GYSS 2022 PROGRAMME FOR MORNING (17 TO 21 JANUARY 2022)

Time (SGT)	Monday, 17 January	Tuesday, 18 January	Wednesday, 19 January	Thursday, 20 January	Friday, 21 January
0800		**Small group informal sessions (by invite only)** *Prof Leslie Valiant* *Prof M. Stanley Whittingham*	**Small group informal sessions (by invite only)** *Prof Ngô Bảo Châu** *Prof Thomas Cech* *Prof B. Jayant Baliga**	**Small group informal sessions (by invite only)** *Prof Robert Langer*	**Small group informal sessions (by invite only)** *Sir Andre Geim* *Sir Konstantin Novoselov* *Prof Michael Young* *Prof Takaaki Kajita* *Prof Thomas Südhof*
0900		**Panel Discussion** **Preparing for the Next Pandemic** *Prof Thomas Cech* *Prof Robert Langer* *Prof Wang Linfa* *Moderator: Prof Teo Yik Ying*	**Plenary Lecture** **The Riemann zeta function** *Prof Ngô Bảo Châu*	**Plenary Lecture** **Chronic Social Isolation Signals Starvation in the Drosophila Brain and Reduces Sleep** *Prof Michael Young*	**Plenary Lecture** **Drug Development for Neurodegenerative Disorders** *Prof Thomas Südhof*
0915					
0930					
0945			**Panel Discussion** **Start-Up Opportunities for Young Scientists** *Prof Robert Langer* *Prof Stuart Parkin* *Prof Alberto Sangiovanni-Vincentelli* *Moderator: Dr Lim Jui*	**Panel Discussion** **Next Generation Grid** *Prof B. Jayant Baliga* *Prof Stanley Whittingham* *Prof Ron Hui* *Moderator: Dr Yeoh Lean Weng*	**Plenary Lecture** **The Critical Role of Storage for Renewable Energy and Climate Change** *Prof M. Stanley Whittingham*
1000		**Plenary Lecture** **The IGBT Device: From Invention and Commercialization to Global Social Impact** *Prof B. Jayant Baliga*			
1015					
1030					**Plenary Lecture** **Complete Replication of Chromosome Ends** *Prof Thomas Cech*
1045		**Plenary Lecture** **Where Neuroscience Meets Computer Science** *Prof Leslie Valiant*	**Plenary Lecture** **How Curiosity Driven Research Resulted in the Nobel Prize in Medicine** *Prof Barry Marshall*	**Plenary Lecture** **Random Walk to Graphene** *Sir Andre Geim*	
1100					
1115					***Closing Remarks*** *Prof Low Teck Seng, CEO, NRF* *Prof Bertil Andersson, Senior Advisor, NRF*
1130		Young Scientist Presentation	Young Scientist Presentation	Young Scientist Presentation	
1145					
1200					
1215					
1230			Networking	Networking	
1245		Networking			
After 1245		Recordings of the morning sessions will be published on the NRF YouTube channel			

	Plenary Lectures		Panel Discussions		Small Group Informal Sessions		Young Scientist Presentation

GYSS 2022 PROGRAMME FOR AFTERNOON (17 TO 21 JANUARY 2022)

Time (SGT)	Monday, 17 January	Tuesday, 18 January	Wednesday, 19 January	Thursday, 20 January	Friday, 21 January
1600	**Opening Address** *Mr Heng Swee Keat, Deputy Prime Minister of Singapore, Chairman of the National Research Foundation*	**Networking/ Small group informal sessions (by invite only)** *Prof Alessio Figalli* *Prof Didier Queloz*	**Networking/ Small group informal sessions (by invite only)** *Prof Ada Yonath* *Prof Barry Marshall* *Prof Stefan Hell* *Dr Venki Ramakrishnan*	**Networking/ Small group informal sessions (by invite only)** *Prof Aaron Ciechanover* *Prof Stuart Parkin*	
1615	**Panel Discussion** **Has Scientific Research Fundamentally Changed** *Prof Aaron Ciechanover* *Prof Stefan Hell* *Dr Venki Ramakrishnan* *Moderator: Sir Peter Gluckman*				
1630					
1645					
1700		**Plenary Lecture** **Materials for the Future** *Sir Konstantin Novoselov*	**Panel Discussion** **Unmet Challenges in Physics** *Prof Didier Queloz* *Prof Takaaki Kajita* *Prof Artur Ekert* *Moderator: Prof Lai Choi Heng*	**Plenary Lecture** **Exploiting Genetic Code Translation Principles for the Design of Next Generation Therapeutics** *Prof Ada Yonath*	
1715	**Plenary Lecture** **Recent Developments in Optimal Transport Theory** *Prof Alessio Figalli*				
1730					
1745		**Plenary Lecture** **MINFLUX and MINSTED provide molecule-scale resolution in fluorescence microscopy** *Prof Stefan Hell*		**Plenary Lecture** **Memory on the Racetrack** *Prof Stuart Parkin*	
1800	**Plenary Lecture** **Exoplanets and life in the Universe** *Prof Didier Queloz*		**Plenary Lecture** **COVID-19: The Road to Cure is Strewn with Bioethical Bumps** *Prof Aaron Ciechanover*		
1815					
1830		**Plenary Lecture** **Using Electron Microscopy to Study Ribosomes in Action** *Dr Venki Ramakrishnan*		**Plenary Lecture** **On Finding Theorems, and a Career** *Prof Cédric Villani*	
1845	*Interim Break with Videos*		**Plenary Lecture** **Neutrino Oscillations** *Prof Takaaki Kajita*		
1900	**Panel Discussion** **Artificial Intelligence, Ethics and Governance** *Prof Cédric Villani* *Prof Leslie Valiant* *Prof Simon Chesterman* *Moderator: Prof Chan Heng Chee*				
1915		**Plenary Lecture** **Chemical Catalysis as Enabling Science and Technology for Humankind** *Prof Benjamin List*		Young Scientist Presentation	
1930			Young Scientist Presentation (1hr)		
1945					
2000		Young Scientist Presentation (1hr)			
After 2015	Recordings of the afternoon sessions will be published on the NRF YouTube channel.				

	Plenary Lectures		Panel Discussions		Small Group Informal Sessions		Young Scientist Presentation

Detailed GYSS 2022 Daily Programme

Monday, 17 January 2022	
Singapore Time	**Programme**
4.00pm	**GYSS 2022 Launch and Opening Address** by Mr Heng Swee Keat, Deputy Prime Minister of Singapore, and Chairman, National Research Foundation Singapore
4.15pm	**Panel Discussion: Has Scientific Research Fundamentally Changed** Moderator: Sir Peter Gluckman, Director, Koi Tū: The Centre for Informed Futures, The University of Auckland Panellists: • Prof Aaron Ciechanover • Prof Stefan Hell • Dr Venki Ramakrishnan
5.15pm	**Plenary Lecture by Prof Alessio Figalli** *Recent Developments in Optimal Transport Theory* At the end of the 18th century, Gaspard Monge introduced optimal transport as a tool to understand the most efficient way of transporting a distribution of material from one place to another to build fortifications. Later on, in the 1940s, Kantorovich developed this theory, and for his work, he received the Nobel prize in economics. In the last 30 years, optimal transport has found various applications in many problems. In particular, very recently, it has become a tool in machine learning. In this talk, I will give an overview of this theory and present some selected applications.
6.00pm	**Plenary Lecture by Prof Didier Queloz** *Exoplanets and life in the Universe* The wealth and diversity of planetary systems that have now been detected modified our perspective on planet formation and our place in the Universe. It also presents an opportunity of historical perspectives and an irresistible call to look for signs of life on these new worlds and to reflect on the origin of life in the Solar System. I will introduce the audience with the challenges and recent progresses in this new field of research and will touch upon the emergence of a new paradigm for the origins of life on Earth.
6.45 to 7.00pm	**Interim Break** **GYSS Videos**
7.00pm	**Panel Discussion: Artificial Intelligence, Ethics and Governance** Moderator: Prof Chan Heng Chee, Ambassador-at-Large, and Professor, Lee Kuan Yew Centre for Innovative Cities in the Singapore University of Technology and Design Panellists: • Prof Cédric Villani

	• Prof Leslie Valiant • Prof Simon Chesterman
8.00pm	**End**

Tuesday, 18 January 2022	
Singapore Time	**Programme**
8.00am	**Small group informal sessions**
9:00am	**Panel Discussion: Preparing for the Next Pandemic** Moderator: Prof Teo Yik Ying, Dean, Saw Swee Hock School of Public Health, National University of Singapore Panellists: • Prof Robert Langer • Prof Thomas Cech • Prof Wang Linfa
10.00am	**Plenary Lecture by Prof B. Jayant Baliga** *The IGBT Device: From Invention and Commercialization to Global Social Impact* The IGBT device, invented in 1980, is now extensively used in all sectors of the economy for the distribution, management, and generation of electrical energy. It revolutionized power electronics from analog to digital control, producing efficiency enhancements of 40-70%. During the last 40 decades, the IGBT-based electronic ignition system has reduced gasoline consumption by over 1.8 trillion gallons; and IGBT-based CFL lamps and adjustable speed motor drives have reduced electricity consumption by 133,000 TWhrs. This has resulted in reducing carbon dioxide emissions by over 180 trillion pounds while saving consumers more than $ 33 trillion. The IGBT is an essential components for future deployment of all renewable energy generation systems and electric vehicles to eliminate carbon dioxide emissions and mitigate global warming.
10.45am	**Plenary Lecture by Prof Leslie Valiant** *Where Neuroscience Meets Computer Science* The brain performs hundreds of thousands of individual cognitive acts over a lifetime. Some involve the learning of new knowledge. Others involve acting on knowledge learned earlier. It is difficult to reconcile the large-scale computational capabilities needed, given the fast reaction times achieved in some of these acts, with the known resource constraints on cortex, such as low connectivity and low average synaptic strength. It is not that there are several competing theories known, among which experimentalists need to resolve. It is that there are no generally accepted theories that meet the known quantitative constraints. Here we shall describe an approach to this fundamental problem that attempts to explain these phenomena in terms of concrete algorithms for a model of computation that is faithful to the most basic quantitative resources, such as neuron numbers, synapse numbers and synaptic strength. Some potential neuroscience experiments to test this will be described that have recently become feasible.
11.30am to 12.50pm	**Young Scientist Presentation (Session 1)** Moderator: Dr Ang Yuen-Siang, Principal Investigator, Institute of High Performance Computing, A*STAR
	Ms Rebecca Cooper, The University of Melbourne *Longitudinal Relationships Between Patterns of Sleep Disturbance and Psychopathology across the Adolescent Transition Period*

	This study aimed to model the changes in sleep across the transition into adolescence, a period characterised by significant changes in sleep behaviour. In addition, the change and stability in sleep behaviour was assessed in relation to emerging psychopathology symptoms during this key period in development. This study utilised data from baseline and 2-year follow-up data from the Adolescent Brain Cognitive Development (ABCD) Study®, a multicentre longitudinal study in the US consisting of over 11,000 participants, aged 9-10 years at baseline. A latent transition analysis was conducted to define latent classes based on multiple sleep-related behaviours, and identified four discrete classes at both waves of assessment. These classes differed not only in sleep behaviour but also in psychopathology symptoms at baseline and follow-up. These findings are relevant for understanding bidirectional relationships between adolescent sleep and mental health.
	Mr Pu Xue, University of Illinois Urbana-Champaign *iBioFAB – Illinois Biological Foundry for Advanced Biomanufacturing* Microbial cell factories (MCFs) have been extensively engineered to produce chemicals, fuels, and materials. However, metabolic engineering of MCFs remains time-consuming and labor-intensive. One major reason is the lack of a general platform for large-scale mutagenesis and high-throughput screening. To address this limitation, we performed genetic engineering and phenotypic screening by integrating the Design-Build-Test-Learn cycle with a biofoundry. As proof-of-concept, we are building a fully automated gene deletion workflow for the construction of transcriptional factor (TF) knock-out variants combinatorially in *Saccharomyces cerevisiae*. 175 single, double, or triple gene deletion variants are being created by our biofoundry in a single day. In parallel, we developed a mass spectrometry (MS)-based high-throughput screening method for rapid profiling of these TF variants. Most triple gene deletion variants were identified with improving shorter-acyl chain free fatty acids production. Through the integration of automated acoustic liquid handling and MS-based screening, the throughput of phenotyping can achieve up to 2 colonies/liquid cultures per second. Additionally, we attempted to develop a fully automated DNA assembly method for quick plasmid construction, which could achieve ~100% fidelity for assembly of 2-12 fragments with a final plasmid size of 25 kb. Thousands of plasmids in 96-well plate format can be created by our biofoundry in a single day. These developed workflows should be generally applicable to metabolic engineering of MCFs for production of value-added products.
	Dr Michele Nguyen, Nanyang Technological University *Spatial Dependence: Boon or Bane?* Everything is related to everything else, but near things are more related than distant things. This is Tobler's First Law of Geography and a fundamental concept underpinning much of Spatiotemporal Statistics. In this talk, I will introduce the classical geostatistical model and highlight the ways it has been applied, adapted, and combined with other statistical techniques to help answer questions in contexts ranging from public health to disaster risk. While dependence in data is useful for prediction, it is a double-edged sword: neglecting dependence when it is present can lead to model misspecification and overconfidence in the estimates. This issue arises in the environmental sciences when physical models are calibrated with loss functions such as mean squared error which implicitly assume independent data. To wrap up, I will outline ongoing research which uses concepts from Information Theory to improve model calibration of complex physical models with spatial data.
	Mr Chen Siteng, Shanghai Jiao Tong University *Clinical Use of Deep Learning Strategy in Renal Cell Carcinoma*

	My primary research focuses on the transformation of artificial intelligence for clinical practices. I apply deep learning algorithms in intelligent diagnosis and prognosis prediction of patients with malignant tumors. I believe that traditional histopathology performed by pathologists through naked eyes remains labor-intensive and time-consuming, which is difficult to meet the growing demand. With the help of artificial intelligence, we can facilitate the progress of precision medicine. I proposed novel neural networks for the training and optimization of practical models, which have been verified to perform well in automatic and quick identification of malignant lesions. My work could provide intelligent advice for pathologists and help clinicians legitimately tailor the treatment plan using histopathologic images, without expensive gene detection or high-throughput sequencing, which could greatly promote individualized therapy and reduce the medical cost.
12.50pm to 4.00pm	**Networking session**
4.00pm to 5.00pm	**Networking / Small group informal sessions**
5.00pm	**Plenary Lecture by Sir Konstantin Novoselov** *Materials for the Future*
5.45pm	**Plenary Lecture by Prof Stefan Hell** *MINFLUX and MINSTED Provide Molecule-Scale Resolution in Fluorescence Microscopy* I will show how an in-depth description of the basic principles of diffraction-unlimited fluorescence microscopy (nanoscopy) [1] has spawned a new powerful superresolution concept, namely MINFLUX nanoscopy [2-5]. MINFLUX utilizes a local excitation intensity minimum (of a doughnut or a standing wave) that is targeted like a probe in order to localize the fluorescent molecule to be registered. In combination with single-molecule switching, MINFLUX and its more recent 'cousin' MINSTED [6] have obtained the ultimate (super)resolution: the size of a molecule. Providing 1–3 nanometer resolution these novel microscopy concepts are being established for routine fluorescence imaging at the highest, molecular-size resolution levels. Relying on fewer detected photons than popular camera-based localization, MINFLUX and MINSTED nanoscopy are poised to open a new chapter in the imaging of protein complexes and distributions in fixed and living cells. [1] Hell, S.W. **Nat. Methods** 6, 24-32 (2009). [2] Balzarotti, F., Eilers, Y., Gwosch, K. C., Gynnå, A. H., Westphal, V., Stefani, F. D., Elf, J., Hell, S.W. **Science** 355, 606-612 (2017). [3] Eilers, Y., Ta, H., Gwosch, K. C., Balzarotti, F., Hell, S. W. **PNAS** 115, 6117-6122 (2018). [4] Gwosch, K. C., Pape, J. K., Balzarotti, F., Hoess, P., Ellenberg, J., Ries, J., Hell, S. W. **Nat. Methods** 17, 217-224 (2020) [5] Schmidt R., Weihs T., Wurm C., Janssen I., Rehman J., Sahl S.J., Hell S.W. **Nat. Commun** 12:1478 (2021) [6] Weber, M., Leutenegger M., Stoldt S., Jakobs S., Mihaila T.S., Butkevitch A.N., Hell S.W., **Nat. Photonics** 15, 361–366 (2021)
6.30pm	**Plenary Lecture by Dr Venki Ramakrishnan** *Using Electron Microscopy to Study Ribosomes in Action* Revolution in electron microscopy has started a new era for structural biology, where difficult projects can be tackled and important new discoveries can be made. This plenary lecture will share how cryogenic electron microscopy has enabled the study of ribosomes in action, which might not have been possible with traditional

	methods such as X-ray crystallography. We would illustrate how the cryo-EM was used to look at the mitochondrial ribosome, which provided some interesting insights on how the mRNA translation process could be initiated.
7.15pm	**Plenary Lecture by Prof Benjamin List** *Chemical Catalysis as Enabling Science and Technology for Humankind* Catalysis is not only essential to any life on earth; it also is a fascinating chemical science. What is perhaps less known is that catalysis is one of the most important technologies currently available to humans and undoubtedly key to solving critical future challenges. During the last two decades, a new type of catalysis, asymmetric organocatalysis has been developed into a powerful approach to chemical synthesis.
8.00pm to 9.00pm	**Young Scientist Presentation (Session 2)** Moderator: Dr Wong Min Hao, Strategy and Business Development Group Leader, A*STAR
	Ms Dana Cohen-Gerassi, Tel Aviv University *Structural Characterization and Crystallization Kinetics of a Supramolecular System in a Microfluidic Platform* In this study, we focused on enhancing our understanding of the mechanism underlying the assembly of Fmoc-F5-Phe, a well-studied modified amino-acid. We characterized the effect of various solvent conditions on the resulting assembled morphology. Furthermore, we applied microfluidics for real-time monitoring and image analysis of the phase transition, which allowed us to reveal a new metastable phase, spheres. The coexistence of metastable phases manifested as spherical and fibrillar morphologies resulted in the formation of a more stable phase of needle-like crystals as the dominant structure. The crystal structure was resolved by PXRD, displaying aromatic interactions that dictate the crystal state. Finally, we show that the kinetic behavior of the crystallization process adheres to the JMAK model. These results open the possibility of establishing kinetic as well as thermodynamic control over the morphology of supramolecular polymers. [Cohen Gerassi et al, Chem. Mater., 2020.]
	Ms Ines Weber, ETH Zürich *Novel Gas Sensors for Emerging Applications* Chemical sensors are most promising for emerging applications including medical breath analysis and environmental monitoring. Yet, such sensors are not established in daily practice, mainly due to limited selectivity. Catalytic filters offer an effective solution by converting interferants to inactive species, while target analytes remain intact. Here, we show how such detectors accurately detect trace-level acetone concentrations (a marker for fat-burning) in exhaled breath, in excellent agreement with mass spectrometry and blood ketone measurements. Currently, this detector is tested on 72 volunteers performing intermittent fasting diets in a randomized clinical trial. Similarly, a hand-held device detects benzene, a carcinogenic pollutant, in real indoor air below regulatory exposure limits. In a broad perspective, these compact and low-cost devices open up exciting opportunities for personalized metabolic monitoring, as well as distributed air quality assessment in IoT networks.
	Ms Maria Utrilla-Bustamante, The French National Centre for Scientific Research (CNRS)

	Photovoltaic-based Battery-less System to Support the Temporary Islanding of Electrical Grids I will briefly present my current research work, on the development of a photovoltaic-based battery-less system to support the temporary islanding of electrical grids normally operated in interconnected mode. Such a system would allow to temporarily operate certain sections of the electrical grid (i.e., microgrids) in an isolated manner. This would guarantee the continuity of electrical supply in case of disruptions in the upstream grid. Other researchers have already proposed strategies to isolate microgrids. However, the added value of my solution is that it only relies on already-installed photovoltaic plants. Of course, this only allows to isolate microgrids during daylight hours. However, this solution is still very attractive for grid operators: it would allow them to suppress part of the supply disruptions without using emergency diesel generators (which produce greenhouse emissions) or of utility-scale batteries (which, for the moment, require major investments).
9.00pm	**End**

Wednesday, 19 January 2022	
Singapore Time	**Programme**
8.00am	**Small group informal sessions**
9:00am	**Plenary Lecture by Prof Ngô Bảo Châu** *The Riemann zeta function* Introduction of the Riemann Zeta function and how it is related to the prime number theorem and other mathematical functions.
9:45am	**Panel Discussion: Start-Up Opportunities for Young Scientists** Moderator: Dr Lim Jui, Chief Executive Officer, SGInnovate Panellists: • Prof Robert Langer • Prof Stuart Parkin • Prof Alberto Sangiovanni-Vincentelli
10.45am	**Plenary Lecture by Prof Barry Marshall** *How Curiosity Driven Research Resulted in the Nobel Prize in Medicine* The history & future of the stomach bacterium – *Helicobacter pylori*.
11.30am to 12.30pm	**Young Scientist Presentation (Session 3)** Moderator: Prof Xu Rong, Research Director for Engineering & Physical Sciences, Nanyang Technological University, and Director, Singapore Energy Centre
	Ms Ling Chen, City University of Hong Kong *From Fog to Electricity and Clean Water: A Fog Powered Generator* The freshwater crisis is a global issue threatening more than 2 billion people's life and work, because of the lack of sizable natural lakes, rivers and usable ground water, as well as rapid population growth. Meanwhile, a sustainable, stable, low-cost, portable and eco-friendly power supply solution is indispensable for the upcoming intelligent world. Atmospheric moisture, including fog, vapor, aerosol, and cloud, whose amount is equivalent to 5.2 billion Olympic-sized pools, has seldom been utilized and applied in power generation. For the first time in the world, we manage to open up a brand new technology to simultaneously harvest power and freshwater from ubiquitous air moisture, which integrated the newly developed high-power density droplet-based energy generator (DEG) with the nature-inspired hydrophobic fog harvesting meshes. The power will be managed and supplied to IoTs, and the freshwater could be used for farming, cleaning, etc.
	Dr Ho Hsing-Jung, Tohoku University *Carbon Capture and Utilisation via Mineral Carbonation of Alkaline Wastes without CO_2 Purification and Pressurisation*

	Climate change is one of the most urgent issues currently facing society, and therefore, CO_2 emissions reduction is a key goal for mitigating this crisis. Carbon capture and utilization (CCU) is the concept of employing CO_2 as a feedstock in various applications. The mineral carbonation of alkaline material is a promising approach for developing CCU technologies without requiring CO_2 purification or pressurization. Alkaline wastes represent suitable input materials because they are inexpensive, active, and do not require the exploitation of natural resources. Mineral carbonation in the cement and concrete industry could significantly reduce CO_2 emissions. Instead of adopting conventional mixing carbonation or carbonation curing to strengthen concrete during production, this research investigated the use of cement and concrete wastes via mineral carbonation without CO_2 purification or pressurization to achieve carbon neutrality and produce carbonated products for a circular economy.
	Dr Li Zhejun, Chinese University of Hong Kong *Materials Design and Mechanistic Investigation of Advanced Sulfur-based Batteries* Increasing urgency of global crisis emphasizes the integration of the intermittent renewable energy resources to electric grids with the energy storage deployments. Sulfur, as a low cost and high energy density material, receives increasing attention for energy storage applications like aqueous redox flow batteries (RFBs) and Li-S batteries. First, we have invented the first polysulfide-iodide RFBs (PSIB) system with high energy density and low materials cost for energy storage. To extend the lifetime of PSIB, we further developed a charge-reinforced ion-selective membrane (CRIS) that substantially reduce crossover and water migration. Therefore, the CRIS-enabled PSIB demonstrated industrial-relevant cycling stability for long-duration energy storage with competitive levelized cost of storage. For Li-S batteries, we have first established the quantitative model for Li2S electrodeposition, and successfully employed it to guiding the rational design of electrolytes and catalysts.
12.30pm to 4.00pm	**Networking session**
4.00pm to 5.00pm	**Networking / Small group informal sessions**
5.00pm	**Panel Discussion: Unmet Challenges in Physics** Moderator: Prof Lai Choi Heng, Professor of Physics, National University of Singapore, and Deputy Director, Centre for Quantum Technologies Panellists: • Prof Didier Queloz • Prof Takaaki Kajita • Prof Artur Ekert
6.00pm	**Plenary Lecture by Prof Aaron Ciechanover** *COVID-19: The Road to Cure is Strewn with Bioethical Bumps* Almost two years into the Pandemic and we have started to realize that besides the quest for cure there are numerous bioethical issues that are scattered along the road: from the need to prioritise whom to put on a ventilator, to anti-vaxxers, through inequality in availability of vaccines and the storm of misinformation, to mention just a few.
6.45pm	**Plenary Lecture by Prof Takaaki Kajita**

	Neutrino Oscillations Neutrinos are sub-atomic particles which are very difficult to observe. They have been assumed to have no mass. It was predicted that, if they have masses, they could change their type while they fly. This phenomenon is called neutrino oscillations. Neutrino oscillations was discovered by deep underground neutrino experiments. I will discuss the discovery of neutrino oscillations. The implications of the discovery of the neutrino oscillations and the small neutrino masses will also be discussed.
7.30pm to 8.30pm	**Young Scientist Presentation (Session 4)** Moderator: Dr Malika Meghjani, Assistant Professor, Information Systems Technology and Design, Singapore University of Technology and Design
	Ms Anne-Marlene Rüede, École polytechnique fédérale de Lausanne (EPFL) *Connecting Space Logistics and Architecture: a Pattern Language for Robust Mission Design* It took Apollo engineers one million person-hours to determine that separating the Lunar Lander from the orbiter in Lunar orbit is the most efficient (if not only) way to land a man on the Moon before the end of the decade - while saving taxpayers $175B. Exceptionally difficult missions relying on on-orbit servicing, manufacturing and resource utilization are expected to become more common, as missions will need to be increasingly sustainable and ambitious. However, designing such complex missions is challenging, as many more (and difficult to qualify) combinations of routes, technologies and actions are available. By adapting and combining methods from architecture, operations research, circular economy principles, and comparative linguistics, we recreate Apollo's success methodically by developing digital design support tools that can automatically generate, assess and compare complex space mission candidates supported by a novel intuitive human-readable visual representation system.
	Dr Daniele De Sensi, ETH Zürich *Optimization Techniques for High-Performance Interconnection Networks* My research focuses on the area of High-Performance Computing (HPC) systems. These systems are composed of many servers, interconnected with each other to perform complex computations that would not be possible otherwise. HPC is widely used in different sciences to simulate complex systems and to understand the world surrounding us. For example, in the last year, HPC systems have been extensively used to simulate the diffusion of the SARS-CoV-2 virus, and to analyze potential molecules for designing and selecting possible vaccines. In particular, I work on optimizing the network that connects the servers in these systems. When the servers exchange data, congestion might build up in the network, as it happens on road networks, slowing down the applications running on the system. In my research, I design techniques to mitigate congestion, allowing scientists to take the best performance out of these systems.
	Mr Moritz Flaschel, ETH Zürich *EUCLID – Efficient Unsupervised Constitutive Law Identification & Discovery*

	Over the past centuries, material scientists have developed a tremendous amount of material models to mathematically describe the macroscopic behavior of different materials under mechanical loading. However, choosing the right model and calibrating its parameters remains a challenging and often time-consuming task. In our work, we automize the selection and calibration process by employing data-driven sparse regression. The objective is to use scarce data, i.e., data generated from a single experiment, to discover the characteristic constitutive equation. We successfully demonstrate our method called EUCLID (Efficient Unsupervised Constitutive Law Identification and Discovery) for hyperelastic and elasto-plastic material behavior.
8.30pm	**End**

Thursday, 20 January 2022	
Singapore Time	**Programme**
8.00am	**Small group informal sessions**
9:00am	**Plenary Lecture by Prof Michael Young** *Chronic Social Isolation Signals Starvation in the Drosophila Brain and Reduces Sleep* In contrast to acute social isolation (1 day), chronic isolation (7 or more days) reduces sleep and increases food intake in the fly. Inactivation of a small group of neurons in the central brain blocks aberrant sleep and appetite in chronically isolated flies, while artificial activation of the same neurons causes misperception of acute social isolation as chronic social isolation.
9:45am	**Panel Discussion: Next Generation Grid** Moderator: Dr Yeoh Lean Weng, Senior Director of Urban Solutions and Sustainability, National Research Foundation, and Chief Sustainability Officer, A*STAR Panellists: • Prof Stanley Whittingham, • Prof B. Jayant Baliga • Prof Ron Hui
10.45am	**Plenary Lecture by Sir Andre Geim** *Random Walk to Graphene* Graphene – a single plane of carbon atoms – is not only the thinnest but also probably the simplest material one can imagine in this universe. On the other hand, graphene has acquired so many superlatives to its name that it is often called a wonder material. I will discuss how this research started and then try to explain why graphene has attracted so much attention.
11.30am to 12.30pm	**Young Scientist Presentation (Session 5)** Moderator: Dr Loh Huanqian, President's Assistant Professor, Department of Physics, National University of Singapore
	Dr Lu Bing, Nanyang Technological University *Sustainable 3D Concrete Printing with Fluid Catalytic Cracking (FCC) Ash* The petroleum and oil refinery industry produces large amount of fluid catalytic cracking ash (FCC ash). The current waste treatment as land disposal consumes land resources and may contaminate the environment due to the heavy metal leaching. Here we present a new method to utilize FCC ash as the partial replacement of cement in 3D printable concrete materials. The developed FCC ash-blended concrete materials show a superior 3D printing performance with good mechanical properties. The heavy metal contaminants in the leachate of the developed materials are reduced compared with that of FCC ash, and they also meet the acceptance criteria of Singapore. With the combination of 3D concrete

	printing and reduced usage of cement, significant benefits such as higher efficiency, less labor investment and waste generation, and less carbon emission in the construction are expected in the construction. It also provides a valuable waste treatment solution for the oil refinery industry.
	Ms Disha Pankaj, Australian National University *Probing Deeper into the Gravitational Universe Using Near-Infrared Lasers* This work presents the development and characterisation of a narrow-linewidth external-cavity diode laser at 2-micron wavelength. It represents a low-cost, high-performance alternative to fiber lasers for research into 2-micron photonic technologies for next-generation gravitational-wave detectors. A linewidth of 20 kHz for a 10 ms integration time was measured without any active stabilization, with frequency noise of 15 Hz/sqrt (Hz) between 3 kHz and 100 kHz. This performance is suitable for the generation of quantum squeezed light, and we measure intensity noise comparable to that of master oscillators used in current gravitational wave interferometers. The laser wavelength is tunable over a wide range, and both the frequency and intensity can be modulated at up to 10MHz by modulating the diode current. These features also make it suitable for other emerging applications in the 2-micron wavelength region including medicine, gas sensing, optical communications, and LIDAR.
	Mr Sambit Panda, Johns Hopkins University *Nonparametric MANOVA via Independence Testing* Decision forests are popular tools for classification and regression and produce proximity matrices measuring how often each pair of observations lie in the same leaf node. These proximity matrices can be thought of as kernels, connecting the decision forest literature to the kernel machine literature. While other kernels are known to have strong theoretical properties, such as being characteristic, no similar result is available for any decision forest-based kernel. Here, we prove that the decision forest-induced proximity can be made characteristic, and so guarantee results such as universal consistency for hypothesis testing. We demonstrate the decision forest-induced kernel achieves higher testing power than existing methods on a suite of 20 high-dimensional independence and two-sample test settings. Finally, we demonstrate that this kernel is interpretable. This work demonstrates the existence of a test that is both more powerful and more interpretable than existing methods.
12.30pm to 4.00pm	**Networking session**
4.00pm to 5.00pm	**Networking / Small group informal sessions**
5.00pm	**Plenary Lecture by Prof Ada Yonath** *Exploiting Genetic Code Translation Principles for the Design of Next Generation Therapeutics* Illuminating architectural principles of dynamic genetic code translation led to the design of unique translatable mRNA-collagen constructs, designed for controllable protein synthesis. Similarly, structural analyses of diseases associated with genetically mutated human ribosomes, shed light on specific translation properties and specific biological pathways and provided hints for novel the therapeutical platforms. Parallel studies identified the ribosomal internal active pocket that seems to represent the prebiotic synthetic machinery.
5.45pm	**Plenary Lecture by Prof Stuart Parkin**

	Memory on the Racetrack The era of computing technologies based on charge currents is coming to an end after more than forty years of exponential increases in computing power and data storage. A new era of "Beyond charge!" is emerging based on entirely new concepts. One of these relies on taking advantage of the electron's spin in the form of spin currents. These spin currents carry spin angular momentum that can be used to switch the magnetic state of tiny magnetic nano-elements from "up" to "down", or to move tiny, nanoscopic magnetic objects, in the form of chiral magnetic domain walls, along magnetic racetracks. The latter promises a novel and highly capacious non-volatile memory-storage device, that, moreover, is very fast and highly energy efficient. This Magnetic Racetrack Memory has evolved from just a "pipe-dream" when I proposed it in 2002, to a reality today where this spintronic technology is primed to replace magnetic disk drives, on the one hand, and static random access memory (SRAM), on the other hand. The former is capacious and stores 70% of all digital data today but is slow, mechanical, and energy consuming, and the latter is very fast and essential to high performance computers, but has a large footprint. In this lecture I will briefly describe some of the breakthroughs that have been made over the past decade that makes Magnetic Racetrack Memory so exciting today.
6.30pm	**Plenary Lecture by Prof Cédric Villani** *On Finding Theorems, and a Career* In this plenary lecture I will share my reflections of my interest and career in mathematics, and how it developed beyond the academics.
7.15pm to 8.15pm	**Young Scientist Presentation (Session 6)** Moderator: Dr Andrew William Holle, Assistant Professor, Mechanobiology Institute, National University of Singapore
	Dr Eilam Yeini, Tel Aviv University *P-Selectin Axis Plays a Key Role in Microglia Immunophenotype and Glioblastoma Progression* I would like to share my PhD project, which focused on elucidating the interactions between glioblastoma (GB) cells and the brain microenvironment. Our findings, recently published in Nature Communications, identified P-Selectin (SELP) as an immune checkpoint that can be manipulated for the treatment of cancer. GB is a highly invasive type of brain cancer exhibiting poor prognosis. Importantly, microglia (MG), the brain immune cells, are known to facilitate GB progression and immune suppression. We showed that SELP mediates MG-enhanced GB proliferation and invasion by altering MG activation state. Furthermore, pharmacological or molecular inhibition of SELP led to reduced tumor growth and increased survival in GB mouse models. In my presentation, I will focus on the biological mechanisms we revealed in MG polarization, the advanced research methods we have used, and on our future plans to combine anti-SELP treatment with other immunomodulators which are currently developing.
	Mr Andrea Luppi, University of Cambridge *A Synergistic Core for Human Brain Evolution and Cognition* A fundamental question in neuroscience is how the organisation of neural information-processing enables humans' unique cognitive abilities. Here we demonstrate that synergistic and redundant interactions between brain regions play distinct information-processing roles in the human brain. Combining functional

	and structural neuroimaging, we show that synergistic interactions underpin complex human cognition, supporting integrative processes across the brain's higher-order networks. Synergistic information is more prevalent in humans than non-human primates, with high-synergy association cortices exhibiting the highest degree of evolutionary cortical expansion. Synaptic density mapping and convergent genetic and molecular evidence demonstrate that human-accelerated genes underpin synergistic interactions by enhancing synaptic transmission. This approach reveals the key role of synergistic neural interactions in the evolution and functioning of humans' sophisticated cognitive abilities.
	Dr Sherrianne Ng, Imperial College London *Insights into preterm birth using multi-omics approaches* Globally, preterm birth affects 15 million babies each year and is a leading cause of under-5 mortality with over 1 million deaths annually. Premature babies who do survive are also more susceptible to neonatal sepsis, a bacterial bloodstream infection that increases the risk of death and long-term morbidities. Identifying the specific maternal factors that impact on preterm birth risk in different populations remains challenging. My presentation will focus on how we have used high throughput technologies (i.e. omics-based approaches) to characterise maternal factors during pregnancy that impact on the risk of preterm birth and to interrogate the complex immune-metabolic system of preterm infants to identify potential gene signatures/biomarkers for improved neonatal sepsis diagnosis. The use of these multi-omic technologies has potential to predict and prevent preterm birth leading to reduced mortality and morbidity as well as better health outcomes for these babies born too early.
8.15pm	**End**

Friday, 21 January 2022	
Singapore Time	**Programme**
8.00am	**Small group informal sessions**
9:00am	**Plenary Lecture by Prof Thomas Südhof** *Drug Development for Neurodegenerative Disorders* Neurodegenerative disorders are an increasing burden to all societies as our populations age. New scientific insights enable unprecedented advances in the understanding of these disorders, and open up to development of new treatments. My presentation will discuss where academia and industry stand at present on this topic in light of recent developments.
9:45am	**Plenary Lecture by Prof M. Stanley Whittingham** *The Critical Role of Storage for Renewable Energy and Climate Change* In order for the world to overcome climate change, it is essential that we move to clean renewable energy. This will require storage both on the grid and for vehicles. These two uses may well be integrated if the million-mile battery can be realized. I will discuss the scientific challenges that need to be overcome.
10.30am	**Plenary Lecture by Prof Thomas Cech** *Complete Replication of Chromosome Ends* Telomeres, the ends of our chromosomes, shrink with age and are elongated in cancer cells, with consequences for cell proliferation. Thus, telomere replication is medically important as well as biologically fascinating. We have recently been able to couple telomerase extension with C-strand synthesis to uncover some of the molecular mechanisms of telomere replication.
11.15am	**Closing Remarks by GYSS Co-Chairs** Prof Low Teck Seng, Chief Executive Officer, NRF and Prof Bertil Andersson, Senior Advisor, NRF
11.30am	**End**