



PREFACE

A Special Issue of the Indian Journal of Pure and Applied Mathematics

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The *Indian National Science Academy (INSA)* celebrates its **90th anniversary** in 2025. As part of this significant milestone, the Academy has planned a series of scientific activities and commemorative publications across its journals. The Publications Committee of INSA, chaired by Professor Virendra Tiwari (Vice-President, INSA), resolved to bring out this special issue featuring invited contributions by recently elected Fellows of INSA in the Mathematical Sciences.

This commemorative volume presents expository and research articles intended particularly for young researchers and advanced students. The papers survey active areas of current mathematical research while highlighting contributions from Indian mathematicians and collaborators worldwide. Together, they reflect the strength, vitality, and breadth of mathematical activity in India.

This special issue features ten articles covering algebraic geometry, number theory, analysis and partial differential equations, discrete mathematics, commutative algebra, probability theory, statistics, and computer science. **L. Sunil Chandran, Mathew Francis, and Suraj Kumar Sahoo** present a detailed survey on the *boxicity and cubicity of graphs*. They explore dimensional parameters of geometric intersection graphs, focusing on representations using axis-parallel boxes and cubes in Euclidean space. Their exposition, proof sketches, and techniques serve as an excellent entry point for researchers and a valuable reference for experts.

Amartya Dutta and Neena Gupta provide an expository account of remarkable advances in affine algebraic geometry, focusing on affine fibrations and affine forms. Their survey emphasizes substantial contributions from Indian mathematicians and outlines major developments shaping this vibrant field.

Eknath Ghate discusses recent progress on the *p-adic Local Langlands Correspondence*. He highlights his joint work with Anand Chitrao on the mod p reduction of semi-stable Galois representations of weights up to $p + 1$, leading to the resolution of his zig-zag conjecture for crystalline representations.

Divya Goel and K. Sreenadh review developments in nonlocal, nonlinear partial differential equations, with emphasis on Choquard-type equations, fractional Laplacians, Kirchhoff-type operators, and normalized solutions. They illuminate deep analytical structures and conclude with key open problems.

Neela Nataraj and Ramesh Sau review neural-network-based solvers — specifically the Deep Ritz Method, Physics-Informed Neural Networks (PINNs), and Variational PINNs — for Poisson problems with Dirichlet boundary conditions. They include rigorous error analysis and computational experiments evaluating practical effectiveness.

Nitin Nitsure offers a simplified approach to the celebrated Narasimhan–Seshadri theorem using holomorphic ordinary differential equations with logarithmic singularities, valid uniformly across non-negative genera of Riemann surfaces. His exposition makes this foundational geometric result more accessible.

A. Raghuram and Qiyao Yu introduce a new question in arithmetic statistics concerning the proportion of totally imaginary number fields that contain CM fields. Their study opens new directions in the broader context of counting number fields and their arithmetic properties.

Rahul Roy, Masato Takei, and Hideki Tanemura survey various models of Elephant Random Walks and provide a new proof of a result of Miyazaki and Takei. They also present open problems related to these memory-dependent random walks, inviting further probabilistic investigation.

K. Sandeep presents a comprehensive survey of partial differential equations on hyperbolic space, highlighting how curvature influences analysis and geometry. Topics include Sobolev and Hardy inequalities, symmetry phenomena, semilinear and quasilinear elliptic problems, and heat, Schrödinger, and wave equations.

Vijaylaxmi Trivedi concludes the volume with an exposition of the Hilbert–Kunz multiplicity in prime characteristic. She explains its role in studying singularities of algebraic varieties and describes vector-bundle methods and analytic techniques that yield effective results.

These articles together illustrate the diversity, rigour, and excellence of mathematical research in India. I thank all authors for their insightful contributions and the reviewers for their valuable feedback. It is my hope that this volume will serve as a useful resource and inspiration for young mathematicians.

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