RAHIL VALANI
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EDUCATION

Doctor of Philosophy in Physics/Applied Mathematics 2017 – 2020
Monash University
Thesis title: Superwalking Droplets and Generalised Pilot-Wave Dynamics

Dual Degree: Bachelor of Aerospace Engineering (Honours) and Bachelor of Science 2012 – 2016
Monash University
Majors: Aerospace Engineering, Physics, Mathematics GPA/WAM=3.861/86.879
Thesis title: A numerical study of flow past a forced oscillating circular cylinder at low Reynolds number

LIST OF PUBLICATIONS

- Joshua Perks, **Rahil N. Valani**, ***Dynamics, interference effects and multistability in a Lorenz-like system of a classical wave-particle entity in a periodic potential***, Chaos **33**, 033147 (2023) https://doi.org/10.1063/5.0125727
- **Rahil N. Valani**, David M. Paganin. ***Attractor-driven matter***, Chaos **33**, 023125 (2023) https://doi.org/10.1063/5.0107401
- David Müller-Bender, **Rahil N. Valani**, Günter Radons, ***Pseudo-laminar chaos from on-off intermittency***, Physical Review E, 107, 014208 (2023) https://doi.org/10.1103/PhysRevE.107.014208
- **Rahil N. Valani**, Brendan Harding and Yvonne Stokes. ***Utilizing bifurcations to separate particles in spiral inertial microfluidics***, Physics of Fluids, 35, 011703 (2023). https://doi.org/10.1063/5.0132151
- **Rahil N. Valani**, Brendan Harding and Yvonne Stokes. ***Bifurcations and dynamics in inertial focusing of particles in curved rectangular ducts***, SIADS 21, 2371-2392 (2022). https://doi.org/10.1137/21M1451919
- **Rahil N. Valani**. ***Lorenz-like systems emerging from an integro-differential trajectory equation of a one-dimensional wave-particle entity***, Chaos 32, 023129 (2022). https://doi.org/10.1063/5.0076162
- **Rahil N. Valani**. ***Anomalous transport of a classical wave-particle entity in a tilted potential***, Physical Review E (Letter) 105, L012101 (2022). https://doi.org/10.1103/PhysRevE.105.L012101
- **Rahil N. Valani**, David M. Paganin, A.C. Slim, T. Simula and Theodore Vo. ***Unsteady dynamics of a classical particle-wave entity***, Physical Review E 104, 015106 (2021). https://doi.org/10.1103/PhysRevE.104.015106
- **Rahil N. Valani**, A.C. Slim and T. Simula. ***Stop-and-go locomotion of superwalking droplets***, Physical Review E, 103, 043102 (2021). https://doi.org/10.1103/PhysRevE.103.043102
- **Rahil N. Valani**, Jack Dring, Tapio P. Simula and Anja C. Slim, ***Emergence of superwalking droplets***, Journal of Fluid Mechanics **906**, A3 (2021). https://doi.org/10.1017/jfm.2020.742
- **Rahil N. Valani**, Anja C. Slim, Tapio P. Simula, ***Superwalking Droplets***, Physical Review Letters **123**, 024503. (2019). https://doi.org/10.1103/PhysRevLett.123.024503
    - Focus story published in APS Physics https://physics.aps.org/articles/v12/80
    - Media article published in phys.org https://phys.org/news/2019-07-droplets-liquid-surface.html
    - Media article published in physicscentral.com https://www.physicscentral.com/buzz/blog/index.cfm?postid=5353019309395046474
    - Featured on 'Tom Rocks Maths' youtube channel for Maths outreach https://www.youtube.com/watch?v=RaqbTswDF9A&ab_channel=TomRocksMaths
- **Rahil N. Valani**, Anja C. Slim, ***Pilot-wave dynamics of two identical, in-phase bouncing droplets***, Chaos **28**, 096114 (2018). https://doi.org/10.1063/1.5032128 (Editor's pick)
- **Rahil N. Valani**, Anja C. Slim, Tapio P. Simula, ***Hong-Ou-Mandel-like two-droplet correlations***, Chaos **28**, 096104 (2018). https://doi.org/10.1063/1.5032114
- **Rahil N. Valani**, Andrew J. Groszek, Tapio P. Simula, ***Einstein-Bose condensation of Onsager Vortices***, New Journal of Physics **20,** 053038 (2018). https://doi.org/10.1088/1367-2630/aac0bb

AWARDS and PRIZES

Travel award from The CASS Foundation to present at the Society of Industrial and Applied Mathematics Dynamical Systems (SIAMDS23) conference in Portland, USA — 2023

First place in Maths Outreach — 2022
CARMA-Matrix Maths Art/Poster Competition 2022

Third place in Maths Art — 2022
CARMA-Matrix Maths Art/Poster Competition 2022

Best presentation in the 'Dynamical systems methods in Natural Sciences' symposium — 2022
Nonlinear Science & Complexity (NSC) conference online 2022, Greece

Award for research communication — 2022
Australasian Fluid Mechanics Society (AFMS) Retreat, University of Melbourne

Robert Street Doctoral Prize for best PhD thesis — 2021
School of Physics and Astronomy, Monash University

T.M. Cherry award for best student presentation at ANZIAM conference — 2021

Postgraduate Publication Award by Faculty of Science, Monash University — 2020
Awarded $5000 for preparation and publication of PhD research

2020 Norris Family Award for Outstanding Research Output by a Graduate Research Student — 2020
Faculty of Science, Monash University

Runner-up for 3-minute thesis (3MT) competition in the Faculty of Science, Monash University — 2019

'Best student presentation award' at the 8th Meeting on Hydrodynamics Quantum Analogs — 2018
Brown University, Rhodes Island, USA

J L William Postgraduate Top Up **Scholarship** — 2017
$5000 (AUD) per year, awarded to high achieving PhD students

Best in School Award – School of Physics and Astronomy at Monash University — 2016
Awarded for achieving highest score in 3rd year Physics undergraduate units

Dean's List for Outstanding Academic Achievement — 2012-16
Awarded for 4 consecutive years, awarded to students achieving an average of 85% or above in that year

Australian Mathematical Science Institute (AMSI) **Summer Research Scholarship** — 2015
Awarded $500(AUD) per week for 6 weeks to undertake a summer research project

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CONFERENCE PRESENTATIONS & TALKS

Inertial particle focusing in curved ducts: Bifurcation and dynamics — 16th May 2023

SIAMDS23 (Society of Industrial and Applied Mathematics Dynamical Systems) Conference — Portland, USA

Inertial particle focusing in curved ducts: Bifurcation and dynamics — 9th Feb 2023
ANZIAM (Australian and New Zealand Industrial and Applied Mathematics) Annual Conference — Cairns, Australia

Attractor-driven matter — 8th Feb 2023
ANZIAM (Australian and New Zealand Industrial and Applied Mathematics) Annual Conference — Cairns, Australia

Inertial particle focusing in curved ducts: Bifurcation and dynamics — 22nd Nov 2022
75th Annual Meeting of the American Physical Society's Division of Fluid Dynamics — Indianapolis, USA

Inertial particle focusing dynamics in curved ducts — 16th Nov 2022
Statistics and Mathematical Modelling in Combination Conference (SMMC 2022) — Melbourne, Australia

Bifurcations and dynamics in inertial particle focusing in curved ducts — 7th Nov 2022
SA ANZIAM Meeting 2022 — Adelaide, Australia

Bifurcations and dynamics in inertial particle focusing in curved ducts — 28th Sep 2022
Nonlinear Science & Complexity (NSC) conference 2022 — Online

Anomalous transport in a Lorenz-like system modelling the dynamics of a classical wave-particle entity *(Best presentation award in symposium)* — 27th Sep 2022
Nonlinear Science & Complexity (NSC) conference 2022 — Online

Inertial particle focusing in curved ducts — 18th Jul 2022
Australasian Fluid Mechanics Society (AFMS) Retreat — University of Melbourne, Melbourne, Australia

Strange-attractor-driven matter — 15th Jul 2022
8th Statistical Mechanics of Soft Matter Conference — Monash University, Melbourne, Australia

Inertial particle focusing dynamics in curved ducts — 5th Jul 2022
NSW ANZIAM (Australian and New Zealand Industrial and Applied Mathematics) meeting — Virtual

Superwalking Droplets & Generalised Pilot-Wave Dynamics — 24th May 2022
AFMS (Australasian Fluid Mechanics Society) Conversations in Fluids Seminar Series — Virtual

Anomalous transport of a classical wave-particle entity — 10th Feb 2022
ANZIAM (Australian and New Zealand Industrial and Applied Mathematics) Annual Conference — Virtual

Bifurcations and dynamics in inertial focusing of particles in curved rectangular ducts — 7th Feb 2022
ANZIAM (Australian and New Zealand Industrial and Applied Mathematics) Annual Conference — Virtual

Bifurcations in inertial focusing of particles in curved rectangular ducts — 9th Dec 2021
16th International Conference on Dynamical Systems Theory and Applications (DSTA) — Virtual

Superwalking droplets *(Best student presentation)* — 1st Feb 2021
ANZIAM (Australian and New Zealand Industrial and Applied Mathematics) Annual Conference — Virtual

Stop-and-go motion of Superwalking droplets 14th Dec 2020
Statistical Mechanics of Soft Matter Meeting Virtual

Emergence of Superwalking droplets 24th Nov 2020
73rd Annual Meeting of the American Physical Society's Division of Fluid Dynamics Virtual

Superwalking droplets 17th Dec 2019
Statistical Mechanics of Soft Matter Meeting University of Adelaide, Adelaide, Australia

Superwalking droplets 6th Dec 2019
Australian Institute of Physics Summer Meeting RMIT, Melbourne, Australia

Superwalking droplets 26th Nov 2019
72nd Annual Meeting of the American Physical Society's Division of Fluid Dynamics Seattle, USA

Superwalking droplets 7th May 2019
Fluids Seminar Series Monash University, Melbourne, Australia

Many droplet dynamics and superwalkers *(Best student talk)* 24th Jul 2018
8th Meeting on Hydrodynamic Quantum Analogs Brown University, Providence, Rhode Island, USA

Many-droplet Hydrodynamic Quantum Analogs 22th Sep 2017
Victorian ULtraCold Atoms Network (VULCAN) Workshop Swinburne University, Melbourne, Australia

Einstein-Bose Condensation of Onsager Vortices 27th Nov 2016
Conference on Optics, Atoms and Laser Applications (KOALA) Monash University, Melbourne, Australia

A Numerical Study of Flow past a Forced Oscillating Cylinder 21th Nov 2016
American Institute of Aeronautics and Astronautics (AIAA) Student Conference Monash University, Melbourne, Australia

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MENTORING

- *Jack Dring – Summer research project undergraduate student – Monash University – July 2019*
  - Worked on experiments of superwalking droplets and theoretical modelling of bouncing and walking droplets. This work contributed to the publication:

  Rahil N. Valani, Jack Dring, Tapio P. Simula and Anja C. Slim, ***Emergence of superwalking droplets***, Journal of Fluid Mechanics **906**, A3 (2021). https://doi.org/10.1017/jfm.2020.742

- *James Day – Summer research project undergraduate student – University of Adelaide – Dec 2020/Jan 2021*
  - Worked on integrability of Lorenz-like dynamical systems emerging from the walking-droplet system and investigating a wave-particle entity in a harmonic potential. Inspired from the preliminary investigation during this project, the student conducted independent research and published the following:

  James Day, ***Pilot-wave hydrodynamics: Quantisation of partial integrability from a nonlinear integro-differential equation of the second order***, Bulletin of the Australian Mathematical Society, 1-8 (2023). https://doi.org/10.1017/S0004972723000151

- *Joshua Perks – Summer research project undergraduate student – University of Adelaide – Jan 2021/Feb 2021*

    - Worked on dynamics and stability of a wave-particle entity in a sinusoidal potential. This work led to the following publication:

Joshua Perks, **Rahil N. Valani**, ***Dynamics, interference effects and multistability in a Lorenz-like system of a classical wave-particle entity in a periodic potential***, Chaos **33**, 033147 (2023) https://doi.org/10.1063/5.0125727

PROFESSIONAL RESEARCH WORK EXPERIENCE

University of Adelaide - Adelaide, SA **Feb 2021 - Current**

ARC Grant Funded Postdoctoral Researcher

Key Responsibilities:

- Undertaking cutting edge research in mathematical analysis of particle dynamics in fluid flows inside curved ducts using analytical and computational tools. ***This research will have potential application in `liquid biopsy' – the isolation of circulating tumor cells (CTCs) from blood samples***
- Communicate the research outputs by publishing in high impact international journals and presenting at both national and international conferences

AMOG Consulting - Melbourne, VIC **Jun 2016 - Jul 2016**

Vacation Student Engineer

Key Responsibilities:

- Developing flow charts to understand data flow of a cable simulator software
- Understanding and implementing analytical models for a cable/strand under tension and bending loads
- Investigating analytical models for enhancing wave energy production and performing numerical analysis in MathCAD and MATLAB

School of Mathematical Sciences - Monash University, Clayton, VIC **Jun 2015 - Feb 2017**

Research Assistant

Key Responsibilities:

- Developing a mathematical model to perform quantitative study of a dynamical system of two bouncing droplets on a vibrating bath
- Working independently to analyze the numerical results obtained from MATLAB and verifying with analytical approximations and experiments
- Using effective communication skills to convey the work to colleagues and academics through clear explanations of unfamiliar concepts during group meetings

PROFESSIONAL TEACHING EXPERIENCE

Monash College - Melbourne, VIC **Feb 2019- Dec 2020**

Teaching Professional

Courses: MCD4160 – Physics for Engineering, MCD1200 – Physics A

Key Responsibilities:

- Teaching Physics and Engineering to a class of diverse senior international diploma students
- Conducting Lab session where I guide students in performing Physics experiments and help them connect the theoretical concepts to hands-on experiments
- Occasionally conducting lectures and tutorials where I teach them theoretical concepts in Physics and Engineering

Monash University - Melbourne, VIC **Mar 2017 – Dec 2020**

Teaching Assistant

Courses: ECE3093 – Optimisation, Estimation and Numerical Methods (*Semester 1 – 2019*)**, MTH3360** – Fluid Dynamics (*Semester 1 – 2017 and 2018*) and **PHS2061** and **PHS2062** – 2nd year Physics (*Semester 1 and 2 – 2017*)

Key Responsibilities:

- Reviewing content covered in lectures and concepts that the students are struggling with
- Identifying students' learning gaps and assisting them in understand and applying the concepts learned in lecture to solve problem set
- Giving feedback to students on their work and help them become independent learners

Teach Me Tutoring - Melbourne, VIC **Feb 2017- Current**

Mathematics/Physics Tutor

Key Responsibilities:

- Assisting students one-on-one with high school Mathematics and Physics
- Explain concepts to students and identifying and addressing their learning gaps
- Help them develop good study habits and assist them in becoming independent learners

VOLUNTARY WORK AND EXTRA-CURRICULAR ACTIVITIES

Various roles - Community Centre, Vermont, Melbourne, VIC **2017 - Current**

Conducted Science Workshops for primary school students at the local community center.

- Create hands-on experiments and engaging content every second school holidays for these students.
- Train youth volunteers to assist in conducting this session.
- Managing the full program by working effectively with different teams

Mathscraft workshops **2021 - Current**

Assisted as a Mathematician at the workshop to provide school maths teachers an experience of doing maths like a research mathematician