

# PROGRAM SCHEDULE


20<sup>TH</sup> SEPTEMBER 2021, MONDAY

*CELEBRATING 21 YEARS OF MATHEMATICAL SYNERGY*

---

8.40 am	Registration Guests to be seated
8.55 am	Arrival of Guest of Honor Professor TAN Eng Chye President of NUS
9.00 am	Welcome Address by Director of IMS, Professor CHONG Chi Tat  Speech by Guest of Honor, President of NUS, Professor TAN Eng Chye  Pre-recorded Messages Emeritus Professor Roger HOWE – Yale University Professor Yum-Tong SIU – Harvard University Professor Iain JOHNSTONE – Stanford University  Live Virtual Address Emeritus Professor Andrew BARBOUR – The University of Zurich  <i>Jointly</i> Professor Ted SLAMAN – The University of California, Berkeley Professor Hugh WOODIN - Harvard University  Musical Performance Ms Michelle ZHU <i>Solo Cello</i> <i>Bach Cello Suite No. 3 in C Major, Sarabande and Gigue</i>  Group Photo
10.00 am	Break
10.15 am	Session Chair: Professor Adrian RÖLLIN Professor SHEN Zuowei, NUS <i>Mathematics Behind Deep Neural Networks</i>
11.00 am	Session Chair: Professor TOH Kim Chuan Professor ZHU Chengbo, NUS <i>Orbit Method: From Matrices to Unitary Representations</i>

---



# MICHELLE ZHU

Solo Cello

School of the Arts, Singapore

## **Biography**

Michelle is a secondary 2 student at the School of the Arts, Singapore. She has been a student of the cello since age 6 and has had a wealth of performance experiences nationally and abroad. Among others, Michelle was a diploma winner of the 18th International Television Contest for Young Musicians 'Nutcracker', Russia in 2017, and the 7th International Dotzauer Competition for Young Cellists, Germany in 2019. At home, Michelle was the Junior Category Winner of Symphony 924 Young Talents Project, and performed at the National Day Concert, Gardens By The Bay, both in the year 2019.

## **Bach Cello Suite No. 3 in C Major, Sarabande and Gigue**

The six Cello Suites, BWV 1007–1012, are suites for unaccompanied cello by Johann Sebastian Bach. They are some of the most frequently performed and recognizable solo compositions ever written for cello.

The suites have since been performed and recorded by many cellists. Yo-Yo Ma won the 1985 Grammy Award for Best Instrumental Soloist Performance for his album Six Unaccompanied Cello Suites. János Starker won the 1998 Grammy Award for Best Instrumental Soloist Performance for his fifth recording of Six Unaccompanied Cello Suites.

# **SHEN ZUOWEI**

Department of Mathematics  
National University of Singapore

## **Biography**

Shen Zuowei is Tan Chin Tuan Centennial Professor of Mathematics at the National University of Singapore. He received his PhD in 1991 from the University of Alberta and joined NUS in 1993 after spending two years at the University of Wisconsin (Madison) as a postdoc. Prof Shen's research interests are in mathematical foundations of data science, especially in the areas of approximation and wavelet theory, image processing and compressed sensing, computer vision and machine learning. Together with his collaborators, he developed mathematical theories that led to several major theorems and algorithms, including a duality analysis that resulted in three mathematical principles: the duality principle for Gabor frames, the unitary extension principle and the oblique extension principle for wavelet frames. His recent research interests focus on approximation theory of deep neural networks.

Professor Shen was an invited speaker at the International Congress of Mathematicians in 2010 and the International Congress of Industrial and Applied Mathematics in 2015. He was a recipient of the NUS Outstanding Researcher Award (1997 and 2008), the Wavelet Pioneer Award from the Society of Photographic Instrumentation Engineers, US (2012), and the Singapore National Science Award (1998). He is a Fellow of the World Academy of Sciences, the Society for Industrial and Applied Mathematics, USA, the American Mathematical Society and the Singapore National Academy of Science.

## **Abstract**

### **Mathematics Behind Deep Neural Networks**

Deep neural networks have made significant impacts in many fields of engineering and sciences. Well-designed neural network architectures, efficient training algorithms, and high-performance computing technologies have made neural-network-based methods very successful in a tremendous number of applications. Especially, in supervised learning, e.g., image classification and objective detection, the great advantages of deep neural network based methods have been demonstrated over traditional methods. A large number of experiments in real applications have shown the super capacity of deep network approximation from many empirical points of view. This motivates much effort in establishing the mathematical foundation of deep network approximation. In this talk, we will discuss the mathematics behind deep neural networks through approximation theory points of view.

# ZHU CHENGBO

Department of Mathematics  
National University of Singapore

## **Biography**

Zhu Chengbo is Provost's Chair Professor of Mathematics at the National University of Singapore. He received his BSc from Zhejiang University in 1984, and his PhD from Yale University in 1990, and joined NUS the following year. Prof Zhu's research interests are in representation theory of Lie groups. Together with his collaborators, he has made significant contributions to the branching problem of smooth representations, the theory of local theta correspondence, and to the understanding of a fundamental class of unitary representations known as special unipotent representations.

Professor Zhu received the Singapore National Academy of Science Young Scientist Award in 1998 and is a Fellow of the Singapore National Academy of Science. He is an invited speaker of the 2022 International Congress of Mathematicians to be held in St. Petersburg, Russia.

## **Abstract**

### **Orbit Method: From Matrices to Unitary Representations**

The talk is intended as a leisurely introduction to one of the fundamental tasks of representation theory: the construction of irreducible unitary representations. I will discuss two major sources of unitary representations of Lie groups, one from Symplectic Geometry (Kirillov theory) and another from Number Theory (Langlands philosophy). I will also touch on a recent development (due to Barbasch, Ma, Sun and the speaker) on the construction and classification of a fundamental class of (unitary) representations known as special unipotent representations.