Complex analysis: techniques, applications and computations
Isaac Newton Institute Cambridge
2 September – 19 December 2019

Short Report

The "Complex analysis: techniques, applications and computations" (CAT) programme ran from 2nd September 2019 to 19th December 2019. It brought together participants from diverse geographical and scientific communities to develop and apply complex analysis to a host of problems from areas including pure and applied mathematics, physics, engineering, and medicine.

Three workshops were central to the success of the programme: "The complex analysis toolbox: new techniques and perspectives"; "Complex analysis in mathematical physics and applications"; and "Computational complex analysis." Each was accompanied by masterclasses that ranged from pedagogical background to the latest techniques, including real-time computer demonstrations. The second workshop also incorporated a Newton Gateway "Open for Business" day on Industrial Applications of Complex Analysis, which featured presentations by participants from industry. All workshops were very well attended with a diverse group of participants, and the talks provided a unique overview of the state of the art. The generous support of the National Science Foundation's Division of Mathematical Sciences allowed a number of early-career researchers based in the USA to attend these workshops.

Leslie Ward gave the Kirk Lecture: "Fourier, harmonic analysis, and spaces of homogeneous type", a beautifully clear account of the relations between these subjects and complex variables. Mark Ablowitz delivered the Rothschild lecture: "Extraordinary waves and math: from beaches to photonics", which ranged over the history of integrable systems and its link with complex variables, from beginning to the present, including videos of intersecting waves on the beach and far more. The Simons Foundation helped support the participation of 5 participants.

A regular seminar series provided a forum for the exchange of ideas and projects, and the tables and offices of the Institute were in continuous use. Exchanges with the concurrent synergistic programme "Geometry, compatibility and structure preservation in computational differential equations" and with the previous programme "Bringing pure and applied analysis together via the Wiener-Hopf technique, its generalisations and applications" were an enriching addition to the CAT programme. Networking sessions also were organised by programme participants for early career attendees and for members of under-represented groups in mathematics; these sessions led to productive discussions and were very well received.

A highlight of the programme was the unusually broad spectrum of areas of mathematics represented by its participants spanning classical and harmonic analysis, asymptotic techniques, and numerical analysis. Together with other participants representing more applied fields such as mathematical physics, fluid and solid mechanics, mathematical modelling, acoustics and optics, this contributed to a fertile and engaging research environment in which discussions and collaborations frequently crossed traditional disciplinary boundaries. Some of the recurrent themes included recent developments in the Riemann-Hilbert problem, conformal mappings, and special functions, along with their manifold extensions and applications.

Many collaborations started during the programme: an incomplete list includes novel selection problems in Hele-Shaw flow using asymptotics beyond all orders, the general methodology for doubly-connected Stokes flows in non-quadrature domains, relations between Riemann-Hilbert problems and vortex sheets, applying the Szego kernel in conjunction with conformal mapping to the Unified Transform Method, and complex plane singularity dynamics of nonlinear PDEs.