UNIVERSITY OF CAMBRIDGE

Winton Programme for the Physics of Sustainability

Inaugural Celebration

24 March 2011

Transforming Tomorrow

The Kapitza and Microelectronics Research Centre of the Cavendish Laboratory. These will house programmes in optoelectronics, nanophotonics and microelectronics.

Kelvin Fagan

“The Cambridge University 800th Anniversary Campaign has an objective: ‘The Freedom to Discover’ and I am hoping I can give the scientists at the Cavendish more freedom to discover,” says David Harding. “I studied theoretical physics at Cambridge, and the Cavendish has always had the reputation of attracting the finest minds in the world. While it is not quite as simple as using physics to save the world, this is an opportunity to use, for example, quantum physics to develop materials with seemingly miraculous properties that could combat the growing effect humans are having on the planet. I want to encourage research to keep the skies blue.”

David Harding

David Harding, the Founder, Chairman and Head of Research of Winton Capital Management, has pledged to donate £20 million to the Cavendish Laboratory to set up and fund the Winton Programme for the Physics of Sustainability. His gift, the largest donation to the Laboratory since its creation in 1874, will create a new programme in the physics of sustainability, applying physics to meet the growing demand on our natural resources.

David Harding and Winton Capital

Since graduating from Cambridge in 1982, **David Harding** has become one of the most successful fund managers in the world. Early on he recognised the advantages of hiring individuals with science backgrounds. **Winton** currently employs over 90 researchers with PhDs or Master’s degrees in subjects including extragalactic astrophysics, mathematics, statistics, particle physics, planetary science and artificial intelligence.

“At its core Winton is much more than an investment manager,” says David Harding. “We are a scientific research centre using empirical methods to analyse data. The financial markets may be **our** laboratory but just like the Cavendish we are driven by research.”

“The University is most grateful to David Harding for this donation, which is truly exceptional both in its generosity and in its vision of translating fundamental discoveries in physics, to meet one of the most pressing needs of our generation.”

The Vice-Chancellor, Professor Sir Leszek Borysiewicz

“Advances in fundamental physics have always had the capacity to solve very real problems. This programme will support the people with the radical ideas that bring practical solutions - very much the Cambridge way of doing science.”

Cavendish Professor of Physics, Sir Richard Friend

Winton Programme for the Physics of Sustainability

The donation will support research programmes that explore basic science which can generate the new technologies and new industries that will be needed to meet the demands of a growing population on our already strained natural resources. The programme's director is Professor Sir Richard Friend, the Cavendish Professor of Physics and a world-renowned leading expert on the physics, materials science and engineering of semiconductor devices.

The programme will provide PhD studentships, research fellowships, and support for new academic staff as well as investment in research infrastructure of the highest level, pump-priming for novel research projects, support for collaborations within the University and outside, and sponsorship for outreach activities. There will be a strong emphasis upon fundamental research that will have importance for the sustainability agenda in the long-term.

Head of the Cavendish Laboratory, Professor Peter Littlewood

A new cryogenic system that enables high pressure experiments to be performed at millikelvin temperatures in a routine manner with a fast turnaround time.

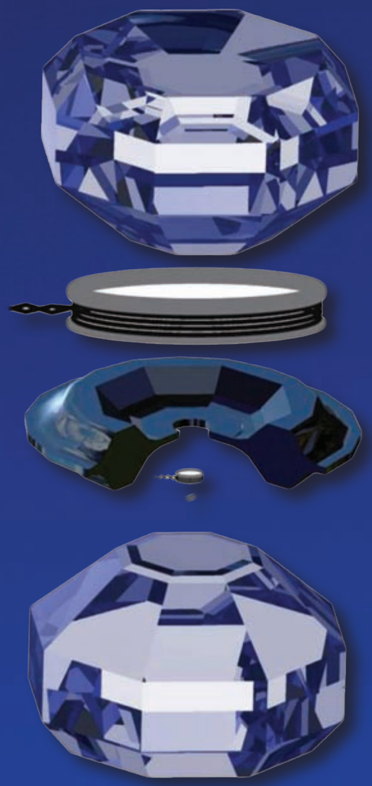
The Physics Challenge

Professor Peter Littlewood, Head of the Cavendish Laboratory, described his vision of the challenges facing society and the underlying physical problems to be addressed by the Winton Programme.

"In 2100, the sources of energy on this planet will be either solar or fusion, and the preferred means to transport and use energy will be electrical. The "magic" technologies needed to deliver this new age and make them available to societies world-wide are: photovoltaics, electrical storage, refrigeration, and lighting.

These technologies are particularly important for use in the developing world. There are no basic physical principles preventing breakthroughs in all these areas. Today, solid state lighting is the closest we have got to the appropriate performance. New materials discoveries and the development of new physics concepts are needed to bring this vision to fruition and make resulting technologies available worldwide."

Matt Bilton

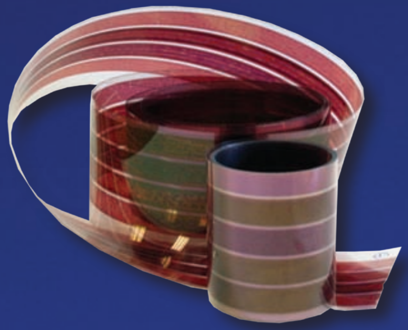


An artificial diamond anvil with external modulation coil and internal sensing microcoil used to study materials under extreme conditions of low temperature and high pressure.

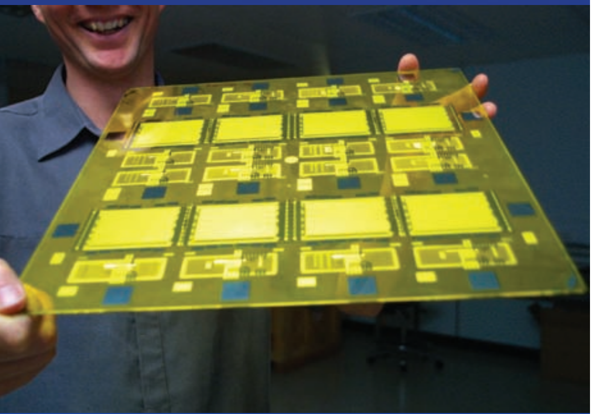
Physics Challenge: Designer materials

Atom by atom manipulation and growth may allow the creation of new chemical environments with desirable properties. Molecular engineering using materials chemistry can already be used to grow molecular solids containing functional units. We can further tune properties of materials by applying extreme conditions of temperature, pressure and magnetic and electric fields to search for emergent properties such as superconductivity or magnetism. We are seeking to reach the ultimate limits: a room temperature superconductor for dissipationless electrical wires; a material with a large tuneable entropy change as an ideal refrigerator material; electrical storage densities to rival gasoline; and new mechanisms for thermoelectricity to scavenge heat from the environment.

Matt Bilton



Solar cells can now be produced by roll-to-roll printing.

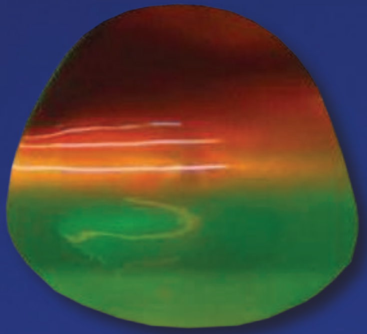


Cambridge Display Technology's plastic light-emitting diode test cells.

Physics Challenge:
Light and matter

The primary source of energy on our planet is sunlight. Converting incident light to useful electrochemical stored energy needs heterogeneous materials with controlled quantum chemistry, delivered on a vast scale in cheap and robust devices. Patterns of metals and dielectrics on the nanoscale may be used to enhance the sensitivity of molecular detection, and are also a method to manipulate quantum coherence which will be the ultimate efficient computing technology. Photovoltaics require both strong optical absorption and good electrical transport, best arranged in a three-dimensional structure that is largely interface. Future efforts will involve active tuning of structures as well as fully three-dimensional patterns.

Matt Bilton



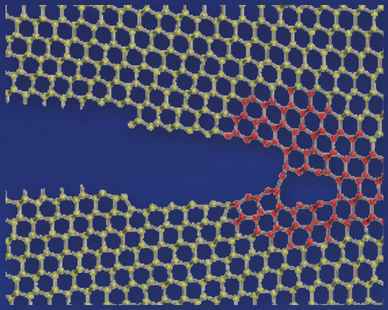
Colour changes induced by the bending of a nanophotonic crystal.

Using established nano-fabrication procedures, self-assembly and atomic layer deposition, identical copies of butterfly scales on areas of several square centimetres have been created.

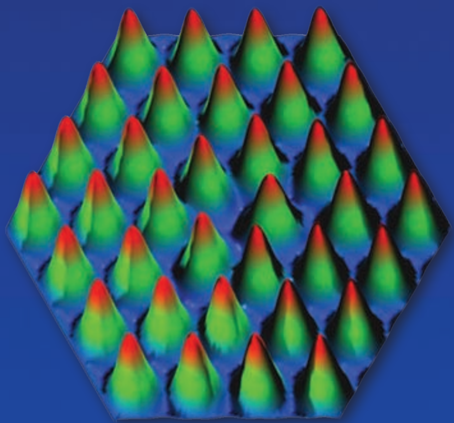
Physics Challenge: Self-assembly

Energy applications will need nanoscale engineering that can be delivered by the tonne and by the hectare, which will require the invention of new manufacturing methods. Biology currently holds the only examples of functional and interacting structures at the nanoscale, using nanomachines for everything from photosynthesis to the transfer of energy through cells. We will strive to replace top-down fabrication by bottom-up self-assembly of structures, using natural systems for inspiration and exploiting a mixture of physical processes and programmed methods.

Matt Bilton



Crack propagation in silicon determined by computational codes for electronic structure calculations.



The electron density of a two dimensional crystal containing a vacancy. The study of systems like this may provide insight into possible realisations of quantum computers.

Physics Challenge: Multiscale modelling

Developing novel sustainable materials and technologies will require an understanding of how quantum mechanical models on atomic scales can be melded with classical modelling on large scales, and to model physical processes on time-scales from picoseconds to seconds. Advances in computational techniques will enable massive simulations of large-scale systems to be carried out at the quantum level. Work will strive to integrate modelling with experiment, and eventually use it to design complex devices.

The Programme

- The programme will be supported by the Winton Fund for the Physics of Sustainability, the managers of which will be responsible for its planning and implementation, in conjunction with the Programme Director.

- An International Advisory Board will be appointed to help inform the programme’s research, under the chairmanship of Professor Paul Alivisatos, Director of the Lawrence Berkeley National Laboratory in the USA.

- The 'bottom-up' parts of the programme - PhD studentships and 5-year Fellowships - are already being advertised. The intention is to fund very bright younger physicists. The emphasis for Fellowships will be on exciting and novel ideas that bring new activities to the Cavendish.

- ‘Top-down' activities will involve introducing new areas of research to the Cavendish research programme. In the 'materials' area, programmes may be generated in which the physics is supported by the complementary materials science and materials chemistry that allow us to take new directions.

Collaborations

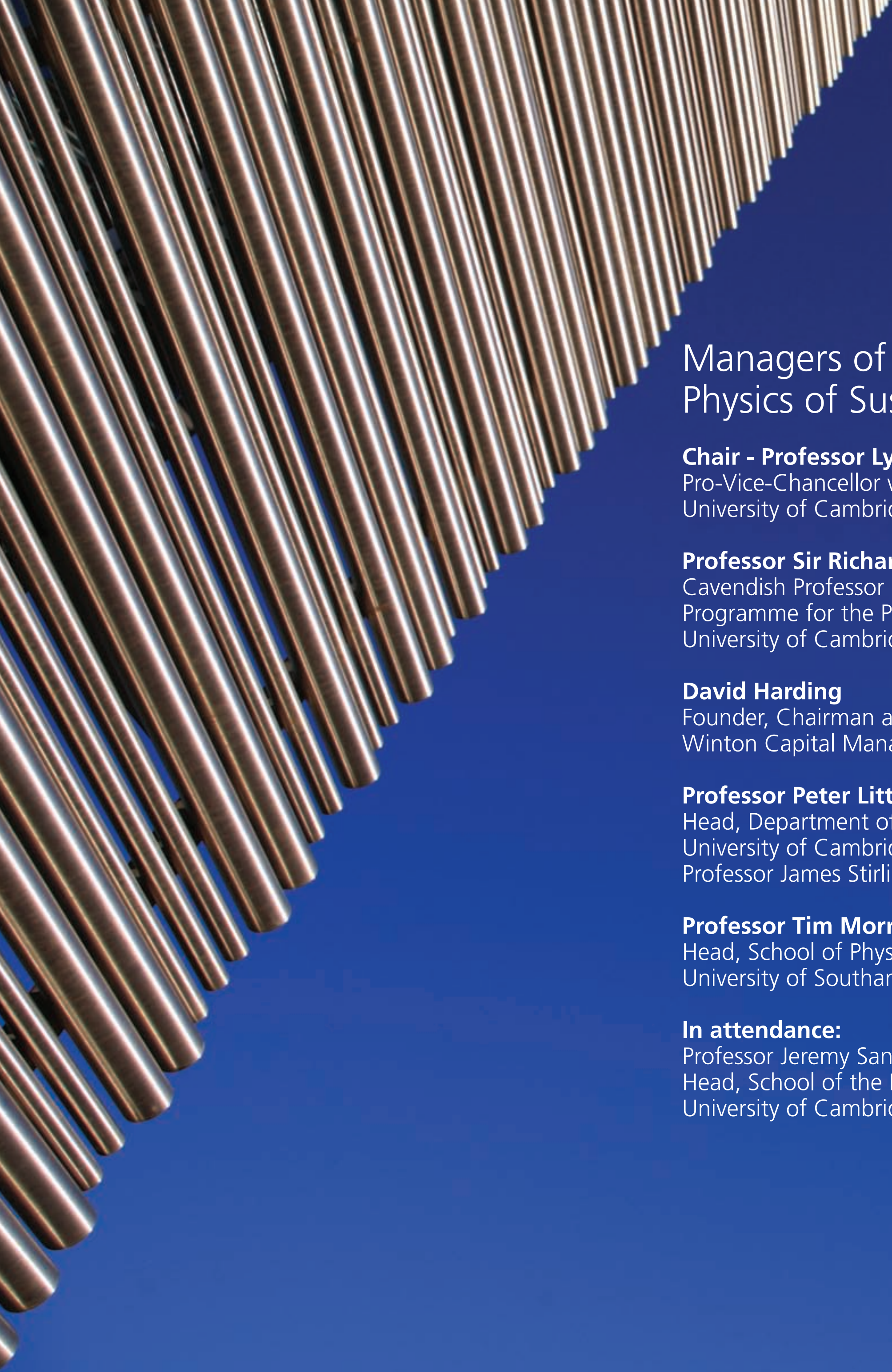
Strong interactions already exist between the Cavendish Laboratory and:

- the **Department of Chemistry** (including with the Melville Laboratory for Polymer Chemistry);

- the **Department of Materials Science and Metallurgy**;

- the **Department of Engineering** (particularly the **Centre for Nanoscience**).

Collaborations will also be developed with cognate departments in other universities where there is complementary expertise. Cambridge collaborates worldwide, and the Winton Programme will strengthen current links and build new ones to UK and international partners.



Managers of the Winton Fund for the Physics of Sustainability

Chair - Professor Lynn Gladden CBE FRS
Pro-Vice-Chancellor with responsibility for research,
University of Cambridge

Professor Sir Richard Friend FRS
Cavendish Professor of Physics and Director of the Winton Programme for the Physics of Sustainability,
University of Cambridge

David Harding
Founder, Chairman and Head of Research,
Winton Capital Management Ltd

Professor Peter Littlewood FRS
Head, Department of Physics,
University of Cambridge (ex officio – to be succeeded by Professor James Stirling CBE FRS from April 2011)

Professor Tim Morris
Head, School of Physics and Astronomy,
University of Southampton

In attendance:
Professor Jeremy Sanders FRS,
Head, School of the Physical Sciences,
University of Cambridge

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