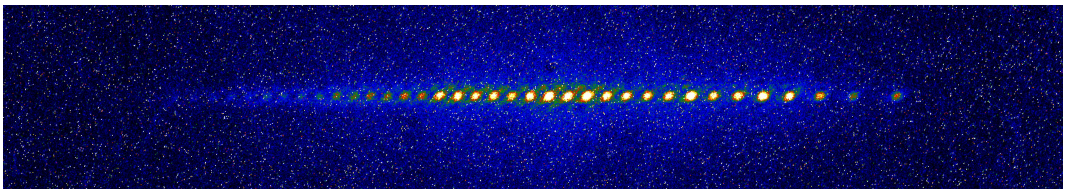
## Program

**Apr 20 – 22, 2026**



# Asian Conference on Trapped Ions 2026

National University of Singapore
Shaw Foundation Alumni House 11 Kent Ridge Dr, #01-02, Singapore 119244

# Mon, April 20

8:00 AM – 8:50 AM

## Registration

**Session** | **Location:** Shaw Foundation Alumni House, Foyer

8:50 AM – 9:00 AM

## Opening: Prof José Ignacio Latorre (Centre for Quantum Technologies)

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

9:00 AM

## Invited Talks - Session 1

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Manas Mukherjee (Centre for Quantum Technologies, NUS)

9:00 – 9:30 AM

### Developing modular microwave trapped-ion quantum computers for operation with millions of qubits

**Description**

Speaker:
**Prof Winfried Hensinger**
*University of Sussex*

Abstract:
Microwave technology poses a significant opportunity to scale trapped ion quantum computers to system sizes that support utility scale quantum computation within the fault-tolerant regime. I will present progress on making microwave quantum gates faster with errors much below the fault-tolerant threshold by creating much larger magnetic field gradients. We have successfully developed a new generation of ion microchips capable of generating large magnetic field gradients in excess of 100 T/m. I will show progress on realizing high-fidelity gates with these new chips. We have invented a new approach to generate magnetic field gradient enabling orders of magnitude lower noise, while reducing expected power dissipation for the operation within utility scale-quantum computers and I will report on the first demonstration of this new approach. I will discuss progress in the development of trapped-ion quantum microchips including the integration of atomic ovens into the microchips and materials studies enabling much deeper trap depths in such chips.

As an application of our quantum computing research, I will discuss the realisation of a new electric field quantum sensor with unprecedented electric field sensitivities for the measurement of both DC signals and AC signals across a frequency range of sub-Hz to ~ 500 kHz.

9:30 – 10:00 AM

### Matter-Wave Interferometer of a Trapped Single Ion for a Quantum Sensing Application

**Description**

Speaker:
**Takashi Mukaiyama**
*Institute of Science Tokyo*

Abstract:
Atoms in a coherent superposition of different momentum states enable high-precision measurements of physical quantities. Matter-wave interferometers typically exploit the entanglement between an atomic internal and motional states. The accumulated matter-wave phases along different paths are extracted from the interference signal of the internal states after the final pulse of the interferometer sequence. Achieving precise sensing requires exquisite control over both the internal and external states of individual quantum particles. Atoms and ions are ideal candidates for these applications, as their quantum states can be precisely manipulated using electronic and optical techniques.

Here we present our experimental demonstration of matter-wave interferometry of a trapped 171Yb+ ion in a three-dimensional motion, initiated by a momentum kick. We irradiate a mode-locked laser at 355 nm to bring the ion into a superposition of one spin state with no momentum and the other spin state with a momentum, namely a spin-motion entangled state. When the laser is applied along the direction diagonal to any of the trap principal axes, the moving half of the ion wave packet travels in a harmonic potential in a complicated way. After the free evolution time, we irradiate the second laser pulse to close the interferometer. Our experiment successfully observed matter-wave interference of ions in three-dimensional motion by exciting the motion of an ion. To realize a large interferometric area, we developed a technique to significantly expand the ion orbital area by rapidly moving the ion trap center. Additionally, we constructed the entire experimental setup on a rotatable optical table, allowing us to rotate the system for a future trial to detect rotation.

10:15 AM

10:45 AM

## Invited Talks - Session 2

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Hiroki Takahashi (Okinawa Institute of Science and Technology (OIST))

10:45 – 11:15 AM **Beyond-Ten-Hour Coherence in a Decoherence-Free Clock Qubit**

**Description**

Speaker:
**Prof Kihwan Kim**
*Tsinghua University*

Abstract:
Quantum coherence fundamentally limits quantum computer and memory performance. While trapped atomic ions theoretically support million-year coherence based on spontaneous emission, experimental demonstrations have fallen orders of magnitude short. This gap raises whether we face fundamental physical limitations or addressable technical challenges.

We combine clock-state qubits with decoherence-free subspace (DFS) encoding to achieve coherence times exceeding ten hours—an order-of-magnitude improvement. Using 171Yb+ ion pairs sympathetically cooled by 138Ba+, we demonstrate this without magnetic shielding or enhanced microwave stabilization. DFS encoding cancels common-mode magnetic fluctuations across micrometer separations while clock states provide environmental insensitivity.

Our exponential fits yield a coherence time of 37,750 ± 10,890 seconds. These results experimentally verify that trapped-ion qubits are limited by technical factors rather than fundamental decoherence, establishing a pathway toward ultimate quantum memories for scalable information processing. I will also discuss our related work on scaling up qubit numbers using two-dimensional ion crystals.

11:15 – 11:45 AM **Programmable quantum simulation of anharmonic dynamics**

**Description**

Speaker:
**Dr Cameron McGarry**
*University of Sydney*

Abstract:
Continuous-variable–discrete-variable (CV–DV) quantum simulators offer a natural route to simulating bosonic dynamics relevant to many branches of physics and chemistry. However, programmable simulation of arbitrary dynamics is an outstanding challenge. In particular, simulating anharmonic dynamics, which is ubiquitous across the physical sciences, is challenging due to the highly harmonic nature of oscillators used in CV–DV simulators. Here, we experimentally demonstrate programmable CV–DV quantum simulation of anharmonic dynamics in a range of double-well potentials, implemented in a trapped-ion system. We synthesise the time-evolution operators using a bosonic-quantum-signal-processing subroutine, which allows the potential to be tuned between experiments by controlling classical experimental parameters. We observe coherent dynamics in various double-well potentials, where a wavepacket tunnels through the potential barrier, and we suppress this effect by programmatically introducing asymmetry.

11:45 AM – 12:15 PM

### Nonlinear and non-Hermitian dynamics with trapped ions and cavity QED

**Description**

Speaker:
**Prof Moonjoo Lee**
*Pohang University of Science and Technology (POSTECH)*

Abstract:
We begin by discussing our experimental study of nonlinear mechanical oscillations in trapped ions. Specifically, we demonstrate the tunability of the Duffing nonlinearity of the ion oscillator, allowing it to transition from the softening to the hardening regime. Furthermore, when the ion velocity exceeds a critical threshold, we observe the formation of a phononic frequency comb in the ion's motional spectrum. By analyzing the experimental data, we reconstruct the phase-space dynamics and the Poincaré map of the ion motion.

The next part focuses on theoretical work with non-Hermitian dynamics arising when a single ion or atom is coupled to an optical resonator. When the strength of coherent interaction balances the dissipation rate, second- or third-order exceptional points can emerge in the system. In addition, we show that introducing a nanotip into the mode of a Fabry-Perot-type resonator enables controlled tuning of the dissipation rate. This capability allows us to generate an exceptional line and realize a dissipation-induced topological transition, in which the exceptional point can be tuned solely through the control of dissipation.

Finally, we present our experiments with a chain of approximately 100 ions. The ions can be individually manipulated and cooled close to their motional ground state. We discuss experiments on phonon hopping in the ion chain, as well as measurements of both the local and global density of states.

12:15 PM

12:15 PM

## Photo-taking

**Session** | **Location:** Shaw Foundation Alumni House

12:35 PM

2:00 PM

## Invited Talks - Session 3

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Junki Kim (Sungkyunkwan University)

2:00 – 2:30 PM

### Scalable and High-Fidelity Quantum Entanglement in Trapped-Ion Systems

**Description**

Speaker:
**Taeyoung Choi**
*Department of Physics, Ewha Womans University*

Abstract:
Achieving high-fidelity and scalable entanglement is one of the central challenges in realizing quantum error correction and building a practical quantum computer. Among various physical platforms, trapped-ion systems have emerged as a particularly successful approach for precise control of quantum states, enabling high-fidelity single-qubit operations and two-qubit entangling gates for quantum computation and simulation.

In this talk, I will focus on the challenges of scaling up trapped-ion systems from both hardware and software perspectives, including increasing the number of qubits and improving gate performance through various modulation techniques. I will also introduce several ongoing research topics in our laboratory aimed at developing scalable and practical trapped-ion–based quantum processors.

2:30 – 3:00 PM

## Superconducting ion traps

**Description**

Speaker:
**Prof Atsushi Noguchi**
*The University of Tokyo & RIKEN*

Abstract:
Recent experiments in trapped-ion platforms have demonstrated two-qubit gate fidelities reaching 99.99% using RF-based quantum gates. Because gate fidelity directly determines the achievable performance and scalability of quantum computers, a central challenge is how to realize such ultra-high-fidelity gates in a scalable architecture. To enhance the scalability of RF-based gates, we employ high-Q resonators fabricated from superconducting thin films. A high-Q resonator effectively enhances the circulating current in the circuit, enabling the generation of large magnetic-field gradients at the ion position with high efficiency relative to the input drive power. This approach allows strong spin–motion coupling while significantly reducing the required microwave power. Furthermore, by integrating superconducting cavities, the RF voltages for ion trapping can be achieved with substantially lower input power, providing a pathway toward energy-efficient and scalable trapped-ion systems. In addition to presenting detailed results of our superconducting-resonator–based RF gate architecture, we will also discuss our ongoing efforts toward an alternative platform: an electron-trap quantum computer, in which single electrons are confined in vacuum and coupled to superconducting circuits. This hybrid approach opens new possibilities for compact, strongly coupled, and scalable quantum information processing.

3:00 PM

3:00 PM

## Poster Session (Sponsored by TOPTICA)

**Session** | **Location:** Shaw Foundation Alumni House, Seminar Room

### Description

Poster session will be held in the seminar room next to the auditorium.
Alcoholic and non-alcoholic beverages will be served.

4:30 PM

# Tue, April 21

9:00 AM

## Invited Talks - Session 4

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Dzmitry Matsukevich (Centre for Quantum Technologies, NUS)

9:00 – 9:30 AM

### Precision at the Extremes: Exploring the Standard Model with Trapped Exotic Ions

**Description**

Speaker:
**Prof Klaus Blaum**
*Max Planck Institute*

Abstract:
The four fundamental interactions and their symmetries, along with the fundamental constants and properties of elementary particles – such as masses and magnetic moments – form the foundational structure of the universe and underpin the well-tested Standard Model (SM) of particle physics. Conducting stringent tests of these interactions and symmetries under extreme conditions, at low energies and with the highest precision, for example by comparing particles and their counterparts, the antiparticles, allows us to probe for potential physics beyond the SM. Advancing these tests beyond their current limits requires the development of innovative experimental techniques.
This overview highlights recent technical advancements and measurements of atomic and nuclear masses, as well as  -factors, with unprecedented precision, performed on individual or a few cooled exotic ions stored in Penning traps. Notably, these experiments have among others enabled the most precise tests of bound-state quantum electrodynamics and have significantly improved the accuracy of several key fundamental constants.

9:30 – 10:00 AM

### Coherence of local-phonon hopping in a trapped-ion string

**Description**

Speaker:
**Prof Kenji Toyoda**
*Osaka University*

Abstract:
Vibrational excitations in trapped ions, or phonons, serve as useful
resources for quantum information processing, including quantum simulation and quantum computing. Localized excitations of the vibrational motion of individual ions (local phonons) offer both large information capacity and straightforward scalability, and can be used to simulate quantum particles propagating in a lattice. Hopping of local phonons, described by a hopping Hamiltonian, is an elementary process in such systems, and the coherence of local-phonon hopping is of central importance for applications based on this mechanism. Here we investigate local-phonon hopping and its coherence in the radial direction of a two-ion crystal. We experimentally observe the decay of phonon hopping as a function of the principal trap parameters and compare the results with numerically simulations. In the simulations we incorporate two main effects: residual thermal motion in the axial direction, which affects the dynamics through the nonlinearity of the Coulomb coupling, and electric-potential noise in the trapping environment. Incorporating these effects enables a quantitative comparison between the experimental observation and the numerical results.

10:00 AM

10:30 AM

## Invited Talks - Session 5

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Taeyoung Choi (Ewha Womans University)

10:30 – 11:00 AM

### Structural Transitions and Stochastic Dynamics in Trapped Ion Crystals

**Description**

Speaker:
**Prof Sadiq Rangwala**
*Raman Research Institute*

Abstract:
We present a new ion trap experiment, with an end cap type Paul trap built for precision spectroscopy and metrology [1,2]. We will discuss the performance of this experiment and then move quickly to the observation of three dimensional trapped ion crystals of Ca+ ions. The crystals form when the ions attain their configuration of minimum energy (CME) as a result of laser cooling of the ions. As the trap anisotropy is tuned, the crystals deform and structural transitions are seen. We study in detail three distinct structural transitions, all of which break symmetry with a change in the parity-odd octopole order parameter. Our observations show spontaneous symmetry breaking illustrated by a Higgs-like mode, dynamical catastrophe resulting in hysterisis, and stochastic switching [3].
In another experiment we study the thermal activation of the spontaneous inversion of a square pyramid ion crystal, which is aided by permutation symmetry and use this paradigm to test the multidimensional Kramers-Langer theory for reaction rates for the first time [4].

References
[1] A. Prakash, A. Ayyadevara, E. Krishnakumar, and S. A. Rangwala, Low divergence cold-wall oven for loading ion traps, Rev. Sci. Instrum. 95, 033202 (2024)
[2] AnandPrakash,AkhilAyyadevara,E.Krishnakumar, M. Ibrahim, K. M. Yatheendran, Subhadeep De, Sayan Patra, S. A. Rangwala, Endcap-Type Paul Trap for Precision Spectroscopy and Studies of Controlled Interactions, arXiv:2601.07328
[3] Akhil Ayyadevara, Anand Prakash, Shovan Dutta, Arun Paramekanti, and S. A. Rangwala, Observing the dynamics of octupolar structural transitions in trapped-ion clusters, arXiv:2505.16378v3 (Accepted PRR)
[4] Akhil Ayyadevara, Anand Prakash, Shovan Dutta, Arun Paramekanti, and S. A. Rangwala, Symmetry-controlled thermal activation in pyramidal Coulomb clusters: Testing Kramers-Langer theory, arXiv:2601.04883

11:00 – 11:30 AM

### Evaluating Excess Micromotion in an Asymmetric Segmented Trap for Ytterbium Optical Clocks

**Description**

Speaker:
**Dr Piyaphat Phoonthong**
*National Institute of Metrology (Thailand)*

Abstract:
In this work, we present an evaluation of excess micromotion within a linear, asymmetric segmented Paul trap developed at the National Institute of Metrology, Thailand (NIMT). To characterize the micromotion amplitude, we employ the photon correlation method, which utilizes the correlation between the ion's fluorescence and the trap's RF drive phase to quantify the underlying stray electric field. Following the systematic compensation of these stray fields, we evaluate the resulting frequency shifts on the 435-nm electric-quadrupole clock transition in 171Yb+. Our results demonstrate a second-order Doppler shift contribution of -1.2(8)x10-18, successfully validating both the trap's performance and the effectiveness of our compensation.

12:00 PM

2:00 PM

## Invited Talks - Session 6

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Moonjoo Lee (Pohang University of Science and Technology (POSTECH))

2:00 – 2:30 PM **Validating 176Lu+ Optical Frequency References at the 10-19 level**

**Description**

Speaker:
**Dr Kyle Arnold**
*Centre for Quantum Technologies, NUS*

Abstract:
The 176Lu+ 1S0 --> 3D1 transition serves as a robust frequency reference due to its low sensitivity to blackbody radiation and electromagnetic perturbations, allowing for high-accuracy operation at room temperature without extensive shielding [1]. Building on recent advances in micromotion control [2], quadrupole shift assessment [3], and studies of background gas collision effects [4], we report a comprehensive evaluation of two independent 176Lu+ single-ion optical frequency references, achieving total systematic uncertainties of 1.1 x 1E-19 and 1.4 x 1E-19 [5]. The two systems were directly compared using correlation spectroscopy with Ramsey times of up to 10 seconds, yielding a measurement instability of $4.8 \times 10^{-16}(\tau/s)^{-1/2}$. After 200 hours of averaging, the clocks demonstrated a relative frequency agreement of $[-2.4 \pm (5.7)_{\text{stat}} \pm (1.0)_{\text{sys}}] \times 10^{-19}$ [5]. While other individual clocks have reported assessed uncertainties below 1E-18, this work represents the first demonstrated agreement of optical clock performance with total uncertainty below this level. These results open the way for new applications in millimeter-scale relativistic geodesy and tests of fundamental physics at the 1E-19 frontier of accuracy.

[1] K. Arnold, R. Kaewuam, A. Roy, T. Tan, and M. Barrett, Nature communications 9 (2018).
[2] K. Arnold, N. Jayjong, M. Kang, Q. Qichen, Z. Zhang, Q. Zhao, and M. Barrett, Physical Review A 110, 033115 (2024).
[3] M. Lee, Q. Zhao, Q. Qichen, Z. Zhang, N. Jayjong, K. Arnold, and M. Barrett, Physical Review A 113, 012805 (2026).
[4] M. Barrett and K. Arnold, arXiv preprint arXiv:2512.05474 (2025).
[5] K. Arnold, M. Lee, Z. Qi, Q. Qin, Z. Zhao, N. Jayjong, and M. Barrett, arXiv preprint arXiv:2512.07346 (2025).

2:30 – 3:00 PM

## Crossing the Reusable Entanglement Threshold over Telecom Fibre in Trapped-Ion Quantum Networks

**Description**

Speaker:
**Dr Yong Wan**
*University of Science and Technology of China*

Abstract:
Trapped-ion systems have achieved exceptional performance in local quantum control, with long coherence times and high-fidelity operations routinely demonstrated in single-node processors. Extending these capabilities to longdistance networking, however, introduces a fundamental challenge: exponential photon loss in optical fibre suppresses entanglement generation rates, often causing remote entanglement to decay before subsequent links can be established.
Restoring balance between entanglement generation and memory coherence in the telecom-loss regime is a central requirement for scalable quantum repeaters.

Here, we demonstrate memory–memory entanglement between two trapped-ion nodes connected by telecom fibre, with the entangled-state coherence time exceeding the average entanglement generation time under realistic link delay [1]. This operational regime is achieved through the co-optimization of long-lived ion memories, phase-stabilized single-photon interference, and low-noise quantum frequency conversion to the telecom band. Entering this rate–coherence-balanced regime enables reusable entanglement, in which sequential entanglement generation and storage become viable within a single link.

As a proof-of-principle application, we implement device-independent quantum key distribution over spooled fibre links. More broadly, crossing this threshold shifts the focus from demonstrating a single high-performance connection to systematically upgrading node capabilities and expanding network topology. In trapped-ion platforms, mixed-species memories and cavity-enhanced photon interfaces provide scalable routes toward higher link e iciency, while multi-ion nodes enable entanglement swapping and purification across extended chains. Together, these elements outline a practical pathway from two-node demonstrations to modular trapped-ion quantum networks.

[1] Liu et al., Nature 626, 263 (2026).

3:00 – 3:30 PM

## Hour-scale lifetime and non-equilibrium steady state of trapped ions in an ultracold atom-ion hybrid trap

**Description**

Speaker:
**Dr Sourav Dutta**
*Tata Institute of Fundamental Research (TIFR)*

Abstract:
Hybrid atom-ion systems offer unique opportunities for ultracold chemistry, precision measurements, and quantum simulation; but prolonged trapping of non-laser-coolable ions (the vast majority of atomic and molecular species of interest) remains challenging due to rapid losses due to rf heating and background collisions. We demonstrate ion lifetimes more than 80 minutes in a linear Paul trap by cooling ensembles of $Cs^+$ ions with ultracold Cs atoms, thus realizing the long-lived regime for ions ensembles that cannot be laser cooled. We report a genuine attracting fixed point in the hybrid system: ion number converges to the same steady state population independent of the initial number of ions. The results open a pathway towards sympathetic cooling of complex species and facilitate studies of rare reactions and driven dissipative systems.

3:30 PM

3:30 PM

## Poster Session (Sponsored by TOPTICA)

**Session** | **Location:** Shaw Foundation Alumni House, Seminar Room

### Description

Poster session will be held in the seminar room next to the auditorium.
Alcoholic and non-alcoholic beverages will be served.

5:00 PM

6:00 PM

## Evening Program: Evening Talk - Dr. Anthony “Tony” Ransford (Quantinuum)

**Session** |
**Location:** NUSS Kent Ridge Guild House, Della and Seng Gee Guild Hall, 9 Kent Ridge Dr Singapore 119241

6:00 – 7:00 PM **Helios: A 98-qubit trapped-ion quantum computer**

**Description**

Speaker:
**Dr. Anthony “Tony” Ransford**
*Quantinuum*

Abstract:
- Trapped-ion quantum processors provide a leading platform for quantum computation due to their high-fidelity operations and reconfigurable connectivity. Scaling system size while maintaining uniform performance, however, remains a central challenge for realizing fault-tolerant quantum computation. We present Helios, a 98-qubit trapped-ion quantum computer based on an advanced quantum charge-coupled device (QCCD) architecture designed to combine novel ion transport with high-precision quantum control.
- Helios utilizes hyperfine qubits encoded in 137Ba+ ions and integrates multiple quantum operation regions connected through a junction transport network and rotatable storage ring, enabling flexible ion rearrangement and all-to-all connectivity.
- System characterization demonstrates average single-qubit gate fidelity of $2.5(1)\times10-5$, two-qubit gate fidelity of $7.9(2)\times10-4$ ,and state-preparation-and-measurement (SPAM) error of $7.9(2)\times10-4$, maintained across operational zones. These performance levels support deep circuit execution together with mid-circuit measurement and feedforward required for quantum error correction.
- Beyond the component level benchmarks, system level benchmarks including mirror benchmarking, binary randomized benchmarking and random circuit sampling are characterized. We show that simulating the results of the random circuit sampling is far beyond the ability of modern supercomputers.
- These results demonstrate that the QCCD approach enables simultaneous scaling of qubit number and operational fidelity, establishing a practical pathway toward large-scale fault-tolerant quantum computing with trapped ions.

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Speaker Bio:

Dr. Anthony “Tony” Ransford is the lead architect of Helios, responsible for leading the team that brought the world's most powerful quantum computer to life. Dr. Ransford’s work spans the full stack of quantum hardware design and integration, driving the development of our scalable system architecture through ever increasing heights in fidelity. Dr. Ransford has seen Quantinuum’s journey through 4 QPUs, from our first commercial system with just 4 qubits through our latest design Helios. His leadership has directly contributed to Quantinuum’s leadership in fidelity and computational power and now is leading the archicture of Lumos, a future 1M qubit system at Quantinuum. Prior to joining Quantinuum, Dr. Ransford earned his PHD at U.C.L.A, focusing on high fidelity qubit manipulation.

7:00 PM

# Wed, April 22

9:00 AM

## Invited Talks - Session 7

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Prof Kenji Toyoda (Osaka University)

9:00 – 9:30 AM

### Building a Scalable Trapped-Ion Quantum Computing Platform: Surface Traps, 5-Qubit Control, and Photonic Interconnect

**Description**

Speaker:
**Prof Taehyun Kim**
*Seoul National University*

Abstract:
Trapped-ion systems are among the leading platforms for quantum computing because of their long coherence times, high-fidelity operations, and flexible qubit connectivity. Realizing scalable quantum processors, however, requires progress not only in qubit control but also in trap-chip fabrication, system integration, integrated photonics, and modular networking. In this talk, I will present our recent efforts toward a scalable trapped-ion quantum computing platform built on microfabricated surface traps, multi-qubit control, and photonic technologies.

I will first discuss progress in MEMS-based surface-ion-trap chips, including our studies of photoinduced charging in semiconductor-based traps and fabrication strategies developed to suppress laser-induced electric-field noise while supporting large ion chains and elementary shuttling operations. I will then describe the development of a 5-qubit trapped-ion system with arbitrary individual qubit control, together with RFSoC-based electronics aimed at more compact and scalable system integration. Finally, I will discuss two photonics-related directions for scaling: the development of integrated photonic components for surface-ion-trap chips, and quantum networking capabilities based on ion-photon interfaces, remote entanglement, and quantum frequency conversion. Together, these efforts outline a path from robust trapped-ion processors to modular and distributed quantum computing architectures.

9:30 – 10:00 AM

### Architecting Scalable Quantum Computers with Ion Shuttling

**Description**

Speaker:
**Prof Junki Kim**
*Sungkyunkwan University*

Abstract:
There has been significant progress in building trapped-ion quantum computers with dozens of ion qubits; however, a clear blueprint for a fully fault-tolerant, large-scale system remains elusive. In this talk, I present a Shuttling-based Distributed Quantum Computing (SDQC) architecture that combines deterministic qubit shuttling with distributed entanglement to interconnect multiple processor nodes while keeping data qubits stationary. Through comprehensive architecture-level modeling with realistic error and timing assumptions, we show that SDQC enables near scale-independent logical clock speeds via aggressive pipelining and achieves competitive logical error rates under fault-tolerant operation compared to conventional QCCD and photonic distributed approaches in large-scale regimes. We further assess application-level performance, including QLDPC problem and Fermi–Hubbard simulations, demonstrating efficient execution in terms of overall runtime and success probability with moderate space–time overhead. These results highlight the critical role of architectural co-design in shaping the scalability and practical performance of future large-scale ion-trap quantum computers.
[1] S. Baek, S.-H. Lee, D. Min, and J. Kim, arXiv:2512.02890

10:00 AM

10:30 AM

## Invited Talks - Session 8

**Session** | **Location:** Shaw Foundation Alumni House, Auditorium

### Description

Chairperson: Dr Piyaphat Phoonthong (National Institute of Metrology (Thailand))

10:30 – 11:00 AM

### Quantum Simulation and Lindbladian Learning on a Trapped-Ion Quantum Simulator

**Description**

Speaker:
**Prof Manoj Joshi**
*IQOQI Innsbruck & Singapore University of Technology and Design (SUTD)*

Abstract:
Quantum simulators and quantum computers are progressing toward solving complex problems in science. Trapped ions are one of the key platforms, offering unprecedented qubit control. At this conference, I will present recent advancements in quantum simulation using long ion chains in a radio-frequency trap in Innsbruck. In particular, I will discuss Hamiltonian and Liouvillian learning (Lindbladian learning) techniques used to quantitatively validate experimentally implemented Hamiltonians in trapped-ion systems. For this purpose, a broad set of ansatz terms is incorporated into the analysis to identify the Hamiltonian that best captures the observed dynamics. Once the optimal candidate is determined, statistical noise and estimation bias are carefully analyzed to obtain reliable estimates of the Hamiltonian parameters. These studies are carried out on a trapped-ion quantum simulator consisting of ion strings with up to N=51 ions. I will also present a practical perspective on Hamiltonian learning methods and their role in establishing trust in analog quantum simulations. Furthermore, I will discuss potential future research directions for my group in Singapore using trapped ions.

11:00 – 11:30 AM

### Towards a full stack quantum computer based on trapped ion platform

**Description**

Speaker:
**Dr Pei Jiang Low**
*Centre for Quantum Technologies, NUS*

Abstract:
Trapped ion quantum computing features advantages such as good gate fidelities, all-to-all qubit connectivity and the ability to operate in room temperature over other quantum computing platforms. Conventionally, trapped ion quantum computers are built in a laser lab environment, where the hardware setup takes up a large space – typically spanning one or multiple optical tables, which one may argue is one of the downsides of the trapped ion platform. In this work, we engineer a compact and modular trapped ion quantum computer setup that is rack-mountable to a standard 19-inch rack. This makes the size of the quantum machine compatible with high-performance computing (HPC) facilities. In this talk, I will present the features and the engineering work of our quantum machine. In addition, I will also present a preliminary study of a new method for improving quantum measurement performance with barium ions, which eliminates the noise from background scattering of lasers.

11:30 AM – 12:00 PM

### Bosonic Non-linearity with Trapped Ions

**Description**

Speaker:
**Nigel Lee**
*Centre for Quantum Technologies, NUS*

Abstract:
Mechanical oscillators represented by the bosonic motional modes of trapped ions are a promising candidate to realize continuous-variable quantum information processing. However, universal control of these modes require non-linear operations, such as cubic phase gates, which are challenging to implement on trapped ions. Here, we report the experimental implementation of the approximate cubic phase gate evolution by applying a series of spin dependent displacement pulses to a single mode of motion [1].

[1] K. Park and R. Filip, npj Quantum Inf 10 (2024).

This project is supported by the National Research Foundation, Singapore through the National Quantum Office, hosted in A*STAR, under its Centre for Quantum Technologies Funding Initiative (S24Q2d0009) and Quantum Engineering Programme (NRF2021-QEP2-02-P08).

12:00 PM

2:00 PM
3:30 PM

### Post-Conference: Lab Visits

**Session** | **Location:** Centre for Quantum Technologies

2:00 PM
3:30 PM

### Post-Conference: Sightseeing

**Session**