

Quantum Biology: Current Status and Opportunities



17 September 2012 - 18 September 2012

WORKSHOP REPORT

Evidence has recently emerged that plants use a form of quantum computing to calculate how best to direct energy through their photosynthetic apparatus. Scientists have discovered that birds, insects and other animals appear to use entanglement (what Einstein called “spooky action at a distance”) to detect the earth’s magnetic field. And there is solid evidence that enzymes, those metabolic workhorses that drive much of the action in our cells, use the process known as quantum tunnelling to accelerate chemical reactions. We may even use quantum mechanics to smell! Centres of quantum theoreticians and experimentalists on both sides of the Atlantic are struggling to understand how fragile quantum mechanical phenomena previously thought to be confined to highly rarefied laboratory systems at temperatures close to absolute zero, manage to survive in the wet, warm biological world.



The workshop sponsored by the Institute of Advanced Studies, BBSRC (Biotechnology and Biological Sciences Research Council) and MILES (Models and Mathematics in Life and Social Sciences) proved to be a great success and was attended by some of the leading researchers in this exciting new interdisciplinary field from across the world.

The talks, both plenary and shorter ones, stimulated much discussion and led to a vibrant and informative 'discussion' session at the end of Day 2. Filmed keynote talks, interviews and a group discussion are available below.

Keynote presentations and interviews (Surrey YouTube Channel)

DAY 1

Session 1

Professor Johnjoe McFadden, University of Surrey

Why biology needs quantum mechanics

[Presentation](#) and [interview](#)

Dr Paul Davies, Arizona State University

Quantum epigenetics

[Presentation](#) and [interview](#)

Session 2

Professor Jim Al-Khalili, University of Surrey

Quantum tunnelling models of genetic mutations

[Presentation](#) and [interview](#)

Session 3

Professor Greg Scholes, University of Toronto

Evolution, speciation, and coherence in the light harvesting proteins of photosynthetic algae

[Presentation](#) and [interview](#)

Dr Alexandra Olaya-Castro, University College London

Quantum phononics in biology

[Presentation](#)

Session 4

Professor Greg Engel, University of Chicago

Design principles behind long-lived quantum coherence

[Presentation](#) and [interview](#)

DAY 2

Session 5

Professor Thorsten Ritz, UC Irvine

A biological compass built on coherent quantum reactions: Design principles and supporting evidence

[Presentation](#) and [interview](#)

Dr Jennifer Brooks, University College London / Harvard University

Can the nose smell quantized properties of odorant molecules in olfaction?

[Presentation](#) and [interview](#)

Session 6

Professor Nigel Scrutton, University of Manchester

Quantum effects in biological catalysis

[Presentation](#)

Session 7

Professor Vlatko Vedral, University of Oxford

Quantum thermodynamics of electron transport

[Presentation](#) and [interview](#)

Session 8

Filmed Group discussion can be viewed [here](#)

A complete Programme with paper and poster abstracts can be found [here](#).

THEMES

Overall, this was a meeting of three very different fields: quantum physicists, quantum chemists and molecular biologists tend to use different approaches, skills and language. This was a wonderful opportunity not just to cross-fertilise ideas but to reach a common understand and consensus on the major problems in this field. Broadly, the scientific themes that emerged from the talks can be split into two categories that match very well with the subheading of the workshop itself:

* **Current status** (in both experimental biology and theoretical quantum modelling).

* **Opportunities** (for future experiments, for theoretical developments and for research collaborations).

- * *The need for quantum mechanics in biological systems.*
- * *New approaches in studying open quantum systems.*
- * *Quantum dynamics in photosynthesis (theory and experiment).*
- * *Quantum dynamics in enzymes (theory and experiment)*
- * *Quantum effects in DNA and mutations (theory and experiment).*
- * *Other experimental systems (sensory, neural, etc.).*
- * *Maintaining quantum coherence in wet warm cells.*
- * *Establishes the Surrey organisers as part of the international community working in this field (building contacts with other researchers, invited to future meetings and conferences elsewhere, etc).*
- * *Allowed the opportunity to discuss the science at an informal, yet deep level, that is difficult to achieve in any other setting.*
- * *Helped clarify future research direction and aims of organisers with hope of Surrey publications in 2013, potentially jointly with collaborators elsewhere, such as the quantum chemistry group at UCL.*
- * *Led to the organisers establishing a series of seminars (once monthly) to be held at Surrey (initially funded by the BBSRC). Already, a commitment has been made by Nobel Prize winning biochemist, Sir Tim Hunt, to give a seminar at Surrey during early summer of 2013.*
- * *Provided very useful background material for a book on the subject currently being written jointly by the organisers and to be published in UK (Bantam Press) and US (Random House) in 2014.*

******LATEST UPDATE****SEMINAR SERIES******

Friday, 21 June 2013 at 2pm, University of Surrey

The Secrets of Cell Division

Sir Tim Hunt, Cancer Research UK

Sir Tim won the 2001 Nobel Prize in Physiology or Medicine for his part in discovery of the protein that controls cell division.

[More information and registration](#)

SPONSORS

Institute of Advanced Studies at the University of Surrey, BBSRC, MILES (Models and Mathematics in Life and Social Sciences) project

WORKSHOP CONVENORS

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Professor Johnjoe McFadden, Microbial Sciences, University of Surrey

Professor Vlatko Vedral, University of Oxford

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Event filming: Kippertie Productions

