Maxwell Lectures at King's College London

Monday 2pm in Lucas Lecture Theatre S-2.18

Mo 29 Sep **Giovanna Tinetti,** Professor of Astrophysics, Royal Society URF
University College London, Dept. of Physics and Astronomy

<u>The exoplanet revolution</u>

Our knowledge of planets other than the eight "classical" Solar System bodies is in its infancy. We are discovering thousands of planets orbiting stars other than our own, and yet we know little or nothing about their chemistry, formation and evolution. Planetary science therefore stands at the threshold of a revolution in our knowledge and understanding of our place in the Universe: just how special are the Earth and our Solar System? It is only by undertaking a comprehensive chemical survey of the exoplanet population that we can hope to answer these critical questions.

Little more than 10 years ago, the detection of a signal from an exoplanet atmosphere was still in the realm of science fiction. Pioneering results were then obtained through transit spectroscopy with Hubble, Spitzer and ground-based facilities, making it possible the detection of ionic, atomic and molecular species and of the planet's thermal structure.

With the arrival of improved or dedicated instruments in the coming decade, planetary science will expand beyond the narrow boundaries of our Solar System to encompass our whole Galaxy.

Mo 6 Oct **Mark Green**, Department of Physics, King's College London

<u>Quantum dots - from Lab to Tescos</u>

The preparation and use of quantum dots is now well established, and are used in applications such as biological disease markers, to the latest Kindle Fire, and even Apple are rumoured to be investing in the UK quantum dot market. Here, we will describe exactly what quantum dots are, how they're made, what they're used for and some research that's happening in KCL physics - with the help of tescos.

Mo 13 Oct **Marina Kuimova,** EPSRC Career Acceleration Fellow, Department of Chemistry, Imperial College London

<u>Illuminating biological cells: from cell viscosity to cancer treatment</u>

Many biological processes are based on chemical reactions. Viscosity determines how fast molecules can diffuse, and react. Therefore in cells viscosity can affect signalling, transport and drug delivery, and abnormal viscosity has been linked to disease and malfunction. In spite of its importance, measuring viscosity on a scale of a single cell is a challenge. I will describe a new approach used in my lab which allows two distinct advantages over the current state of the art: (i) imaging viscosity with high resolution, for example in single live cells and (ii) measuring how viscosity changes in real time, over the course of seconds or hours. I will also explain how our viscosity measurements can be put to diagnostic use in medical treatment called photodynamic therapy of cancer.

Mo 20 Oct **Emmanuel Fort**, Institut Langevin, ESPCI ParisTech

Wave-particle duality with the naked eye

Some three centuries ago, Newton suggested that corpuscles of light generate waves in an aethereal medium like a skipping stone generates waves in water, their motion then being affected by these waves. Today, light corpuscles are known as photons, and the notion of aether has been abandoned. Nevertheless, certain features of Newton's metaphor live on in some theories in which particle are guided by their own wave. The weakness of these theories is that their physical nature remains unclear because there is no macroscopic analogue to draw upon.

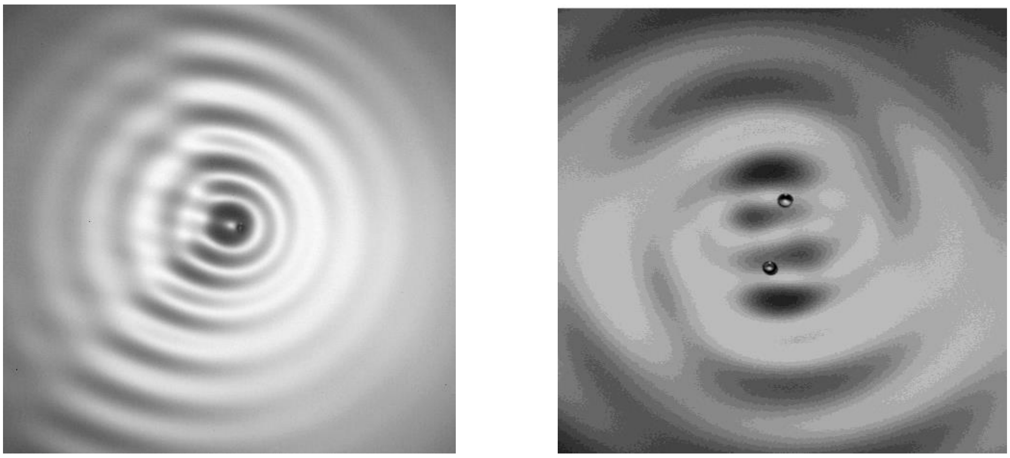

Figure: A “walker” composed of a droplet driven by the surface wave it has emitted during the previous bounces (left); Orbiting walkers (right)

We have recently discovered a macroscopic object composed of a material particle dynamically coupled to a wave packet. The particle is a droplet bouncing on the surface of a vertically vibrated liquid bath, its pilot-wave is made of the superposition of the surface waves it excites. Above an excitation threshold, this symbiotic object, designated as a “walker” becomes self-propelled.

Such a walker exhibits several features previously thought to be specific to the microscopic realm. The unexpected appearance of both uncertainty and quantization behaviours at the macroscopic scale originates in the essence of this “classical” duality. I will present experiments that are analogous to the historical quantum experiments: diffraction and Young’s double slit experiment in dim light, orbital quantization, tunnelling, etc.

The dynamics of the droplet depends on previously visited spots along its trajectory through the surface waves emitted during each bounce. This path memory dynamics gives a walker an intrinsic spatio-temporal non-locality. I will discuss the characteristics of these objects that encode a wave memory. In particular, I will show the presence of temporal mirrors to generate backward propagating waves.

This work was carried out with a number of colleagues, chief among whom Yves Couder, Antonin Eddi, Julien Moukhtar, Mathias Fink, Suzie Protière, Julien Moukhtar, Stéphane Perrard, Matthieu Labousse, Marc Miskin & Vincent Bacot.

Reading week 27 Oct

Mo 3 Nov **Carolyn Crawford,** Institute of Astronomy, University of Cambridge

Dark Energy and the ever-expanding Universe

Get up to date with the new cosmology - what are dark matter and dark energy? Why do astronomers think they account for the 'missing' 96% of our Universe, and what does this mean for the future?

Mo 10 Nov **Todd Huffmann**, Department of Physics, University of Oxford

Why Must One Apply the Brakes to Stop?

On July 4 2012 a particle was discovered that we now believe is the Higgs boson. This is the quantum field which pervades all of space and gives inertial mass to all of the sub-atomic particles in the Universe, presumably both seen and unseen.

When the discovery was announced millions were watching and I dare say most of them were not Particle Physicists. The presentation given, however, was clearly for a Particle Physics audience. This talk is about how the Higgs boson was found boiled down to its essential bits. One still needs some basic maths, but the essence of how experimental particle physics makes a discovery is not as arcane as one might at first believe. So using this most recent discovery as the primary backdrop, I hope to impart a flavour of the process of search and discovery at a particle physics experiment and along the way help to illuminate the answer to the question as to why brakes are necessary to come to a stop.

Mo 17 Nov **Tony Mann**, Director, Greenwich Maths Centre, Department of Mathematical Sciences, University of Greenwich

Puzzles, Paradoxes and Physics

We often react with amusement to paradoxes and puzzles with counter-intuitive solutions. But puzzles and paradoxes - when Nature apparently doesn't behave in the way that our theories tell us she should - present an opportunity for us to improve our understanding. Examples such as the Einstein-Podolsky-Rosen (EPR) Paradox have helped us establish the validity of quantum theory, while Olbers' Paradox - the apparently naive question as to why the sky is dark at night - provides very convincing evidence of the Big Bang. And puzzles, illusions and magic tricks show us how easy it is for unexamined assumptions to lead us to the wrong conclusion.

This talk will demonstrate a wide range of puzzles, illusions and paradoxes to show how they can help us develop our understanding of various branches of physics and of the way we perceive the world. Why are drops of water suspended in mid-air? How can we explain the patterns of the pendulum wave? When I drop a weight, where will it hit the floor? How do I make a playing card move invisibly from one pile to another? Members of the audience will have to keep their wits about them! And appropriately for a talk to the Maxwell Society, Maxwell's Demon will feature.

Mo 24 Nov **Daniel Pooley**, Science and Technology Facilities Council (STFC), Didcot

Neutron Science; an overview of technique and instrumentation with emphasis on the new field of energy-resolved neutron imaging.

The ISIS pulsed neutron and muon source at the Rutherford Appleton Laboratory in Oxfordshire is a world-leading centre for research in the physical and life sciences. Neutron scattering is a powerful technique giving unique insight into complex structures. I will present an overview of neutron scattering techniques and the state-of-the art instrumentation at the ISIS facility. I will emphasise how the current shortfall in instrumentation for the novel technique of *energy resolved neutron imaging* is being addressed. The demand for energy resolved neutron imaging has generated a huge advance in detector instrumentation and technique development [1], particularly with the use of borated MCP's [2] and fast, gated, CCD technology [3]. I will also present the development of an exciting new detector type, the GP2 detector, currently in the prototype phase of R&D. The GP2 detector utilises a fast PImMs CMOS sensor [4], so named as it was developed for Particle Imaging Mass Spectrometry, to record event-mode data from a pulsed neutron source. The CMOS sensor has been made neutron sensitive by using gadolinium as a conversion material; directly detecting electrons from gadolinium.

[1] M. Strobl NIMA. 604 (2009) 646
[2] A. S. Tremsin, et.al., Nucl. Instr. Meth. Phys. Res. A. 592 (2008) 374
[3] M. Strobl, et.al., J. Phys. D: Appl. Phys. 42 (2009) 243001
[4] I. Sedgwick, et.al., NEWCAS 2012 IEEE 10 (2012) 497

Mo 1 Dec **William Proud**, Director: Institute of Shock Physics, Imperial College London

Shock and Blast Waves: Natural, Accidental and Scientific

The Subject: Shock waves can be thought of as very high-pressure pulses which move through material causing rapid acceleration, temperature rise and velocity changes. They are often thought of as destructive as a result. This talk will provide an overview of this area including natural shock waves, accidents, technical applications and fundamental research which can be conducted using this phenomena e.g. turning graphite into diamond, investigating the process during high-velocity impact and protection of people and vehicles from blast waves. Examples will be illustrated by high-speed photography.

Natural: Mount St. Helens / Accidental: Effects of Explosion in North Korean accident / Scientific: the dynamic strength of iron.

The speaker: WG Proud is the director of the Institute of Shock Physics, Imperial College London and chair of the Institute of Physics Shock Waves and Extreme Conditions Group. He has been investigating shock waves since 1994 and has written numerous articles on the subject.

Mo 8 Dec – no Maxwell lecture (deadlines for undergraduate teaching)