

# Sun Woo Kim

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## Education

### King's College London

*MPhil/PhD in Physics*

Condensed matter theory.

London (UK)

2023–

### University of Cambridge

*MASt in Physics*

Distinction. Notable courses: Theories of Quantum Matter, Quantum Field Theory, Gauge Field Theories

Cambridge (UK)

2018–2019

### Imperial College London

*BSc Physics with Theoretical Physics*

1<sup>st</sup> Class (80.7%), Dean's List for all three years. Notable courses: Foundations of Quantum Mechanics, General Relativity, Complexity and Networks

London (UK)

2015–2018

### United World College of South East Asia Dover Campus

*International Baccalaureate*

41/45 (91%). Additional Standard Chemistry 6/7.

7 Subjects, Higher Physics 7/7, Higher Mathematics 7/7, Higher Geography 7/7, Standard English 6/7.

Singapore (Singapore)

2012–2014

## Research/Publications/Employment

### The planted polymer: a simple model for object tracking

2023–

- Upcoming work with Prof. Austen Lamacraft. A simple model for Bayesian object tracking was mapped to a modified version of the directed polymer. The tree case maps to a mean-field spin glass, with a magnetic field corresponding to signal. The magnetisation is the overlap with the true path. 1d maps to the KPZ equation with a delta potential.
- Currently exploring quantum error correction/state preparation in the lens of student/teacher inference.

### Research scientist at AIRS Medical (Republic of Korea national service)

2019–2023

- Part of National service in Republic of Korea as a 'Skilled Industry Personnel', applying machine learning to medical imaging and diagnostic settings.
- Came 1<sup>st</sup> places in all tracks, achieving State-Of-The-Art status in MRI reconstruction in the 2020 Facebook FastMRI Challenge, using a CNN-based architecture, which combines deep learning with MRI physics [IEEE:9420272].

### Visiting scientist at MPI-PKS: Many-Body localisation in bosons

2019–2022

- Supervisors: Prof. Markus Heyl, Giuseppe De Tomasi. Developed a method to calculate local dynamical observables for 2D bosonic MBL systems which required calculation time only polynomial in system size, and also allows for analytic arguments [PhysRevB.104.144205]. Numerically computed the observables using Numba on the MPI-PKS cluster.
- This research project was done part-time during my time in Republic of Korea's national service.

### MASt project: non-linear metric tomography using Sobolev gradients

2018–2019

- Supervisor: David Al-Attar. In delay time tomography, seismic observations are used to deduce the internal structure of an elastic media, which is an example of an ill-posed inverse problem.
- In inverse problems, the space of solutions must be chosen appropriately to ensure that the solution has the desired properties. Sobolev gradients can be used to restrict the solutions to be differentiable. We introduced Sobolev gradients in the context of geodesic tomography and showed that unlike conventional gradients, our solutions maintained regularity even when spatial resolution is increased. Demonstrated the theory using Fortran.

### Undergraduate research project: group theoretic analysis of structured elastic plates

2018

- Supervisors: Prof. Richard Craster, Dr. Mehul Makwana. Band-structure of many wave-like systems with lattice symmetry can be predicted using representation theory. This method is not system-dependent and therefore can be used in photonics, condensed matter, and platronics, which was the focus of the project. Using rep. theory of 2D nonsymmorphic wallpaper groups and  $k \cdot p$  perturbation theory, predicted features of its bulk band structure. Combined this with Chern insulator theory to design topological waveguides. Demonstrated the theory using MATLAB.
- Was awarded the UROP Prize in Mathematics. Details at personal website.

## BSc Project: N=4, d=2+1 supersymmetric quiver gauge field theories

2017-2018

- Supervisor: Prof. Amihay Hanany. Quiver Gauge Theories describe toy universes of different configurations. Moduli Space of these theories is an abstract space of vacuum expectation values of scalar fields. The properties of the 'Coulomb Branch' of the Moduli Space was calculated using a generating function called the Hilbert Series, which describes algebraic spaces. Analytic calculations used Mathematica.

## Skills

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### Computing

- Scientific programming using mainly Python, using modules such as NumPy, SciPy, Numba, and ML using PyTorch, PyTorch Lightning, TensorFlow. Also have experience in MATLAB, Mathematica, Fortran, C++. Used programming tools git, LaTeX, Slurm.

### Languages

- English (native fluency), Korean (native fluency)

## Awards

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### E. M. Burnett Prize

2019

In recognition for obtaining Distinction in Master of Advanced Studies.

### UROP Prize in Mathematics

2018

Awarded to students of outstanding performance in the Undergraduate Research Opportunity Programme (UROP), for the project 'Group Theoretic Analysis of Structured Elastic Plates'.

### Dean's List for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> Year

2016, 2017, 2018

Awarded for being the top 10% of students in cohort of 2017/18 of the Physics programme at Imperial College London.

## Other Experiences

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### Organiser for Many Body Circle Journal Club.

2023

- Collaborated PhD students from condensed matter theory and disordered systems groups at KCL. Invited external speakers (Imperial)
- Past events at [sites.google.com/view/kclmanybodycircle/events](https://sites.google.com/view/kclmanybodycircle/events)

### Teaching Assistant

2023

- For module 'Mathematical methods for physics', a second year undergraduate course at KCL.
- Worked through example questions in lecture theatre for 40+ students.

### OUTREACH Mentoring Scheme

2016-2017

- Mentored students and prospective students on various areas such as Physics, Maths, and Computing. Worked with a group of mentors organising activities and demonstrations for 20 students.
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### Map Designer for Starcraft II

2013-2014

- Created official maps, such as Frost, Bridgehead, and Fruitland for real time strategy game, Starcraft II.
- Combined game knowledge with critical thinking to create effective, balanced, and fun maps, that were used for over 4 years in the competitive scene, played in over 3000+ competitive matches.

## Further Interests

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**Jazz Guitar** Played guitar for small band (Duo, Trio, Quartet) and big band settings (Churchill Jazz Band, Jesus College Big Band).

**Learning/Teaching** Interested in learning new things and developing new skills, and sharing it with others. Self-taught programming, music theory and jazz guitar. Expository writing for research projects and concepts at homepage ([sunwookim.github.io](https://sunwookim.github.io)).

**Design** sensitive and interested in design elements, such as font designs and design languages such as minimalism, and skeuomorphism, in the context of UI design, and coding modules.

Details are available upon request