IOP | Institute of Physics In Scotland

Edinburgh Programme – 2013 / 14

All talks start at 7.30pm in the Royal Society of Edinburgh, 22 - 26 George Street, with refreshments from 7.00 pm
Download the talk abstracts and speaker biographies at:
http://home.eps.hw.ac.uk/~phyrrt/IOPinEdinburgh2013to14.htm

Tuesday 19th November 2013

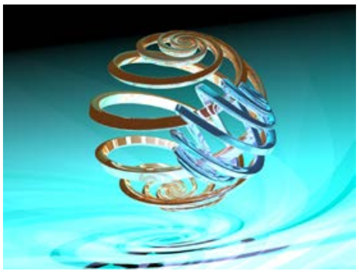
Dr Jay Farihi (University of Cambridge)

Archaeology of Exo-Terrestrial Planetary Systems

Tuesday 17th December 2013

Dr John J. L. Morton (University College London)

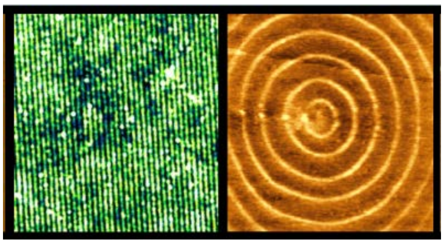
Quantum technologies using electron and nuclear spins



Tuesday 14th January 2014

Prof. Graham Leggett (University of Sheffield)

Low-Dimensional Molecular Systems

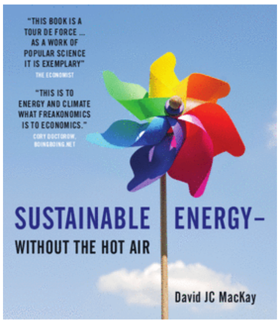


Tuesday 11th February 2014

Prof. David J.C. MacKay FRS (University of Cambridge)

Sustainable energy - without the hot air

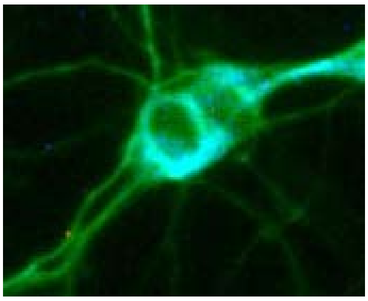
(Booking will be required for this lecture – details will be available on the website above at least one month before the lecture)



Tuesday 18th March 2014

Prof. Wei Sun (Drexel University & Tsinghua University)

Bio – 3D Printing



Free and open to non-members
For more information contact Robert Thomson (R.R.Thomson@hw.ac.uk)

Institute of Physics in Scotland, Edinburgh Programme – 2013 / 14

Lecture Abstracts

Tuesday 19th November 2013

Archaeology of Exo-Terrestrial Planetary Systems - Dr Jay Farihi (University of Cambridge)

Abstract: We now stand firmly in the era of solid exoplanet detection via Kepler and other state of the art facilities. Yet the empirical characterization of these most intriguing planets is extremely challenging. Transit plus radial velocity data can yield planet mass and radius, and hence planet density, but the bulk composition remains degenerate and model−dependent.
The abundances of a handful of exoplanet atmospheres can be estimated from transit spectroscopy, but probing only the tenuous outer layers of those planets.

Fortunately, as demonstrated by Spitzer and complementary ground−based observations, debris disk−polluted white dwarfs can yield highly accurate information on the mass and chemical structure of rocky minor planets (i.e. exo−asteroids), the building blocks of solid exoplanets. The white dwarf distills the planetary fragments, and provides powerful insight into elemental composition of the parent body. This archaeological method provides empirical data on the assembly and chemistry of exo-terrestrial planets that is unavailable for any planetary system orbiting a main−sequence star. In the Solar System, the asteroids (or minor planets) are leftover building blocks of the terrestrial planets, and we obtain their compositions -- and hence that of the terrestrial planets -- by studying meteorites. Similarly, one can infer the composition of exo-terrestrial planets by studying tidally destroyed and accreted asteroids at polluted white dwarfs.

I will present ongoing, state of the art results using this unconventional technique. Some highlights will include the recent detection of terrestrial-like debris in the Hyades star cluster, as well as the detection of water-rich planetesimals that may represent the building blocks of habitable exoplanets.

Tuesday 17th December 2013

Quantum technologies using electron and nuclear spins - Dr. John Morton (University College London)

Abstract: Many conventional technologies have not yet been pushed to their ultimate limits, as defined by the laws of quantum mechanics. Quantum technologies offer the possibility to do just that, yielding more sensitive metrology, more secure communication, and more powerful computation. The most basic unit of quantum information, the quantum bit (or qubit), can be realized in a wide range of physical systems. I will discuss the use of electron and nuclear spins as qubits, with particular focus on defects in semiconductors, and present a number of recent results which have placed such systems at the forefront of candidates for realising quantum technologies. These include quantum coherence lifetimes ranging from seconds to hours and the ability to measure the spins of individual atoms in real time. Finally, I will discuss some of the outlook for scaling up this work to larger systems to create quantum devices that are more powerful than their classical counterparts

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Tuesday 14th January 2014

Low-Dimensional Molecular Systems - Prof. Graham Leggett (University of Sheffield)

Abstract: Many biological systems exhibit reduced dimensionality. The cellular membrane is a two-dimensional milieu in which isolated proteins, or small groups of interacting proteins, control complex processes. For example, a transmembrane proton gradient drives ATPsynthase to convert ADP to ATP. Our aim is the construction of biological nanostructures to test hypotheses about energy transfer in biological systems. This requires the development of sophisticated tools for organization of molecules on nanometre length scales. The integration of top-down (lithographic) and bottom-up (synthetic chemical) methodologies remains a major goal in nanoscience. At larger length scales, light-directed chemical synthesis, first reported two decades ago, provides a model for this integration, by combining the spatial selectivity of photolithography with the synthetic utility of photochemistry. We have sought to realise a similar integration at the nanoscale, by employing near-field optical probes to initiate selective chemical transformations in regions a few tens of nm in size. A combination of near-field exposure and an ultra-thin resist yields exceptional performance: in self-assembled monolayers, an ultimate resolution of 9 nm (ca. $\lambda/30$) has been achieved. A wide range of methodologies, based on monolayers of thiols, silanes and phosphonic acids, and thin films of nanoparticles and polymers, have been developed for use on metal and oxide surfaces, enabling the fabrication of metal nanowires, nanostructured polymers and nanopatterned oligonucleotides and proteins. Strategies based upon the use of nitrophenyl-based photocleavable protecting groups have enabled the introduction of synthetic chemical methodology into nanofabrication. Using near-field techniques, proteins may be immobilized site-specifically, with full retention of biological function, in nanoscopic regions. Nanoscale control of chemistry over macroscopic areas remains an important challenge. Recently parallel near-field lithography approaches have demonstrated the capacity to pattern macroscopic areas at high resolution, yielding feature sizes of ca. 100 nm over an area four orders of magnitude larger; they have also demonstrated the ability to function under fluid, yielding feature sizes of ca. 70 nm in photoresist under water and suggesting exciting possibilities for surface chemistry at the nanoscale. Finally, the monolayer patterning methods we have developed are by no means restricted to near-field lithography; all that is required is a suitable means of confining the optical excitation. For example, SAM photochemistry has been combined with interferometric exposure to facilitate the fabrication of periodic nanostructures (metal oxides and gold nanostructures with strong plasmon bands) over macroscopic areas in fast, simple, inexpensive processes, underlining the versatility of photochemistry as a nanofabrication tool.

Tuesday 11th February 2014

Sustainable energy - without the hot air - Prof. David J.C. MacKay FRS (University of Cambridge)

Abstract: What do the fundamental limits of physics say about sustainable energy? The British Isles, we often hear, have 'huge' renewable resources - but we need to know how this 'huge' source compares with another 'huge': our huge power consumption. The public discussion of energy policy needs numbers, not adjectives.

The 2050 Calculator is an open-source model of the UK energy system (2050-calculator-tool.decc.gov.uk), founded on the laws of physics and the realities of engineering, which enables the public and policy-makers to explore the range of technically feasible pathways and the trade-offs between different options.

Tuesday 18th March 2014

Bio – 3D Printing - Prof. Wei Sun (Drexel University & Tsinghua University)

Abstract: Bio – 3D Printing, using cells, biologics and/or biomaterials as building block to fabricate personalized 3D structures or functional in vitro biological models through Additive Manufacturing techniques, emerges as a new frontier in advanced manufacturing and in 3D Printing. Bio – 3D Printing has provided a viable tool to making tissue engineered substitutes, novel medical devices, orthopedic implants and advanced cell/tissue-on-a-chip micro-fluidic systems. This presentation will report some salient advances on the field of Bio – 3D Printing, covering computer-aided tissue engineering, biomimetic design and fabrication of 3-dimensional tissue scaffolds, and cell/organ printing. Selected bio-modeling and additive manufacturing techniques for design and fabrication of advanced tissue scaffolds and customized tissue replacements will be presented. Printing/assembling living cells for constructing in vitro biological models and applications to regenerative medicine, disease study, drug testing and micro-tissue/organ systems will be introduced. Challenges and opportunities of Bio-3D Printing in advanced manufacturing will also be discussed.