

THEORETICAL PHYSICS RESEARCH GROUP

University of Leeds

NEWS AND EVENTS ARCHIVE – 2016

PhD position available: "Quantum computing with photonic networks"

16 December 2016

Funded PhD position available for project on "Quantum computing with photonic networks" in close collaboration with the Oxford Quantum Technology Hub NQIT.

Please contact Almut Beige [A.Beige@leeds.ac.uk] for more information.

PhD position: Photoactive molecular complexes

9 December 2016

Contact: Dr. Arend G. Dijkstra (a.g.dijkstra@leeds.ac.uk)

In our group, we use models to understand how molecular systems use light to function. These models are compared with state of the art optical experiments, which allow us to probe the fundamental motions of electrons and nuclei that take place on femtosecond to picosecond time scales. Inspiration for our work comes from biological systems. Our work uses mathematics and computer programming. The projects are suitable for chemistry, physics and mathematics graduates. The first project is about photosynthesis. How is the energy that is collected by plants and bacteria from sunlight transported? It turns out that answering this question requires a detailed description of the pigment molecules that interact with the light, as well as of the protein and solvent environment. In this project, you will build a new model of the energy transport mechanism. The model will be based on quantum mechanics of an electronic system interacting with vibrations. A main goal of the project is to accurately determine the parameters that describe real systems, from either simulation or comparison to experiment.

The second project is about photo switching. Some of the fastest events in biology occur within the eye. As in photosynthesis, electrons are excited by light absorption, However, in the primary step in vision the nuclear motion induced by electronic excitation is very large. Cis-trans isomerization in the rhodopsin molecule completely changes the structure. The system clearly explores parts of the potential energy surface far away from equilibrium, such that a harmonic description is completely invalid. This is also the case in man-made photo switches. This is a challenging regime for models that treat both the electronic and the nuclear motion under the

influence of the protein environment. This project aims at developing a new theory to describe quantum decoherence and friction outside the harmonic approximation.

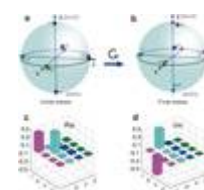
References

- [1] Dijkstra, A. G. and Tanimura. Y., *New J. Phys.* 14, 073027 (2012);
- [2] Prokhorenko, V. I., Picchiotti, A., Pola, M., Dijkstra, A. G. and Miller, R. J. D., *J. Phys. Chem. Lett.* 7, 4445 (2016);
- [3] Dijkstra, A. G., Wang, C., Cao, J. and Fleming, G. R., *J. Phys. Chem. Lett.* 6, 627 (2015).

New paper in Nature Communications on exchanging Majorana zero modes

31 October 2016

Nature Communications 7, Article number: 13194 (2016)



Experimental Simulation of the Exchange of Majorana Zero Modes

Majorana zero modes are an eagerly anticipated resource for quantum information processing as they offer immunity to noise, but they are difficult to create and control experimentally. In collaboration with theorists and experimentalists from Hefei University of Science and Technology in China, Dr Jiannis Pachos from the Theoretical Physics Group in Leeds demonstrated in a recent publication in [Nature Communications](#) a fundamental property of Majorana fermions: their non-trivial statistics. This was performed with a quantum simulation of a superconducting chain with linear optics. This system provided the degree of controllability that enabled the manipulation of Majorana quasiparticles and the demonstration of their anyonic statistics. A popular version of the article has been published in [2Physics](#).

2016: The Year of Topology in Condensed Matter Physics

19 October 2016

Read about Nobel Prize in Physics 2016 and how it relates to our research.

This year two of the most important physics prizes have been awarded to pioneers of topology in condensed matter physics.

The 2016 Nobel Prize for Physics was divided between David Thouless, Duncan



Haldane and Michael Kosterlitz for “Theoretical Discoveries of Topological Phase Transitions and Topological Phases of Matter”, while the Oliver Buckley Condensed Matter Physics Prize went to Alexei Kitaev and Xiao-Gang Wen for “Theories of Topological Order and its Consequences in a Broad Range of Physical Systems”

[Read more](#)

New paper in Physical Review Letters

11 October 2016

"Power-Law Entanglement Spectrum in Many-Body Localized Phases", Maksym Serbyn, Alexios A. Michailidis, Dmitry A. Abanin, and Z. Papić, Phys. Rev. Lett. 117, 160601 (2016).



Efficiently simulating many-body localisation

The amount of quantum entanglement in a many-body wave function determines whether it can be efficiently compressed and encoded by a small number of classical parameters. Ground states of many-body systems are known to have low entanglement, and can be efficiently simulated by the so-called "matrix product states" -- the property which underlies the success of the density-matrix renormalisation group.

In a new paper published in [Phys. Rev. Lett.](#), the authors characterise the entanglement of highly excited states in many-body localised (MBL) systems by studying its "entanglement spectrum". MBL phases have been a subject of much recent interest as phases of matter that break ergodicity and thus avoid thermalisation. The paper argues that the entanglement structure of MBL states, while different from ground states, still allows for compact parametrisation by matrix product states. An efficient algorithm is developed to obtain highly excited states of large MBL systems. This work opens a door for studying a broad class of disordered quantum systems, inaccessible by other techniques. It is expected that the new algorithm will also give a much-needed insight into the nature of the transition between MBL and ergodic (thermal) phases.

journals.aps.org/prl/abstract/10.1103/PhysRevLett.117.160601

Royal Society Meeting: Breakdown of Ergodicity in Quantum Systems

15 September 2016

Scientific discussion meeting organised by Professor Sir Michael Pepper FRS, Dr Arijeet Pal, Dr Zlatko Papic, Dr Ulrich Schneider and Professor Steven Simon



Ergodic systems lie at the heart of statistical physics since they reach thermal equilibrium and 'forget' their initial conditions, thereby allowing for coarse-grained classical descriptions. Recently, non-ergodic quantum many-body systems, which fail to thermalise and decohere completely, came into focus. This interdisciplinary meeting will address their fundamental challenges and experimental realisations, including many-body localisation and other novel, non-classical long-time behaviour. [Register here](#)

Sarah Harris published paper in Nature Communications

19 May 2016

Dr Sarah Harris who leads the Computational Biophysics group has published a paper entitled "Structural diversity of supercoiled DNA" in Nature Communications.

The article's reference is:

Rossitza N. Irobalieva, Jonathan M. Fogg, Daniel J. Catanese Jr, Thana Sutthibutpong, Muyuan Chen, Anna K. Barker, Steven J. Ludtke, Sarah A. Harris, Michael F. Schmid, Wah Chiu & Lynn Zechiedrich. Nature Communications 6, Article number: 8440

It can be accessed [here](#)

20th Symposium on Topological Quantum Information, Athens (May 25-27, 2016)

28 April 2016

The series of Symposia on Topological Quantum Information aims at bringing together researchers interested in understanding topological phases, how they emerge in physical systems, and their potential for facilitating quantum computation.

[Information and registration](#)

Quantum Matter Out of Equilibrium Symposium taking place soon!

31 March 2016

4th-5th April

[This series of symposia](#) take place every few months and typically last for two days. Their purpose is to bring together young scientists (mainly PhD students and Postdocs) interested on topological quantum information promote their recent work and inspire collaborations.

To register please email you name and institution to topo-symp@leeds.ac.uk with 'Registration' as the subject heading.

Please see below for the schedule the day will follow:

Monday

09:30-12:30 Juan Garrahan: Aspects of slow relaxation, glasses and non-equilibrium.
12:30-13:30 Lunch
13:30-14:30 Henning Schomerus: Signatures of chaotic scattering from Majorana zero modes.
14:30-15:30 Earl Campbell: Cellular automata decoders on the toric code.
15:30-16:00 Break
16:00-17:00 Marta P Estarellas: Topologically protected localised states in spin chains.
17:00-17:30 Konstantinos Meichanetzidis: Topological edge states are monogamous.
17:30-19:00 Poster and Discussion Session

Tuesday

09:30-12:30 Andrew Green: Combining eld theory and tensor networks.
12:30-13:30 Lunch
13:30-14:30 Aires Ferreira: Robustness of topological phases in adatom-decorated graphene.
14:30-15:30 James Wootton: Quantum computing with parafermions.
15:30-16:00 Break
16:00-17:00 Adam Stokes: Decomposition of Hilbert Spaces and the second law of thermodynamics
17:00-17:30 Chris Self: Ising anyons at nite temperature.

Tune in!

15 March 2016

Tune in and listen to Dr Jiannis Pachos on the Leeds University Union Radio Show at 2pm tomorrow (Wednesday 16th March) as part of the #heartofscience discussions.



Anyone can get involved by sending questions through via Twitter using the #heartofscience.

Photo16 deadline approaching

16 February 2016

Photon16 is the largest photonic and optics conference in the UK and the eighth event in the biennial series organised by the Institute of Physics.

Over four days, Photon16 participants will have the opportunity to visit exhibitions on the latest in optics and photonics technology, attend lectures from experts in the field, and get up to date with cutting-edge research. The conference programme will consist of plenary and invited talks, as well as contributed presentations and posters, tutorials and an Industry Technology Programme.

Plenary speakers

- ◆ Professor Paola Borri, Cardiff University, UK
- ◆ Professor Shanhui Fan, Stanford University, USA
- ◆ Professor Helen Gleeson, University of Leeds, UK
- ◆ Professor John Tisch, Imperial College London, UK
- ◆ Professor Birgitta Whaley, University of California, Berkeley, USA
- ◆ Professor Eli Yablonovitch, University of California, Berkeley, USA

Abstract submission

Online abstract submission is open for poster and contributed oral presentations. Abstracts of up to 300 words should be submitted online at www.photon.org.uk <http://iop-london.msgfocus.com/c/167ha1joAFYmAB91ng0QjdF>

Key dates

Abstract submission deadline: 29 February 2016

Early registration deadline: 1 July 2016

Registration deadline: 26 August 2016

Congratulations To Tom Barlow

4 February 2016

Congratulations to Tom Barlow. His recent article on a physically-motivated quantisation of the electromagnetic field reached more than 1000 full-text download within three months of publication:



iopscience.iop.org/article/10.1088/0143-0807/37/1/014001/meta

Dr Pachos takes on Singapore

22 January 2016

Dr Jiannis Pachos from University of Leeds is lecturing at the School of Quantum Information Processing, Singapore 18-29 January 2016 (<http://www.ntu.edu.sg/ias/upcomingevents/ICTP/Pages/default.aspx>).

Among the lecturers of the school are three Nobel Laureates, Prof Gerard t'Hooft (pictured with Jiannis), Prof Tony Leggett and Prof Serge Haroche. The topic of his lectures is Topological Quantum Information.

Deadline approaching

20 January 2016

Please note there is an upcoming deadline in June to apply for a PhD studentship in Mathematical Physics and Applied Mathematics. Details for this are below, but for any candidates interested in this, could you please contact the potential PhD supervisors.

Please see here: [PhD details](#)



Saying goodbye

8 January 2016

On the 4th of December, we said goodbye to Prasenjit Deb, who joined the group for 6 months as a visiting PhD student. We also welcome Dr Mubashir Khan, who joined us as a visiting Associate professor from Pakistan.