



**NANYANG
TECHNOLOGICAL
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Institute of Advanced Studies



FRONTIERS IN SCIENCE: A CONFERENCE IN HONOUR OF PROFESSOR CN YANG AT 100

8 June 2022
Nanyang Auditorium, NTU Singapore & Live-Streaming

PROGRAM & ABSTRACT BOOKLET

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CN Yang Scholars
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Foreword

On behalf of the organising committee, it is my pleasure to welcome you to the Frontiers in Science: A Centennial Conference in Honour of Nobel Laureate Prof Chen-Ning Yang at 100. Prof Yang is one of Asia's first Nobel Laureates and was awarded the 1957 Nobel Prize in Physics, together with Tsung-Dao Lee, at the age of 35 for the work on parity non-conservation of weak interaction.

Prof Yang is a strong supporter of the scientific programs in NTU. In 1971, he was appointed External Examiner for the Department of Physics at Nanyang University. The NTU's CN Yang Scholars Programme, launched in 2006, was named after him. Whenever he visited Singapore, Prof Yang engaged in lively discussions with our CN Yang Scholars, encouraging our students to be more creative and passionate about science and technology.

This centennial conference aims to commemorate Prof Yang's remarkable contributions to theoretical physics, ranging from particle physics, quantum field theory to statistical mechanics and condensed matter theory. We are honoured and delighted to have Nobel Laureates Prof Konstantin Novoselov from the National University of Singapore and Prof Brian Schmidt from the Australian National University as our keynote speakers. We will also be hearing about the broad perspective of Prof Yang's immense contributions in Physics and Education from our eminent invited speakers from Nanyang Technological University, National University of Singapore and Shanghai University.

We look forward to the inspiring and fruitful information exchange in this exciting conference!

We also sincerely wish Professor Yang a blessed 100th Birthday and the best of health!

Professor Sum Tze Chien
Chairman of the Organising Committee
Director, Institute of Advanced Studies
Nanyang Technological University



Organising Committee

Conference Chair

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Frontiers in Science

A Conference in honour of Professor CN Yang at 100

Wednesday, 8 June 2022
Nanyang Technological University Singapore

Time (GMT +8)	Conference Programme
08:00 - 08:50	Arrival of Guests / Virtual Attendees' Login
	Opening Ceremony (Emcee: Zann Teo Jiexin, CN Yang Scholar)
09:00 - 09:05	Welcome Address by Conference Chair Prof SUM Tze Chien (Director, Institute of Advanced Studies, NTU)
09:05 - 09:15	Opening Speech by Guest-of-Honour Prof LING San (NTU Deputy President and Provost)
09:15 - 09:25	Introductory Talk about Prof Chen-Ning Yang Prof Kok Khoo PHUA (Chairman and Editor-in-Chief, World Scientific Publishing Company)
09:25 - 09:35	Video Tribute to Nobel Laureate Prof Chen-Ning YANG
09:35 - 09:45	Group Photo-Taking
	Session 1 Chairs: Prof FAN Hongjin and Assoc Prof David WILKOWSKI (Nanyang Technological University)
09:45 - 10:30	Prof Konstantin NOVOSELOV (Nobel Laureate in Physics 2010; National University of Singapore) <i>Materials for the Future</i>
10.30 - 11:00	Coffee Break
11:00 - 11:30	Prof Christos PANAGOPOULOS (Nanyang Technological University) - online <i>Superconductivity-Magnetism Duality in Chiral Quantum Matter</i>
11:30 - 12:00	Prof OH Choo Hiap (National University of Singapore) <i>Prof CN Yang and Physics Education in Malaysia and Singapore</i>
12:00 - 12:30	Prof Ping AO (Shanghai University) - online <i>The Lee-Yang Theorem, the Foundation of Discontinuous Phase Transition Theory and its Modern Implication</i>



Frontiers in Science

A Conference in honour of Professor CN Yang at 100

Wednesday, 8 June 2022
Nanyang Technological University Singapore

12:30 - 13:00	Assoc Prof GU Mile (Nanyang Technological University) <i>Quantum-Enhanced Autonomous Agents: Can Quantum Reasoning Better Adapt to Complex Realities?</i>
13:00 - 14:15	Lunch Break
	Session 2 Chairs: Prof GONG Jiangbin and Assoc Prof KWEK Leong Chuan (National University of Singapore)
14:15 - 14:45	Assoc Prof Meng-Chwan TAN (National University of Singapore) - online <i>Yang-Mills Theory and the Physical Mathematics Revolution</i>
14:45 - 15:15	Nanyang Assistant Prof Nelly NG (Nanyang Technological University) <i>Quantifying Disorder in a Quantum World</i>
15:15 - 15:45	Assoc Prof ARIANDO (National University of Singapore) <i>The Rise of A New Superconducting Era "The Nickel Age"</i>
15:45 - 16:15	Coffee Break
16:15 - 16:45	Assoc Prof David WILKOWSKI (Nanyang Technological University) <i>Making and Using Ultracold Gases: Artificial Non-Abelian Gauge Field</i>
16:45 - 17:15	Prof José Ignacio LATORRE (National University of Singapore) <i>Entanglement in Particle Physics</i>
17:15 - 18:00	Prof Brian SCHMIDT (Nobel Laureate in Physics 2011; Australian National University) - online <i>The Evolution of Physics in the 100 Years of Professor CN Yang</i>
18:00 - 18:10	Closing Remarks by Prof FAN Hongjin (Director, CN Yang Scholars Programme, NTU)



Keynote Speaker 1



Materials for the Future

Prof Konstantin Novoselov

National University of Singapore

Short Abstract:

Graphene and 2D materials, despite being relatively fresh materials, have already taken a firm place in research, development and applications. A number of exciting phenomena have been discovered in these crystals and they continue to bring exciting results on a regular basis. However, probably the most important characteristic about 2D materials is that they offer a possibility to form on-demand van der Waals heterostructures, where individual 2D crystals are stacked together, forming a novel, 3D structure, whose composition (and thus, their properties) can be controlled with atomic precision. This has opened a new direction of research of materials on demand. Furthermore, since individual components in such heterostructures interact through a number of channels (elastic, van der Waals, electronic, etc.) – a degenerate energy landscape is formed, leading to a number of competing phases, which opens a way to engineer particular phase transitions between different states and, thus, study also the out-of-equilibrium phenomena in such structures.

Short Bio:

Prof Novoselov was born in Russia in August 1974. He has both British and Russian citizenship. He is best known for isolating graphene at the University of Manchester in 2004, and is an expert in condensed matter physics, mesoscopic physics and nanotechnology. Every year since 2014 Prof Novoselov is included in the list of the most highly cited researchers in the world. He was awarded the Nobel Prize for Physics in 2010 for his achievements in graphene. Prof Novoselov holds positions of Langworthy Professor of Physics and the Royal Society Research Professor at the University of Manchester.

He graduated from the Moscow Institute of Physics and Technology, and undertook his PhD studies at the University of Nijmegen in the Netherlands before moving to the University of Manchester in 2001. Prof Novoselov has published more than 250 peer-reviewed research papers. He was awarded with numerous prizes, including Nicholas Kurti Prize (2007), International Union of Pure and Applied Science Prize (2008), MIT Technology Review young innovator (2008), Europhysics Prize (2008), Bragg Lecture Prize from the Union of Crystallography (2011), the Kohn Award Lecture (2012), Leverhulme Medal from the Royal Society (2013), Onsager medal (2014), Carbon medal (2016), Dalton medal (2016) among many others. He was knighted in the 2012 New Year Honours.



Invited Speaker 1 (online)



Superconductivity-Magnetism Duality in Chiral Quantum Matter

Prof Christos Panagopoulos

Nanyang Technological University

Short Abstract:

There are profound links between superconductivity and magnetism. Twenty years ago, research to study these links was restricted to bulk single crystals with exotic structures and compositions. Tuning of the electronic properties involved the application of strong magnetic fields or destructively high pressures to macroscopic samples, with no obvious pathway to technological upscaling. Modern capabilities now enable studies in atomically controlled structures, opening pathways to engineer and explore quantum orders and their potential for energy and information handling.

I will discuss the creation of the first material platform in which superconductor-magnet duality opens pathways towards fluxonics and chiral superconductivity. It offers adaptable recipes for quantum processes including non-perturbative, non-contact Majorana braiding. Time permitting, I will also talk about complementary studies on topological solitons developing quantized helicity excitations with well-separated energy levels and distinct out-of-plane magnetizations for quantum logic elements.

Short bio:

Prof Panagopoulos is currently in the School of Physical and Mathematical Sciences, Nanyang Technological University since 2008. For his research he develops quantum materials, measurement techniques that provide multiple length-scale and time-scale windows, and theoretical insights into how the wavefunction geometry and topology affect materials performance. Leveraging these capabilities, he connects the quantum architecture of materials with new device responses. He has published more than 140 research articles and delivered over 240 invited presentations at conferences and universities. Honours accorded Prof Panagopoulos include the European Young Investigators Award, the European Excellence Grant, the National Research Foundation Fellowship and Investigatorship, Singapore and his election as Research Fellow of Trinity College, Cambridge, University Research Fellow of the Royal Society, and Fellow of the American Physical Society.



Invited Speaker 2



Prof CN Yang and Physics Education in Malaysia and Singapore

Prof Oh Choo Hiap

National University of Singapore

Short Abstract:

Recall Prof Yang's contribution to physics education program, he was the external examiner for Nanyang University, University of Science of Malaysia (Penang) and National University of Singapore.

Short Bio:

Emeritus Professor, National University of Singapore.

Fellow of the American Physical Society.

National Science Award 2006 (Singapore).



Invited Speaker 3 (online)



**The Lee-Yang Theorem, the Foundation of
Discontinuous Phase Transition Theory and its Modern
Implication**

Prof Ao Ping

Shanghai University

Short Abstract:

In the framework of Boltzmann-Gibbs statistical mechanics it had been a puzzle that how different phases could arise from a sum of smooth functions. There had been doubt whether or not partition function based on Boltzmann-Gibbs equilibrium distribution could be used for such purpose. While firmly believed it could, Ehrenfest could not find a suitable scenario. In 1933 Kramers proposed the thermodynamic limit to do the job. But he did not offer a positive and exactly solved example. Onsager provided it in 1944, announced his exact results for the 2d Ising model for continuous phase transition. Then, in a series of efforts culminated in 1952, Chen-Ning Yang and Tsung-Dao Lee showed rigorously that the insights of Ehrenfest and Kramers are correct. It was an elegant demonstration of their insightful intellect powers and ingenious mathematical skills. By now there exist 4 types of fundamental interactions in Nature, but only 3 types of phase transitions: discontinuous, continuous and topological for the bewilderingly complex world. All those show the deep unity and simplicity in physics, and an amazingly beauty. One may notice that the establishments of theories for the last two types of phase transitions had already been recognized by Nobel prizes. Even the formulation of the extremely useful mean-field theory was in a sense rewarded with a Nobel prize, to witness the importance of phase transitions in the understanding of our world.

In my talk I will discuss their 1952 results from a physics perspective, with a modern implication. It is a student's learning report during past 40 years on a still active fundamental contribution of masters.

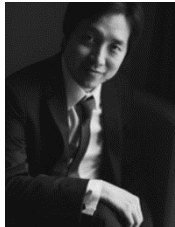


Short bio

Prof Ao had his BS in physics in 1983 from the Peking University, Beijing, China. That year he went to the United States for further study in physics via China-US Physics Examination and Application (CUSPEA) program initiated by Tsung-Dao Lee. He studied the quantum measurement problem and the macroscopic quantum phenomena at the University of Illinois at Urbana-Champaign. Supervised by Sir Anthony James Leggett he obtained his PhD in physics. He then did his postdoc with David James Thouless FRS at the University of Washington, with a focus on the dynamics of topological defects and their physics implications. Together with Thouless and others, he established the effective equation of motion for vortices in superconductors and superfluid, with underpinning in microscopic theories. He explained the anomalous Hall effect in type II superconductors. During the last 20 years, he has been working on systems biology and systems medicine. For example, with Leroy "Lee" Edward Hood and others, he proposed a new theory for cancer genesis and progression to supersede the dominating cancer gene mutation theory. His biological research in evolution motivated him to develop an open, nonlinear stochastic dynamical framework for non-equilibrium processes, providing a unifying theoretical foundation for both biology and physics. His current research covers problems from biology, engineering, medicine, and physics.



Invited Speaker 4



Quantum-Enhanced Autonomous Agents: Can Quantum Reasoning Better Adapt to Complex Realities?

Assoc Prof Gu Mile

Nanyang Technological University

Short Abstract:

The world is awash with complex, interacting systems. Predators chasing prey, investors trading stocks, grandmasters playing chess: all share that they process information from their environment and act appropriately in response. As the processes we seek to tackle, automate or adapt to have become ever more complex, success requires automated agents that adapt to stimuli over ever-greater timescales, creating a key challenge in the dawning era of big data.

Could the quantum mechanical laws that govern fundamental particles provide a tool to surmount this challenge? Such prospects may first sound surprising. Can a theory designed to model the dynamics at the level of photons and electrons aid in the understanding of systems with no quantum effects?

In this talk, I will survey recent developments exploring such possibilities, and illustrate that quantum-enhanced agents - the automated machines capable of processing data quantum mechanically - can better isolate essential data for executing complex strategies. I will also illustrate how such advantages can be general and may scale without bound in environments where optimal performance necessitates tracking information about events far into the past. Thus, we see how fundamental physics initially motivated to understand unique properties of particles at the quantum scale may have relevance in scientific domains that initially appear unrelated.

Short Bio:

Assoc Prof Gu Mile obtained his PhD at the University of Queensland in 2009, spent three years as faculty at the Tsinghua University under the 1000 talents program starting 2013, and joined the Nanyang Technological University as a National Research Foundation Fellow in 2016. He is presently an associate professor at the School of Mathematical and Physical Sciences, Nanyang Technological University. He leads the quantum and complexity science initiative - which seeks to explore how quantum technologies can enhance our capacity to analyse complex systems (www.quantumcomplexity.org). Assoc Prof Gu is a member of the Nanyang Quantum Hub and is also affiliated with the Centre for Quantum Technologies at the National University of Singapore.



Invited Speaker 5 (online)



Yang-Mills Theory and the Physical Mathematics Revolution

Assoc Prof Tan Meng-Chwan

National University of Singapore

Short Abstract:

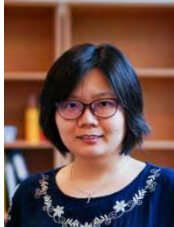
I will explain how Yang-Mills theory, first formulated to describe the non-gravitational forces of the universe, has led to the Physical Mathematics revolution where physics is once again helping to define new mathematics, like how Newton's study of motion helped to define calculus. To this end, I will elucidate the theory's ubiquitous presence in almost everything from quantum gauge theories to string theory, and its far-reaching mathematical implications in these various contexts.

Short Bio:

Assoc Prof Tan was formerly a Major in the Republic of Singapore Air Force who completed his part-time PhD with the National University of Singapore in 2007. His doctoral thesis was examined and endorsed by Einstein's successor to the title of the greatest theoretical physicist of our time, Edward Witten, who also invited Assoc Prof Tan to the Institute for Advanced Study in Princeton, Einstein's old stomping ground, to be a postdoctoral member from 2007-2008. Assoc Prof Tan then went on to the California Institute of Technology as a postdoctoral fellow in 2009 before returning to Singapore to join NUS in 2010, where he was promoted to Associate Professor with tenure in 2014. He is the founder and leader of the NUS String Theory Group, Southeast Asia's first and only String Theory group, and is also Assistant Dean of Science.



Invited Speaker 6



Quantifying Disorder in a Quantum World

Nanyang Asst Prof Nelly Ng Huei Ying

Nanyang Technological University

Short Abstract:

I discuss the role of generalized entropies in quantum information and how they are used in the study of resource theories, which can be applied to a wide variety of phenomenon, such as entanglement, communication and thermodynamics. The spectrum of differences between single-shot and i.i.d. processes are highlighted, and I show how this motivates the study of the variance of relative surprisal as a complementary way of quantifying fluctuations. I then summarize some recent progress made in this direction.

As an alumnus of the CNYang scholars program in NTU, I will also share some of my memories of key experiences in the program, and how they have shaped my values as an academic.

Short Bio:

Asst Prof Ng received her BSc (Hons) from the physics department of the School of Physical and Mathematical Sciences, Nanyang Technological University in 2012. She worked as a research assistant at the Centre for Quantum Technologies for a few years. In 2017, she received her PhD on the study of quantum information theory and thermodynamics from the Delft University of Technology. From November 2017 to March 2020, Asst Prof Ng was hosted at the Free University of Berlin, first as an Alexander von Humboldt Postdoctoral Research Fellow, and then subsequently as a postdoctoral fellow. She joined the Division of Physics and Applied Physics at SPMS, NTU in November 2020 as Nanyang Assistant Professor.



Invited Speaker 7



The Rise of A New Superconducting Era "The Nickel Age"

Assoc Prof Ariando

National University of Singapore

Short Abstract:

After the reward of decades-long pursuit on the superconducting cuprate analog with the hope to obtain a better understanding of the mechanism of high-temperature superconductivity, the recent discovery of superconductivity in infinite-layer nickel-oxides brings more mystery to the picture than anticipated. In this talk, I will present challenges and progress in studying superconductivity in the nickelate-analogs of the cuprates. Despite the structural and electronic similarities between the nickelates and the cuprates, it seems nickelate superconductivity shows substantial dissimilarities and requires further consideration of multiple orbitals, raising new questions for physicists and chemists about the mechanism of superconductivity.

Short Bio:

Assoc Prof Ariando is currently the Deputy Head of Research and Graduate Studies of the Department of Physics, National University of Singapore (NUS). He received his PhD in Physics from the University of Twente, the Netherlands, in 2005, on the study of pairing symmetry in high-temperature superconducting cuprates and imaging quantum vortices in s-wave/d-wave Josephson junctions in collaboration with IBM TJ Watson Research Center. He then took a post-doctoral position under the Dutch Nanoscience Research Network (NanoNed) and joined the National University of Singapore as a Faculty member in 2008. He was the Deputy Director of NUS Nanoscience and Nanotechnology Initiative (NUSNNI) and has been recognized with Omicron Gold Medal by the Institute of Physics Singapore (IPS), Young Investigator Award, Dean's Chair Professor, and Outstanding Researcher Award, Faculty of Science, NUS, and a NEXT Visiting Investigator at LNCMI, CNRS France.



Invited Speaker 8



Making and Using Ultracold Gases: Artificial Non-Abelian Gauge Field

Assoc Prof David Wilkowski

Nanyang Technological University

Short Abstract:

Since their first achievement 25 years ago, ultracold gases becomes a major player in many aspects of quantum technologies such as sensing, quantum simulation and quantum information. In the first part of the presentation, I will give an overview of the various techniques used for cooling atomic gases. I will also give a brief sketch of the most popular applications. In the second part, I will focus on quantum simulations and in particular on the generation of artificial gauge fields useful in many problems of condensed-matter physics and eventually in high-energy physics.

Short Bio:

Assoc Prof Wilkowski is an associate professor at the University of Nice in France and at the Nanyang Technological University in Singapore. He is a principal investigator at the Centre for Quantum Technologies, at the Centre for Disruptive Photonic Technologies, and at Majulab (CNRS IRL 3654). His research interests range from quantum simulation, quantum sensing, coherent transport to nanophotonics and plasmonics. He is mainly working with ultracold gas systems.



Invited Speaker 9



Entanglement in Particle Physics

Prof José Ignacio Latorre National
University of Singapore

Short Abstract:

Entanglement is at the heart of quantum mechanics. We here explore how entanglement is generated from first principles, and how much is related to gauge symmetry.

Short Bio:

Prof Latorre was appointed Director of the Centre for Quantum Technologies in July 2020. He is also Professor and Provost's Chair in the National University of Singapore's Department of Physics. A leading figure in particle physics and quantum information, Prof Latorre joined CQT, NUS from the University of Barcelona. He has been heading a research group at the Barcelona Supercomputing Center to build the first quantum processor in Spain. Prof Latorre is also the founder of the Centro de Ciencias de Benasque Pedro Pascual, a Spanish scientific facility that is well known in the quantum information community for hosting workshops and conferences.



Keynote Speaker 2 (online)



The Evolution of Physics in the 100 Years of Professor CN Yang

Prof Brian Schmidt

Australian National University

Short Abstract:

Prof CN Yang has lived through almost the entirety of the evolution of Modern Physics, and I will reflect on the journey of the field during his lifetime. From the Birth of Cosmology in the year he was born, through the development of particle physics for which his work was seminal, the 100-year revolution of the field will continue into the foreseeable future.

Short Bio:

Prof Brian P. Schmidt AC FAA FRS

Vice-Chancellor and President, the Australian National University

2011 Nobel Laureate Physics

Prof Schmidt was appointed Vice-Chancellor and President of the Australian National University (ANU) in January 2016.

He is the 12th Vice-Chancellor of the Australian National University (ANU). Winner of the 2011 Nobel Prize in Physics, Prof Schmidt was an astrophysicist at the ANU Mount Stromlo Observatory and Research School of Astronomy and Astrophysics before becoming Vice-Chancellor.

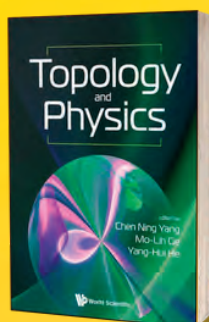
Prof Schmidt received undergraduate degrees in Astronomy and Physics from the University of Arizona in 1989, and completed his Astronomy Master's degree (1992) and PhD (1993) from the Harvard University. Under his leadership, in 1998, the High-Z Supernova Search team made the startling discovery that the expansion rate of the Universe is accelerating. Fellow of the Australian Academy of Science, the United States Academy of Science, and the Royal Society, he was made a Companion of the Order of Australia in 2013.

Special Collection of Prof. Chen Ning Yang's Works in Honor of His 100th Birthday



On the joyous occasion of Prof. Yang's centenary, World Scientific pays tribute to his immense intellectual achievements by presenting a collection of his books, book chapters and journal articles, among which selected contributions are free to read until July 2022.

Find out more at worldscientific.com/page/cnyang100



Topology and Physics

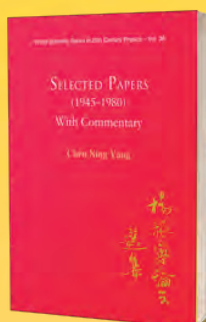
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Aug 2005 624pp
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