



The Conference on Everything Churchill College



Abstracts

1 **Adam Jermyn** - *Tidal Heating of Hot Jupiters*

Thousands of exoplanets have been discovered in recent years, and many of them bear little resemblance to planets in our own system. Probably the most strikingly different are so-called hot Jupiters, which are Jupiter-mass planets orbiting very close to the host star, such that radiation from the star heats the tops of their atmospheres. Some of the hottest of these are bloated in radius to twice the size of Jupiter. This requires that their atmospheres be heated not just at the top where the light hits but also somewhat deeper down. This requires an internal source of heat. In this talk we explore the possibility that this heat is a result of feedback between tidal effects and the thermal structure of the planet. This represents a new mechanism for tidal heating, and the results show good agreement with observation.

2 **Flaviu Bulat** - *Developing Targeted Imaging Agents for Detection of Tumour Cell Death in Early Treatment Response*

Currently, cancer patients undergo therapy for 4-8 weeks before its outcome can be measured and evaluated. A non-toxic protein, called C2Am, conjugated to novel targeted molecular imaging agents can be used to monitor tumour cellular death and reduce this timeframe down to 48 hours. This imaging method has immense potential to cut healthcare costs and minimise the deleterious side effects of ineffective chemotherapy. The protein has a wide range of potential applications besides oncology. For example, in cardiology it can be used to assess the extent of heart ischemia following a heart attack.

3 Fernando Riveros Mckay Aguilera - *The Genetic Architecture of Human Thinness*

Obesity prevalence is rising and it is one of the leading causes of preventable death worldwide. In Western countries this rise in prevalence has been linked to an increasingly obesogenic environment. Genetic association studies so far have been focused on identifying genes and pathways associated with either body mass index or obesity. From a drug development perspective though, identifying biological pathways associated with lifelong healthy thinness within an obesogenic environment can lead to novel plausible therapeutic targets. To this end, we performed the first genome-wide characterisation of the heritability of persistent human thinness in 1471 individuals, and contrasted it with that of early onset severe childhood obesity (N=1456). We found that persistent thinness is a heritable trait and note incomplete genetic overlap between both traits suggesting genetic differences at the tails of BMI distribution. Our results support expansion of human thinness studies as an approach to identify potential anti-obesity targets.

4 Hansini Mallikarachchi - *Investigating the Effect of Loading Rate on the Uplift Movements of Buried Offshore Pipelines in Low Permeable Sand*

Geohazards and associated ground deformations pose a substantial threat to the structural integrity of pipelines. The focus of this research is to develop an engineering solution to predict the uplift resistance of buried pipelines in saturated and low permeable sand. The main objective of this study is to numerically simulate the vertical soil-pipe interaction under large deformations, taking into account geometrical and material instabilities. A detailed parametric study is conducted using the software ABAQUS on the effects of density, friction, dilation and loading rate on the peak uplift resistance and the mobilised displacement of pipelines. It is observed that the dimensionless peak uplift resistance, as well as the displacement to reach the peak, increase with the loading velocity for dilative sand and decrease for contractive sand. Depending on the degree of drainage, the considered velocity range can be divided into three separate regimes: drained, partially drained and undrained.

5 Sri Jagannathan - *Mechanics of Spatial inAttention*

Imagine that you suddenly lost sight of the left side of the world or failed to eat the food in the left half of your plate! This condition, known as inattention or neglect, is commonly observed in stroke recovery patients, however, this condition is also observed in healthy adults when they become drowsy or less conscious of their surroundings. What exactly happens in the brain that causes inattention to one side of the space? Does being a left-hander protect you from this debilitating condition? Can this model of inattention in healthy adults be used for improving recovery after stroke? In this talk we explore the brain mechanics behind this inattention and show how it is modulated by handedness.

6 Sam Ainsworth - *Extremely Efficient Computer Processor Error Detection*

Hard and soft faults in silicon processors are becoming an increasing issue for reliability in modern systems: temporary or permanent errors from physical properties can cause executed computation to be incorrect. Traditional schemes to detect errors within the processor involve repeating the computation on either an identical copy of processor, or on the same processor at a later time, and have typically doubled power and silicon area requirements, or reduced performance significantly. However, we have developed a scheme which significantly reduces the overheads of all three by exploiting new parallelism in the checking of computation which may not exist in the original run. This allows execution of the checks on many tiny, highly efficient micro-controller sized units attached to the processor, reducing overheads by over an order of magnitude.

7 Mia de los Reyes - *Revisiting the Global Star-Formation Law*

People who study space think that stars are made when lots of cold gas gets pushed together. But in galaxies, many things are happening, and making stars isn't so simple anymore. We know that we need cold gas to make stars, so if you have more cold gas, you can make stars more quickly. But how much more quickly? And do other things in galaxies help make stars more or less quickly? I try to answer these questions by looking at lots of galaxies that are near us. I study what they have in them and how fast they make stars. If I can figure out how stars are made in these galaxies, then other people can use my answers in their really really big computers to study how all of space changed over time.

8 Jocelino Rodrigues - *Combustion Noise: Current Work and Future Challenges*

Combustion noise is becoming a major concern within the air and ground based turbine industry. This is due to developments in designs which have reduced other sources of aircraft noise and to the increasingly unsteady burning of novel combustors designed to reduce NOx emissions. Pressure fluctuations due to combustion are often associated with either the gas expansion due to heat release (direct noise) or the passage of temperature or composition non-uniformities through an outlet nozzle (indirect noise). Accurate predictions of unsteady pressure and flow perturbations can significantly cut device test and development time, increase reliability and reduce greenhouse emissions. Experiments using the Cambridge Entropy Generator (CEG) have been able to separate and measure the contributions between direct and indirect noise in a system with well controlled boundary and operating conditions, suitable for direct comparison with computational models. Results are presented and future work is outlined.

9 **Travis Sawyer** - *Identifying the Spectral Fingerprint of Disease: A Multi-Modal Imaging System for Tissue Analysis.*

Light-tissue interaction is governed by the chemical, structural, and intrinsic (scattering and absorption) properties of the tissue, which are altered through the progression of disease. Extracting these parameters with optical techniques shows great potential for non-invasive and early disease detection. While there has been much success assessing individual optical properties using various imaging approaches, little work has been done to multiplex different techniques and systematically extract a comprehensive set of tissue properties to correlate with disease state. We present a multi-modal imaging system built to address this challenge. The system employs visible and near-infrared hyperspectral imaging, Mueller-matrix polarimetry and spatial frequency domain imaging to extract chemical abundances, polarization properties, scattering and absorption of excised tissue. Designed for clinical implementation, the system enables large-scale analysis of tissue samples to co-register with pathology and generate a database of optical properties. This provides an ideal foundation to correlate tissue properties with disease state and identify a so-called spectral fingerprint, a critical, but not yet realized, step toward non-invasive disease detection.

10 **Victoire** - *United We Stand: Study of Collective Cell Behaviour During Embryo Development*

The mechanisms driving the emergence of the shape of an organism are complex and largely unknown. Their study requires a better understanding of the constraints acting on cells and tissues, and of their coupling with biological processes. Among these processes, collective cell migration plays a key role: during development, wound healing or cancer invasion, cells coordinate and form complex migration patterns. Experimental approaches have shown that the geometrical confinement of cells into specific micropatterns such as stripes, circles or rings can induce a persistent and coordinated rotation of cells. We develop a computational mechanics-based model of this kind of experimental systems. This model will help us understand how the information propagates between cells depending on various parameters including their density or their polarity, and how the system breaks its symmetry to start and maintain collective rotation.

11 **Alex Bastounis** - *The Limits of Computation*

Computers are capable of many things they make access to information easier, they allow us to read and write complex documents and they let us watch funny cat videos on Youtube. We also use computers to perform various mathematical calculations, from finding properties of complicated operators used in physics to denoising images. But can these calculations really be performed accurately on a computer? In a brief talk, I will give specific examples of problems which were previously thought to be possible but in fact cannot be done to arbitrary accuracy on a computer and discuss the implications of these results.

12 Amberley Middleton - *Educational Experiences of Resettled Refugees in the U.S.: a Case Study with the Somali Bantu*

According to the UN Refugee Agency, the UNHCR, the world is now witnessing the highest levels of human displacement on record, with nearly 21.3 million people classified as refugees. Historically, the U.S. government has resettled between 40,000-70,000 refugees a year in the United States. However, there is no long-term policy or comprehensive plan to ensure that the particular and often extensive educational needs of refugee youth are being met. My research focuses on examining and exploring the educational experiences of one particular group of resettled refugees, the Somali Bantu. By delving into the lived experiences of Somali Bantu students, my research seeks to identify barriers and structural obstacles to educational attainment as well as examine ways in which students (and their families) persist, resist, and potentially overcome obstacles in pursuit of education.

13 Michael Schoof - *Identifying and Validating Age-Specific Promoter and Enhancer Regions in *Caenorhabditis Elegans**

Aging is a complex, multifaceted process characterized by progressive cellular and tissue dysfunction. An understudied area in relation to aging is how promoter and enhancer (gene regulatory units) activity changes throughout life, and what effect this may have on gene expression and the organism at large. Using the worm *Caenorhabditis elegans* as a model system, I identify candidate age-specific regulatory regions via whole genome sequencing assays and validate these regions in vivo.