NANOSTRAND

THE PHOTONICS & NANOTECHNOLOGY RESEARCH GROUP
THE BIOLOGICAL PHYSICS & SOFT MATTER GROUP
REVIEW OF 2020

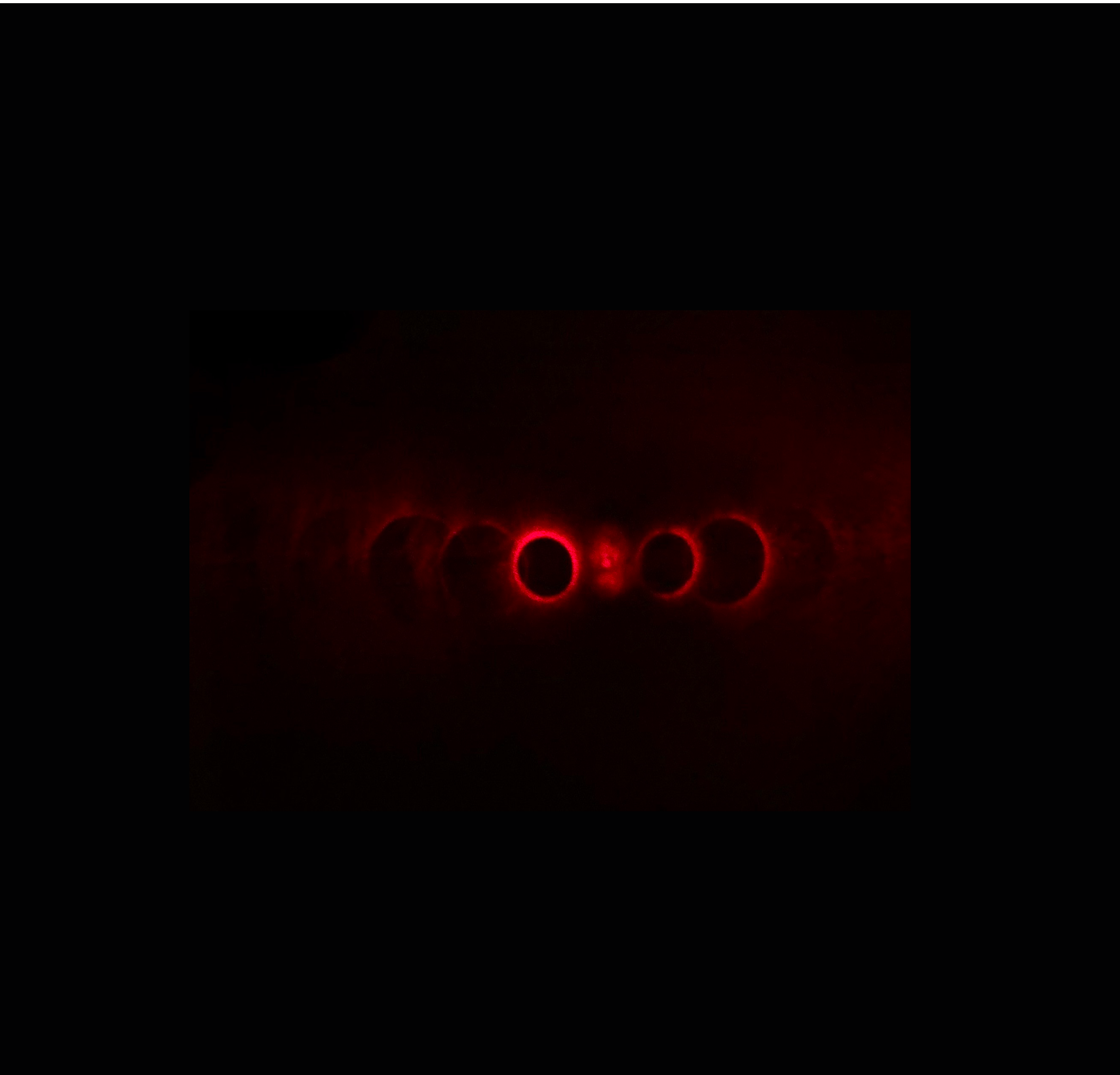


Image Credit - A gaussian beam reflecting from a spatial light modulator Vittorio Aita

NANOTECHNOLOGY | PHOTONICS | BIOPHYSICS

WELCOME TO NANOSTRAND

THE ANNUAL REVIEW FOR THE PHOTONICS & NANOTECHNOLOGY GROUP AND THE BIOLOGICAL PHYSICS & SOFT MATTER GROUP AT KING'S COLLEGE LONDON.

An update from Heads of Group Professor Sergi Garcia Manyes & Professor Anatoly Zayats

This was a very challenging year for all of us in many different aspects. Research wise, both theoretical and experimental activities have been significantly impacted due to the ongoing situation with COVID. Our research laboratories were re-opened in July under the COVID-safe measures, and albeit at relatively low capacity, we were able to resume research activity. We are incredibly grateful to professional and technical services in the Physics Department in particular, and the Faculty in general, for all their help with making it possible to operate laboratories under these unexpectedly tough conditions. We are extremely proud of our colleagues, especially our post-docs and PhD students, who continued to progress with their research despite all the challenges and managed to continue producing science of the highest standards.

PHD OPPORTUNITIES

The Biological Physics Across Scales (BiPAS) CDT focus is to understand how complex macroscopic phenomena—observed at scales appropriate to tissue, organism, or even population—arise from mechanisms at the cellular, molecular, and atomic level.

The Leverhulme Doctoral Scholarship Programme "Understanding the Mechanics of Life' aims to train future research leaders to develop new techniques, methodologies and analytical tools required to resolve outstanding challenges underpinning Mechanobiology across a broad range of biological themes.

In 2021, the P&N group invites enthusiastic and highly qualified candidates to work on the projects related to studies of light-matter interactions on the nanoscale, ultrafast optics, optomechanics, nanoparticles and in particular:

Highly ordered nanophotonic systems

Pseudo-3D optical metamaterials for biophysics

SYNTHETIC SYNAPSES GET MORE LIKE A REAL BRAIN

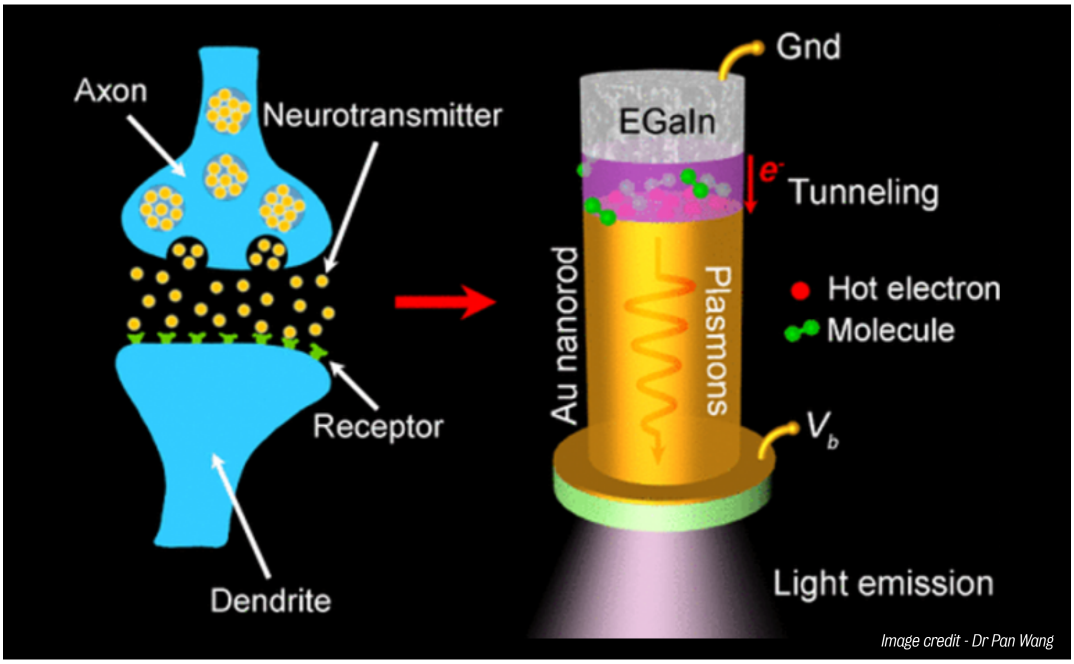


Image credit - Dr Pan Wang

The human brain easily outperforms today's state-of-the-art supercomputers fed on just the calorie input of a modest diet, as opposed to the full-scale power station energy input that a supercomputer guzzles through. The difference stems from the multiple states the brain processes with versus the two binary states of digital processors, as well as the ability to store information without power consumption – 'non-volatile memory'. These inefficiencies in today's conventional computers have prompted great interest in developing 'synthetic synapses' for use in computers that can mimic the way the brain works. Now researchers at King's College London, UK, report in ACS Nano Letters an array of nanorod devices that mimic the brain more closely than ever before. The devices may find applications in artificial neural networks.

How the brain works

Conventional computers have processors and memory components connected by wires in a circuit. However, in the brain the connections themselves also have memory functions. Signals pass from one biological neuron to another thanks to connecting synapses, and the connectivity of these synapses changes depending on what signals they have transferred in the past – practise makes perfect because repetition improves these synaptic connections.

Efforts to emulate biological synapses have revolved around types of 'memristors' - circuit elements that have a resistance that chang-

Continued on the next page

es depending on what signals have passed through previously. "A memristor is very similar to how a synapse works," explains Anatoly Zayats, head of the Photonics & Nanotechnology Group who led the team behind the recent results. Previous synthetic synapses based on memristors have responded to an input voltage through material changes such as the formation of filaments in insulator layers or a chemical change. This might be detected as a change in the electrical resistivity or the light emission characteristics. However, unlike the brain the devices reported so far have all needed a reverse polarity electrical voltage to reset them to the initial state.

"In the brain a change in the chemical environment changes the output," explains Zayats. These chemical changes may be fluctuations in the ion concentrations around the synapse. Exposure to different chemicals then reverts the changes, even though the polarity of the electric field remains unchanged. The King's College London researchers have now been able to demonstrate this brain-like behaviour in their synthetic synapses as well.

Synapse-like polymer junctions

Zayats and team build an array of gold nanorods topped with a polymer (poly-L-histidine, PLH) junction to a metal contact. Either light or an electrical voltage can excite plasmons – collective oscillations of electrons that release hot electrons into the PLH, changing the chemistry of the polymer. Depending on the chemical environment around the synthetic synapse, the chemical changes will increase or decrease the electrical conductivity or light emission intensity of the junction. In air oxidative dehydrogenation reactions gradually take place, changing the junction's characteristics in a series of multiple levels until the polymer is fully dehydrogenated. In a 2% molecular hydrogen environment this reaction reverses, gradually resetting the junction to its initial state with no change in the polarity of the electric field across the junction. A chemically inert nitrogen chemical environment will preserve the state without any energy input required so that it acts as non-volatile memory.

The junction can also be set and read either optically or electrically or set one way and read the other allowing great versatility in the device. "The advantages of optical control is you can wirelessly switch and read the device," says Zayats. The preference for electrical or optical operations depends on the application, but as he points out, there have been a number of attempts to create neuromorphic circuits that compute the way the brain does, and if you introduce optical switching or read out you can compute faster.

The researchers stumbled on the polymer junction's neatly synaptic behaviour during experiments to develop a nanoscale light source

They had constructed different tunnel PLH junctions, and noticed the light source was not stable in air or hydrogen. "By chance I read a paper about synapses and thought – that is our light source," says Zayats. "It was completely by chance."

Catching up with the brain

Another impressive feature of the human brain is the sheer density of synaptic connections, which can reach 7.2 x 10^8 synapses/mm^3. The first realisations of synthetic synapses were based on CMOS electronics and limited by the density of elements that could be fabricated on a chip, several orders of magnitude lower than that found in the brain.

Progress in memristor technology has made some inroads in closing this gap. The synaptic nanorod arrays Zayats and colleagues report gets impressively close, falling short by just a factor of a thousand or so. The next challenge will be finding a way to switch individual nanorods instead of the whole array. Exposing single nanorods to different chemicals may prove problematic but Zayats suggests there may be a way to expose just some from the array to a bias voltage or excitation light to change the state, which would bring them yet another step closer to mimicking the brain.

Funding Success

A selection of recent grant announcements:

BHF Centre Theme 2
Pump prime
Dr Katelyn Spillane

Development of antimicrobial peptides against Gram-negative antibiotic resistant pathogens
Prof Chris Lorenz

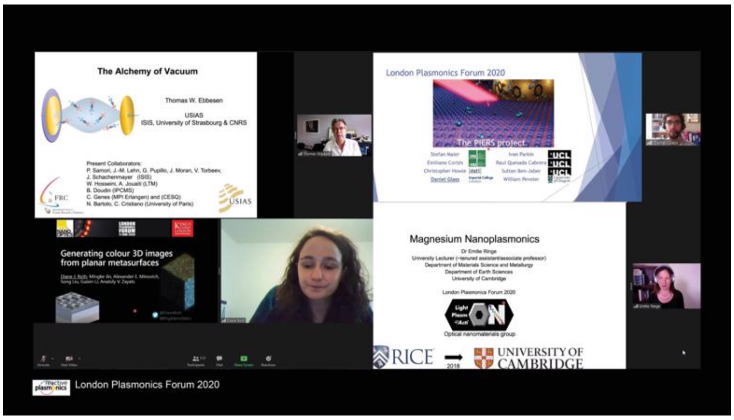
DisCoVer: Aptamer biosensors for the detection of SARS-CoV-2 on surfaces
Prof Mark Green
Prof Chris Lorenz

LeviTech: Levitated particles as the heart of miniaturized sensing technologies
Dr James Millen

Regulation of epithelial and endothelial cell-cell junctions by mechanical forces
Prof Sergi Garcia-Manyes
Dr Katelyn Spillane

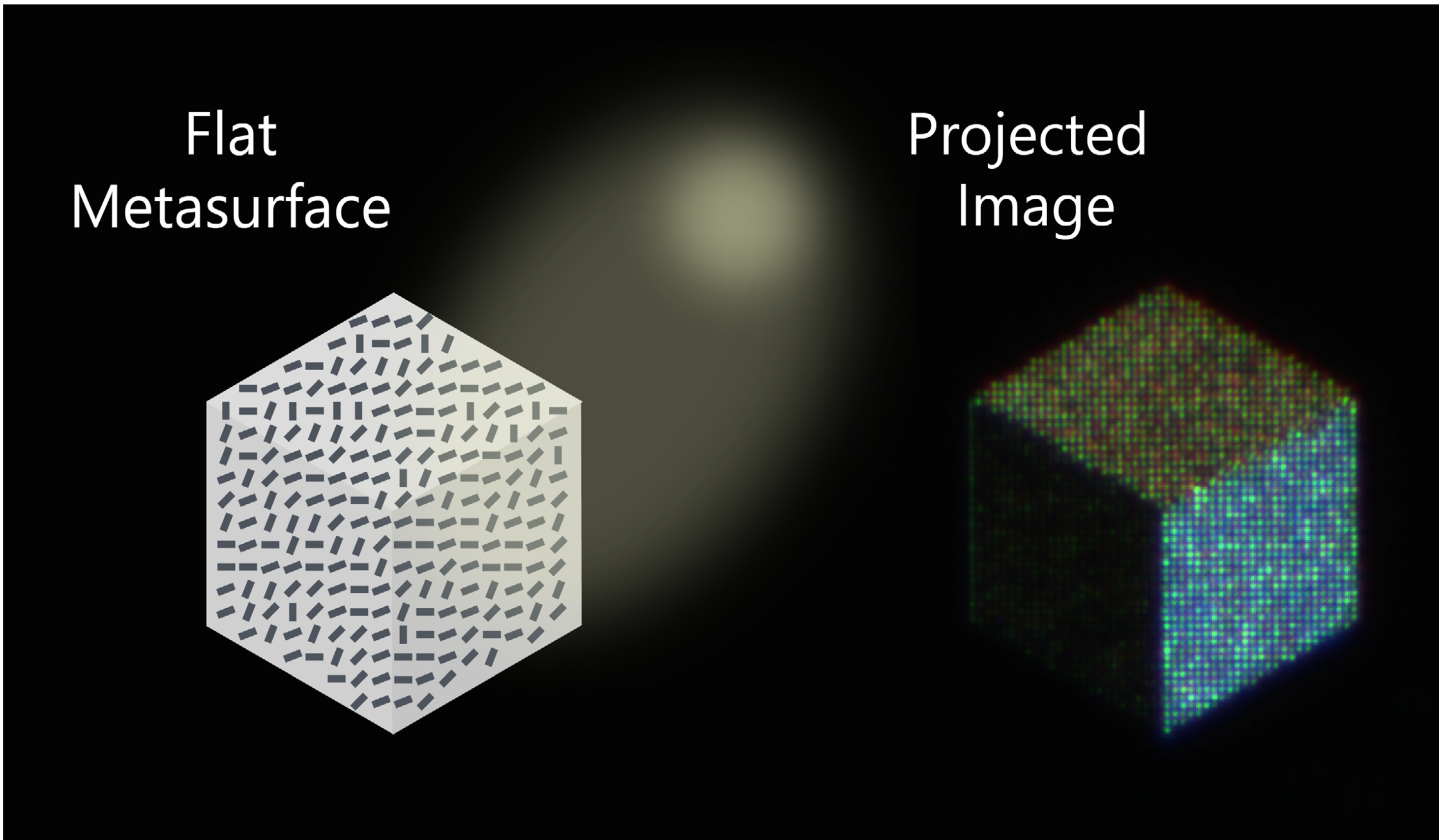
Safe hydrogen gas sensors based on optical interrogation of metamaterials
Prof Anatoly Zayats

LONDON PLASMONICS FORUM GOES DIGITAL



The annual London Plasmonics Forum was conducted online for the first time, attracting a global audience of over 140 delegates. The Forum has been held at King's since 2015, and is hosted by Anatoly and Professor Stefan Maier from Imperial College London as lead investigators on the EPSRC funded programme grant Reactive Plasmonics. Due to social distancing rules, it was not possible to meet in person so the event was moved online.

The online format of the event allowed for greater involvement with the wider international plasmonics community, with delegates tuning in from Japan to the US. The digital poster session drew entries from researchers from all over the world, including Russia, India, the UK and Europe. It was judged by science journalist Dr Anna Demming, Dr Nina Meinzer from Nature Physics, and Dr Rachel Won from Nature Photonics.



GENERATING COLOUR 3D IMAGES WITH DESIGNED REFLECTIVE METASURFACES

Image credit - Dr Diane Roth

THE IMAGES HAVE A WIDE RANGE OF APPLICATIONS INCLUDING SECURITY

As part of an international collaboration with Southern University of Science and Technology in Shenzhen (China), P&N researchers at King's College London have developed a novel way of generating colour 3D images using a reflective metasurface performing through the entire visible spectral range. Metasurfaces are 2D engineered materials typically made of subwavelength elements, which provide excellent control over the shaping of optical wavefronts via the manipulation of polarisation, phase and amplitude of the light. Unlike typical metasurface-based holography techniques, the developed method does not rely on interleaved nanostructures for wavelength multiplexing or wavelength-dependent off-axis illumination. Instead, the researchers used specially-designed aluminium nanostructures to achieve a high metasurface efficiency across the visible spectrum, including the three main RGB colours. A combination of specular and diffuse reflections was employed to generate images of 2D structures with 3D effects. The true perception of a 3D object through shading effects is therefore ensured by an adequate change in the brightness of the reflected light from the flat metasurface in response to variations in the illumination or observation angle. In contrast with 3D holograms, this structure performs under incoherent illumination.

As a proof of concept, an image of a 3D cube was encoded onto the metasurface and illuminated with white light. The projected image displays shading effects changing according to the incident angle, therefore emulating the behaviour of a real 3D cube.

The lead author on the paper published in the journal Nano Letters, Dr Diane Roth said, "Metasurfaces are extremely versatile and have the potential to enable progress in many different areas of science, either introducing new functionalities or making existing technology smaller and lighter. The practical potential of our design is very interesting for a wide range of applications including security features for protection against counterfeiting but also artistic purposes." More generally, the unique properties of diffuse metasurfaces could also have an impact on the development of new display technologies, flat light diffusers and integrated optical components. Results from this international project have been published in the journal Nano Letters.

> *'Metasurfaces are extremely versatile and are an excellent solution to control and manipulate light with an incredible degree of precision, enabling progress in many different areas of science, either introducing new functionalities or making existing technology smaller and lighter.'*
>
> *Dr Diane Roth*

QUANTUM CIRCUITS WITH A LEVITATED HEART

The latest development in this UKRI and European Research Council-funded project explores how the motion of charged microparticles can be detected and affected by nearby electrical circuitry, such that they can form a crucial component in a quantum network.

Do you believe in quantum physics? Quantum theory is the unchallenged description of the microscopic realm, yet seemingly has little impact on the world around us. While it is possible for photons or electrons to "be in two places at once", known as quantum superposition, the chair you're sitting on displays a stubborn refusal to play quantum ball.

There are good reasons why it's hard to make big objects behave in a quantum way; quantum mechanics requires exquisite isolation to manifest its stranger behaviours. The bigger something is, the harder it is to isolate. In his lab at King's, Dr. James Millen uses light and electrical fields to levitate microparticles in a vacuum, achieving the required isolation from the environment. Although they sound tiny, microparticles are more than a thousand times larger than the current largest quantum objects, and much larger than components used in modern electronics.
We do exploit quantum physics in technology, with companies like Google and IBM building quantum computers using tiny electrical quantum systems called qubits. The lead author on this collaborative project, Lukas Martinetz from the University of Duisburg-Essen, found a way to connect qubits and levitated microparticles, sharing their quantum behaviour with the otherwise non-quantum particles.

By working with charged microparticles, their motion can be detected and effected by nearby electrical circuitry. The team considers interfacing a charge quibit, meaning that the voltage in the circuit can be in a quantum superposition. This voltage will exert a force on the levitated microparticle, pushing it into a superposition of positions. By introducing the levitated object, the utility of the quantum circuit is greatly enhanced. Delicate quantum information can be stored in the motion of the particle, and shared between other distant qubits, building a robust quantum network. This will boost the usefulness of quantum computers, and help us build a quantum internet.

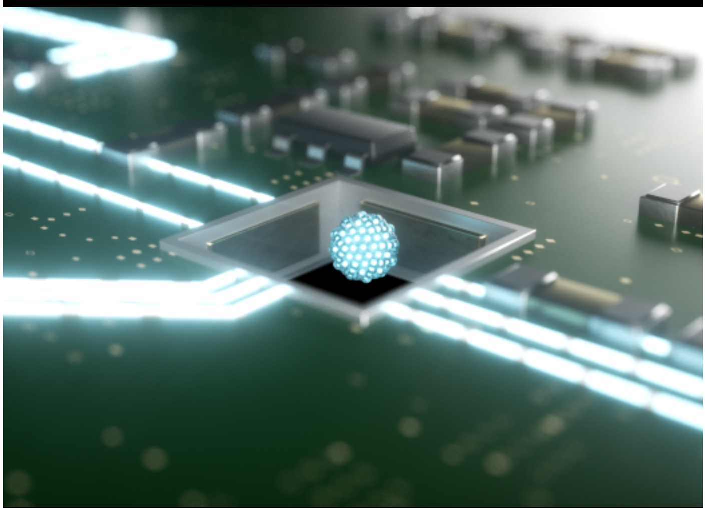


Image credit - Mark Mazaitis for Dr James Millen

Observing a micro-scale object in a quantum superposition would extend the reach of quantum theory into the world around us. In the future, this could be used to understand the interaction between quantum physics and gravity, one of today's greatest scientific challenges.

Quantum electromechanics with levitated nanoparticles is published in [NPJ Quantum Information](#).

RESEARCHERS AWARDED £3.5M TO STUDY HOW CERTAIN CELLS USE AND RESIST FORCE

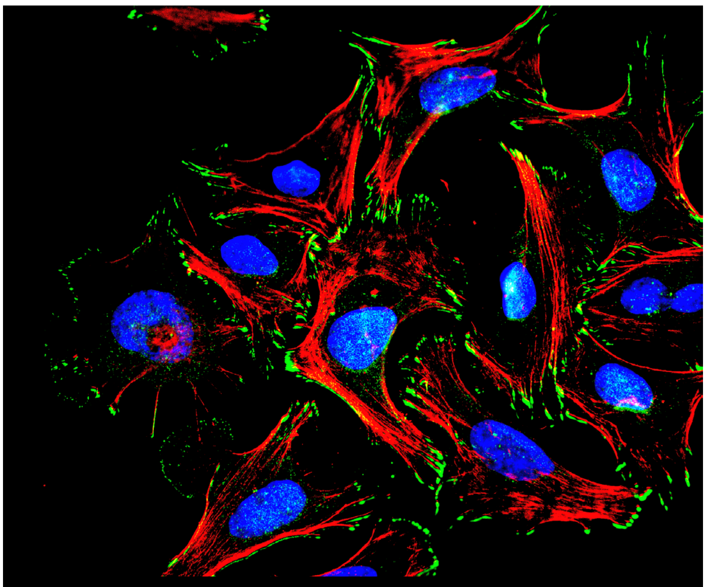


Image credit - Garcia-Manyes Lab

Researchers have long understood that biochemical signals affect cells, and recently it has been recognised that mechanical forces regulate a wide variety of biological processes, ranging from the expansion of our lungs when we breathe, to the extension of our skin every time that we stretch an arm.

Researchers including members of the BPSM Group alongside Bristol University and University College London, have been awarded a £3.5m grant from the BBSRC to develop an integrated understanding of these bodily forces, known as mechanobiology, and how they influence our physiology.

The multidisciplinary team aim to better understand mechanobiology through the careful experimental analysis of single molecules, cells, tissues and ultimately whole organisms under a variety of different conditions using a cutting-edge combination of techniques including 3D tissue culture, optogenetics and novel DNA-based mechanosensors. This integrated approach requires strategies from different areas of science.

P&N RESEARCHERS MAKE ELECTRICAL NANOLASERS EVEN SMALLER

TECHNOLOGY WILL REVOLUTIONISE ON-CHIP DATA TRANSFER

P&N researchers, in collaboration with a team at Moscow Institute of Physics and Technology have developed a concept of an electrically driven nanolaser which is not only much smaller than the other integrated lasers but even smaller than the free-space wavelength it is emitting.

The Nano-Optics group at King's College London, led by Professor Anatoly Zayats, have previously reported on nanoscale electro-optical modulators and together these nanodevices will mark a milestone in the development of fully functional highly-integrated optoelectronic circuits for optical data communication.

Once incorporated into electronic computational chips, such circuitry will revolutionise on-chip data transfer, substituting 'slow' and lossy metallic wiring overheating the chip with broadband and energy-efficient optical network. This means that the best technology for data communication (photonics) will be merged with the best technology for data processing (electronic), leading to hybrid electronic/photonic chip architecture with superior computational power.

Nanolasers have been at the edge of nanophotonic research of the last decade. However, the vast majority of the proposed designs utilise optical pumping schemes, requiring high-power 'ordinary' external lasers, which makes their practical application challenging. Electrically-pumped nanoscale counterparts met a fundamental problem when the Ti- or Cr-based low-resistance contact required to supply the electrical pumping to the optical mode simultaneously did precisely the opposite introducing unacceptable losses related to the optical absorption in the

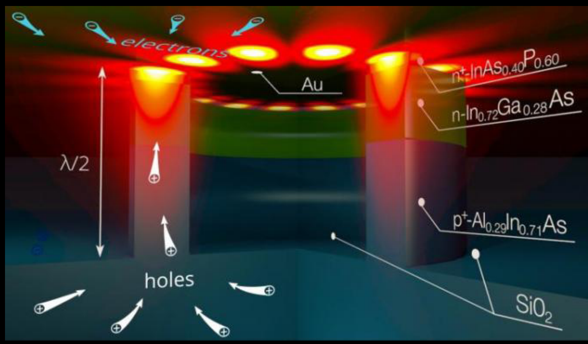


Image credit - Electrically pumped surface plasmon-polariton nanolaser - Dmitry Fedyanin

metals. The researchers have now solved this problem by proposing a novel electrical pumping scheme based on a tunnelling Schottky contact, which gets rid of highly-absorbing materials and supplies the electrical power with no loss penalties. Furthermore, the contact simultaneously confines the nanoscale optical mode in the form of surface plasmon polaritons in its vicinity – precisely in the region of most efficient amplification. Importantly, the nanolaser operates at room temperature and emits light directly into an optical waveguide, which makes it easy to integrate it into the optoelectronic circuitry. Despite the nanoscale dimensions the emitted optical power of a single nanolaser is high enough to transmit 100s of Gb/s of data, matching record-high data speeds. The article 'Lasing at the nanoscale: coherent emission of surface plasmons by an electrically driven nanolaser' was published in Nanophotonics.

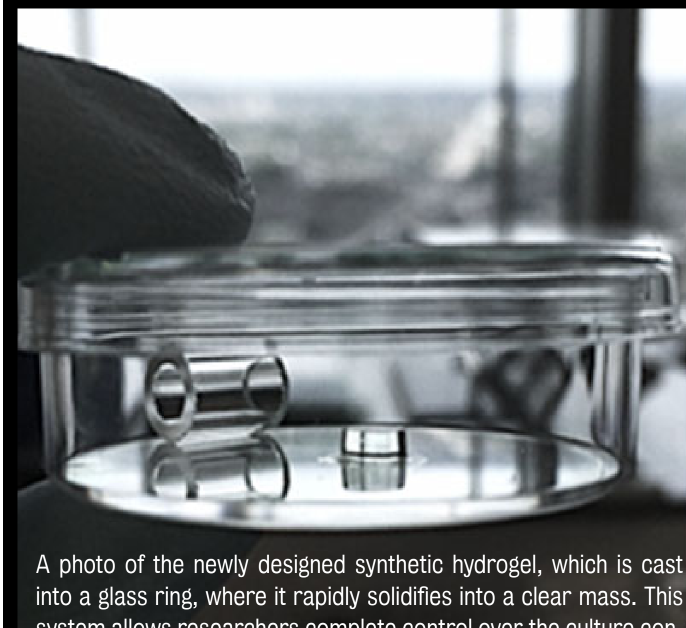
RARE IMMUNE CELLS DRIVE GUT REPAIR, BUT CAN TIP TOWARD CANCER OR FIBROSIS IN INFLAMMATORY BOWEL DISEASE

As part of an international collaboration BPSM researchers have discovered an unexpected tissue reparative role for a rare immune cell type in the gut that could tip toward fibrosis or cancer if dysregulated. The breakthrough will have important implications for treating patients who suffer from inflammatory bowel diseases (IBD) such as Crohn's disease and ulcerative colitis.

The team of researchers found that type-1 innate lymphoid cells (ILC1) can promote tissue repair, but when they accumulate in inflamed tissues, can also contribute to IBD co-morbidities such as cancer and fibrosis. It was previously assumed that these cells drove inflammation, so these findings could inspire completely new therapeutic approaches for those suffering from IBD.

The team's findings may also have implications for COVD-19 patients, as ILC1 are more typically known as the key first responders to viral infections in the lung and the gut. Even young, asymptomatic patients infected with SARS-CoV2 have presented with early signs of lung fibrosis. Since ILC1 are enriched during chronic viral infections, it is possible that ILC1 also accumulate and play a role in driving fibrosis in the lungs of COVID-19 patients, providing a potential therapeutic target for the urgent research efforts currently underway.

These finding were published in Nature Materials.



A photo of the newly designed synthetic hydrogel, which is cast into a glass ring, where it rapidly solidifies into a clear mass. This system allows researchers complete control over the culture conditions, enabling them to study IBD-associated co-morbidities like fibrosis or fistulae.

LEVITATING NANOPARTICLES USING LIGHT: CONVEYOR BELTS OF THE FUTURE

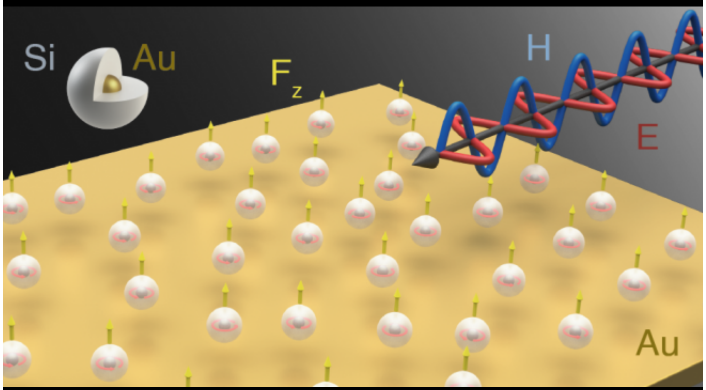
FUTURE APPLICATIONS INCLUDE NANOFACTORIES NANO-CONVEYOR BELTS, TO LEVITATE AND MOVE NANOPARTICLES ACROSS A SURFACE.

P&N researchers have reported an exciting new levitation phenomenon that involves shining light on nanoparticles which are made from a non-magnetic material. The light resonates with the nanoparticles to produce a magnetic property, in a process known as optical magnetism. When placed near a metallic surface, these resonating particles behave like nanoscale oscillating magnets which are naturally repelled by their own reflected fields from the surface, leading to levitation. This kind of levitation is highly-scalable and their new approach increases the feasibility for real-world applications over previous methods.

Lead author Jack Kingsley-Smith said:"Controlling the movement and position of small objects precisely may seem like a simple problem at first but it's a problem that many fields of research still face and encounter issues with. The modern way to approach this is to use light, since it's contactless, non-invasive and flexible. By shining light on these particles, they become temporarily magnetic and when placed near a metallic surface, they naturally levitate. This type of levitation was previously only possible with exotic materials. By utilising optical magnetism, we have enabled the use of common materials and thus greatly increased the real-world feasibility of this phenomenon."

The research published in Nano Letters has the potential for wide-ranging applications in nanomechanical devices including nano-conveyer belts.

The team has previously published work to engineer a special surface to repel the particles, but in this work the design is focused on the levitating particle using high index dielectric spheres or core-shell particles. This new approach allows for any metal surface to be used which would reduce the cost of manufacturing considerably.



A non-magnetic nanoparticle levitates above a gold surface when illuminated with a polarised laser beam. A magnetic resonance is excited in each nanoparticle and this results in a repulsive force from the metal surface.

Image Credit: Jack Kingsley-Smith

Principal Investigator Dr Francisco Rodríguez Fortuño said, "The optical levitation of particles from a surface could enable applications in future nanofactories, such as nano-conveyor belts, to levitate and move nanoparticles across a surface. Conventional optical-tweezer-based optical forces need to focus on levitating particles one at a time. The advantage of our dipolar repulsion approach is that it acts on all illuminated particles simultaneously. Therefore, using a wide-area illuminating beam, this can be massively-parallel, with thousands or millions of particles simultaneously levitating."

PHD STUDENT WINS INSTITUTE OF PHYSICS JOCELYN BELL BURNELL AWARD

Jocelyn Bell Burnell Award Winner, Bethan Cornell

Bethan Cornell, PhD student in the BPSM Group, has been recognised as an exceptional early career female physicist. The Jocelyn Bell Burnell Medal and Prize is awarded by the Institute of Physics (IOP) in recognition of substantial contribution to physics and work to support and encourage others in the field.

At King's, Bethan's PhD topic is on 'Unravelling the working mechanisms of fluorescent molecular rotors for bioimaging'. Her multi-disciplinary research in molecular physics focuses on furthering understanding of how light interacts with biological environments, specifically in application to the viscosity of cells in order to advance the understanding of diseases such as dementia and cancer.

Bethan's nomination for the award also recognised her work promoting diversity and inclusion within the wider STEM field. She has contributed towards the IOP's Gender Action activities and also worked with the Social Mobility Foundation and local councils in mentorship schemes aimed at supporting young people interested in STEM.

NOBEL LAUREATE TELLS HOW TO BEAT HIS OWN AWARD-WINNING IMAGING TECHNIQUE

PROFESSOR STEFAN W. HELL DELIVERS WHEATSTONE LECTURE 2020

In the 1990s an optical imaging technique emerged that overturned the "diffraction limit", which for over a century had defined the maximum achievable resolution an optical microscope could achieve at around half the wavelength of the illuminating light. At King's College London's Wheatstone Lecture 2020, attendees heard from Stefan Hell, the Nobel laureate who had developed the technique – stimulated emission depletion microscopy (STED). In his talk he described a new kid on the block in the world of optical imaging techniques that can beat the resolution of STED by a further factor of 10.

Hell began his talk with an overview of his STED technique and two others developed in the 2000s - photo-activated localization microscopy (PALM) and stochastic optical reconstruction microscopy (STORM) - that together led to the award of the 2014 Nobel Prize for Chemistry to Eric Betzig, Stefan W. Hell and William E. Moerner "for the development of super-resolved fluorescence microscopy."

"I'm still struggling with this chemistry thing," smiled Hell "I don't know much about chemistry." Despite the modesty of his claim, as his talk pointed out all these super-resolution techniques hinge on the use of fluorescing molecules that stain the sample being imaged. The chemistry becomes important for choosing the right molecules that will fluoresce with the right behaviour – emitting photons and "bleaching" or ceasing to emit them when flooded with light, only in ways that allow the techniques to work. Nonetheless he was true to his word that there wouldn't be too much chemistry in the talk, giving instead a tour de force of the physics behind these techniques.

Professor Stefan Hell

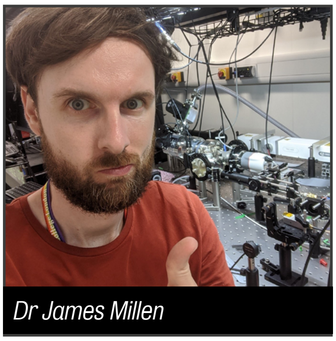
Both STED and PALM/STORM illuminate a diffraction-limited region to excite the molecules there to fluoresce. However, STED uses an additional, for example, doughnut-shaped beam to deplete emissions from part of this region, while PALM and STORM use the stochastic nature of the molecules' fluorescence and bleaching to build up a picture with a resolution that beats the diffraction limit. Both techniques should be capable of resolution at the molecular level but as Hell pointed out, in practice they are limited to a resolution of ten times this at around 20 nm. This is still ten times better than diffraction-limited optical microscopy can achieve, but he was keen to resolve molecular level detail, which is what is achieved by his group's new technique "MINFLUX".

Hell described the Achilles heel of the previous super-resolution techniques – the sheer number of photons needed. In contrast MINFLUX operates by the absence of photons emitted. It tracks fluorescing molecules with a doughnut shaped illuminating beam where fluorescence is suppressed in the centre, and uses the known mathematical description of how that fluorescence changes from the centre of the hole in the beam to pinpoint the molecule from what photons have been emitted. In an ideal world tracking the molecule with it dead centre of the beam would involve no fluorescence at all. This not only liberates the achieved resolution from a performance limited by the number of photons involved but means that images can be collected much faster – something biologists love. He showed a movie of a protein moving around in an e coli cell where the technique tracked 8000 protein localizations a second.

The Wheatstone Lectures are an annual event at King's College London that attract lay public and academics alike. The excitement of one University College London student pursuing a Masters on super-resolution techniques was infectious as he waited to hear the man who had won a Nobel Prize for work in this field describe the state of the art. The lectures commemorate the life and work of one of the college's alumni Charles Wheatstone (1802-1875), a scientist and prolific inventor whose legacy includes the symphonium, the stereoscope and work on establishing the telegraph system and the Wheatstone Bridge.

AND FINALLY.. SOME VERY HAPPY RESEARCHERS IN SOCIALLY DISTANCED LABS

From l-r: Claudia Almutairi, Mayela Romero Gómez & Anastasia Zaleska



Dr James Millen

Dr Eva Philippaki

Mayela Romero Gómez

A SELECTION OF OUR RECENT PUBLICATIONS

Wang, P, Nasir, M.E, Krasavin, A.V, Dickson, W. And Zayats, A.V (2020)
Optoelectronic Synapses Based on Hot-Electron-Induced Chemical Processes.
Nano Letters https://doi.org/10.1021/acs.nanolett.9b03871

Deng, J, Tang, Y, Chen, S, Li, K, Zayats, A.V and Li, G (2020)
Giant Enhancement of Second-Order Nonlinearity of Epsilon-Near-Zero Medium by a Plasmonic Metasurface.
Nano Letters https://doi.org/10.1021/acs.nanolett.0c01810

Roth, D.J, Jin, M, Minovich, A.E, Liu, S, Li, G and Zayats, A.V (2020)
3D Full-Color Image Projection Based on Reflective Metasurfaces Under Incoherent Illumination.
Nano Letters https://doi.org/10.1021/acs.nanolett.0c01273

Lee, J.B, Walker, H, Li, Y, Nam, T.W, Rakovich, A, Sapienza, R, Jung, Y.S, Nam, Y.S, Maier, S.A and Cortés, E (2020)
Template Dissolution Interfacial Patterning of Single Colloids for Nanoelectrochemistry and Nanosensing.
ACS Nano https://doi.org/10.1021/acsnano.0c09319

Millen, J, Monteiro, T.S, Pettit, R and Vamivakas, A.N (2020)
Optomechanics with Levitated Particles.
Reports on Progress in Physics https://doi.org/10.1088/1361-6633/ab6100

Kingsley-Smith, J.J, Picardi, M.F and Rodríguez-Fortuño, F.J (2020)
Optical Magnetic Dipole Levitation Using a Plasmonic Surface.
Nano Letters https://doi.org/10.1021/acs.nanolett.0c02313

Ciattoni, A, Conti, C, Zayats, A.V and Marini, A (2020)
Electric Control of Spin Orbit Coupling in Graphene Based Nanostructures with Broken Rotational Symmetry.
Laser & Photonics Reviews https://doi.org/10.1002/lpor.202000214

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Lasing at the Nanoscale: Coherent Emission of Surface Plasmons by an Electrically Driven Nanolaser.
Nanophotonics https://doi.org/10.1515/nanoph-2020-0157

Jowett, G.M, Norman, M.D, Yu, T.T, Rosell Arévalo, P, Hoogland, D, Lust, S.T, Read, E,Hamrud, E, Walters, N.J, Niazi, U, Wai Heng Chung, M, Marciano, D, Omer, O.S, Zabinski, T, Danovi, D, Lord, G.M, Hilborn, J, Evans, N.D, Dreiss, C.A, Bozec, L, Oommen, O.P, Lorenz, C.D, da Silva, R.M, Neves, J.F & Gentleman,E (2021)
ILC1 Drive Intestinal Epithelial and Matrix Remodelling.
Nature Materials https://doi.org/10.1038/s41563-020-0783-8

Kepiro, I.E, Marzuoli, I, Hammond, K, Ba, X, Lewis, H, Shaw, M, Gunnoo, S.B, De Santis, E, Łapinska, U, Pagliara, S, Holmes, M.A, Lorenz, C.D, Hoogenboom, B.W, Fraternali, F & Ryadnov, M.G (2019)
Engineering Chirally Blind Protein Pseudocapsids into Antibacterial Persisters.
ACS Nano https://doi.org/10.1021/acsnano.9b06814

Steinmark, I.E, Chung, P.H, Ziolek, R.M, Cornell, B, Smith, P, Levitt, J.A, Tregidgo, C, Molteni, C, Yahioglu, G, Lorenz, CD & Suhling, K. (2020)
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