

Dr. Nick Keeper

RESEARCH ASSOCIATE · NEWCASTLE UNIVERSITY

Consett, County Durham, UK

✉ nkeeper@gmail.com | 🏠 nickkeeper.github.io | 📧 nickkeeper | 🌐 nick-keeper

About me

I recently obtained a PhD in applied Mathematics, dedicated to the numerical study of out-of-equilibrium properties of quantum many-body systems which are driven through phase transitions across dimensionality. It also includes the numerical study of quantum vortex nucleation and transient vortex dynamics with a particular attention to the role of roughness in employed experimental trapping geometries. This has given me a vast array of skills in the analysis and visualisation of large stochastic data-sets. Outside of academic life, I enjoy rock climbing, the great outdoors, martial arts and travelling. I also spend some of my free time improving my programming skills, by developing code to solve hobby projects of mine. I thrive most in an environment which provides difficult and complex challenges and excel best within a motivated and driven team. I have experience with both Windows and Unix-based computer systems and also extensive experience with the following softwares and programming languages: Microsoft suite, Tableau, Python, R, Fortran, Julia, Matlab, Maple, XMDS2, LaTeX. I have experience with Deep learning frameworks such as Flux and Pytorch where I have integrated and trained complex neural networks.

Education

Newcastle University / Trento University

Newcastle, UK / Trento, Italy

PH. D. APPLIED MATHEMATICS.

THESIS TITLE: **CONFINED BOSE SUPERFLUIDS: A STUDY OF VORTICITY IN A ROTATING BUCKET, AND PHASE TRANSITIONS AND SOUND IN A TRAP FROM TWO TO THREE DIMENSIONS.**

2018 - 2022

Newcastle University

Newcastle, United Kingdom

MMATH. FIRST CLASS WITH HONS. VORTEX NEUCLEATION IN ROTATING SUPERFLUID SYSTEMS.

2014 - 2018

York College

York, United Kingdom

A LEVELS: MATHS - A*, FURTHER MATHS - A, PHYSICS - B.

2012 - 2014

Work Experience

Newcastle University

Newcastle, United Kingdom

RESEARCH ASSOCIATE

January 2023 - Present

- Working on the theoretical modelling of ultracold atomic quantum droplets.
- Developed a Machine Learning model to perform 3D reconstruction of quantum vortices from planar images.
- Supervision of PhD student.
- Developed and supervised a final-year undergraduate group project on terrain generation with Generative Adversarial Networks.

TSYS

York, United Kingdom

BUSINESS INTELLIGENCE ANALYST

July 2016 - September 2016

- Developed a new potential product. This involved handling big data, which would otherwise be unused, then collating and packaging it to turn it into something informative and aesthetically pleasing. The objective was to market the informational package to a large commercial bank so that they could make sense of their customer's transactional data.
- Delivered high quality presentations to both director and executive level management figures showcasing my work and advertising its value to the company.
- Researched the take up of different banking products and analysed the spending patterns and customer demographics across Great Britain for these products, as well as analysing how customers utilise contactless or online payments.
- Operated independently to deliver informative business intelligence by creating mathematical models to measure and predict trends in the data.

Iroquois Springs

New York, USA

ROCKETRY SPECIALIST

June 2017 - August 2017

- Acted as the independent specialist on a summer camp, leading a 3-day exercise for children from ages 9-16 to build, decorate and launch model rockets. Often working unaided with up to 16 young people whilst maintaining a calm and safe environment.
- Developed the rocketry program, working extra hours to find and create the resources to allow the children to safely build and launch rocket-powered cars which I ran alongside the standard rocketry program to target older children.
- Worked around the clock for over 6 weeks, taking care of and leading a large group of young people. This involved acting as a counsellor as well as leading exercises and activities ranging from bubble football to outdoor adventure.

Publications

Droplet formation from an instantaneous quench in homonuclear mixtures

IN PREPERATION

TBA

SuperVortexNet: Reconstructing Superfluid Vortex Filaments Using Deep Learning

IN REVIEW

📄 arXiv:2312.14815

22 December 2023

Trapped Imbalanced Quantum Droplets

ACCEPTED FOR PUBLICATION IN: PHYSICAL REVIEW RESEARCH

 [arXiv:2309.04300](https://arxiv.org/abs/2309.04300)

8 September 2023

Phase transition dimensionality crossover from two to three dimensions in a trapped ultracold atomic Bose gas

PHYSICAL REVIEW RESEARCH

 [PhysRevResearch.4.033130](https://doi.org/10.1103/PhysRevResearch.4.033130)

16 August 2022

Spin-up of a superfluid vortex lattice driven by rough boundaries

PHYSICAL REVIEW B

 [PhysRevB.102.144520](https://doi.org/10.1103/PhysRevB.102.144520)

21 October 2020

Talks and Presentations

Three-Dimensional Reconstruction of Quantum Vortices using Deep Convolutional Neural Networks

QUANTUM SYSTEMS 23 (QUSYS23) - NORONHA, BRAZIL

 [File available on request](#)

November 2023

Dimensionality crossover in a weakly interacting atomic Bose gas and the dynamics of quantum droplets: A study of phase transitions

INTERNATIONAL CONFERENCE ON QUANTUM FLUIDS AND SOLIDS (QFS2023) - MANCHESTER (INVITED SPEAKER)

 [File available on request](#)

August 2023

Machine Learning for Quantum Gases

APPLIED MATHS INTERNAL SEMINAR "QUANTUM MEETS COSMOLOGY"

 [File available on request](#)

November 2023

Spin-up of a superfluid vortex lattice driven by rough boundaries

UK QUANTUM FLUIDS NETWORK - WEBINARS



March 2021

Solving nonlinear partial differential equations on GPU supercomputers using Julia

PLATFORM FOR ADVANCED SCIENTIFIC COMPUTING CONFERENCE 2021



March 2021

Non-equilibrium dynamics in atomic systems

APPLIED INTERNAL SEMINAR SERIES - NEWCASTLE UNIVERSITY

 [Video available on request](#)

June 2020

Superfluids in rotating rough buckets - poster presentation

VORTEX DYNAMICS, TURBULENCE AND RELATED PHENOMENA IN QUANTUM FLUIDS SUMMER SCHOOL, INTERNATIONAL INSTITUTE OF PHYSICS, NATAL, BRAZIL

 [File available on request](#)

June 2019

Second sound of a quasi-2D Bose gas across the BKT transition - poster presentation

ATOMQT SUMMER SCHOOL, UNIVERSITAT AUTÒNOMA DE BARCELONA, SPAIN

 [File available on request](#)

June 2019

Teaching

Introduction to Git/Github Workshop

DESIGNED AND RAN AN INTERACTIVE WORKSHOP FOR STAFF WITHIN THE MATHEMATICS, STATISTICS AND PHYSICS DEPARTMENT ON USING GIT/GITHUB.

 [Repo](#)

February 2024

PhD Project Supervisor

JOINT PHD SUPERVISOR OF A PHD STUDENT WORKING ON IMBALANCED QUANTUM DROPLETS

2023-Present

Group Project Supervisor

RAN A GROUP PROJECT FOR FINAL-YEAR UNDERGRADUATED ON USING GENERATIVE AI FOR TERRAIN GENERATION.

2023

Summer Project Supervisor

CO-SUPERVISED A SUMMER STUDENT WORKING ON MIXTURES OF QUANTUM GASES, SPECIFICALLY CONSIDERING THE EFFECTS OF ROTATION.

2023-Present

Conferences and Summer Schools

Conf.	Unconventional Superfluids , Lancaster University	Sept., 2018
Conf.	Non-Equilibrium Phenomena in Superfluid and Coherent Quantum Systems , Newcastle University	June, 2019
School	AtomQT Summer School , Universitat Autònoma de Barcelona	Sept., 2019
Conf.	Vortex Dynamics, Turbulence And Related Phenomena In Quantum Fluids , IIP, Natal	June-July, 2019
Conf.	Workshop on Quantum Mixtures , Trento University	July, 2019
Conf.	Division of Atomic, Molecular and Optical Physics , Online	June, 2021
School	NFFDy Summer Programme , Cambridge University	October., 2023

Workshops & Modules

Workshop	Message Passing Programming with MPI , Archer, National Supercomputing Service	Nov. 28-30, 2018
Module	Quantum Information and Technology , Newcastle University	Semester 1, 2018-19
Module	Atomic and Molecular Interactions , Durham University	Semester 1, 2018-19
Module	Atom-Light Interactions , Durham University	Semester 1, 2018-19
Module	Computational Research Skills in Physics , Newcastle University	Semester 1, 2018-19

Programming Languages

Julia, Matlab, Fortran, XMDS2

Expert

In each language I have written a fully 3D-SPGPE solver to explore the dimensionality crossover between 3D and 2D. In Fortran, I used CUDA to offload calculations to a Graphical Processing Unit (GPU). The Julia code supports multi-GPU implementations using the MPI standard to communicate across distributed devices. Experience with Flux, the deep learning Library for Julia.

Python, Maple, R

Advanced

Main projects include performing Bayesian statistical inference on medical data to advance treatments for people with cerebral palsy, creating a forecasting model for disease spread and development as well as computationally modelling the Gross-Pitaevskii Equation. I have also written codes to solve the Point-vortex model with both an object-orientated and array-based approach. I also have experience using Deep Learning library PyTorch.

Honours & Awards

2011	Bronze award , Duke of Edinburgh
2012	Wado-Ryu Karate 1st Dan , Mura Budo Kan
2012	Head Prefect , Selby High School
2013	Gold award , UKMT Maths Challenge
2015/2016	Selected for British university championships , Newcastle University Judo Club
2016/2017	Treasurer , Newcastle University Judo Club
2018	Outstanding Masters project , Newcastle University, School of Mathematics, Statistics and Physics

Referees

Referees available upon request