and expansion of like-sign quantum vortex clusters, verification of K41 spectra without fitted parameters, and Kraichnan condensation of quantum vortices.
Friday 23 November 9:15am, 07-222 Hui Hu Swinburne U.	Radio frequency spectroscopy of a spin-orbit coupled atomic Fermi gas Interacting Fermi gases with spin-orbit coupling are responsible for many intriguing phenomena such as topological superfluids and Majorana fermions. To date, spin-orbit coupled Fermi gases of 40K atoms and of 6Li atoms have been realized at ShanXi University (Jing Zhang group) and at MIT (Martin Zwierlein group), respectively, by using two counter-propagating Raman beams. Radio frequency (rf) spectroscopy would be a powerful tool to characterize this interesting new many-body system. In this talk, I will discuss about some new features in rf-spectroscopy arising from spin-orbit coupling.
Friday 23 November 11:00am, 07-222 Tod Wright U. Queensland	TBC
Monday 26 November 9:15am, 14-116 Craig Savage ANU	Are there classical objects in the world? Classical and quantum physics sit uneasily together. We usually assume that at the end of the von Neumann chain, measurement devices are classical. However, we lack a complete theory that describes, for example, the back action of the measured quantum system on the classical measurement device. Interestingly, this fact limits the scope of quantum chemistry, in which the parts of a molecule treated as quantum and as classical must interact. Our theory of gravity is also classical, but there is presently no coherent way to couple it to the rest of the quantised world. In both of these examples the lack of experimental data is the major impediment to theory development. I will explore the problem of unifying quantum and classical physics, including the range of failed attempts.
Monday 26 November 11:00am, 14-116 Joachim Brand Massey U.	More is different: Symmetry breaking in a metastable quantum phase transition with ultra-cold bosons in a one-dimensional ring trap The role of spontaneous symmetry breaking in the emergence of mean-field phenomena has been both ideologised and denied or treated as suspect in the context of quantum gas experiments with finite samples. Here we consider a case study of symmetry breaking in the quantum phase transition between metastable states of a one

	dimensional Bose gas in a ring. The metastable states are characterised by the presence or absence of dark solitons or their quantum equivalent called yrast states. While dark solitons represent symmetry-broken mean-field states, the translationally invariant (symmetric) yrast states are the true eigenstates of the quantum system described as "type II" elementary excitations by Lieb. We discuss how explicit external symmetry breaking can create an adiabatic passage that nucleates the phase transition and leads the way to spontaneous symmetry breaking and classicality in a thermodynamic limit. Open questions to the role of global versus local symmetry breaking for the nucleation of metastable quantum phase transitions will be discussed.
Tuesday 27 November 9:15am, 14-116 Dave Kielpinski Griffith U.	The shadow of a single atom We have performed absorption imaging of a single atom for the first time [1]. A trapped Yb ⁺ atomic ion scatters light out of an illumination beam tuned to atomic resonance at 369.5 nm. When the beam is reimaged onto a CCD camera, we observe an absorption image of 440 nm diameter and 5% contrast. The absorption contrast is investigated as a function of laser intensity and detuning, and closely conforms to the limits imposed by simple quantum theory and known properties of our imaging system. Defocused absorption images provide spatial interferograms of the scattered light, permitting accurate retrieval of the amplitude and phase of the scattered wave. We measure a phase shift of >1 radian in the scattered light as a function of laser detuning, which may be useful in quantum information protocols. The interferograms point to the possibility of observing the focusing of light by a single atom.
Tuesday 27 November 11:00am, 14-116 Charles Clark JQI	TBC
Wednesday 28 November 9:15am, 14-217 Andre Luiten U. Western Australia	Hybrid Gas-Fibre Photonics
Wednesday 28 November 11:00am, 14-217 Ulrich Zuelicke Victoria U. Wellington	Low-dimensional spin-orbit-coupled BECs: Inspirations from semiconductor spintronics The recent experimental realisation of synthetic gauge fields in ultra-cold atom gases has opened up the possibility for studying a host of interesting magnetic-field and spin-orbit-coupling effects for macroscopic quantum states. My presentation will be focussed on two-component (pseudo-spin-1/2) systems that are subject to (pseudo-)spin-dependent gauge fields. As is familiar from semiconductor spintronics, the interplay of spin-orbit coupling and confinement results in unusual single-particle properties. Using grey solitons in a ring-trapped BEC as an example, the additional presence of the (in general, pseudospin-dependent) contact interactions in cold-atom gases is shown to enable new types of spin-dependent phenomena.
Thursday 29 November 9:15am, 14-116 Andrew Truscott ANU	TBC
Thursday 29 November	Atomic-photonic hybrid circuits and the future of quantum enhanced atom interferometry

<p>11:00am, 14-116 Simon Haine U. Queensland</p>	<p>Atom interferometry provides extremely sensitive measurements of quantities such as rotations and accelerations, and has the potential to enable tests of fundamental theories beyond the standard model. I will discuss recent advances in quantum enhanced atom interferometry, and the possibility of creating practical high-flux sub-SQL devices that provide a real increase in sensitivity. In particular, I will focus on a new type of device: an atomic-photon hybrid circuit, that uses atom-light entanglement rather than atom-atom entanglement to enhance the sensitivity of an interferometric measurement.</p>
<p>Friday 30 November 9:15am, 14-116 TBC</p>	<p>TBC</p>
<p>Friday 30 November 11:00am, 14-116 Joel Corney U. Queensland</p>	<p>TBC</p>

Participants

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