

PROFILE

Melissa Tacy



Dr Melissa Tacy is a Lecturer⁵ in Mathematics at the University of Auckland, and is the incoming NZMS president (2022-2024).

Melissa grew up in Canberra, Australia. She has always had a strong interest in mathematics, and after completing an undergraduate degree in mathematics at the Australian National University (ANU) in 2005, she began her PhD studies under the supervision of Prof. Andrew Hassell again at the ANU. Melissa was a highly successful PhD student, and was awarded a Fulbright scholarship to spend a year of her PhD at the University of California, Berkeley. Some of her fondest memories of her PhD occurred as she traveled home to Canberra via Europe involving a healthy mix of conferences, summer schools, and holidays (incidentally I happened to visit Canberra as a summer research student at this time, also under the supervision of Andrew Hassell, but just missed meeting Melissa).

Melissa completed her PhD entitled ‘*Semiclassical L^p estimates for quasimodes on submanifolds*’ in 2010, after which she spent a year as a postdoc at the Institute for Advanced Study at Princeton University, and then three years at Northwestern University. In 2014 Melissa returned to Australia to take up a lecturing position at the University of Adelaide, and then a short term research position at the ANU. At this point Melissa tells me that due to lack of long term academic position on the horizon, she was considering leaving academia. Thankfully she persevered, and the University of Otago was lucky enough to have her join the Department of Mathematics and Statistics as a lecturer in 2017. In 2020 Melissa moved to her current position at the University of Auckland.

Melissa’s research interests lie in the intersection of semiclassical, microlocal, and harmonic analysis. One could also list partial differential equations here, as much of her work is closely connected to estimates for solutions to differential equations. The typical setting of Melissa’s research involves a high frequency parameter, a Riemannian manifold, and a differential operator. Given these objects, one can construct eigenfunctions and then ask questions like “how do these eigenfunctions grow as the frequency becomes larger?” and “can eigenfunctions

⁵Editorial note: Melissa has been promoted Senior Lecturer from February 2023.

concentrate their energy in small sets?”. This latter question is also known as *scarring*, and can be thought of as an echo of the classical system (i.e. the dynamics of a billiard ball bouncing around the domain) inside the quantum system (as represented by the eigenfunctions of the differential operator under consideration).

One of Melissa’s recent results includes considering the difficult case of products of eigenfunctions. In certain situations Melissa shows that it is possible to significantly improve the L^p bounds that one would naively expect from the case of one eigenfunction. The paper where Melissa proves this fact is highly regarded; in fact it was awarded the Kalman prize for best paper by the NZMS in 2020! Recently Melissa has also worked on random waves, and their small scale structure. These results have a slightly different flavour, and involve proving that certain random variables are equidistributed. The random variables are typically an average of the wave over a small region (such as a ball with a shrinking radius).

Melissa is also active in promoting mathematics. In the past this has included giving a talk on quantum chaos to a crowded pub, publishing articles on infinity for a general audience, and explaining mathematics to school students. While she was based at Otago, she also organised a well attended weekly ‘shut up and write’ session. This involved herding a group of mathematicians into a quiet room, and getting us to finish writing up projects for a few hours with the promise of a visit to the pub once we were done.

Looking ahead Melissa has a number of projects working on proving L^p estimates by combining Fourier integral operator theory together with harmonic analysis ideas from wavelet/Fourier analysis. Outside of research, she is taking over as the President of NZMS and is looking forward to her two years in the role. One of her goals is to get New Zealand universities collaborating in sharing honours offerings (like what is done in Australia). The NZMS also has its 50 year anniversary on her watch in 2024. As part of the celebrations, the NZMS is running a joint meeting with the Australian Mathematical Society, and the American Mathematical Society (hopefully by the time the newsletter comes out there will be something more to announce about this). That should keep her pretty busy over the next few years!

Timothy Candy