Whitehead Prize: citation for Euan Spence

Short citation:

Professor Euan Spence of the University of Bath is awarded a Whitehead Prize for his profound contributions to the theoretical understanding and design of numerical algorithms for wave propagation and scattering at high frequency, particularly through the development and application of methods from the world of semiclassical analysis.

Long citation:

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In one strand of this work Spence, with collaborators, has combined arguments in a numerical analysis tradition with new semiclassical results to shed light, through rigorous analysis, on the high frequency behaviour of classical numerical methods for time harmonic wave scattering and propagation.

Notably, this work has led, via new semiclassical results about the high frequency components of integral operators, to a proof of a long-standing heuristic in the engineering literature that, to maintain accuracy in the h-version Galerkin boundary element method for obstacle scattering as the frequency k increases, it is enough to reduce the step-size h in proportion to the wavelength, i.e., to keep kh small. It has also led, via the first application of semiclassical defect measures in a numerical analysis context, to a complementary result for the h-version finite element method. This is the sharp estimate that, to maintain small relative errors in the large frequency limit, h must decrease faster than the wavelength, precisely keeping h^2k^3 sufficiently small in the case of classical piecewise linear basis functions.

Spence has also, with other collaborators, introduced the use of Morawetz identities to the numerical analysis of waves community, for example using them to challenge the conventional wisdom that the Helmholtz equation is highly indefinite, developing new weak formulations that are coercive for arbitrarily high frequencies for star-shaped domains, and establishing this surprising property also for standard and novel boundary integral equation formulations.

In other work he has made important contributions to semiclassical analysis itself. As one notable example, Spence, with collaborators, has studied the growth of the (cut-off) resolvent of the Laplacian on the positive real axis in the exterior of an obstacle (or more generally, some black-box scatterer). It is well-known that, in the strongest cases of trapping, this resolvent can grow exponentially through some sequence of positive values, and moreover the spacing between values in this sequence decreases as one moves along the axis, so that one expects this exponential growth to be exhibited generically. The surprising result, published at the end of 2021, is that there exists a subset of the positive real axis of arbitrarily small measure such that, if this set is excluded, the resolvent exhibits only polynomial growth. This result has important implications for the effectiveness of numerical methods, implying that, with high probability, methods will be reliable even in the presence of the strongest trapping.