Mathematics

AIMS Mathematics, 11(2): 3560–3562.
DOI: 10.3934/math.2026145
Received: 04 February 2026
Revised: 04 February 2026
Accepted: 05 February 2026
Published: 05 February 2026

https://www.aimspress.com/journal/Math

Editorial

Special issue "Advances in Partial Differential Equations: Theory, Methods and Applications"

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Partial differential equations (PDEs) constitute one of the most powerful and versatile frameworks in mathematical analysis, providing essential tools for describing physical phenomena, engineering systems, and complex geometric structures. This Special Issue, Advances in Partial Differential Equations: Theory, Methods and Applications, was conceived as a platform for presenting original contributions that advance both the theoretical foundations and practical methodologies of PDE analysis, whilst demonstrating their applicability to concrete problems in science and engineering.

The twenty papers published in this Special Issue reflect the breadth and depth of contemporary research in partial differential equations. They encompass a wide range of topics including existence and uniqueness theory, regularity of solutions, numerical methods, qualitative behaviour, boundary value problems, and applications to mathematical physics. Beyond their methodological diversity, these contributions share a common commitment to mathematical rigour and to advancing our understanding of the fundamental structures underlying differential equations.

The collection addresses several core themes in modern PDE theory. A significant group of papers focuses on elliptic and parabolic equations, examining regularity properties, variational formulations, and the interplay between analytic and geometric approaches. These works contribute to our understanding of how solutions behave under various structural assumptions and boundary conditions, with implications for both pure analysis and applications to physical models.

Another substantial theme concerns hyperbolic equations and evolution problems, where questions of well-posedness, stability, and long-time behaviour are addressed through sophisticated

analytical techniques. Several contributions develop new methods for treating nonlinear systems, exploring how energy estimates, functional spaces, and symmetry properties can be leveraged to establish existence theorems and characterise solution structures.

The Special Issue also includes important work on numerical methods and computational approaches. These papers demonstrate how modern numerical techniques—including finite element methods, spectral methods, and adaptive discretisation schemes—can be rigorously analysed and effectively implemented to solve challenging PDE problems. The interplay between theoretical analysis and computational practice remains essential for tackling equations that arise in complex applications.

Applications to physical sciences and engineering constitute another vital component of this collection. Several papers address specific equations arising in fluid dynamics, heat transfer, wave propagation, and materials science, showing how PDE methods provide both qualitative insights and quantitative predictions. These contributions highlight the continuing relevance of PDE theory to understanding natural phenomena and designing engineering systems.

Finally, the Special Issue features work on geometric and variational aspects of PDEs, including studies of free boundary problems, minimal surfaces, and geometric flows. These investigations demonstrate the deep connections between differential equations, differential geometry, and the calculus of variations, enriching our understanding of how geometric structures emerge from and influence PDE solutions.

This Special Issue received a total of 42 submissions, all of which were processed under the journal's rigorous peer-review procedures to ensure scientific quality, mathematical soundness, and thematic coherence. Finally, 20 papers were published. As Guest Editors, we sincerely thank all authors for their valuable contributions, the reviewers for their careful evaluations and constructive recommendations, and the editorial office of AIMS Mathematics for its dedicated support throughout the editorial process.

We hope that this Special Issue will serve as a useful reference for researchers working in partial differential equations and related fields, and that it will stimulate further investigations that advance both the theoretical understanding and practical applications of this central area of mathematical analysis.

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Conflict of interest

The Guest Editors declare no conflicts of interest.