



AUT

2020 New Zealand Mathematical Society Colloquium

**Auckland University of Technology
Auckland, New Zealand**

1st – 2nd December 2020



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Mathematical Sciences Research Group

School of Engineering, Computer and Mathematical Sciences

Auckland University of Technology

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Contents

Colloquium Information	4
Colloquium Schedule	6
Covid Modelling	7
Online Teaching and Learning in the Mathematical Sciences	9
Butcher-Kalman Lecture	11
Special Sessions	12
NZ Mathematics in Wave Phenomena	13
AUT Mathematical Sciences Symposium	17
Education Group Special Session	20

Colloquium Information

Viewing the Colloquium

The colloquium will take place on microsoft teams. This can be accessed either by downloading the client (which is recommended for ease of use), or simply through your web browser (Chrome and newer versions of Edge work best). **Links to each session will be sent to registered participants around 27 November.**

If you are in the Auckland area, the online content will be shown in room WZ416, on the 4th floor of the WZ building on St Paul Street at the AUT City Campus, a map is below. Note that this is simply a projection of the online content, the presenters will not (in general) be at this location.

Panel Discussions

Each morning from 10:00am there will be a series of short presentations and a panel discussion on the topics

- COVID modelling on Tuesday, and
- Online teaching and learning in the mathematical sciences on Wednesday.

Butcher-Kalman Lecture

This year's lecturer will be Melissa Tacy, giving a talk titled 'A "choose your own adventure" in microlocal analysis'. This will take place at 1:30pm on Tuesday.

Special Sessions

There are three special sessions running parallel on Wednesday afternoon from 1:30pm. These are:

- NZ Mathematics in Wave Phenomena,
- Mathematics Education Group Special Session, and
- AUT Mathematical Sciences Symposium.

NZMS Activities

The NZMS prizegiving will take place at 2:00pm on Tuesday, this will be followed by the AGM at 2:20pm

ANZIAM AGM

This will take place from 12:30pm on Wednesday.

Film Evening

From 5pm on Tuesday, the film "Secrets of the Surface: The Mathematical Vision of of Maryam Mirzakhani" will be available to registered participants for viewing through the colloquium website. Like other activities, it will be shown in room WZ416 at AUT. Details of how to access the film will be sent to registered participants on the Tuesday of the colloquium.

Regional Dinners

If the COVID alert level allows, dinners will be organised at local restaurants in the various regions, if there is sufficient interest. These will be informal and 'pay for yourself'. More details will follow.

Further Queries

If you have any queries please do not hesitate to contact a member of the local organising committee: Jiling Cao, Hyuck Chung, Michael Lockyer, Kerri Spooner, and Wenjun Zhang

AUT Campus Map



Colloquium Schedule

Tuesday 1 December

9:45-10:00am	Welcome
10:00am-12pm	COVID modeling presentations and panel
1:30pm-2pm	Butcher-Kalman lecture: Melissa Tacy
2pm-2:20pm	NZMS Prizegiving
2:20pm-4pm	NZMS AGM
5pm-6pm	Film: Secrets of the Surface: The Mathematical Vision of of Maryam Mirzakhani

Wednesday 2 December

10:00am-12pm	Online teaching and learning in the mathematical sciences presentations and panel
12:30pm- 1:00pm	ANZIAM AGM
1:30pm-2:30pm	Special Sessions: session 1
2:45pm-3:45pm	Special Sessions: session 2
3:45pm-4:00pm	Conclusion and handover
from 6:30pm	Regional dinners (if possible)

Covid Modelling

The covid modelling session will feature a series of short presentations from local researchers involved with modelling the spread of Covid in New Zealand, followed by a panel discussion. This session will be chaired by Shaun Hendy.

Community testing: ground truth or anecdotal?

Thomas Lumley

The University of Auckland

Testing for SARS-CoV-2 or antibodies is complementary to epidemic modelling, providing much more limited information but relying less on modelling assumptions. A group of statisticians self-assembled to provide advice to the Ministry of Health (and anyone else who would listen) on what would be needed for sampling to assess prevalence of undiagnosed infection. Our primary pieces of advice were that testing could only give a surprisingly crude upper bound on prevalence, and that establishment surveys were a good way to conduct sampling.

We must have $R < 1$

Mick Roberts

Massey University, Albany

The Covid-19 pandemic has made us all amateur epidemiologists. We know that we must get the ‘ R number’ below one and keep it there. The basic reproduction number and its cousin the effective reproduction number have verbal definitions that include the words *typical* and *expected*. They have mathematical definitions that include the assumption of an infinite homogeneous and homogeneously mixing population. These definitions, and some extensions, will be discussed.

Vegvari et al. Commentary on the use of the reproduction number R during the Covid-19 pandemic. *Stat. Meth. Med. Res.* 2020.

Adventures in epidemiology

Rachelle Binny and Alex James

Te Pūnaha Matatini, University of Canterbury

It seems like years ago that we were idly reading the Guardian and learning about a new type of pneumonia in China. A chat with a friend over coffee and we laughed about how the Public Health folks were always waiting for "The Big One". Less than a couple of months later and we were dusting off our publication from over 10 years ago on superspreading and being pleased we'd published something on epidemiology before needing it for real. Since then the last 8 months have passed remarkably quickly and we can tell you what it feel like when the results of your models actually matter...

Online Teaching and Learning in the Mathematical Sciences

The online teaching and learning in the mathematical sciences session will feature a series of short presentations from local educators, followed by a panel discussion. This session will be chaired by Rachel Passmore and Julia Novak.

Engaging Distance Students

Cami Sawyer

Massey University, Manawatū

Teaching an introductory university mathematics course for students studying by distance is challenging. We have students with diverse backgrounds including many adult learners and students with full-time jobs. We have worked on the design of our learning management system, incorporating a readiness survey, online quizzes, and specialised videos for each topic. I will discuss what makes my videos different from Khan academy or other videos online and how I incorporate my teaching philosophy around student engagement into them. Treating students as individuals and creating an ethic of care helps students break down barriers to learning maths. I will discuss how I do this in an online, asynchronous environment.

Tackling online mathematics teaching in 2020, a case study

Richard Brown

Massey University, Manawatū

Learning mathematics online is a challenging proposition. The material is cognitively demanding, and working through a course requires significant self-regulation and persistence. Since this talk is delivered virtually, I'll take the opportunity to attempt to give you some insight into what it feels like to be on the receiving end of an online mathematics course! I'm going to focus primarily on how we redeveloped a core first-semester first-year linear algebra paper at Massey, and some of the strategies we've used to help with making the experience as student-friendly as possible. I'll talk about what worked (and what

didn't) with engagement and providing regular feedback, and I'll also talk briefly about some of the more specific techniques we've used, such as STACK quizzes for formative assessment, and a little about our approach to online content creation. The COVID-19 pandemic gave us the opportunity to compare the student experience across two quite different cohorts of students: one who took the course online by choice, and one who ended up online by necessity. I'll close with some thoughts and observations.

Online teacher professional development, how COVID has changed the way we do things

Robyn Headifen

Auckland Mathematics Kaiarahi

Auckland Mathematical Association has always run face to face professional development for teachers then along came COVID. As teachers grappled with emergency teaching and learning from a distance AMA grappled with how to support teachers of mathematics and statistics. AMAonline was born. Robyn will share how AMA flipped to an online space, what have been the pluses and minuses, and where we might go next.

Online assessment at scale, keeping academic integrity in mind

Peter Bier

The University of Auckland

One consequence of going into lockdown was that our large part 1 engineering mathematics course (with 1000+ students) ended up being assessed entirely online. This presented not only logistical challenges but academic integrity challenges (particularly in an age where "contract cheating" is of increasing concern). Fortunately, we had already planned to move our weekly assignments to be fully online, in a way that was designed to maximise opportunities for instant feedback while minimising opportunities to cheat. I will discuss how we moved our assignments, tests and final exam online and some of the consequences of those choices (ideas to emulate and mistakes to avoid!)

Butcher-Kalman Lecture

This years Butcher-Kalman lecturer is Melissa Tacy from the University of Auckland. This session will be chaired by Tom ter Elst.

A “choose your own adventure” in microlocal analysis

Melissa Tacy

The University of Auckland

A common question posed to microlocal analysts is ‘which part is micro and which local?’. The descriptor however should not be decomposed into parts. Microlocal analysts are interested in characterising singularities and the phrase microlocalisation refers to a localisation that takes into account both position and direction. This way of understanding singularities has proved extremely valuable; particularly to the fields of PDE and harmonic analysis. In this talk I will introduce some of the basic ideas and achievements of the area. At some points the audience will be invited to collectively choose their own adventure by participating in an online poll to determine the direction of the talk.

Special Sessions

The special sessions involve a collection of sessions on various themes which will run in parallel. A timetable is as follows:

Time	NZ Mathematics in Wave Phenomena	AUT Symposium	Education Group Workshop	Education Group Contributed Talks
1:30pm - 1:50pm	Dimitrios Mitsotakis	Victor Miranda	John Rowe	Tanya Evans
1:50pm - 2:10pm	Nicolas Mokus	Robin Hankin		Jonny Stephenson
2:10pm - 2:30pm	Fabien Montiel	Simon Harris		Priscilla Murphy
2:30pm - 2:45pm	BREAK			
2:45pm - 3:05pm	Marie Graff	Catherine Hassell Sweatman	Igor' Kontorovich and Kim Locke	Peter Bier
3:05pm - 3:25pm	Kasper van Wijk	Winston Sweatman		John Mitry
3:25pm - 3:45pm	Yiming Ma	Alna van der Merwe		-
3:45pm - 4:05pm	Chris Stevens	-	-	-

NZ Mathematics in Wave Phenomena

Nonlinear and dispersive waves in a basin

Dimitrios Mitsotakis

Victoria University of Wellington

Surface water waves of significant interest such as tsunamis and solitary waves are nonlinear and dispersive waves. Unluckily, the equations describing the propagation of surface water waves known as Euler's equations are immensely hard to solve. In this presentation we show that among the so many simplified systems of PDEs proposed as alternative approximations to Euler's equations there is only one proven to be well-posed (in Hadamard's sense) in bounded domains with slip-wall boundary conditions. We also show that the system obeys most of the physical laws that acceptable water waves equations must obey. Validation with laboratory data is also presented.

Strain response of ice floes to flexural-gravity waves

Nicolas Mokus

University of Otago

Fragmentation of the sea ice cover by wind-generated waves is an important mechanism driving the ice dynamics and introducing feedback loops accelerating sea ice retreat. Although this process has been incorporated in several sea ice models and its impact on the floe size distribution has been estimated, the physical mechanisms governing the ice breakup under wave action are poorly understood and their parametrisation remains highly simplified. A two-dimensional scattering model is proposed to examine the strain response of an array of floes to a monochromatic swell forcing. This model is based on linear water wave theory and viscoelastic sea ice rheology; the sensitivity of the strain field to rheological parameters will be discussed

Acoustic scattering by a multi-ring resonator

Fabien Montiel

University of Otago

The problem of two-dimensional acoustic scattering by a multi-ring cylindrical resonator is considered. The resonator is made up of an arbitrary number of concentric sound-hard split rings. The scattering problem is formulated as a reflection/transmission problem between adjacent rings, whereby the scattering operators of the rings are combined using an efficient iterative scheme. Simulations show that increasing the number of rings while alternating their orientation lowers the first resonant frequency and exhibits a dense and nearly regular resonant structure that is analogous to the rainbow trapping effect.

How to solve inverse scattering problems without knowing the source term

Marie Graff

The University of Auckland

Solving inverse scattering problems using optimization techniques always presupposes knowledge of the incident wavefield and requires repeated computations of the forward problem, for which knowing the source term is essential. Here we present a three-step strategy to solve inverse scattering problems from total field measurements when the time signature of the source is unknown. Applications can be found among medical imaging and seismic exploration. The proposed strategy combines three recent techniques, developed for the time-dependent acoustic wave equation: (i) wave splitting, (ii) time-reversed absorbing conditions, (iii) adaptive eigenspace inversion. The main challenge lies in the combination of (i) and (ii). Numerical experiments will be displayed to illustrate each step of the strategy towards the reconstruction of the scatterer from the original total field measurements.

Seismic stations around the globe warn us about earthquakes and volcanic activity

Kasper van Wijk

The University of Auckland

Advances in hardware and installation procedures aim to improve the signal-to-noise ratio of the seismic waveforms they record, but still noise remains an issue. The sources of noise are a topic of active research. The city of Auckland, New Zealand sits on top of an active volcanic field. Seismic stations in and around the city monitor activity of the Auckland Volcanic Field (AVF), and provide data to image its subsurface. The seismic sensors – some positioned at the surface and others in boreholes – are generally noisier during the day than the night. For most stations weekdays are noisier than weekends, proving human activity contributes to recordings of seismic noise. Lock-down measures in New Zealand to battle the spread of COVID-19 allow us to separate sources of seismic energy and evaluate both the quality of the monitoring network, as well as the level of local seismicity.

Automated detection of slow slip events in GPS time series with a novel isolation technique

Yiming Ma

University of Otago

A slow slip event (SSE) is a type of recurring slow earthquakes, part of which plays an important role in releasing strain in subduction zones and have been found to precede large natural earthquakes. Over the past few decades, a wealth of GPS stations (over 15,000) have been deployed to detect SSEs worldwide. The huge amount of daily GPS time series makes it impossible to virtually inspect SSEs, therefore demanding a robust automatic detection method. In this talk, we present a new method, called Isolate-Detect (ID), to estimate the start and end times of each SSE in noisy data. To validate the detection performance for a range of noisy data, we first simulate the artificial GPS time series by a physical SSE simulator, which only contain the pure signal related to SSEs, so different noise models can then be added. Initial results show ID can work extraordinarily well for detecting SSEs only when white noise exists, while it still needs further improvements when color noise is considered.

Numerical Evolution of Gravitational Waves in an Expanding Universe

Chris Stevens

University of Otago

It has been observed that our universe is expanding at an accelerated rate. One way to represent this acceleration is by adding a positive cosmological constant to Einstein's field equations. A consequence of this is that the equations become more complicated, and many exact solutions with vanishing cosmological constant cannot be easily analogized. In this talk we focus on the numerical computation of plane gravitational waves propagating and colliding in an expanding universe using an initial boundary value problem formulation of the equations. Unlike with a vanishing cosmological constant, there are little to no analytical or numerical results in the current literature describing such events.

AUT Mathematical Sciences Symposium

Towards ARIMAX models with non-normal errors: An initial approach using VGLMs

Victor Miranda

Auckland University of Technology

As part of the class of vector generalized linear time series models, in this talk I will introduce a new family function, called `ARMA.studentt.ff()`, to estimate ARMA-like models with Student-t errors. This work is at the earliest stages and is part of my endeavours towards developing ARMA-like forecasting frameworks for time series beyond the ordinary assumption of normal errors. Many R packages for time series analysis can easily estimate ARMA models which, however, are expected to work fine under conditions, such as large sample sizes, anticipating the eventual normality of the residuals, or residuals with "normal" tails. But this is not achieved in general, for example, in financial modelling or stock market returns. `ARMA.studentt.ff()` is available in the `VGAMextra-0.0.2` (August 2020) package for R. Some examples are discussed and compared to results from other R packages.

Reified entities in Bradley-Terry: does mental fatigue exist?

Robin Hankin

Auckland University of Technology

In inference problems where the dataset comprises Bernoulli outcomes of paired comparisons, the Bradley-Terry model offers a simple and easily interpreted framework. However, it does not deal easily with chess because of the existence of draws, and the white player advantage. Here I present a new generalization of Bradley-Terry in which a chess game is regarded as a three-way competition between the two players and an entity that wins if the game is drawn. Bradley-Terry is then further generalized to account for the white player advantage by positing a second entity whose strength is added to that of the white player. These techniques afford insight into players' strengths, response to playing black or white, and risk-aversion as manifested by probability of drawing.

Genealogies within branching processes

Simon Harris

The University of Auckland

What does the family tree look like for a random sample of individuals taken from some population? Surprisingly, until recently this fundamental question remained an open problem even for one of the simplest of stochastic population models. We will discuss some progress made here, including the emergence of certain universal limiting genealogies when sampling uniformly from the classical Galton-Watson process.

Challenge from Transpower: Determining the effect of the aggregated behaviour of solar photovoltaic power generation and battery energy storage

Catherine Hassell Sweatman

Auckland University of Technology

With limited data beyond the grid exit point (GXP) or substation level, how can Transpower determine the effect of the aggregated behaviour of solar photovoltaic power generation and battery energy storage systems on GXP load in order to maintain an accurate load forecast? In this initial study from MINZ 2018 it is assumed that the GXP services a residential region. An algorithm based on non-linear programming, which minimises the financial cost to the consumer, is developed to model consumer behaviour. Input data comprises forecast energy requirements (load), solar irradiance and pricing. Output includes both the load drawn from the grid and power returned to the grid. The algorithm presented is at the household level. The next step would be to combine the load drawn from the grid and the power returned to the grid from all the households serviced by a GXP, enabling Transpower to make load predictions. Various means of load forecasting are considered in the published report. This presentation focusses on the non-linear programming algorithm and results.

Fun with a few masses

Winston Sweatman

Massey University, Albany

Study of the motion of a few masses moving under their mutual gravitation can be challenging but also rather fun. I will present some simple examples of such orbits.

Modal analysis of hyperbolic heat conduction models

Alna van der Merwe

Auckland University of Technology

The Fourier heat conduction model is inadequate for modelling heat transfer in situations where the assumption that the onset of heat flow is instantaneous, is not suitable. The assumption that heat flow starts only after a certain time delay or lag time leads to the Cattaneo-Vernotte (CV) model (also called the thermal wave model). The dual phase lag (DPL) model allows for time lags in both the heat flux and the temperature gradient. As these models are second order hyperbolic partial differential equations, modal analysis of the models is an option for investigating the properties of the models.

Education Group Special Session

Workshops

Digital Assessments Done Differently - A Desmos & NZQA Collaborative Project

John Rowe

Desmos

A brief introduction of the NCEA Level 2 maths project, a look at one of the tasks, exploring the rationale and possibilities that assessments through Desmos provides. Followed by a brief showcase and comparison of the two other tasks.

Can digital resources help students overcome their systematic errors?

Igor' Kontorovich, Kim Locke

The University of Auckland

In Colloquium 2019, we discussed that some ways of students' mathematical thinking are exceptionally robust to change. This time, we will present some online resources that we developed using STACK - an online assessment system for mathematics and science. We will share some insights into students' experiences of our resources with an eye to opportunities and challenges for learning and teaching in the digital era.

Contributed Talks

Evidence-based research-informed teaching and learning: insights for future directions

Tanya Evans

The University of Auckland

The recent unintentional worldwide shift to online teaching and learning as the emergency response to the COVID-19 pandemic resulted in an unprecedented use of educational technology at scale. For example, it appears that a large majority of tertiary teachers had to develop video resources to replace face-to-face lectures and deliver them online, putting their hesitation and trepidation aside. With the abundance of newly developed video resources, the post-COVID-19 educational landscape is foreshadowed to be vastly different, skipping a natural gradual stage of continuous developmental changes to the sector. This development could be a welcomed break-through but, as never before, it amplifies the big issue: research is lagging the implementation. In this talk, I first report on the most recent research on the impact of technology adoption at the tertiary level, synthesising the findings to inform future developments for university mathematics specifically. Secondly, I will highlight seminal research discoveries, bringing to the fore potential pitfalls of innovations that are based on the integration of new technological gadgets with only anecdotal evidence about their merits.

The Online Assistance Room during COVID-19

Jonny Stephenson

The University of Auckland

The University of Auckland offers a drop-in assistance room for its undergraduate science courses, in which advanced students provide advice to stage one and stage two undergraduates. Following the example of our Department of Statistics, I implemented an online version of the assistance room for students seeking help with mathematics courses during the second COVID-19 lockdown. In this talk I will discuss our implementation, describe what engagement I saw, and mention some pros and cons to this approach.

Teaching creativity and problem-solving

Priscilla Murphy

Auckland University of Technology

Future trends towards blended learning would necessitate paradigmatic shifts in teaching and learning. My presentation focuses on student perceptions about the attributes of creativity in non-routine problem-solving. Based on a 2-year research project, a group of tertiary educators taught non-routine problems to 64 science, technology, engineering, and mathematics (STEM) university students in New Zealand. We reflect on the research findings and their pedagogical implications for mathematics practitioners.

Video Creation – principles and practicalities

Peter Bier

The University of Auckland

This year thrust most of into the role of video content creators. Creating engaging, high quality mathematics education videos, armed only with whatever technology you have at hand, can be quite a challenge. I will share some of the lessons I have learned from over a decade of video creation experience and we will explore some of the different setups mathematics educators have used to create videos during lockdown.

This will include a look at some general principles that apply to video content creation, regardless of your particular setup, and also a discussion of practicalities relating to particular hardware and software (e.g. how to turn your phone into a makeshift document camera, with the aid of zoom).

Review of an assessment in which students review an assessment

John Mitry

The University of Auckland

During semester 1 this year I implemented a modified mid-semester assessment so that students would be encouraged to review their own work. Usually only a few students would recognisably follow up on an assessment after marks and solutions being released for the mid-semester test. Taking the idea from a recent seminar (by Chad Topaz), once students had sat and then received marks for the mid-semester test (which was an non-invigilated 24 hr take home exam) i gave students an opportunity to review their work and submit their review for marks they had lost. This is my attempt at a review of the whole thing.