UNIVERSITY OF HULL

Postgraduate School of Natural Sciences Conference

16th June 2023

Arrival	9:00 – 9:45
Introduction	9:45 – 10:00
Talks Session 1	10:00 – 11:00
Chris Carter	A PDMS Based Gold Nanoparticle Memristor as a Possible Gateway to Pressure Sensitive Memristors
Charlie Nash	A Matrix Isolation Investigation of the Reactive Intermediates Formed in the Miller-Urey Synthesis
Amber Wagstaffe	Comparative Variation in Kinematic Transmission of the Beak Among Birds
Coffee Break	11:00 – 11:30
Talks Session 2	11:30 – 12:30
Kate Womack	Chemical Evolution of Fluorine in the Milky Way
Michael Winter	Awkward Allopolyploid Assembly: aaagh!
Afshan Dabeer	Microfluidic Channel Architecture for Cell Sorting Applications
Posters and Lunch	12:30 – 14:00
Guest Speaker - Steve Cross	14:00 – 15:00
Coffee Break	15:00 – 15:30
Talks Session 3	15:30 – 16:50
Edward Gilbert	Molecular markers associated with lizard environmental adaptability
Areeg Al-Hamadani	Development of hybrid metal-dielectric nanogap for surface enhanced Raman Scattering (SERS)
Stephan Conopo-Holyoake	Measurement of chiral domain formation in Ntb thin films
Nazish Fatima	Biodegradable chitosan Derivatives for 3D printing applications

Talks Session 1 – 10:00-11:00, AMB LT1

Chris Carter

A PDMS Based Gold Nanoparticle Memristor as a Possible Gateway to Pressure Sensitive Memristors

Polydimethylsiloxane (PDMS) is a compressible polymer. We investigated the possibility of using gold nanoparticles suspended in PDMS as a means of producing a pressure sensitive memristor. Here we report a novel memristor based on 5 to 7 nm gold nanoparticles suspended in (PDMS), diluted to a concentration of 5% by weight in hexane. Suspensions were prepared to give nanoparticle concentrations of 0.005, 0.01, and, 0.05, by Relative Mass (Rm). Polymer thickness was variable between devices in the range 100 to 200 nm. Mono-layer crossbar devices were constructed, comprising a central PDMS-nanoparticle layer sandwiched between top and bottom chromium electrodes of thickness 100 nm deposited by electron beam (EB) evaporation under vacuum. Memristance, was defined by an IV response showing zero point, pinched loop hysteresis. This was present at all concentrations. The ON OFF ratios of devices was variable between those of the same and differing nanoparticle concentrations.

Charlie Nash

A Matrix Isolation Investigation of the Reactive Intermediates Formed in the Miller-Urey Synthesis

In 1953 Stanley L. Miller performed his now famous experiment, under the supervision of Nobel-laureate Harold C .Urey, in search of the origin of amino acids (the building blocks of proteins) on early Earth. Gases thought to be representative of the early Earth atmosphere (CH_4, H_2, NH_3, H_2O) were circulated in a sealed glass apparatus, and subjected to electrical sparks via tungsten electrodes, simulating lightning. When the experiment was ended and the resulting turbid water analysed, several amino acids were identified. Many subsequent studies have investigated various aspects of the original experiment, but very little is known about the reactive intermediates formed directly in the spark. Here, the matrix isolation technique has been employed to isolate and identify these reactive intermediates, providing further insight into how abiogenesis may have occurred on the early Earth.

Amber Wagstaffe

Comparative Variation in Kinematic Transmission of the Beak Among Birds

Most birds exhibit cranial kinesis, and can rotate the upper beak relative to the skull. Cranial kinesis has been largely overlooked in birds, but may provide new insights into the relationship between bird form and feeding.

The avian kinetic system was modelled as a four-bar linkage system using lateral images of 315 species of bird. Kinematic Transmission (KT) was compared with diet data from AVONET, as well as with our own feeding method categories. Link lengths were also compared with KT for information on mechanical sensitivity of the system. The overall shape of the linkage system was also investigated to give an insight into mechanical equivalence.

We found no clear relationship between KT and diet; however when KT is combined with gape, separation of dietary groups is more significant. Principle components analysis of the shape of the linkage system revealed that mechanical equivalence is common in bird four-bar systems. Additionally, the majority of shape change occurs within the output of the system, and analysis of link lengths revealed that as in other four-bar systems, the output link, which corresponds to beak depth, is more strongly correlated with KT than the input. This is despite the fact that in birds, the output link is not the shortest part of the system, which was the trait previously believed to drive mechanical sensitivity.

Talks Session 2 – 11:30-12:30, AMB LT1

Kate Womack

Chemical Evolution of Fluorine in the Milky Way

Fluorine has many different potential astrophysical sites and channels of production. As a result, modelling its evolution using simulations of galactic chemical evolution is particularly challenging. The most discussed sites of fluorine production are: AGB stars, Wolf-Rayet stars, the v-process in core-collapse supernovae, novae and rotating massive stars. We use the galactic chemical evolution code OMEGA+ to investigate the chemical evolution of fluorine in the Milky Way. We explore the impact of a variety of AGB and massive star yield sets, with a particular focus on varying the prescription for the initial rotational velocity of massive stars. We find models which include rotating massive stars with v_{rot}=300kms^{-1} provide the best fit to observations, while a combination of initial rotational velocities provides a more physical solution. We also investigate the fluorine abundance of Wolf-Rayet stars and rule them out as a dominant contributor to the galactic fluorine abundance.

Michael Winter

Awkward Allopolyploid Assembly: aaagh!

Genome assembly has progressed greatly over the last several years due to the increase in computational power available and the advent of ultra high quality long read sequencing technology. One area of this field that still remains difficult is the process of assembling complex allopolyploid genomes. Due to the complexity of these genomes, common modern algorithms struggle and fail, reducing the amount and power of analysis able to be performed and limiting the insight we can gain into a particular species or group. I have assembled one such genome - Meloidogyne javanica - and will talk about successes and stumbling blocks, as well as what we have learned since its generation.

Afshan Dabeer

Microfluidic Channel Architecture for Cell Sorting Applications

Microfluidics are commonly used for many applications. These are expensive and mostly with non-biodegradable materials. To develop a biodegradable lab on chip microfluidic device in 3D channel architecture for cell sorting applications is a challenge. PDMS is widely used for microfluidics and I am working on buried micro size channels inside the PDMS for cancer cell sorting. It can be used for clinical purposes as identifying the type of cancer or killing cancer cell using optical fiber integration in microfluidics (like dialysis). This device will be cheap (cost effective), painless, environmental friendly (bio degradable and recyclable) and easy to handle (portable). Optical fiber will be used in this device to isolate the cell to manipulate and destroy the cancer cells. In future applications, we will be able to develop a CTC meter to identify cancer at its first stage and it will be portable, cheap and easy to handle.

Posters – 12:30-14:00, AMB LT2

Joseph Morrison	3D Printing of Embedded Electronics
Floyd Askin	AI at the Speed of Light
Antonia Barnard	ALPINE - Agile Laser Processing In iNdustrial Environments
Isaac Noman	Colloidal Quantum Dot Supraparticle Microlasers Incorporated Into Photonic Glasses on Flexible Substrates
Elliot Henderson	Creating and Testing an Electronic 3D printer
Jordan Bartley	Creating Resistive Switches
Natalie March	Design and Development of Aluminium Porphyrins as PET/PDT Theranostics
Ali Al Temimi	Designing Software for Creating 3C Printed Electronics in 3D Space
Zakia Tebetyo	Development of a Portable, Distance-Based Paper Analytical Sensor for Carbonate Detection
Daniel Whitt	Development of Level and Adjustable Nanocavities for Hydrogen Production
Ugonna Opara	Development of Methods for 2-Carbon Extension of Fatty Acids Under Mild Conditions

Joe Ercolano	Development of Small-Molecule Programmed Death-ligand 1 (PD-L1) Targeted Positron Emission Tomography (PET) Radiopharmaceuticals.
Tom Spencer	Evaluating Biodiversity Impacts of Beavers on Invertebrate and Vertebrate Communities Using Environmental DNA
Sarena Nagoor Pitchai	Fitness Trade-Off in Heat-Stressed Cells
Lucy Smith	Generative Modelling of Exoplanet Transits
Karl Hornsby	Green and Sustainable Catalyst Using Palladium Doped Biochar
Matthew Morgan	Greening Blue Spaces in Hull
Ryan Alexander	Inhomogeneous GCE Modelling of Ultra Faint Dwarf Galaxies
Frances Longbottom	Inorganic Hybrid Materials for the Capture of CO_2
Chidimma Lawrence Ihebie	Ionic Liquid as surfactant in Pickering emulsions
Clare Cowgill	Monitoring Terrestrial Rewilding with eDNA Metabarcoding
Oliver Bartlett	Noise Reduction on Single-Shot Images Using an Autoencoder

Jacob Gordon	Particle Self-assembly into Plasmonic Structures and their Immobilisation at an Oil-Water Interface
Michael Winter	Phased Assembly of an Asexual Allopolyploid Reveals Complex Subgenomic Structure
Yi Gong	Pillared MOFs: Structure and Ring Opening Polymerization of Cyclic Esters.
Ali Al-dulaimi	Plasmonic-Nanogap Enhancement, Fabrication and Applications
Jonathan Proctor	Plume Evolution Dynamics in Industrial Laser Environments
Georgia Lowes	PSR J2108+4516: A Pulsar in a Rare Binary with a Main Sequence Star
Wanhe Jiang	The Investigation of Dimeric Nematogens Linked to Polysiloxane Main Chains
Elliot Howatson	Tracing Outflows in Galaxies on FIRE
Laura Hunt	Using AI To Predict Galaxy Ages
Angus Monaghan	Using eDNA to Assess the Distribution of the Critically Endangered European Eel in Pumped Catchments and Inform Policy

Guest Speaker – 14:00-15:00, AMB LT1

Steve Cross

Get Your Science Out of the Lab

Steve Cross is a science communicator and trainer whose life goal is to make experts fun and interesting. He's a Wellcome Engagement Fellow, CEO of two companies and was Head of Public Engagement at UCL for seven years. He's mentored hundreds of scientists like you to share their knowledge and ideas publicly, and today will tell you how to get involved in events, videos, podcasts, radio, festivals and everything else. Come along to pick up one tip to make your talks better or to take the first step towards being the next Hannah Fry. Your call.

https://drstevecross.squarespace.com/

https://scienceshowoff.wordpress.com/steve/

https://clevermakefunny.com/

Talks Session 3 – 15:30-16:50, AMB LT1

Edward Gilbert

Molecular markers associated with lizard environmental adaptability

Environmental adaptability is pertinent to an organisms survival, of which, temperature influences numerous biochemical pathways. Variation of biochemical pathways and their underlying molecular constraints may elucidate how organisms persist in the face of a constantly changing environment, and more generally, evolutionary trajectory. Variation in the genome and protein modifications can contribute to short term adaptations.

Reptiles largely rely on external temperatures to regulate biological functions providing a model for studying climate stress. Changes in distribution and behaviour may provide some relief to temperature change, but for populations to persist adaptation must happen at the molecular level.

Areeg Al-Hamadani

Development of hybrid metal-dielectric nanogap for surface enhanced Raman Scattering (SERS)

Plasmonic sensing leverages the interaction between light and plasmons - collective oscillations of electrons on a metal surface to detect changes in samples. This detection is based on the principle that when light strikes a metal surface, it can excite plasmons, which then interact with the environment and alter the metal's optical properties. These changes can be observed and used to identify specific analytes, such as biological molecules or chemicals, within the sample. This is achieved by leveraging the unique optical properties of plasmonic nanostructures, which are able to enhance the local electromagnetic fields in response to changes in the environment. This enhancement results in highly sensitive detection of small changes in the surrounding media. Additionally, plasmonic sensors have several advantages over traditional sensing techniques, including high sensitivity, fast response times, and the ability to detect analytes in real-time, making them ideal for use in a range of applications, such as disease diagnosis and food safety testing.
This study explores the development of hybrid nanogaps, which is a type of nanoscale structure that combines two or more different materials on the nanoscale to create a small gap with unique optical properties. Hybrid nanogaps can be used to enhance the sensitivity and specificity of sensing by utilizing the unique optical properties of the gap. Our hybrid nanogaps are composed of a metal, gold or silver, and a dielectric material, silicon, or a polymer, that creates a small gap between the two layers. The gap size is typically in the nanometer range and its properties are determined by the size and composition of the gap, as well as the properties of the materials that make it up. These gaps are characterized by highly enhanced electromagnetic field arising from the coupling of plasmonic/photonic modes, making them well suited for enhancing Raman scattering also known as SERS, where the signal enhancement factor (EF) is proportional to the fourth power of the enhanced field at the location of the molecule. A high EF leads to improved SERS sensitivity enabling the detection of trace amounts of target molecules, and the study of weak Raman-active molecules that cannot be detected with traditional spectroscopy.

Using Finite Difference Time Domain (FDTD) simulations, we calculated Raman signal enhancement for a wide range of hybrid nanogaps. In most structures, we obtained an EF of approximately 105. Moreover, the emission of some samples showed directionality, meaning that all the signal is focused on a single direction, leading to high collection rates by simply pointing the detector in the defined direction.

Stephan Conopo-Holyoake

Measurement of chiral domain formation in Ntb thin films

In previous work, it has been extensively reported by numerous researchers that the CBCnCB (n= CH_2 spacer units) series of molecules display a twist-bend nematic phase (Ntb.). This phase is characterized by the emergence of chirality in non-chiral molecules and formation of helical structures, with a helical pitch ranging typically between 8-16 nm. The emerging chirality can be observed through the use of circular dichroism (CD) [1]. However, measurements of CD of thin films of liquid crystals are very often affected by positive interference of other optical properties, such as linear birefringence (LB), and linear dichroism (LD). Moreover, the LB and LD non-chiral contributions are often much larger than CD giving rise to misleading interpretations. Typically this issue can by minimized by repeating the experiments after rotating and flipping samples, so that LB and LD are averaged out; ideally samples are oriented parallel to the CD beam, so that linear effects are at a minimum. [1,2]

Here we report the results of our experiments studying the characteristics of chiral domain clusters of the CBCnCB (n = 7, 9, 11) series in thin films at various temperatures. We show that the use of a dedicated nematic dopant achiral dye molecule admixed in small concentrations to the thin films, permits the recording of chirality beyond the absorption wavelength of the CBCnCB systems. Using the high resolution B23 beamline for Synchrotron Radiation Circular Dichroism (SRCD) and Mueller Matrix Polarimetry (MMP) at Diamond Light Source [3], we also conducted mapping experiments across an area of the thin films, in order to visualise the formation of real chiral domains at the dopant-active wavelength. Using these results, we discuss the onset characteristics of chiral domain formation and compare this data with other results.

[1] W. D. Stevenson, X. B. Zeng, C. Welch, A. Thakur, G. Ungar, G. H. Mehl, *J. Mater. Chem C.*, 2020, **8**, 1041
[2] H. Yu, W. Qu, F. Liu,G. H Mehl, *Chem. Sci.,* 2021, **12**, 1778
[3] R. Hussain, T. Jávorfi, G. Siligardi, *Front. Chem.*, 2021, **9**, 616928

Nazish Fatima

Biodegradable chitosan Derivatives for 3D printing applications

Bio polymers obtained from natural sources have become demanding materials for variety of applications due to their intrinsic properties which includes biocompatibility, biodegradability, and bioactivity and the ability to precisely control their material properties.

The research is based on developing novel biodegradable polymeric materials for 3D printing and develops a 3D printing setup for this purpose.

Special thanks to

Grazia Francesconi
Chris Armstrong
Pam Doyle

School of Natural Sciences PGR Conference Committee

Clare Collins
Natalie March
Joe Morrison
Charlie Nash
Tom Spencer
Amber Wagstaffe
Kate Womack