

Press Release



ArtScience Museum opens up All Possible Paths

*Contemporary artworks, including commissioned work
by Jun Ong, celebrate Richard Feynman's 100th
birthday*

SINGAPORE (20 October 2018) – ArtScience Museum has launched a brand new exhibition, ***All Possible Paths: Richard Feynman's Curious Life***, to mark the centenary and remarkable achievements of Nobel Laureate, Richard Feynman. *All Possible Paths* is curated and produced by ArtScience Museum, in collaboration with Nanyang Technological University, Singapore (NTU Singapore) and the Nobel Museum in Sweden, with support from the Centre for Quantum Technologies (CQT) at the National University of Singapore.

One of the most influential physicists of the 20th century, Feynman was known for his work in quantum mechanics – the basis of modern physics. His achievements laid the grounds for modern science and many technological advances such as lasers and global positioning systems (GPS), which are now indispensable in our everyday lives. Feynman was also known as the “Great Explainer” with his creative approach to problem solving, unconventional perspective, and his ability to synthesize and explain complex scientific knowledge.

Together with the exhibition and as part of the global celebration of Feynman's centenary, NTU is hosting a three-day scientific conference, ***Richard Feynman at 100***, from 22 to 24 October 2018.

The exhibition – which runs till 3 March 2019 – underscores Feynman's curious nature and creative thinking which drove him to explore many possibilities in life, including art and music. Visitors to the exhibition will have the opportunity to get to know Feynman through a collection of over 70 personal letters, papers, artefacts, photographs, his famous bongo drums, and his original paintings, all of which are being exhibited outside of the United States for the first time.

The exhibition's opening ceremony was officiated today by Mr. Heng Swee Keat, Minister for Finance and Chairman of the National Research Foundation (NRF).

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Minister Heng giving a speech at the opening ceremony of All Possible Paths



(From left to right) Prof Lee Soo Ying, Honor Harger (Executive Director of ArtScience Museum), George Tanasijevich (President and CEO of Marina Bay Sands), Minister Heng Swee Keat, Prof Subra Suresh (NTU President), Nobel Laureate Prof Frank Wilczek, Betsy Devine and Prof Lars Brink at the opening ceremony of All Possible Paths

All Possible Paths also uses art and science, as well as striking contemporary exhibition design, to convey the importance and relevance of Feynman's work in today's world. Visitors are encouraged to learn more about Feynman's science through the installations, sculptures and immersive environments created by 12 contemporary artists, including British digital artist, Markos R. Kay, Belgian artist, Frederik de Wilde, Thailand-based Japanese media artist, Eiji Sumi, Russian media artist, and American data visualization pioneer, Edward Tufte.

One of the key installations is a new artwork by Malaysian architect and artist, Jun Ong. Co-commissioned by ArtScience Museum and CQT, *Quantum* is a visually stunning and immersive laser light installation inspired by quantum computing. The installation sees mirrors placed strategically to form continuous laser paths, distorting dimension and spatial logic, akin to the quantum phenomenon known as entanglement. (Refer to Appendix for description of the contemporary artworks)

"Richard Feynman was unique amongst scientists in his broad range of passions. As well as being one of the most brilliant physicists of modern times, he was an avid musician, a keen painter, a captivating teacher, and a notorious prankster. He is a figure who captured the imaginations of scientists, artists and the public at large. It is fitting then, that we celebrate his centenary with a major new show, conceived, curated and delivered by ArtScience Museum, working hand-in-hand with NTU, the Nobel Museum and CQT. The curatorial direction of *All Possible Paths* is bold and unique, just like Feynman's science. We begin the show with a quantum computing chip - a technology made possible by Feynman that may yet change the world - and end it with a shamanistic ritual from Tuva, that illustrates the unexpected confluence of culture and science within Feynman's story. Along the way, we explore weird and wonderful ideas within quantum mechanics through the artworks of 12 major contemporary artists from around the world. It is an exhibition that epitomizes our identity as a museum where art and science meet," said Honor Harger, Executive Director of ArtScience Museum.

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Over at the NTU campus, the three-day scientific conference, ***Richard Feynman at 100***, will see 18 renowned scientists and Nobel Laureates discuss Feynman's contributions in Physics and beyond.

NTU President Professor Subra Suresh, said, "Richard Feynman's achievements are truly inspiring as they teach us the importance of multidisciplinary thinking, within and beyond science. NTU also places a strong emphasis on such an approach in both learning and research."

Exhibition overview

Presented in four thematic sections, the show transports visitors into the world of one of the most important scientists of modern times, and shows how his discoveries have revolutionised our understanding of nature.

Section 1: A Curious Life

Feynman's contributions to science began with his work on the atomic bomb in the early part of his career, continued with his breakthroughs in quantum mechanics which earned him a Nobel Prize, and culminated with his role in investigating the Challenger Space Shuttle disaster in 1986. Feynman was also a pioneer of quantum computing and nanotechnology. Yet, Feynman led an unusual life. He put joy and humour into science, and was famous for his practical jokes, passion for playing the bongos and fondness for cracking safes.

The first section of the show provides a fascinating insight into Feynman's world through 72 unique artefacts, including personal letters, family photographs, his bongos, his own paintings, and a recreation of the quirky van he used to drive.

Section 2: The Great Explainer

Feynman was a brilliant communicator of science, and his captivating lectures still resonate with audiences today. He was known as the 'Great Explainer', due to his natural ability to convey complex ideas to both scientists and the public in a fun and enthusiastic way. The second section of the exhibition showcases Feynman's infectious passion in a cinema playing excerpts of some of his most important lectures.

Section 3: The Pleasure of Finding Things Out

Taking inspiration from Feynman's own highly visual way of thinking, the third section of the exhibition explores quantum physics, and its applications, through the medium of art. Sculptures, installations, photographs and immersive environments made by 12 contemporary artists, articulate the uncanny quantum world in a visual way. The artworks introduce six topics closely associated with Feynman's work: Parton Theory, the Weak Force, Quantum Electrodynamics, Feynman Diagrams, Nanotechnology and Quantum Computers.

Section 4: A Million More Discoveries

Feynman's brilliant mind and wonderfully curious personality have inspired scientists from around the world. One of the ways that Feynman has influenced physicists is through the development of Feynman Diagrams, which act as a visual dictionary for processes that takes place in the microscopic world. In the final section of the exhibition, the influence of Feynman

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is demonstrated in series of original Feynman Diagrams drawn by fellow Nobel Laureate, Frank Wilczek. Animations, commissioned for this show, bring the Feynman Diagrams to life, vividly illustrating scientific discoveries which have helped shape our understanding of the universe.

Programmes

To launch *All Possible Paths*, ArtScience Museum has developed a series of programme starting from the weekend of 20 October.

Event:	Date/ Time:	Description:	Remarks:
Conversation: All Possible Paths	20 Oct, 11am – 6pm	<p>This full-day programme presents discussions and talks by Nobel Laureates, pioneering scientists, innovative artists and insightful curators, who will explore Feynman's contributions to science and society, as a scientist, teacher and creative genius.</p> <p>Speakers include:</p> <ul style="list-style-type: none"> • Frank Wilczek, Nobel Laureate • Thomas L. Curtright, Professor of Physics at the University of Miami and Fellow of the American Physical Society • Maria Spiropulu, Shang-Yi Ch'en Professor at the Division of Physics, Math & Astronomy at California Institute of Technology (Caltech) • Betsy Devine, American author, journalist and guest curator of Nobel Museum • Jun Ong, Kuala Lumpur-based architect and artist • Eiji Sumi, Bangkok-based Japanese artist and lecturer in Communication Design at Chulalongkorn University • ::vtol::, Moscow-based media artist and musician • Betsy Devine, Guest curator of Nobel Museum 	<p>Level 4, Expression Gallery</p> <p><i>Admission is free on a first-come-first-served basis, subject to availability. Refer to Facebook event page for more information.</i></p>
Public Guided Tour (45mins)	Family Friday, 26 Oct, 3pm – 4pm	<p>Join our guided tour to peer into the mind of Richard Feynman and discover how his thinking has provided the</p>	B2, Exhibition Entrance

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	<p>Saturdays 20 & 27 Oct, 5pm – 6pm</p> <p>Sundays 21 Oct, 11.30am – 12.30pm & 5pm – 6pm</p> <p>28 Oct 5pm – 6pm</p>	starting point for some of the most exciting ideas in science today.	<p><i>Complimentary to ticket-holders of All Possible Paths</i></p> <p><i>Limited to a maximum of 25 pax.</i></p>
Mandarin Guided Tour	<p>Saturday, 27 Oct, 2.30pm – 3.30pm</p> <p>Sunday, 28 Oct, 2.30pm – 3.30pm</p>		
Workshop: 'Feyn' out about Nano!	<p>Family Fridays 2, 9, 16 & 30 Nov, 14 & 28 Dec, 4.30pm – 5.30pm</p>	Explore the wonders of the nano world in this hands-on workshop. Work with your friends to find the micro-letters in our daily lives and have a go at 'decoding the quote'.	Level 4, Expression Gallery \$5 per participant. Up to 20 participants on a first-come, first-served basis.

All Possible Paths runs from 20 October 2018 till 3 March 2019.

Tickets are available at all Marina Bay Sands box offices and website. Terms and Conditions apply. Tickets prices as follows:

	STANDARD TICKET (SGD)	SINGAPORE RESIDENT (SGD)
Adult	15	12
Senior (65 years and above)/ Student/ Child (2-12 years)	10	8
Family package (2 kids & 2 adults)	40	32

For more information on *All Possible Paths*, visit <https://www.marinabaysands.com/museum/richard-feynman.html>.

For more information on *Richard Feynman at 100*, conference, visit <http://www.ntu.edu.sg/ias/upcomingevents/RF100/Pages/default.aspx>

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About Marina Bay Sands Pte Ltd

Marina Bay Sands is the leading business, leisure and entertainment destination in Asia. It features large and flexible convention and exhibition facilities, 2,560 hotel rooms and suites, the rooftop Sands SkyPark, the best shopping mall in Asia, world-class celebrity chef restaurants, a theatre and an outdoor event plaza. Completing the line-up of attractions is ArtScience Museum at Marina Bay Sands which plays host to permanent and marquee exhibitions. For more information, please visit www.marinabaysands.com

About ArtScience Museum

ArtScience Museum at Marina Bay Sands is the cultural institution in Singapore that explores the intersection between art, science, technology and culture. Since opening in February 2011, the museum has staged large-scale exhibitions by some of the world's major artists, including Leonardo da Vinci, Salvador Dalí, Andy Warhol, Vincent Van Gogh, and M.C. Escher. In addition, it has presented significant exhibitions which explore aspects of science, including, in recent shows, big data, particle physics, natural history, marine biology and space exploration.

ArtScience Museum's striking lotus-inspired building, designed by Moshe Safdie, features 21 gallery spaces spanning nearly 5000m². The museum has staged international exhibitions in partnership with renowned museums and galleries around the world, including the British Museum and Science Museum in London, the American Museum of Natural History in New York, the Ambrosiana in Milan, Mori Art Museum in Tokyo, the Australian Centre for Moving Image in Melbourne, and many others. ArtScience Museum also originates and produces exhibitions in-house, and runs a full programme of education, events, activities and learning opportunities for a wide range of audiences. ArtScience Museum is owned and operated by Marina Bay Sands.

About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, set up jointly with Imperial College London.

NTU is also home to world-class autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Ranked 12th in the world, NTU has also been placed the world's top young university for the past five years. The University's main campus is frequently listed among the Top 15 most beautiful university campuses in the world and it has 57 Green Mark-certified (equivalent to LEED-certified) building projects comprising more than 230 buildings, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Singapore's healthcare district.

For more information, visit www.ntu.edu.sg

About the Nobel Museum

The Nobel Museum is a museum devoted to circulate information on the Nobel Prize, Nobel laureates from 1901 to present, and the life of the founder of the prize, Alfred Nobel (1833-1896). The Nobel Museum's aim is to spread knowledge as well as to create interest and discussion around the natural sciences and culture through creative learning and exhibition techniques, modern technology and elegant design. Please visit: www.nobelmuseum.se

About The Centre for Quantum Technologies

The Centre for Quantum Technologies (CQT) is a National Research Centre of Excellence in Singapore. It brings together physicists, computer scientists and engineers to carry out basic research on quantum physics and to build devices based on quantum phenomena. Experts in this new discipline of quantum technologies are applying their discoveries in the fields of computing, communications and sensing.

CQT was established in December 2007 with support from Singapore's National Research Foundation and Ministry of Education. It is hosted by the National University of Singapore and also has staff based at Nanyang

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Technological University and Singapore University of Technology and Design. For more information, please visit www.quantumlah.org.

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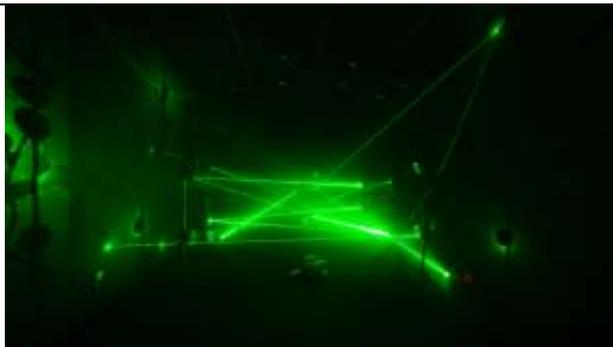
For hi-res images:

<https://drive.google.com/open?id=1jwmGlgT8N-J57LN4CjBsBwrqJOcCaNd> (Credit as indicated in the captions)

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Appendix: Highlights of artworks on show



Quantum by Jun Ong

2018

Mixed media installation

New commission

Co-commissioned by ArtScience Museum and the Centre for Quantum Technologies at the National University of Singapore in 2018

The field of quantum computing was born from Feynman's lecture titled *Simulating Physics with Computers*. A quantum computer could perform calculations based on the behaviour of small isolated systems such as atoms or superconductors at very low temperatures. A quantum computer would be capable of executing some calculations millions of times faster than any previous computers.

Co-commissioned by ArtScience Museum and the Centre for Quantum Technologies, *Quantum* is a responsive laser light installation inspired by quantum computing. It references a phenomenon known as entanglement, in which the quantum states of two or more objects are strongly connected even when the objects are spatially separated.

Each mirror in *Quantum* is precisely placed to form continuous laser paths, so the immersive installation distorts dimension and spatial logic, akin to entanglement.

Jun Ong (b. 1988) is a Kuala Lumpur-based light artist. Trained as an architect, Jun looks at how artificial light can be both spatial and atmospheric. He is interested in the adaptability of artificial light, pairing technology with materials to create interactive relationships between man, light and space. Ong has created site-specific installations in USA, Hong Kong, Thailand and Cambodia and was nominated for Best in Spatial Art at the Media Architecture Biennale 2016 in Sydney, Australia.

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***wave is my nature* by ::vtol::
2015
Mixed media installation**

Quantum Electrodynamics (QED) is the theory of light and matter. In order to describe the interactions between light and matter, Feynman came up with a new calculation method, Path Integral Formulation. Feynman proposed that when light travels from one point to another, it takes all possible paths between two points at the same time.

wave is my nature is a manifestation of Feynman's theory. The LED strips in this installation move in wave-like patterns, creating unique 'light paths' in space, demonstrating the movement of particles as they take 'all possible paths' while moving from one point to another.

::vtol:: aka Dmitry Morozov (b.1986) is a trans-disciplinary artist and researcher based in Moscow. He focuses on creating contemporary installations involving the use of sound and robotics.



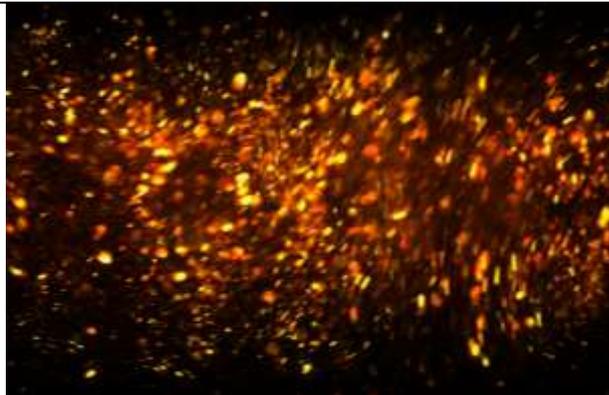
***Quark IV* by Eiji Sumi
2016
Mixed media installation
Sound by Thitipant Chongcharoenchokeskul**

In the early 1960s, experiments showed that protons have internal structure. In 1967, Feynman proposed that the proton is made up of nearly independent particles that he called partons.

Suspended in air, the light reflecting particles in *Quark IV* creates both controlled and unpredictable patterns of movement. The internal structure of the sculpture is only visible on close inspection. It also echoes the scientific exploration that led to the understanding of the proton's structure and the independent movement of its partons. Perhaps this is how Feynman first imagined the internal structure of the proton?

Sumi (b.1970) is a Japanese artist based in Bangkok. Sumi's particle physics-based

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explorations have led him to create open-ended installation series that capture the relationship of art and science. His experimental approach towards creating mix media installations allows him to combine raw materials with digital media to form new ideas and configurations.



***Quantum Foam #2* by Frederik De Wilde**
2018
3D printed polyamide
Number 1 in an edition of 7

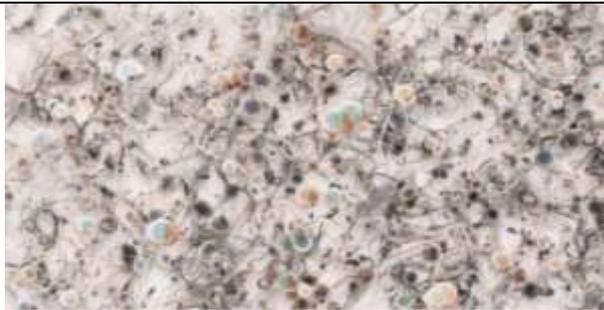
According to the uncertainty principle of quantum mechanics, it is impossible to know both the exact position and the exact speed of a particle at the same time. That is, the more precisely the position is determined, the less can be determined about the speed and vice versa.

Quantum Foam by Belgian artist Frederik De Wilde represents a speculative concept that emerged from the application of the uncertainty principle to our understanding of the fabric of space and time. According to this idea, when spacetime is examined at fantastically small scale, it appears to fluctuate wildly like the violent surface of boiling water.

De Wilde (b. 1975) works at the interstice of art, science and technology. He considers art as the poetics of the imagination and science as the poetics of reality. De Wilde's fascination with dark ecologies and invisible territories has led him to create artworks that experiment with the notion of the inaudible, intangible and invisible.

De Wilde will also be in ArtScience Museum's exhibition, *Minimalism*, opening in November and will visit Singapore.

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Quantum Fluctuations by Markos Kay 2017 Digital video (Four minutes)

In *Quantum Fluctuations*, particle simulations are used to create abstract moving images that visualise events taking place in the microscopic world. By using computer simulations as an artistic tool, this conceptual reimagining of quantum theory aims to challenge our ideas of how scientific observation and knowledge are formed.

Markos Kay (b.1984) is a digital artist from the UK, known for his video art featuring particle physics. His art and design practice ranges from screen-based artworks, to projections and prints, and has been featured in museums, festivals and art publications worldwide.



Nanotechnology photographs by various artists

Nanotechnology is the science of manipulating matter on an atomic or molecular scale. Feynman is often credited as the founding father of nanotechnology, due to his landmark 1959 speech, *There's Plenty of Room at the Bottom*.

A series of images by nanotechnologists, including Jeanette Böckmann, Monika Lelonek (pictured), Maria Lenk, Eva Mutoro and Amelia Barreiro are on show in the exhibition. The nanotechnologists, who are all women, used nanotechnological techniques to construct microscopic landscapes and sculptures, effectively establishing a new way to use science for the creation of artwork.