Sun Woo Kim

+82 10 2959 7667 | sunwoo-kim@outlook.com | www.sunwoo-kim.github.io

Education

University of Cambridge — Cambridge (UK)

MASt in Physics — *2018-2019*

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

Imperial College London — London (UK)

BSc Physics with Theoretical Physics — *2015-2018*

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

United World College of South East Asia Dover Campus — Singapore (Singapore)

International Baccalaureate — *2012-2014*

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.

International GCSEs — *2010-2012*

7 Subjects, Co-ordinated Sciences: A*, CIM Mathematics: A*.

Research/Publications/Employment

Republic of Korea National Service: Research Scientist at AIRS Medical — *2019-*

- Part of National service in Republic of Korea as a 'Skilled Industry Personel', applying machine learning to medical imaging and diagnostic settings.
- Came 1st 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 concepts such as coil sensitivity, and k-space **[IEEE:9420272]**.

Research Project: Many-Body Localisation in Bosons — *2019-*

- Supervisors: Prof. Markus Heyl, Giuseppe De Tomasi. Many-Body Localisation (MBL) generalizes Anderson Localisation to interacting particles, where, in contrast to conventional wisdom in statistical mechanics, interacting quantum systems retain knowledge about their initial state even after long times. 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. We aim to apply this method as an ansatz for Time Dependent Variational Principle, or on ordered systems.
- 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.
- With a known forward model, a loss function can be defined, and, gradient descent can be used to 'solve' the inverse problem. However, 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 a Fortran program.

UROP (Research Program): Group Theoretic Analysis of Structured Elastic Plates — *2018*

- Supervisors: Prof. Richard Craster, Dr. Mehul Makwana. The band-structure of many wave-like systems with lattice symmetry can be predicted using group and representation theory. This method is not system-dependent and therefore can be used in photonics, quantum mechanics, and even platonics, which was the focus of the project. Using representation theory of 2D nonsymmorphic wallpaper groups and $k \cdot p$ perturbation theory, predicted features of its bulk band structure. We combined this result with Chern insulator theory to create topological waveguides, and demonstrated the theory using MATLAB.
- Was awarded the UROP Prize in Mathematics.

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. Calculations were done using pen and paper and Mathematica.

Skills

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

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 1st, 2nd and 3rd 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

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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Publicity Officer for UNICEF-on-Campus *2015–2016*

- Was in charge of design of media for advertising events, such as posters and pamphlets.
- Appointed members for roles in publicizing. Participated in organising fundraising events.

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

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. Took/audited extra courses - chemistry in high school, electronics, group theory, statistical mechanics in undergraduate, advanced quantum field theory during masters. Self-taught programming, music theory and jazz guitar. Wrote expository writing for research projects on my homepage (sunwoo-kim.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