2026 Dynamical Systems Workshop – Theory and Application Information Booklet

Heron Island

2–6 November 2026



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Venue

Heron Island Research Station

For more information on the venue, please visit heron-island.research.uq.edu.au

Organisers

Cecilia González-Tokman, Sakshi Jain and Max Auer

Acknowledgements

The organisers gratefully acknowledge financial support of the Australian Research Council, the University of Queensland, Martin Wechselberger and Sasha Fish through the University of Sydney, and Michael Small through the University of Western Australia.

Schedule

Time	Monday	Tuesday	Wednesday	Thursday	Friday
07:45 – 08:30	Check-in at Marina Terminal*	Breakfast Please arrive by 7:45am	Breakfast Please arrive by 7:45am	Breakfast Please arrive by 7:45am	Breakfast and Check-out† Please arrive by 7:45am
08:30 – 09:00					
09:00 – 09:30		Activity or Discussion Session	Subnugget (Session 3)	Nugget (Session 2)	Subnugget (Session 7)
09:30 – 10:00	Ferry to Heron Island**				
10:00 – 10:30			Coffee/Tea break		Coffee/Tea break
10:30 – 11:00			Activity or Discussion Session	Coffee/Tea break	Subnugget (Session 8)
11:00 – 11:30		Coffee/Tea break		Subnugget (Session 5)	
11:30 – 12:00		Subnugget (Session 2)			Takeaway Lunch at 11:30am
12:00 – 12:30	Arrival and Check–in				Departure††
12:30 – 12:45	Lunch Please arrive by 12:30pm	Lunch Please arrive by 12:30pm	Lunch Please arrive by 12:30pm	Lunch Please arrive by 12:30pm	
12:45 – 14:00					
14:00 – 14:30		E-Poster (Session 2)	Subnugget (Session 4)	Subnugget (Session 6)	
14:30 – 15:00	E-Poster (Session 1)				
15:00 – 15:30					
15:30 – 16:00		Coffee/Tea break	Discussion Session	Discussion Session	
16:00 – 16:15	Coffee/Tea	E-Poster (Session 3)			
16:15 – 16:30	Nugget (Session 1)				
16:30 – 17:00					
17:00 – 17:30	Subnugget (Session 1)				
17:30 – 18:30	Pre-dinner break	Pre-dinner break	Pre-dinner break	Pre-dinner break	
18:30 – 19:00	Dinner	Dinner	Dinner	Dinner	
19:00 – 20:00	Please arrive by 6:30pm	Please arrive by 6:30pm	Please arrive by 6:30pm	Please arrive by 6:30pm	

*: Check-in opens at 7:45am. Please check–in **by 8:30am** to ensure passage. The Marina Terminal is located at **72 Bryan Jordan Drive, Gladstone**.

: The ferry will depart Gladstone Marina at **9:30am.

†: Check-out of room **at 9am** and collect boarding passes from the staff at the research station.

††: Please be ready at the jetty for departure **at 12pm**. The ferry will depart Heron Island at 12:45pm.

Abstracts

E-Poster Session 1

Session Chair: Cecilia González-Tokman

The transition between synchronization and chaos for random Blaschke products

Renee Oldfield

University of Queensland

We establish sufficient conditions for which a class of random circle maps, the so-called random Blaschke products, exhibits either synchronization or chaotic dynamics. We also establish necessary and sufficient conditions for such systems to have a unique random fixed point attractor in the unit disc. As an example, for a class of two map cocycles we identify the random physical measures as a parameter is varied and investigate the critical value where the dynamics transitions from order to chaos.

Training information for dynamical reconstruction with reservoir computing

Xiaoting Liu

University of Western Australia

Echo state networks (ESNs) have become widely used for time-series prediction, tipping-point anticipation and attractor reconstruction. Their success depends strongly on the information provided during training. A small but informative training dataset can support reconstruction across different dynamical regimes, whereas a much larger dataset may fail if it lacks the relevant dynamical information. This raises two fundamental questions: what information is useful, and how much is sufficient? We use parameter-aware reservoir computing (PARC) to assess the training data required for crisis prediction and dynamical reconstruction across parameter space. I will discuss how the distribution and quantity of training data influence extrapolation and to what extent PARC can infer unobserved dynamics.

Alice in Queensland: Will she regret her choice of model?

Antony Mizzi
University of Western Australia

Join Alice and her friend Bob as they try to choose the best model class to describe their dataset. After hearing about the Minimum Description Length principle, Alice and Bob decide to look for the class that can most efficiently encode their dataset. However, there are many ways to use a model for data encoding. Initially, they use a normalised maximum likelihood (NML) scheme, which promises to minimise worst-case inefficiency and lead to a model class that balances simplicity and performance. Unfortunately, for the class of linear models, the NML scheme is undefined. By accounting for regularisation and tweaking the NML scheme accordingly, Alice and Bob are able to make their modified scheme well-defined and universal (optimal in the asymptotic limit of dataset size). Since the efficiency of their modified scheme depends on the regularisation strength, they can also use it to select an appropriate penalty strength for ridge regression. The efficiency of Alice and Bob's modified coding scheme also offers a nice interpretation: regularisation simplifies models by constraining the space of possible datasets that can be fitted well.

Symmetry Decomposition of the Koopman Operator

Irteza Ali Chaudhry
University of New South Wales

Many dynamical systems are defined on domains possessing some symmetry, such as the torus or an orbit of the Earth. When a dynamical system commutes with these symmetries, it is called equivariant, and the associated symmetry may be considered a redundant aspect of the dynamics that we seek to remove. This is especially true for eigenfunctions of the Koopman operator, where the number of eigenfunctions scales with the size of the symmetry group. In this talk, we look at a class of skew product maps on the cylinder which are equivariant with respect to rotations and reflections, and use the irreducible representations of these symmetry groups to decompose the full Koopman operator into smaller operators on reduced spatial domains. We examine the connection between the eigenfunctions of the Koopman operator and the eigenfunctions of the reduced operators, establishing a robust projection/lift formalism to go between these. Time permitting, we may touch on expanding this framework to more general groups on a broader class of phase spaces, and discuss efficiency gains in the computation of Koopman eigenfunctions.

Changes in Time-Scale Hierarchy: Multi-Parameter Singular Perturbation Problems

Matthew Lim

University of Sydney

For systems with several independent singular perturbation parameters, the dynamics in the joint singular limit depend on the path along which the parameters tend to zero. Standard reduction techniques assume an a priori hierarchy of time scales, but when parameters vary independently this hierarchy can change, and different limits yield different configurations of nested slow manifolds. We investigate conditions under which non-uniform persistence of slow manifolds generates complex local dynamics, even when the fast dynamics remain normally hyperbolic. The geometric parameter blow-up allows us to identify distinguished asymptotic sectors and to relate them to families of smoothly deforming slow manifolds over the blown-up sphere.

Beyond Static Topology: Synchronization Through Fast and Slow Switching Regimes in Time-Varying Complex Networks

Atefeh Ahmadi

University of Western Australia

Although complex network theory has traditionally relied on static wiring, real-world systems in physics and biology are inherently time-varying. A critical, yet often overlooked, aspect of these systems is the rate at which network topology changes. This talk presents a framework for understanding how the timescale of structural switching governs the emergence of synchronization across two dynamical regimes. In the fast-switching limit, rapidly toggling a network with its restricted complement produces an effective average topology that optimizes coupling efficiency and lowers the required synchronization threshold without increasing connection weight. In contrast, in the slow-switching regime, where the network evolves more slowly than the intrinsic node dynamics, refined analytic conditions based on eigenvector projections demonstrate that switching can paradoxically induce synchronization even when all underlying static topologies fail.

E-Poster Session 2

Session Chair: Robby Marangell

Understanding dynamics of the 2 population Kuramoto model using a decomposition of Lorentzians

Henry Irvine
University of Sydney

By approximating an arbitrary distribution of native frequencies $g(\omega)$ as a weighted sum of finitely many Lorentzian distributions we are able to invoke the power of the Ott-Antonsen ansatz to produced a greatly simplified approximation of the dynamics.

TBD

Khanh Truong Le Ghia
University of Sydney

Compact Surfaces of Revolution with All Geodesics Closed

Gleb Palshin
University of Sydney

Plato and Aristotle considered the round sphere the most perfect and symmetrical of all shapes. As modern scientists, we do not stop at contemplating the beautiful; instead, we ask: which of its remarkable properties can we preserve while destroying its perfect symmetry? For example, if you travel on the sphere always moving straight ahead, you eventually return to where you started (even facing in the same direction). In geometric language, these shortest possible paths are called geodesics, and on the round sphere they are all closed. Two of David Hilbert's students, Otto Zoll and Paul Funk, made fundamental contributions to this question, with Funk settling the rotationally symmetric case.

Modern mechanics gives this story another twist. The fact that all geodesics close is linked to three independent conserved quantities: kinetic energy, angular momentum, and a third reflecting a hidden symmetry. Continuing to pose strange questions, we now ask: for which of Funk's metrics can this third conserved quantity be chosen to be polynomial in the velocities? In this talk, I will present an answer.

Building dynamical systems out of finite trees!

Sean Skinner
University of Sydney

I will try my best to try and explain some beautiful ideas dating back to Furstenberg and Weiss which connect combinatorial questions about trees and fractal geometry to dynamical systems, namely Markov processes and ergodic theory. More concretely, I will try to explain how we build a dynamical system out of a sequence of finite trees in such a way that dynamical properties of the resulting dynamical system will encode combinatorial consequences for our initial sequence of trees. Moreover, I will try and do all of this in 5 minutes!

A tale of two rotations

Babak Attarha
University of Sydney

In this talk, I will explain how the idea of rotation appears naturally in the mathematics of periodic Schrödinger equations.

There are two different ways to measure rotation in this problem. Floquet theory follows a solution through one period and uses the Krein sign to select the correct Floquet multiplier, producing the Maslov phase $\Theta_{\mathrm{Mas}}(\lambda)$. Johnson and Moser instead follow a real solution over a long distance and define an average rotation number $\alpha_{\mathrm{JM}}(\lambda)$.

One construction examines what happens during a single period, while the other measures the behaviour accumulated over infinitely many periods. Although they arise from different viewpoints and are expressed in different mathematical languages, I will explain why they satisfy the beautiful identity

$$\Theta_{\mathrm{Mas}}(\lambda) = P\,\alpha_{\mathrm{JM}}(\lambda),$$

where P is the period of the potential.

Pulled–Pushed Transitions and Spectral Stability of Travelling Fronts in the Zeldovich–Frank-Kamenetskii Equation

Zhiyi Wang

University of Sydney

The ZFK equation is a reaction–diffusion model for premixed flame propagation, characterised by an exponential reaction term involving a parameter β. This equation exhibits different front propagation mechanisms depending on β, with pulled fronts arising for $\beta \ll 1$ and pushed fronts for $\beta \gg 1$. In this talk, I will examine the transition from pulled to pushed fronts as β varies, and explore its connection to the spectral stability of the corresponding travelling waves. I will discuss the presence and absence of a spectral gap and its relationship to the pulled–pushed transition.

E-Poster Session 3

Session Chair: Thomas Stemler

Learning dynamically inspired bases for Koopman and transfer operator approximation

Kevin Kühl Oliveira

University of New South Wales

Transfer and Koopman operator methods offer a framework for representing complex, nonlinear dynamical systems via linear transformations, enabling a deeper understanding of the underlying dynamics. The spectra of these operators provide important insights into system predictability and emergent behaviour, although efficiently estimating them from data can be challenging. We approach this issue through the lens of general operator and representational learning, in which we approximate these linear operators using efficient finite-dimensional representations. Specifically, we machine-learn orthonormal basis functions that are dynamically tailored to the system. This learned basis provides a particularly accurate approximation of the operator's action and enables efficient recovery of eigenfunctions and invariant measures. We illustrate our approach with examples that showcase the retrieval of spectral properties from the estimated operator, and emphasise the dynamically adaptive quality of the machine-learned basis.

Spectral Classification of Quenched Ergodic and Weak Mixing

Enxi Lin

University of New South Wales

For a deterministic dynamical system, ergodicity and weak mixing have well-known characterisations in terms of the spectrum of the Koopman operator. We extend these characterisations to random dynamical systems (RDS). We formulate quenched notions of ergodicity and weak mixing, and relate them to the Koopman cocycle acting on a Hilbert bundle of L^2 functions on fibre spaces. Techniques from the relative theory of measure-preserving systems — extensions, factors and relatively independent joinings — turn out to be the natural framework, and we adapt them to the RDS setting.

Combining Multiple Time-Scale Dynamics and Switching via the Geometric Blow-up Method

Tyson Rowe

Adelaide University

Multiple time-scale dynamics are studied through Geometric Singular Perturbation Theory (GSPT), while switching – characterised by abrupt changes in dynamics upon reaching a certain prescribed threshold – is studied via regularised piecewise smooth theory. Both of these frameworks are well-established for singular analysis, however, much less is known about how they interact with each other. In this talk, we explore how the geometric blow-up method can be used to bring these two closely related theories together, providing a framework for analysing systems that exhibit both multiple time scale dynamics and switching. We focus on planar systems using derived normal forms that describe a number of the generic interactions that may occur when these two phenomena collide.

Unpacking high-dimensional climate data dynamics with covariant Lyapunov vectors

Andrew Axelsen

University of Tasmania

Identification of the persistent atmospheric highs and lows as they form, mature and decay is an ongoing challenge. Their association with surface-level extreme events such as heat waves and cyclones has kept this a problem of interest for decades. In this one-slide nugget, we present a method for extracting the dynamics directly from high-dimensional, non-autonomous atmospheric data. This process solves a PDE for a given velocity field (e.g. zonal + meridional wind speed) using an upwind scheme to construct a time series of tangent linear propagators (TLPs). By calculating the leading few covariant Lyapunov vectors (CLVs) of the TLPs, we unpack the dynamics of a ten-day period in June-July 2025 with a cut-off low over eastern Australia, identifying key moments such as the development of transport barriers and lifecycles of atmospheric patterns in the manifested modes. We explore CLV alignments and associated diagnostic tools as they relate to the observable dynamics.

Overshoots in Delay Differential Equations for Saddle-Node Bifurcations

Sarthak Sahoo

University of Tasmania

Tipping refers to a rapid transition in a dynamical system following a change in its control parameter(s), often associated with the loss of stability of an equilibrium through a saddle-node bifurcation. Recent work on ordinary differential equations (ODEs) has established an inverse-square scaling law relating the amplitude of parameter overshoot to the time taken to cross the tipping threshold. We extend this investigation to delay differential equations (DDEs) and examine how the delay influences the overshoot dynamics. Our analysis reveals a similar inverse-square scaling relationship between the overshoot amplitude and the time taken to cross the tipping threshold in DDEs, together with an additional dependence on the delay. To investigate these dynamics numerically, we have developed an explicit DDE solver based on method of steps and trapezoidal scheme. We test the solver using time-dependent forcing profiles that begin near the equilibrium level, rise to a maximum, and subsequently return towards the initial level, thereby modelling transient overshoots. Numerical comparisons with the exact solution demonstrate that our solver remains effective at relatively large step sizes, where the standard ddeint (python) package exhibits limitations, and achieves lower errors than ddeint (python) for the cases considered.

Taming Spurious Correlations in Networks of Coupled Oscillators

Meghna Mistri

University of Auckland

Networks of coupled oscillators can spontaneously synchronise once the coupling strength exceeds a critical value. The nature of the transition from incoherence to coherence state is dependent on the intrinsic parameters of the oscillators. These parameters are usually not directly measurable, which limits our ability to predict and control collective behaviour in real networks. Data assimilation can be used to estimate these parameters using model predictions and observational data, and specifically we use the ensemble Kalman filter (EnKF) to do so. However, with a finite ensemble size the EnKF suffers from spurious correlations between uncorrelated oscillators, which causes eventual filter divergence. Localisation aims to alleviate this problem by using topological knowledge of the network to restrict which observations can affect the estimates obtained from the EnKF. We introduce new localisation schemes and investigate their performance, and demonstrate that there is an increase in the accuracy of parameter recovery.

Subnugget Session 1

Session Chair: Sam Jelbart

Linear response for random Blaschke products

Sakshi Jain

University of Queensland

I will present ongoing work in collaboration with Cecilia González-Tokman on the linear response of random Blaschke products. We investigate the conditions necessary for the existence of both quenched and annealed linear response. I will then present a counterexample and conclude with some open questions and directions for future research.

Subnugget Session 2

Session Chair: Martin Wechselberger

Asymptotic limit of transient patterns in a continuous-space interacting particle system.

Dietmar Oelz
University of Queensland

We (joint work with C. Gonzalez Tokman) explore a minimal model for pattern formation through biased turnover in actin filament networks of living cells. The resulting discrete-time interacting particle system can also be interpreted as voter model with continuous opinion space. Its solutions are characterised by transient clusters. For an alternative formulation of the process in terms of the particle distances we construct a recurrence relation for the partial derivatives of the associated characteristic functions and pass to the large population limit. This enables us to compute the moments of the asymptotic single particle distribution characterising the transient aggregates.

An algorithm to detect and rigorously verify blenders

Natalia McAlister Caffarel
Monash University

A blender is a geometric object known to give rise to a special type of chaotic behaviour. By definition, a blender is a hyperbolic set whose stable, or unstable, manifold, when looking at certain intersections, appears to have a greater dimension than it actually does. This abstract definition is difficult to rigorously verify, and consequently there are not many concrete examples. In this talk, I will present a characterisation of blenders based on mapping properties of certain sets of curves that can be rigorously verified by computer-assisted methods. Then, I will outline an algorithm to construct these sets of curves and verify the existence of blenders for a family of three-dimensional Hénon-like maps. Finally, I will discuss ongoing work and challenges regarding the application of this method to another family of maps in $\mathbb{R}^3$.

Subnugget Session 3

Session Chair: Courtney Quinn

Linear response theory for driven maps

Caroline Wormell
University of Sydney

For large enough chaotic systems, we expect that physical measures change differentiably with the map, even in the absence of nice hyperbolicity properties; on the other hand, we know that for the logistic map this relationship is no better than Hölder-1/2. In this nugget I will consider driving logistic maps by a discrete random process. This setup models forcing by another chaotic map and/or the effect of stable directions. I will show (non-rigorously) that in this model set-up, you can induce linear response if your discrete process has enough entropy. With a bit of daring, I will even calculate when that happens, and give some numerical information about the rest.

Great Expec-phase-ions: What Does the Maslov Phase Measure?

Robby Marangell
University of Sydney

The connection between the Johnson–Moser rotation number and the Maslov phase raises the question of what the phase measures in more general periodic problems. Of particular interest are self-adjoint operators, where spectral multiplicity can change, and Hamiltonian systems with complex spectrum, where the phase can behave rather differently. These examples lead naturally to questions about spectral counting, the integrated density of states, and what a phase can tell us about the spectrum.

Subnugget Session 4

Session Chair: Shannon Algar

First passage times for random walks with position dependent waiting times

Daniel Han

University of New South Wales

Random walks that jump after waiting at a location with power-law distributed times are a well established model for subdiffusion. These models typically describe stochastic movement in an environment filled with traps and lead to power-law distributed first passage times. The governing equations for the probability density function of these random walks are partial differential equations with time-fractional derivatives. This short talk will show how such equations can be derived, how to formulate the first passage problem and what happens when the waiting times become position dependent.

Eigenfunction convergence for fast–slow SDEs

Nicholas Fleming

University of New South Wales

Fast–slow systems arise in many areas of applied mathematics. A key aim is to identify the slow variables and eliminate the fast variables to obtain a reduced model. Froyland, Gottwald and Hammerlindl proposed algorithms for this purpose based on spectral data of the Koopman operator. We consider a class of fast–slow stochastic differential equations (SDEs) for which averaging holds, and prove results on the convergence of Koopman eigenvalues and eigenfunctions to those of the averaged SDE. Time permitting, we discuss convergence of the proposed algorithms. This is ongoing joint work with Gary Froyland.

Burnt out on GSPT

Sam Jelbart
Adelaide University

Things burn, but can we *prove it*? This is talk about an old problem in combustion theory: existence and stability of steady flame fronts on the real line. Despite an absolute abundance of beautiful formal asymptotic literature on this problem, there seems to be a paucity of rigorous asymptotic results. My aim in the first part of this talk is to show that quite a bit can be said about existence using normal forms, Geometric Singular Perturbation Theory (GSPT) and the geometric blow-up method. My aim in the second part is to embarrass myself completely by posing a handful of (probably ill-defined) questions about the extent to which the same techniques can be used to understand stability.

Subnugget Session 5

Session Chair: Holger Dullin

Transient cycles

Gary Froyland
University of New South Wales

I will describe how the leading complex eigenfunctions of the inflated generator reveal transient cycles in nonautonomous dyamics.

TBD

Courtney Quinn
University of Tasmania

Computer-assisted approach for the Infinitesimal Hilbert 16th problem

Alvaro Fernandez Mora
Monash University

The infinitesimal Hilbert's 16th problem asks for a uniform upper bound on the number of limit cycles in polynomial Hamiltonian vector fields under polynomial perturbations. Let Z(n) denote this maximum number of limit cycles, where n is the degree of the perturbation and n+1 is the degree of the Hamiltonian. Upper bounds for Z(n) remain largely unknown even for low degrees. In this work, we present novel computer-assisted techniques to approach this classical problem. We apply our framework to construct an alternative proof of the celebrated result Z(2)=2. While the quadratic case is one of the few cases that has been fully solved, our primary objective is to build a scalable toolkit capable of overcoming the algebraic complexity that currently limits the study of Z(n) for large n.

Subnugget Session 6

Session Chair: Georg Gottwald

TBD

Jason Atnip
University of New South Wales

Towards a global classification of relative equilibria in the Newtonian four-body problem

Margaux Introna
Monash University

Relative equilibria of the Newtonian four-body problem are determined by central configurations. Although many particular choices of the masses have been studied, a global description as all four masses vary remains open. After normalisation, the masses lie in a three-dimensional simplex, and the aim is to understand how the number of relative equilibria changes across this parameter space.
Ongoing numerical and computer-assisted work on this problem will be presented. Deterministic searches, continuation and adaptive subdivision of mass space are used to explore the solution set and locate candidate degeneracies, where bifurcations may occur. The resulting numerical picture provides a first step towards a rigorous decomposition of mass space into regions with a fixed number of relative equilibria.

Quenched limit theorems via mixing of all orders for random dynamical systems

Max Auer

University of Queensland

We adapt the notion of mixing of all orders to random dynamical systems and use it to establish quenched limit theorems. Assuming quenched exponential mixing of all orders, we prove both the central limit theorem and the Poisson limit theorem. Compared to existing approaches, this framework offers two main advantages. First, it allows for substantially weaker assumptions on the random constants appearing in mixing estimates: in the exponential mixing regime, logarithmic integrability suffices for the central limit theorem, while in the Poisson case, no integrability condition is required. Second, it applies naturally to invertible systems, where standard methods based on L^∞-type estimates or spectral decay are less well suited.

Subnugget Session 7

Session Chair: Gary Froyland

Estimation of the Hausdorff dimension of Julia sets

Mi Hu

Monash University

In 1998, Shishikura proved that for some **complex** parameter c, the Hausdorff dimension of the Julia set of $f(z) = z^2 + c$ can be two. However, it remains unknown whether the Hausdorff dimension can equal two when c is **real**. Recently, Dudko, Gorbovickis, and Tucker (2023) gave a lower bound for the Feigenbaum map $z^2 + c, c \approx -1.401155189$ that $d_H(J_c) > 1.49781$. I will discuss my work in progress with Tucker about estimating the Hausdorff dimension of the Julia set of the Fibonacci map $z^6 + c, c \approx -1.1455757325$.

From Glasner property to IC-rigidity

Sasha Fish
University of Sydney

We discuss two notions of expansivity for actions of countable (semi-)groups G on compact metric spaces X. The first is the Glasner property: for every infinite subset A of X and every positive epsilon, there exists g in G such that gA epsilon-dense in X. The second is the recently introduced notion of IC-rigidity, formulated in terms of the induced action of G on the space K_X of compact subsets of X, equipped with the Hausdorff metric. An action is called IC-rigid if the only G-invariant Borel probability measure on K_X supported on the infinite compact sets is the Dirac measure δ_X. We will discuss the challenges involved in establishing IC-rigidity, focusing on the proof that the natural action of the multiplicative semigroup of positive integers on the circle is IC-rigid. The talk is based on ongoing joint work with Shrey Sanadhya.

Subnugget Session 8

Session Chair: Lauren Smith

On the Lévy area in a Hamiltonian weakly coupled heatbath model

Georg Gottwald
University of Sydney

Physicists have long argued that stochastic models that arise as a limiting process from underlying deterministic microscopic models are to be interpreted in the sense of Stratonovich, envoking (wrongly) the Wong-Zakai theorem. Recently, we showed that corrections to the Wong-Zakai theorem, the so-called Lévy area, are typical even in systems with time-reversibility. In this talk, we present a physical example where the Lévy area is indeed nonzero but where it nevertheless does not contribute to a drift-correction. This is joint work with Mark Peletier.

Heteroclinic Chains in the 3-body problem

Holger Dullin
University of Sydney

The Newtonian 3-body problem has a triple collision that cannot be regularised. Nevertheless, dynamics near the triple collision can be understood after McGehee blow-up. A classical result by Sundman shows that triple collision is only possible for zero angular momentum. Following work of Montgomery and Moeckel I will explain how relative periodic solutions (in particular choreographies) can limit to triple collision, and why their dynamics approaches heteroclinic chains in the limit of vanishing angular momentum. I will discuss a number of examples of near ejection-collision choreographies (NECCs) and their heteroclinic chains.

Nugget Session 1

Session Chair: Sam Jelbart

GSPT for order-one contact manifolds of periodic orbits

Martin Wechselberger & Theo Vo
University of Sydney & Monash University

Standard averaging theory for slow drift along manifolds of periodic orbits fails at contact singularities, where normal hyperbolicity breaks down. We develop a coordinate-independent geometric framework to analyse these singularities. Using the parametrisation method, we compute an extended centre manifold and decouple the fast phase via a spectral Fourier-Galerkin framework. This reduces the degenerate problem to a lower-dimensional singular perturbation problem with a critical manifold of equilibria. We show that spectral shear maps to an order-one contact condition, enabling the use of contact-singularity theory to classify transitional dynamics, including torus canards.

Nugget Session 2

Session Chair: Sasha Fish

We know that swarms can compute. The question is how.

Shannon Algar & Thomas Stemler
University of Western Australia

A flock, a school of fish or a robot swarm can be treated as a physical reservoir computer: its collective dynamics transform incoming signals into rich internal states from which useful outputs can be read. Our starting premise is that the capacity to compute comes from the swarm's emergent organisation. Topological data analysis is built to capture exactly this kind of organisation, which makes it a natural match for the problem rather than a fashionable add-on. Persistent homology, the central tool we use, is also flexible enough to let us pose and test specific hypotheses about which structural features carry the computation. This question, at the intersection of swarms, reservoir computing and topological data analysis, is the focus of a recent ARC Discovery Project submission and the broader research program around it. We will introduce the core ideas at a high level, explain why the question matters, and sketch where the program is heading.

Non-reciprocal dynamics on networks

Lauren Smith & Priya Subramanian
University of Auckland

Non-reciprocal coupling means that when you and I interact, the effect on me is different to the effect on you. In a network of many interacting agents, non-reciprocal coupling means that each pairwise interaction is unequal. Examples of this occur in biology and photonics, where it has been shown to produce rich dynamics, including travelling waves and travelling chimeras. We want to think about different flavours of non-reciprocity, for example, in a ring network of identical oscillators, non-reciprocity can be introduced through non-symmetric nodes, e.g. Janus oscillators, or through non-symmetric interactions, e.g. differing forward-backward interaction strengths, or different interaction length-scales in each direction. We hope to identify universal dynamical behaviours that arise when reciprocity is broken in different ways and in diverse network systems.

List of Attendees

- Atefeh Ahmadi — University of Western Australia
- Shannon Algar — University of Western Australia
- Babak Attarha — University of Sydney

- Jason Atnip — University of New South Wales
- Max Auer — University of Queensland
- Andrew Axelsen — University of Tasmania
- Irteza Ali Chaudhry — University of New South Wales
- Holger Dullin — University of Sydney
- Alvaro Fernandez Mora — Monash University
- Sasha Fish — University of Sydney
- Nicholas Fleming — University of New South Wales
- Gary Froyland — University of New South Wales
- Cecilia González-Tokman — University of Queensland
- Georg Gottwald — University of Sydney
- Daniel Han — University of New South Wales
- Mi Hu — Monash University
- Margaux Introna — Monash University
- Henry Irvine — University of Sydney
- Sakshi Jain — University of Queensland
- Sam Jelbart — Adelaide University
- Kevin Kühl Oliveira — University of New South Wales
- Matthew Lim — University of Sydney
- Enxi Lin — University of New South Wales
- Xiaoting Liu — University of Western Australia
- Robby Marangell — University of Sydney
- Natalia McAlister Caffarel — Monash University
- Meghna Mistri — University of Auckland
- Antony Mizzi — University of Western Australia
- Dietmar Oelz — University of Queensland
- Renee Oldfield — University of Queensland
- Gleb Palshin — University of Sydney

- Courtney Quinn — University of Tasmania
- Tyson Rowe — Adelaide University
- Sarthak Sahoo — University of Tasmania
- Sean Skinner — University of Sydney
- Lauren Smith — University of Auckland
- Thomas Stemler — University of Western Australia
- Priya Subramanian — University of Auckland
- Khanh Truong Le Ghia — University of Sydney
- Theo Vo — Monash University
- Zhiyi Wang — University of Sydney
- Martin Wechselberger — University of Sydney
- Caroline Wormell — University of Sydney