NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Institute of Advanced Studies

IAS 20th Anniversary Symposium

Celebrating Two Decades of Transformative Science

29 July 2025 (Tue), 9AM - 6PM | GAIA Auditorium

Programme and Abstracts

IAS 20th Anniversary Symposium

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29 July 2025 (Tuesday)

	Opening Ceremony
09:00 - 09:10	**Welcome Address**
09:10 - 09:30	**Memento Presentation**
Session Chair: Asst Prof Leonard Ng Wei Tat (Nanyang Technological University)	
09:30 - 10:00	**Prof Phua Kok Khoo** (Founding Director, IAS and Emeritus Professor, NTU) *The Brief History of IAS at NTU from 2005 to 2018*
10:00 - 10:45	**Prof Sir Gregory Winter** (Nobel Prize in Chemistry 2018; Cambridge University) *Deep Tech Commercialisation: The Journey to Antibody Pharmaceuticals*
10:45 - 11:25	Group Photo-Taking and Coffee break
Session Chair: Prof Rajdeep Singh Rawat (National Institute of Education)	
11:25 - 11:55	**Prof Ling San** (Nanyang Technological University) *University-Based Institutes for Advanced Study – Some Personal Musings*
11:55 - 12:25	**Prof Oh Choo Hiap** (National University of Singapore) *Boundary between Quantum Mechanics and Classical Physics*
12:25 - 12:55	**Prof Shen Zexiang** (Nanyang Technological University) *Two Decades of Graphene: Are We Ready for Large-Scale Applications?* *- Celebrate 20 Years of Excellence of IAS@NTU*
12:55 - 14:00	Lunch
Session Chair: Prof Shen Zexiang (Nanyang Technological University)	
14:00 - 14:45	**Prof Aaron Ciechanover** (Nobel Prize in Chemistry 2004; Technion – Israel Institute of Technology) *The Revolution of Personalised Medicine – Are We Going to Cure All Diseases and At What Price?*
14:45 - 15:15	**Prof Loh Teck Peng** (Nanyang Technological University) *Part 1 The IAS at NTU – Personal Perspectives* *Part 2 Green and Biocompatible Technologies: From Discovery to Translation and Beyond*
15:15 - 15:45	**Prof Rajdeep Singh Rawat** (National Institute of Education) *Beyond the Mainstream: Unlocking Fusion Insights with Hot Dense Pinch Plasmas*
15:45 - 16:15	**Prof Kwek Leong Chuan** (NTU Singapore; National Institute of Education) *Part 1 The IAS at NTU - Personal Perspectives* *Part 2 Integrated Photonic Circuit for Quantum and Optical Platforms at NTU*
16:15 - 16:45	Coffee Break
Session Chair: Prof Kwek Leong Chuan (NTU Singapore; National Institute of Education)	
16:45 -17:30	**Prof Stuart Parkin** (Millennium Technology Prize 2014; Max Planck Institute of Microstructure Physics) *Spintronics for Massive Data Memory-Storage – Past, Present and Future*
17:30 - 18:00	**Prof Chang Ngee-Pong** (The City College of New York) *Part 1 The IAS at NTU - Personal Perspectives* *Part 2 Quantum Nature of the Vacuum*
18:00 - 18:00	Closing Remarks by Prof Sum Tze Chien
19:00 - 21:00	Networking Dinner *(by invitation only)*

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The Brief History of IAS at NTU from 2005 to 2018

PHUA KOK KHOO

World Scientific Publishing Co Pte Ltd
Nanyang Technological University, Singapore

Short Abstract

The Brief History of IAS at NTU from 2005 to 2018:

- About IAS
- Workshops & Conferences (since 2005)
- List of Public Lectures organised by IAS
- Visting Nobel Laureates and Fields Medalists of IAS since 2005

Short Bio

Professor Phua Kok Khoo has made important contributions to physics research and education in Singapore, from his research in particle physics at Nanyang University in the 1970s, to founding the World Scientific Publishing Company, and numerous philanthropic programmes in support of physics students in Singapore and the rest of Southeast Asia. He is also the Founding Director Emeritus of IAS NTU, Adjunct Professor at NTU and NUS.

As a young graduate of Birmingham University under Prof Tony Skyrme (Royal Society's Hughes Medallist), Prof Phua returned to Singapore in 1971 and established a particle physics research group at Nanyang University, and later at National University of Singapore, and published over 80 articles in his scientific career.

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Deep Tech Commercialisation: The Journey to Antibody Pharmaceuticals

SIR GREGORY WINTER

Nobel Prize in Chemistry 2018
MRC Laboratory of Molecular Biology, Cambridge

Short Abstract

Sir Professor Winter will share his remarkable journey navigating the complex landscape between academic discovery and commercial success. Drawing from his pivotal roles at the UK Medical Research Council and as a founder of Cambridge Antibody Technology, he will illuminate the uncertain path that led to the development of blockbuster treatments including Humira (adalimumab) and Keytruda (pembrolizumab) - therapies that have improved millions of lives and generated billions in revenue.

This talk offers a rare glimpse into the multifaceted challenges of translating scientific innovation into market-ready solutions. Sir Professor Winter will address the scientific hurdles, commercial considerations, legal complexities, and political factors that shaped his journey from laboratory research to global pharmaceutical impact.

Short Bio

Sir Gregory Winter is a pioneer in protein engineering and therapeutic monoclonal antibody development. He was awarded the 2018 Nobel Prize in Chemistry for his revolutionary work on the phage display of peptides and antibodies, sharing this prestigious honor with Frances Arnold and George Smith. His innovations led to the creation of entirely new classes of therapeutic antibodies that have transformed modern medicine.

As a distinguished researcher at the Medical Research Council Laboratory of Molecular Biology in Cambridge, UK, Sir Gregory developed techniques for humanizing mouse antibodies, making them suitable for human therapeutic use. This breakthrough approach led to the creation of Humira (adalimumab), which became the world's best-selling drug, with annual sales exceeding $20 billion.

Beyond his scientific achievements, Sir Gregory has demonstrated exceptional entrepreneurial vision. He co-founded several successful biotechnology companies, including Cambridge Antibody Technology (acquired by AstraZeneca), Domantis (acquired by GlaxoSmithKline), and Bicycle Therapeutics. His career exemplifies how fundamental scientific research can be translated into commercial ventures with profound global impact.

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University-Based Institutes For Advanced Study – Some Personal Musings

LING SAN

Nanyang Technological University, Singapore

Short Abstract

The number of university-based institutes for advanced study (UBIAS) has grown in the past few decades. Though they may be vastly different in various ways, it is often acknowledged that they facilitate mutual exchange and innovative research.

Within the university context, is a UBIAS the unique silver bullet that achieves such desirable outcomes, or are there alternative approaches? What are some of the pros and cons of the UBIAS approach? Is there more that a UBIAS can or should do to strengthen its relevance and value proposition?

In this talk, I shall share some of my personal reflections.

Short Bio

Professor Ling San is a Distinguished Nanyang Professor in mathematical sciences at NTU Singapore. He was previously President's Chair in Mathematical Sciences from April 2019 to June 2025. Professor Ling joined NTU in April 2005 as the Founding Head of the Division of Mathematical Sciences in the School of Physical & Mathematical Sciences (SPMS). He was Chair of SPMS from April 2008 to December 2010, and Dean, College of Science, from August 2011 to December 2017, before being appointed Provost and Vice President (Academic) on 1 January 2018. He became Deputy President & Provost on 1 January 2020, till 30 June 2025. Prior to joining NTU, he spent 13 years at the National University of Singapore (NUS).

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Boundary between Quantum Mechanics and Classical Physics

OH CHOO HIAP

National University of Singapore

Short Abstract

Quantum mechanics is essentially different from classical physics. For instance, quantum entanglement cannot be described by the separable model, the Bell nonlocality cannot be described by the local-hidden-variable (LHV) model, and the Einstein-Podolsky-Rosen (EPR) steering cannot be described by the local-hidden-state (LHS) model.

In this talk we shall review quantum entanglement and nonlocality, in particular the hierarchical structure of quantum nonlocality.

We then present the recent work on the stronger EPR steering inequalities to detect the boundary between quantum mechanics and classical models, based on the paper, Physical Review A 110, 052210 (2024).

Short Bio

Professor Oh Choo Hiap is an Emeritus Professor at the National University of Singapore (NUS) and a distinguished physicist recognised for his contributions to theoretical physics. A Fellow of the American Physical Society, he has made significant advancements in the field, earning the prestigious National Science Award (Singapore) in 2006.

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Two Decades of Graphene: Are We Ready for Large-Scale Applications? - Celebrate 20 Years of Excellence of IAS@NTU

SHEN ZEXIANG

Nanyang Technological University, Singapore

Short Abstract

Graphene is a magical material with extraordinary properties such as ultra-high mechanical strength, ballistic conductivity, excellent thermal conductivity, corrosion resistance, etc., making it an ideal material for many applications such as nanoelectronics, display, energy storage, environmental technology and reinforced armour. However, since its discovery back two decades ago, graphene has yet to find large scale applications in industry.

In my talk, I will review the prospects of graphene in industrial applications. For example, in traditional graphene application fields, in electrical energy storage, environment and composite materials. I will also introduce non-traditional applications, such as construction, solar cells, uranium enrichment and other fields.

I will also present, from my own perspective, the achievements of IAS@NTU and its immense contribution in connecting Singapore to the world in science.

Short Bio

Professor Shen Zexiang is a Professor with the School of Physical and Mathematical Sciences. He has spent close to 30 years in academic and research positions in China, London and Singapore. His current research works focus on nearfield Raman microscopy, plasmonics, nano materials and devices, graphene and nanosphere lithography, graphene-based supercapicators and batteries, and over 200 of his papers have been published in international journals.

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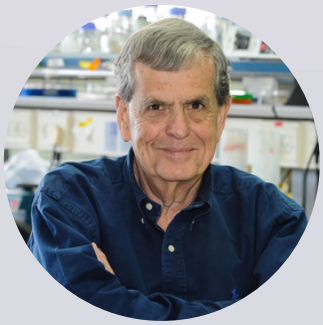

The Revolution of Personalised Medicine – Are We Going to Cure All Diseases and at What Price?

AARON CIECHANOVER

Nobel Prize in Chemistry 2004
Technion-Israel Institute of Technology

Short Abstract

The revolution of Personalised (Precision) Medicine is going to change the face of clinical practice and outcome of treatment of almost all diseases more than any breakthrough discovery that has preceded it – the finding of antibiotics, the development of vaccines, the discovery of X-rays, and others. The revolution has evolved based on the observation or rather the frustration that the course of apparently the same disease in different patients is vastly different, and so is their response to treatment. Among the many reasons for these differences is the fact that human beings are different than one another in their genetic repertoire, which results in different causes and sensitivities to apparently the same disease. Thus breast or prostate cancer can be caused from different mutations in different genes which will result in a different disease course and response to treatment in different patients. Now, that the human genome (DNA) was unraveled and we have a relatively easy access to it and to its products – the RNA and proteins, we shall diagnose diseases more precisely and will be able to treat each patient based on his/her own "individual" disease cause. Clinicians are not going to treat diseases, but rather diseases within the context of individual patients. New drugs will be developed to targets/mutations that are being discovered daily based on efficient screening of patients. The fact the treatment is going to be target-oriented and specific, will reduce harmful side effects like those caused by chemotherapy that is highly non-specific. Many of the road blocks on the way are surprisingly not technical, but rather ethical – the ability to protect our privacy, as our DNA carries a lot of information we may not want to share, or even to know ourselves. So society will have to provide solutions to this and many other bioethical problems that will arise as more information will be available on the health state of each and every one of us. Excitingly – the project is trailblazed by the scientific community world-wide, a wonderful one-of-a-kind collaboration of scientists, clinicians, bioinformaticians and bio ethicists who are scattered all over the world, at times do not communicate with one another, but add their knowledge to this wonderful melting pot where it is being converted into a great chapter in human history.

Short Bio

Professor Aaron Ciechanover is a Distinguished Research Professor in the Faculty of Medicine at the Technion – Israel Institute of Technology. He earned his M.Sc. in 1971 and M.D. in 1973 from the Hebrew University in Jerusalem. Following his national service as a military physician (1973–1976), he completed a D.Sc. in biological sciences at the Technion in 1982.

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Green and Biocompatible Technologies: From Discovery to Translation and Beyond

LOH TECK PENG

Nanyang Technological University, Singapore

Short Abstract

Establishing the chemistry department was both a rewarding and challenging endeavor. In the early stages, attracting prominent speakers and fostering a vibrant research culture proved difficult. With the invaluable support of the Institute of Advanced Studies (IAS), we were fortunate to leverage their networks to initiate a successful seminar series—bringing in leading researchers who not only shared their expertise but also provided mentorship to early-career faculty. I will briefly share some of these early challenges and how they shaped the department's growth.

The second part of the presentation will focus on our research over the past three decades, centered on green and sustainable chemistry inspired by nature. We have developed biocompatible reactions that proceed under mild, aqueous conditions—neutral pH and ambient temperature—without the use of metals or external catalysts. These methodologies have enabled diverse applications, from advances in biologics to innovations in plastic recycling. I will also discuss our recent work on reversible bonds and novel catalytic systems for efficient bond cleavage. Together, these efforts illustrate the potential of green chemistry to deliver impactful, real-world solutions.

Short Bio

Professor Loh Teck Peng is a renowned chemist and Distinguished University Professor at the School of Chemistry, Chemical Engineering, and Biotechnology and also the founding Head of the Division of Chemistry and Biological Chemistry, Nanyang Technological University (NTU), Singapore. Prof Loh obtained his PhD in Chemistry from Harvard University and he joined the faculty of NTU in 2005 and has since made significant contributions to the field of chemistry. Prof Loh has published over 450 scientific papers in top-tier journals, and has an H-index of 76. His research focuses on organic synthesis and green chemistry. Throughout his career, Prof Loh has received numerous awards and recognitions for his research, including the prestigious President's Science Award 2018 for his novel synthesis processes and scientific contributions in the field of chemistry, Thousand Talent Award (PRC) and the Yoshida Prize in Japan. Prof Loh is an elected fellow of the Academy of Sciences in Singapore and Malaysia and currently serves as the associate editor of the Journal of Organic Chemistry and the Green & Sustainable Chemistry.

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Beyond the Mainstream: Unlocking Fusion Insights with Hot Dense Pinch Plasmas

RAJDEEP SINGH RAWAT

National Institute of Education, Singapore

Short Abstract

Since its inception in 1991, the Plasma Radiation Sources Lab at NIE/NTU has been home to some of Southeast Asia's most powerful pulsed-power-driven Z-pinch plasma systems called the Dense Plasma Focus (DPF) devices. These hydromagnetic coaxial plasma accelerators in its final phase into a hot, dense pinch plasma column. This pinch phase lasts approximately 10 to 50 nanoseconds and reaches extreme conditions with temperatures around 1 keV, densities near 10^{25} m^{-3}, and energy densities on the order of $(1–10) \times 10^{10}$ J/m^3.

Far from conventional fusion routes like tokamaks and laser inertial fusion, the DPF provides a compact and cost-effective platform to explore fusion-relevant plasma physics, including plasma dynamics, instabilities, and turbulence. It also serves as an intense source of soft and hard X-rays, high-energy ions, relativistic electrons, and fusion neutrons. These features make it highly valuable for developing advanced plasma diagnostics and for testing and synthesizing materials under extreme conditions.

This talk will present an overview of over three decades of DPF research at PEARL, highlighting device evolution, diagnostic innovation, and wide-ranging applications—from fundamental plasma science to cutting-edge materials research.

Short Bio

Professor Rajdeep Singh Rawat is a Professor of Physics and Head of the Natural Sciences and Science Education Academic Group at the National Institute of Education, NTU. His interdisciplinary research spans plasma sources, pulsed power, plasma diagnostics and applications, as well as materials science and technology.

Since joining NTU, he has contributed to 50 research grants—including NRF-CRP, NRF, MOE Tier 2, HTX, IAEA, and industrial projects—totaling over S$29 million in funding. Prof Rawat has published over 290 journal papers, one edited book, 7 book chapters, and more than 70 conference papers, amassing over 9,960 citations and an H-index of 52. He holds two patents, with two more submitted.

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Part 1: The IAS at NTU: Personal Perspectives; Part 2: Integrated Photonic Circuit for Quantum and Optical Platforms at NTU

KWEK LEONG CHUAN

Nanyang Technological University, Singapore
National Institute of Education

Short Abstract

In Part 1, I will share my personal journey and reflections on my early involvement with IAS@NTU.

Part 2 will focus on my recent work with integrated photonic chips. Integrated photonic circuits (IPCs), also referred to as integrated optical circuits or photonic integrated circuits (PICs), are microchips that combine various photonic components into a cohesive functional circuit. These circuits are engineered to detect, generate, transport, and process light, enabling a diverse array of applications. Recent advancements in IPC technology have been remarkable, finding applications in fields such as quantum walks, machine learning, autoencoders, and boson sampling. In this section, I will discuss some of the notable progress made at NTU in this exciting area of research.

Short Bio

Professor Kwek Leong Chuan is currently a Principal Investigator (PI) at the Center for Quantum Technologies, National University of Singapore and Full Professor of Education and Engineering, National Institute of Education, Singapore. He is currently a co-Director of the Quantum Science and Engineering Centre at the Nanyang Technological University. He was (until December 2020) also the current Deputy Secretary General of the International Union of Pure and Applied Physics (IUPAP).

His main research interests are foundation in quantum mechanics including quantifying multipartite quantum entanglement; quantum cryptography, quantum synchronization, quantum computation and atomtronics.

Prof Kwek has published more than 300 publications with several papers in *Nature Photonics, Nature Communications, Physical Review Letters, Review of Modern Physics, Physics Report* and so forth.

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Spintronics for Massive Data Memory-Storage – Past, Present and Future

STUART PARKIN

Millennium Technology Prize 2014
Max Planck Institute for Microstructure Physics, Germany

Short Abstract

Spintronics is a field of research that harnesses the electron's spin to create novel materials with exotic properties and devices especially those for storing digital data that is the lifeblood of many of the most valuable companies today. Spintronics has already had two major technological successes with the invention and application of spin-valve magnetic field sensors that allowed for more than a thousand-fold increase in the storage capacity of magnetic disk drives that store ~70% of all digital data today. Just recently, after almost a 25-year exploration and development period, a high performance nonvolatile Magnetic Random Access Memory, that uses magnetic tunnel junction memory elements, became commercially available. A novel spintronics memory-storage technology, Magnetic Racetrack Memory is on track to become the third major success of spintronics. Racetrack Memory is a non-volatile memory in which data is encoded in mobile chiral domain walls that are moved at high speeds by spin currents to and thro along synthetic antiferromagnetic racetracks[1-3]. In this lecture I will discuss the developments of spintronics over the past 35 years and its future potential and prospects for both conventional memory-storage as well as for cryogenic racetrack memory technologies to support cryogenic quantum computing systems.

Short Bio

Professor Stuart Parkin received his B.A. in Physics and Theoretical Physics in 1977 and his PhD in 1980 from the University of Cambridge, UK. Parkin is an elected Fellow or Member: Royal Society (London), Royal Academy of Engineering, National Academy of Sciences, National Academy of Engineering, German National Academy of Science - Leopoldina, Royal Society of Edinburgh, Indian Academy of Sciences, and TWAS - academy of sciences for the developing world. Parkin's awards include the American Physical Society International Prize for New Materials (1994); Europhysics Prize for Outstanding Achievement in Solid State Physics (1997); 2009 IUPAP Magnetism Prize and Neel Medal; 2012 von Hippel Award - Materials Research Society; 2013 Swan Medal - Institute of Physics (London); Alexander von Humboldt Professorship – International Award for Research (2014); Millennium Technology Award (2014); ERC Advanced Grant - SORBET (2015); King Faisal Prize for Science 2021; ERC Advanced Grant – SUPERMINT (2022); 2024 APS Medal for Exceptional Achievement in Research; and 2024 Charles Stark Draper Prize of the National Academy of Engineering. Parkin has received 4 honorary doctorates. Parkin was named a "Highly Cited Researcher" for the years 2018-2024 and a Citation Laureate™ for 2023 by Clarivate.

[1] Parkin, S. S. P., Hayashi, M. & Thomas, L. Magnetic Domain-Wall Racetrack Memory. Science 320, 190-194 (2008). https://doi.org/10.1126/science.1145799
[2] Jeon, J.-C., Migliorini, A., Yoon, J., Jeong, J. & Parkin, S. S. P. Multi-core memristor from electrically readable nanoscopic racetracks. Science 386, 315-322 (2024). https://doi.org/10.1126/science.adh3419
[3] Farinha, A. M. A., Yang, S.-H., Yoon, J., Pal, B. & Parkin, S. S. P. Interplay of geometrical and spin chiralities in 3D twisted magnetic ribbons. Nature 639, 67–72 (2025). https://doi.org/10.1038/s41586-024-08582-8

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Part 1: The IAS at NTU- Personal Perspectives; Part 2: Quantum Nature of the Vacuum

CHANG NGEE-PONG

The City College of New York, USA

Short Abstract

In this talk, I will present a radical view of the vacuum. What if the vacuum is a crystalline solid, with each point in space carrying a half-integer spin? The solid is an eigenstate of energy-momentum operator. That is, the solid is translationally invariant. In such a picture, the physical boson fields are the chargons hopping across all the lattice sites of the vacuum. The physical fermion fields are the emergent fields formed from the Bloch waves propagating across the lattice sites. The emergent physical fermion fields act on a composite ground state.

Short Bio

Professor Chang Ngee-Pong is a physicist, currently a Professor at The City College of New York. He has a PhD from Columbia University and holds a BSc from Ohio Wesleyan University. His research interests include theoretical high-energy physics, particularly the Standard Model and particle masses.