

Jessica K. Eastman, PhD

Australian Citizen

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References will be given upon request

Research Interests

Quantum measurement and control, open quantum systems, Quantum many body dynamics, nonlinear dynamics and quantum chaos, many body chaos, Quantum space time, quantum metrology and sensors.

Education

Ph.D. Quantum Physics, The Australian National University

2015-2020

Thesis: "The emergence of chaos in continuously monitored open quantum systems"

Supervisors: Dr. André R. R. Carvalho, Dr. Joseph Hope, Dr. Matt James, Dr. Stuart Szigeti

- Modelling complex open quantum systems with time dependent Hamiltonians and stochastic evolution using XMDS2 (Stochastic differential equations software package), C++ and Python. Using Mathematica for Algebra manipulation. Programming using High Performance Computing (HPC) on the National Computational Infrastructure (NCI) supercomputer at ANU. Using Git for version control.
- Responsible for the development and implementation of numerical simulations to study the continuous weak measurement of quantum chaotic systems, resulting in a journal publication in Scientific reports 2017.
- Investigated the effect of measurement back-action on the dynamical behaviour of the quantum Duffing Oscillator and designed and numerically tested an adaptive control algorithm in order to control chaotic behaviour using only the measurement back-action on the system, resulting in a paper in Physical Review A 2019.
- Began adapting the approach to looking at many body quantum systems, starting with the theoretical quantum driven top in a cloud of ultracold atoms.
- Initiated discussions and collaborations with the experimentalists in the Atomlaser and Quantum Sensors group to develop a chaos experiment in a Bose-Einstein Condensate (BEC).
- Instigator and organiser for the weekly journal club for theorists and experimentalists in the Atomic physics group consisting of 20 people.
- Collaborated with Arjendu Pattanayak's group at Carleton College on the control of semiclassical chaos in a Duffing Oscillator, resulting in a book chapter in conference proceedings.

B.Sc. Physics (Honours), The Australian National University

2011-2014

Thesis: "Efficient generation of random quantum states using quantum trajectories"

Supervisor: Dr. André R. R. Carvalho

- Responsible for the design and implementation of the numerical algorithm to simulate the efficient generation of a random quantum state using the continuous measurement on a system of qubits using QuTiP in python, resulting in a first class honours degree.
- Research into the role of random states and random circuits in Quantum information and computing.

Experience

Employment

Research Associate

2019-2023

Imperial College London

- Co supervised one PhD student working on Quantum transition rates and open quantum systems, resulting in a paper published in Journal of physics A 2022 and another paper to be published this year.

- Wrote and maintained codes for simulating Non Hermitian and PT symmetric quantum billiards using Finite Element Methods (FEM) in Matlab, used by three students in the group. Provided the model based numerical data for developing random matrix theories for PT symmetric quantum systems.
- Supervised one Masters student on Random quantum states in a chaotic system: the Quantum Driven top.
- Wrote and designed my own personal website in HTML with version control in Github.
- Organiser for the Mary Lister McCammon summer school for undergraduate women in mathematics in 2022. This involved organising catered events for the cohort, corresponding with the students via email, mentoring the cohort once a week over coffee. And organising a social trip to the science museum. One on one meetings with the students to give advice on future studies and working in academia. Received a one off payment from the department for my contributions.
- Co supervised one masters student in Non hermitian Quantum billiards working on time dependent evolution using FEM and Split Operator methods in Matlab.
- Assisted in the creation of the weekly assignments for the 3rd year Quantum mechanics I course. Prepared and delivered five one hour problem classes.
- Prepared and delivered two lectures for the 3rd year Quantum mechanics I course on the numerical simulation of a quantum state (3 hours delivery).
- Co organiser for the mathematical physics seminar series. Responsible for inviting and hosting speakers. Hosted over five academics a year including in person and online seminars over the course of 2019-2023.
- Postdoc representative for the department of mathematics from 2020 till 2023.
- Committee member for the Mary Lister McCammon Summer Research Fellowship in 2020-2023.
- Co supervisor for the Mary Lister McCammon Summer Research Fellowship on quantum billiard chaos and eigenvalue statistics 2019.

Physics Tutor

2018

*Research School of Physics and Engineering
The Australian National University*

- Assisted in the delivery of the second-year Classical mechanics course.
- Responsible for running the weekly workshop with the help of two other tutors and the lecturers as well as marking weekly assignments. The Classical mechanics course consisted of three topics, Fourier Analysis, Lagrangian mechanics and fluid mechanics. This course was a flipped class which consisted of a two hour workshop and one hour drop in session and online video lectures.

Visiting Scholar

2017

*Centre for Quantum Dynamics
Griffith University*

- Developed and tested an adaptive control algorithm to control chaotic systems based on the measurement back-action on the system.
- Participated in the collaboration and team work on the applications of chaos control to Energy harvesting with two other visiting scholars.
- Presented a seminar on the paper “Tuning quantum measurement to control chaos” and the preliminary work on adaptive control.

Lab Demonstrator

2016-2017

*Research School of Physics and Engineering
The Australian National University*

- Responsible for teaching undergraduate labs and assessing/grading lab reports for the first and second year physics courses.

Summer Research Scholar

2015

*Department of Quantum Science
The Australian National University*

- Investigated the effects of continuous measurement on semiclassical chaos for a Quantum Duffing Oscillator using a Gaussian semiclassical approximation on the system.
- Developed numerical simulations to calculate the Lyapunov exponents for the semiclassical system.

Presentations

Overall I have given seven talks including two invited seminars and one keynote talk on my research to other experts in my field. I have also given outreach talks about my work to undergraduate and high school students. Below are some of the highlighted talks.

South East Mathematical Physics seminars UK (Online via Zoom)	2021
"Unravelling chaos from quantum mechanics"	Invited Seminar
Quantization of dissipative chaos seminar (Bad Honnef, Germany)	2019
"Controlling chaos in the quantum regime using adaptive quantum measurements"	Talk
Centre for Quantum Dynamics, Griffith University Seminar (Griffith University, Australia)	2017
"Tuning quantum measurements to control chaos"	Invited Seminar
Joint 13th Asia Pacific Physics Conference and 22nd Australian Institute of Physics Congress (APPC-AIP) (Brisbane, Australia)	2016
"Emergence of chaos controlled by quantum measurement"	Keynote Talk

Publications

In refereed Journals

Quantum-jump vs stochastic Schrödinger dynamics for Gaussian states with quadratic Hamiltonians and linear Lindbladians
Robson Christie, <u>Jessica Eastman</u> , Roman Schubert and Eva-Maria Graefe, Journal of Physics A: Mathematical and Theoretical, (2022)
The effects of amplification of fluctuation energy scale by quantum measurement choice on quantum chaotic systems: Semiclassical analysis
S. Greenfield, Y. Shi, <u>J. K. Eastman</u> , A. R. R. Carvalho, A. K. Pattanayak, Proceedings of the 5th International Conference on Applications in Nonlinear Dynamics, Springer, Cham, 72-83 (2019).
Controlling chaos in the quantum regime using adaptive measurements
<u>Jessica K. Eastman</u> , Stuart S. Szigeti, Joseph J. Hope, André R. R. Carvalho Phys. Rev. A, 99 , 012111 (2019)
Tuning quantum measurements to control chaos
<u>Jessica K. Eastman</u> , Joseph J. Hope, André R. R. Carvalho. Scientific Reports, 7, 44684 (2018)

Honors, Awards and Grants

Project time on the National Computational Infrastructure (NCI) supercomputer	2018
Okinawa School in Physics: Coherent Quantum Dynamics travel bursary	October 2017
Centre for Quantum Dynamics Visiting Scholar Stipend	July - September 2017
ANU Ph.D. Scholarship	2015-2019
ANU Summer Research Project Scholarship	Nov 2014 - Jan 2015

Student Supervision

Robson Christie	PhD 2019-2022
"Quantum transition rates"	Assistant supervisor
Adrian Butnar	4th year MSc research project 2022
"Quantum Billiards: Chaos, dynamics and losses"	Co-supervisor
James Hamilton	4th year research project 2020
"Random quantum states in a quantum driven top"	Supervisor
Kate Holmes	Mary Lister McCammon summer student 2019
"Quantum Billiards"	Co-supervisor