PhD Positions in Optical Clocks and Precision Measurement

Lutetium Ion Trap Programme

We invite applications for **two PhD positions** in experimental atomic physics, based in our group's cutting-edge ion trap laboratory. Both projects sit at the frontier of optical clock science, contributing to a broader research programme aimed at pushing the limits of precision timekeeping and fundamental physics with lutetium ions (Lu^+).

Position 1 — Ion-Trap Development for a Multi-Ion Optical Clock (Lu^+)

Project overview

Next-generation optical clocks will need to go beyond the single-ion paradigm to achieve the statistical precision required for applications in geodesy, tests of fundamental constants, and redefinition of the SI second. This project targets the development of a purpose-built ion trap capable of confining and coherently interrogating arrays of Lu^+ ions simultaneously.

You will design, build, and characterise a new Paul trap geometry optimised for multi-ion operation, tackling challenges including:

- Control of ion–ion micromotion and excess heating in multi-ion crystals
- Development of laser-cooling, state-preparation, and clock-interrogation protocols scaled to multiple ions
- Implementation of quantum logic or sympathetic-cooling techniques for state readout
- Systematic evaluation of frequency shifts in a multi-ion environment

This is a hardware-heavy, end-to-end experimental project. You will gain broad skills across precision machining, RF and DC electronics, vacuum technology, laser optics, and data analysis.

What we are looking for

A motivated candidate with a strong undergraduate background in physics. Prior hands-on laboratory experience is an advantage but is not essential — curiosity, rigour, and the drive to solve hard experimental problems matter most.

Position 2 — Cryogenic Ion-Trap Apparatus for Lu^+

Project overview

Cryogenic ion traps offer a compelling route to drastically reduced background gas pressures and suppressed anomalous heating rates — two key technical barriers to ultra-high-accuracy optical clocks. This project involves the construction and commissioning of a cryogenic ion-trap system designed around Lu^+, integrated with our existing clock programme.

Core challenges you will address include:

- Design and assembly of a cryogenic (4 K / 77 K) vacuum and trap system

- Engineering solutions for in-vacuum optics, electrical feedthroughs, and thermal management at low temperature
- Laser cooling and trapping of Lu^+ in the cryogenic environment
- Characterisation of anomalous heating rates and motional decoherence as a function of temperature
- Integration with spectroscopy and clock-interrogation infrastructure

This project offers a rare opportunity to build a novel cryogenic apparatus from first principles, acquiring expertise at the intersection of cryogenics, precision metrology, and atomic physics.

What we are looking for

A motivated candidate with a strong undergraduate background in physics or a closely related discipline. Experience with cryogenic systems, vacuum technology, or optical experiments is welcome but not required. We value practical problem-solving ability and scientific curiosity above all.

About the Programme

Both positions are embedded in a vibrant research programme developing Lu^+ as a leading candidate for next-generation optical clocks. Lu^+ offers exceptionally low sensitivity to blackbody radiation shifts and a highly favourable level structure for clock operation — properties that make it one of the most promising species for surpassing current state-of-the-art clocks.

PhD students will benefit from:

- Access to state-of-the-art ion-trap laboratories and precision laser infrastructure
- Close mentorship from senior researchers and collaboration with national and international metrology partners
- Travel opportunities to conferences and collaborative institutions
- Training in a uniquely broad skill set spanning quantum optics, precision engineering, and fundamental physics
- Opportunity to collaborate with a commercial start-up company working at the interface of quantum technology and real-world applications

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How to Apply

Applications should include:

1. A cover letter describing your motivation and relevant experience (max. 1 page)
2. A full CV including academic transcripts
3. Contact details for two academic referees

Please send applications to **phybmd@nus.edu.sg** with the subject line **"PhD Application — [Position 1 or Position 2]"**.

Informal enquiries are warmly encouraged before submitting a formal application.