Institute of Physics – L & S E Branch – Retired Members Section

AT HOME – Physics relating to Biological Systems

THURSDAY 2 July 2015 (King's College, Strand, London)

This meeting has been organised by David Pick

10:30	Arrival and coffee	
10:55	Welcome and REMS announcements	
11:00	Human sensors	Dareyoush Rassi, Swansea University
11:40	How do we measure colour?	Andrew Hanson NPL
12:20	Bees	Norman Carreck, International Bee Research Association
13:00	Lunch	
14:15	Fans, umbrellas and popup books; how insects fold and unfold their wings	Robin.J.Wootton Exeter University
14:55	How ocean physics affects marine organisms	Stephanie Henson, National Oceanography Centre
15:35	Robert Mayer, Energy, and the Transformation of 19th Century Physiology	Francis A Duck, Bath
16:15	Tea	

Venue: Safra Lecture Theatre, King's College London, Strand

Costs: free without lunch and £27 for a sit down 2 course buffet lunch in the Terrace Café. Wine and a vegetarian option are included in the lunch option.

This is a London & SE Branch meeting and is open to all IOP members and the public. Attendees should preregister via the IOP website.

CVs and Talk abstracts

Human sensors

Dareyoush Rassi, Swansea University

Aristotle developed an elaborate theory of human sensory perception and correctly surmised that a coupling of external agents (what we now call energy) with sensory organs causes the various sensations that connect us to the external world. Over the centuries, our understanding of the structure of sensory organs and the mechanisms by which they convert energy into sensation, has increased enormously. We know a great deal about the specialist cells that detect electromagnetic waves (vision), chemicals (smell and taste) and mechanical disturbances (hearing and touch.) The intricate processes that take place as these stimuli cause the perception of images, sounds and other sensations are truly fascinating but ultimately a direct consequence of the laws of physics. In this talk we will explore some of the known facts about sensory perception, its limitations and how our understanding can help overcome a variety of disabilities as well as devise new applications.

Dareyoush Rassi is a Chartered Physicist with a wide background in many areas of experimental physics and measurement techniques, with particular expertise in bioelectromagnetic phenomena. A major part of his research effort has been focused on the interface between physics, medicine and biology. After joining Swansea University, he set up a laboratory for biomagnetic research using highly sensitive Superconducting Quantum Interference Device (SQUID) instrumentation. Among the topics investigated by his research group were thoracic imaging, magnetopneumography, assessment of hepatic iron levels and brain function studies. He was also involved in developing a new fetal monitoring technique based on magnetocardiographic measurements in close collaboration with clinical specialists in cardiology, obstetrics and paediatrics.His current research interests include the clinical applications of heart rate variability analysis in fetal monitoring, also in neonates and adults. He is involved in several wide-ranging research projects using physiological measurements to improve clinical outcomes. Dr. Rassi has founded two start-up companies registered and based in Wales. Both these companies are active in leading-edge state-of-the-art industrial R&D in different areas of the oil & gas sector.

How do we measure colour?

Andrew Hanson National Physical Laboratory

In late February 2015, the world was confused by numerous experts explaining why different people saw colours in an image of a dress differently. If human colour vision is really that complicated, how can we practicably use colour measurement and specification reliably in quality control, brand assurance and safety regulation? This talk will explain how complicated a model for human colour vision is, expands on the complexities of the phenomena that was ‘that dress’ and describes how well we can get machines to see colour the way we do.

Andrew Hanson spent 21 years at the National Physical Laboratory in the fields of colour vision research and optical measurement – which included certifying the colours of ceramic colour standards and helping build a rig to evaluate mesopic photometry (how the eye sees light at dawn and dusk conditions). He is past Chairman of the Colour Group of Great Britain.

Bees

Norman Carreck, International Bee Research Association

The talk will be about bees and how they find their food. Although bee scientists are mainly biologists, the principles of physics do impinge on many aspects of bee behaviour. The navigation systems used by honey bees, as with humans, are complex, and are complemented by dance communication, so enable them to effectively exploit their environment in order to collect pollen and nectar. On several occasions Norman has worked in close collaboration with physicists, for example in the use of harmonic radar for tracking flying bees, to understand foraging behaviour. Physical principles also enable us to understand, for example, the patterns of pollen dispersal from genetically modified oilseed rape crops.

Norman Carreck has been a beekeeper for more than 30 years and a bee research scientist for more than 20. From 1987 to 2006 he was employed at Rothamsted Research in Hertfordshire, mainly working on bee pollination ecology, bee behaviour and bee diseases. He is now Science Director of the International Bee Research Association, Senior Editor of the Journal of Apicultural Research and a research scientist at the University of Sussex.

Fans, umbrellas and popup books; how insects fold and unfold their wings

Robin Wootton, Exeter University

Most insects fold their wings back over the body when not flying. Some, like beetles and earwigs, have large hind wings that need to fold up into small spaces, and unfold for flight. This presents problems as the wings have no internal muscles; the complex processes need to be driven remotely by simple muscular forces at the wing base. The talk will use models to explore the mechanics involved, which have surprising parallels in a wide range of man-made structures from popup books to aerospace designs.

Robin Wootton taught zoology at Exeter University for four decades. From the 1970s he and his group pioneered an engineering approach to the insect wings, investigating and demonstrating their unique qualities as smart, flexible aerofoils. While most of the research was concerned with the wings' operation in flight, he worked for a period in the 1990s on the mechanics of their folding, and developed then a wider interest in folding structures which has continued into his retirement. He has given many lectures on these, flight and a lot of other things, to a wide range of audiences from aeronautical engineers to primary schoolchildren.

How ocean physics affects marine organisms

Stephanie Henson, National Oceanography Centre

Phytoplankton may be the most important plant you've never heard of. These microscopic plants are ubiquitous in the world's oceans and, despite making up only 1% of global biomass, they produce 50% of the oxygen in the air that we breathe. In addition, they absorb huge quantities of carbon dioxide from the atmosphere, helping to regulate Earth's climate. And as if that wasn't enough, they also form the base of the marine food web, supplying the source of energy for all life in the ocean. The abundance and distribution of phytoplankton is tightly controlled by the physics of the ocean. In this lecture, she will discuss how ocean physics controls where and when phytoplankton thrive and the implications this has for future climate change.

Stephanie Henson leads an active research group in global biogeochemical oceanography, currently made up of 10 PhD and MSc students. During her research career, she has made contributions to the understanding of the physical processes that alter phytoplankton populations and subsequent impacts on ocean carbon storage. She is also developing her research profile in the field of detection of climate change-driven trends in ocean productivity. Her research exploits satellite and in situ data, as well as output from biogeochemical models. In 2012, she received the European Geophysical Union's Award for Outstanding Young Scientist for her 'fundamental contribution to the study of marine ecosystems'.

Robert Mayer, Energy, and the Transformation of 19th Century Physiology

Francis A Duck. University of Bath

Abstract.
The concept of the conservation of energy was developed during the middle of the 19th century. The idea transformed physiology, the final nail in the coffin of vitalism. The history of its development is often told only as an outcome of the search for greater industrial efficiency, but this is to ignore its simultaneous development in the exploration of body heat, and muscular mechanics. This talk will tell the story of the German physician Julius Robert von Mayer, whose early insights into energy transformations within the body, supported by his own calculation of the mechanical equivalent of heat, preceded Joule's experimental determinations. Within two decades, the physics of energy conservation had destroyed the vitalist physiology of contractility, sensibility and vital fluids, ensuring that all subsequent physiological science was properly based upon laws of physics and chemistry. Mayer suffered depression and mental illness partly because his pioneering insights were at first ignored, Joule gaining much greater recognition for his contributions. It was only towards the end of his life that Mayer's work was championed by Hermann von Helmholtz in Germany and John Tyndall in Britain, giving him a rightful place as one of the foremost pioneers in energy conservation.

Francis Duck is a retired medical physicist who spent most of his career in medical ultrasound. He worked on bioeffects mechanisms and safety in diagnostic ultrasound and the measurement of acoustic output and developed several novel approaches to ultrasonic imaging. He is now a Visiting Professor in the Department of Physics, University of Bath. Since retirement from the NHS he has taken a particular interest in how physics and medicine have interacted

over the centuries, and his book, Physicists and Physicians, A History of Medical Physics from the Renaissance to Röntgen, was published by IPEM in 2013. He was awarded an MBE in 2007 in recognition of his services to healthcare.