Tom Szwarcer
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I am a fourth-year MPhys student at the University of Oxford with a strong interest in theoretical physics. I've developed strong research skills and experience through the internships I've undertaken, and am keen to continue my research career by pursuing a PhD. My research interests are gravity, QFT, and applications to compact objects.

Research experience

CERN Summer Studentship: Microscopic Simulation of Space Charge Effects | 2025

• Contributions made to the open source simulation toolkit Garfield++ in order to take the space charge effect into account in microscopic tracking simulations.
• Framework created to model the space charge effect semi-analytically in avalanche simulations, with significant progress made into reducing the added computation overhead of the field calculations. Framework applied to investigate whether resistive anodes in gaseous detectors significantly affect the space charge field. Investigations made into the charge densities required to significantly affect the behaviour of gaseous detectors; results applied in a simulation study, confirming the presence of a gain-limiting effect.
• This work enables more accurate simulations of gaseous and silicon detectors, and improved understanding of the physical processes underlying detector behaviour.
• Developed skills in using C++, including developing and implementing algorithms, profiling with Valgrind/Callgrind, techniques for optimisation and efficiency, and object-oriented programming.
• Simulations run in parallel on CERN computing cluster. Gained experience using HTCondor to manage computing resources.
• Languages used: C++, Python, Bash. All work was done on Linux systems. Git used for version control. Use of lldb for debugging.
• Developed knowledge of the operational principles of gaseous detectors.
• Progress regularly presented to the CERN GDD group. Seminar presentation given to the CERN EP-DT group. Project report written, and added as a DRD1 technical note.
• Work presented at the Oct. 2025 DRD1 collaboration meeting (Warsaw, Poland)
• Supervisors: Djunes Janssens, Heinrich Schindler
• Start: 30/6/2025. End: 19/9/2025

STFC Internship: Dark Matter Summer Placement | 2024

• Investigation done into the use of Garfield++ and Magboltz for tracking the production of scintillation light in CF4/Ar mixtures. Application to the GEM geometry and E-field configuration present in the MIGDAL time projection chamber. A proof of concept scintillation tracking system was developed and results compared to detector data. Methods for reducing computation time of GEM drift simulations were investigated.
• GEM model and mesh generated in Gmsh. Electric potential and boundary conditions implemented with Elmer FEM. Electron drifts simulated with Garfield++ and Magboltz.
• Simulation code written in C++. HTCondor used to run simulations in parallel. Bash scripts used in parallelisation workflow. Python and ROOT used for data analysis. All work was done on Linux systems. Git repository created for the project, including all code, data analysis and outputs.
• Developed knowlege of the operational principles of time projection chambers and GEMs.
• Progress regularly presented to the collaboration. Seminar presentation given to researchers and other summer students. Project report assembled.
• Progress regularly shared with the CERN GDD group.
• Work presented at a CERN DRD1 WG4 Working Meeting (Simulations and Measurements at Low Pressures).
• Start: 1/7/2024. End: 23/8/2024

Projects

Third Year Project: Properties of Open Stellar Clusters | 2025

• Astrophysics project carried out as part of Oxford MPhys course. Gained understanding of techniques for processing astronomical images, including data reduction and photometry. Membership to clusters was confirmed by matching proper motion and parallax data from the Gaia satellite to the processed data using TOPCAT. Colour magnitude diagrams were produced, and isochrones fitted to them. Age, distance and extinction parameters, with estimated errors, were obtained. Literature search carried out to test agreement of results.
• Results presented in a scientific report, which scored 85.
• Developed ability to rapidly learn and adapt to using specialist scientific software (QFitsView, SAOImageDS9, TOPCAT).

Simulation Projects | 2024

Simulation of N bodies interacting under gravity. Written in Python, using the velocity Verlet algorithm. Supports an arbitrary number of bodies with user-defined masses and initial positions/velocities. Capability to track energy and momentum conservation.
Skills: principles of many-particle simulations. Numerical methods for simulating dynamical systems. Writing efficient, vector based code in Python. Using NumPy.
1D Finite-Difference Time-Domain (FDTD) simulation of EM waves. Written in Python and C++. Simulates the propagation, reflection and transmission of EM waves in the presence of dielectrics.
Skills: understanding and using the FDTD method for numerical simulations, programming in C++.

Education

Oriel College, University of Oxford (Physics MPhys) | 2021-2026

• First Class degree classification in Bachelor's component of MPhys
• Academic Scholarship (prize for exam performance) awarded in both second and third year of studies; prizes awarded for performance in all internal college exams to date
• Start date: 10/10/2021. Expected course completion date: 30/6/2026
Courses: quantum mechanics, thermodynamics and statistical mechanics, electromagnetism (second year); classical mechanics, fluids, condensed matter physics, nuclear and particle physics, symmetry and relativity, general relativity (third year); theoretical physics, particle physics (fourth year)

Personal

• Strong interest in teaching: 129 pages of LaTeX-formatted notes on quantum mechanics and linear algebra were created and distributed to students in years below; private tutoring work undertaken. Spanish speaker. Music (guitar/bass/drums): performance and songwriting. Sports: running, football, squash, gym.