Mathematics

@ National University of Singapore

Faculty & Research

The widespread penetration of mathematics into almost every area of science and technology has vastly expanded the opportunities available to mathematicians, both in traditional areas of pure and applied research and in emerging interdisciplinary areas.

The Department of Mathematics, with the combined capabilities and expertise of more than 70 faculty members and researchers, is engaging research that supports the on-going theoretical development of the mathematical sciences, and that simultaneously promotes the interdisciplinary use of mathematics in science, engineering and other fields.

For an overview of the diversity and focus of our research, we profile the main research groups in the Department in pure mathematics, and in applied and computational mathematics.
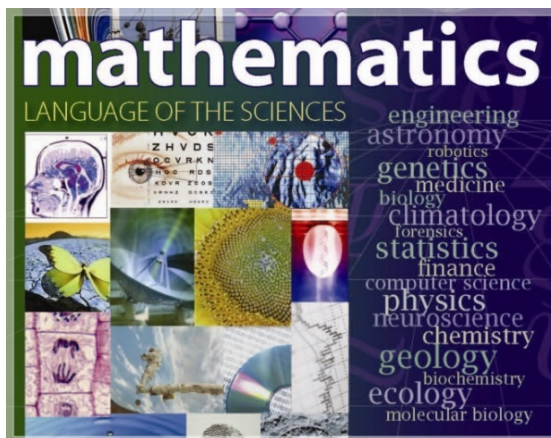
Research Groups (Pure Mathematics)

Algebra & Number Theory

Topics of interest include additive and analytic number theory, arithmetic algebraic geometry, automorphic forms, L-functions, cohomology of groups, representation theory of symmetric groups and related algebras.

BAO Huanchen *(PhD Virgina)*
CHAN Heng Huat *(PhD Illinois)*
CHIN Chee Whye *(PhD Princeton)*
GAN Wee Teck *(PhD Harvard)*

TAN Kai Meng *(PhD Cambridge)*
Victor TAN *(PhD UCLA)*
ZHANG Lei *(PhD Minnesota)*

Combinatorics & Graph Theory

Topics of interest include algebraic methods in combinatorics, graph theory, finite geometry, combinatorial designs and difference sets, rigidity of structures, as well as their applications in biology such as homology detection and gene duplication in comparative genomics.

LEUNG Ka Hin *(PhD Berkeley)*
MA Siu Lun *(PhD Hong Kong)*

NG Kah Loon *(PhD NUS)*
ZHANG Louxin *(PhD Waterloo)*

Dynamical Systems

Topics of interest include real and complex one-dimensional dynamics, complex dynamics in several variables, pluri-potential theory and applications in dynamics and related fields, dynamics of group actions on varieties, geometric structures of complex varieties equipped with automorphisms of positive entropy.

DINH Tien Cuong *(PhD Paris 6)*
TAN Ser Peow *(PhD UCLA)*
ZHANG De-Qi *(PhD Osaka)*
ZHANG Tengren *(PhD Michigan)*
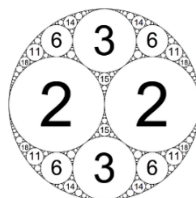
Geometry & Topology

Topics of interest include algebraic geometry, complex geometry, geometric analysis, global differential geometry and mathematical physics, gauge theory, Higgs bundles, homotopy theory, knot theory, geometric structures on surfaces and three manifolds.

AN Xinliang *(PhD Princeton)*
HAN Fei *(PhD Berkeley)*
Brett McINNES *(PhD Sydney)*
TAN Ser Peow *(PhD UCLA)*
TO Wing Keung *(PhD Columbia)*

WONG Yan Loi *(PhD Berkeley)*
ZHANG De-Qi *(PhD Osaka)*
ZHANG Tengren *(PhD Michigan)*

Mathematical Logic & Theoretical Computer Science

Topics of interest include set theory, set theoretic topology, recursion theory, models of Peano arithmetic, reverse mathematics, inductive inference, automata theory and formal languages, information theory and performance modeling.

CHONG Chi Tat *(PhD Yale)*
Dilip RAGHAVAN *(PhD Wisconsin)*
Frank STEPHAN *(PhD Karlsruhe)*

TAY Yong Chiang *(PhD Harvard)*
YANG Yue *(PhD Cornell)*

Partial Differential Equations & Geometric Analysis

Topics of interest include problems on conformal geometry and their applications to Riemannian geometry and mathematical physics; Boltzmann equation, conservation laws, turbulent flows and nonlinear reaction-diffusion equations.

AN Xinliang (PhD Princeton)
BAO Weizhu (PhD Tsinghua)
DAI Min (PhD Fudan)
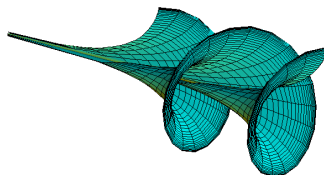LI Qianxiao (PhD Princeton)

LEUNG Man Chun (PhD Michigan)
PANG Peter Yu Hin (PhD Illinois)
TONG Xin, (PhD Princeton)
YU Shih-Hsien (PhD Stanford)

Probability

Topics of interest include disordered systems such as random polymer models in random media, interacting particle systems, random matrices, Schramm-Loewner evolution, Stein's method, stochastic differential equations, and applications to computational biology and finance.

Louis CHEN *(PhD Stanford)*
CHOI Kwok Pui *(PhD Illinois)*
Subhroshekhar GHOSH (PhD Berkeley)
SUN Rongfeng *(PhD NYU)*

WANG Dong *(PhD Brandeis)*
ZHOU Chao *(PhD EcolePoly)*
ZHOU Wang *(PhD HKUST)*

Real, Functional & Harmonic Analysis

Topics of interest include classical analysis, differential equations, Sobolev spaces, Banach space theory, operator algebras, time-frequency analysis, nonstandard analysis and applications to economics.

CHUA Seng Kee *(PhD Rutgers)*
GOH Say Song *(PhD Michigan)*
SHEN Zuowei *(PhD Alberta)*

SUN Yeneng *(PhD Illinois)*
TANG Wai Shing *(PhD Toronto)*

## Representation Theory & Automorphic Forms

Topics of interest include invariant theory, algebraic combinatorics, unitary representations, branching laws, theta correspondence, automorphic representations and L-functions.

BAO Huanchen (PhD Virgina)
GAN Wee Teck *(PhD Harvard)*
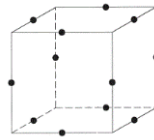LEE Soo Teck *(PhD Yale)*
LOKE Hung Yean *(PhD Harvard)*

TAN Eng Chye *(PhD Yale)*
ZHANG Lei *(PhD Minnesota)*
ZHU Chen-Bo *(PhD Yale)*
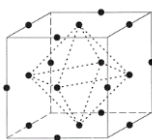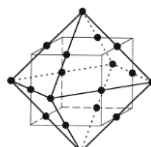
Research Groups (Applied and Computational Mathematics)

Computational Biology & Bioinformatics

The group conducts research in modern biology problems by tapping on strengths in combinatorics, probability and statistics. Our current interests include detection of functional signals in biological sequences and protein networks, algorithms and models for inference of gene duplication history and reconstruction of phylogenetic networks, and discovery of the topological and dynamic principles of transcriptional regulatory networks.

Louis CHEN *(PhD Stanford)*   ZHANG Louxin *(PhD Waterloo)*
CHOI Kwok Pui *(PhD Illinois)*

Imaging & Vision Science

This multidisciplinary research group emphasizes the synergy of mathematics, engineering and computer science in the areas of imaging science, computer vision, information theory and learning. Topics of interest include wavelet frame methods in imaging science, compressive sensing, data assimilation, low rank matrix completion and their applications, time-frequency and scale-space methods in signal processing, human and computer vision, and the interplay between information theory and statistical learning.

GOH Say Song *(PhD Michigan)*   TAN Yan Fu, Vincent *(PhD MIT)*
JI Hui *(PhD Maryland)*   TAN Hwee Huat *(PhD Adelaide)*
LI Qianxiao (PhD Princeton)   Tong Xin (PhD Princeton)
Jonathan SCARLETT (PhD
Cambridge)
SHEN Zuowei *(PhD Alberta)*

Daubechies 4 tap wavelet
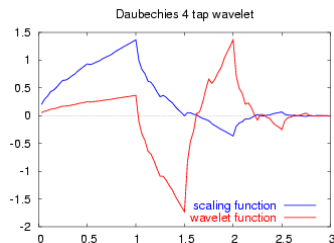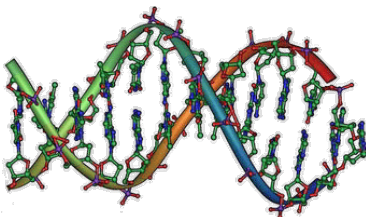
Mathematical Finance & Mathematical Economics

The group works in the interface of mathematics with finance and economics. Topics of interest include pricing of financial derivatives, portfolio selection, risk measure, fixed income products, credit risk, trading strategy, fintech, games with imperfect information or with many players or with location problems, random matching of economic agents, incentive compatibility problems in a large market with asymmetric information.

CHEN Ying (PhD Humboldt-Berlin)   Marko WEBER (PhD SNS di Pisa)
DAI Min *(PhD Fudan)*   ZHOU Chao *(PhD EcolePoly)*
SUN Yeneng *(PhD Illinois)*

Numerical Analysis & Scientific Computing

The group focuses on the design and analysis of efficient, accurate and robust numerical methods and their applications to applied sciences and engineering. Topics include numerical linear algebra, computational fluid dynamics, computational materials science, multi-phase/complex fluids, computational quantum and plasma physics, control theory, analysis of finite element and spectral methods, analysis and modeling of complex energy landscapes and barrier-crossing events, multi-scale/multi-physics methods, and emerging applications.

BAO Weizhu (PhD Tsinghua)   *LI Qianxiao (PhD Princeton)*
CAI Zhenning (PhD Peking)   *REN Weiqing (PhD NYU)*
CHU Delin (PhD Tsinghua)   *TAN Roger (PhD La Trobe)*
Simon ETTER (PhD Warwick)   *TOH Kim Chuan (PhD Cornell)*

Optimization

The group works mainly on the analysis, design and implementation of algorithms for continuous optimization, possibly with stochastic variables. Topics of interest include conic programming and its applications, interior point methods, nonsmooth Newton methods, augmented Lagrangian methods, iterative methods for large linear systems of equations, feasibility problems, first order methods, stochastic gradient descent and data analysis.

CAI Zhenning (PhD Peking)　　　　*TONG Xin, (PhD Princeton)*
LI Qianxiao (PhD Princeton)　　　　*ZHAO Gong Yun (PhD Wuerzburg)*
TOH Kim Chuan (PhD Cornell)

- *Editorial Board Membership in over 60 International Journals, including*

- Computability, Ergodic Theory Dynam. Systems, Internat. Math. Res. Notices, J. Inst. Math. Jussieu, J. Math. Logic, Manuscripta Math., Math. Z., Represent. Theory

- Appl. Comput. Harmon. Anal., Math. Comp., Multiscale Model. Simul., SIAM J. Math. Anal., SIAM J. Sci. Comput.

- Math. Programming A, Math. Programming B, Math. Programming Comput., Math. Oper. Res., SIAM J. Optim.

- Econom. Theory, J. Econom. Dynam. Control, Math. Finance

- Automatica, Genomics, Proteomics & Bioinform., J. Comput. Syst. Sci.

International Awards

- BAO Huan Chen, 2020, Chevalley Prize in Lie Theory (jointly with Wang Weiqiang of the University of Virginia)

- DINH Tien Cuong, 2018, Humboldt Research Award

- TOH Kim Chuan, SUN Defeng and their former graduate student YANG Liuqin (PhD, 2016), 2018, Beale-Orchard-Hays Prize for Excellence in Computational Mathematical Programming

- TOH Kim Chuan, 2017, Farkas Prize of the INFORMS Optimization Society

- REN Weiqing, 2015, 11th Feng Kang Prize for Scientific Computing by the Chinese Society of Computational Mathematics

- BAO Weizhu, 2013, 10th Feng Kang Prize for Scientific Computing by the Chinese Society of Computational Mathematics

- SHEN Zuowei, 2012, Wavelet Pioneer Award by the Society of Photographic Instrumentation Engineers (jointly with Bin DONG, University of Arizona)

- SHEN Weixiao, 2009, Chern Shiing-Shen Prize by the Chinese Mathematical Society

Invited Talks in Selected Major Conferences

- International Congress of Mathematicians (ICM), Rio de Janeiro, Brazil, 2018
  - DINH Tien Cuong (Analysis and Operator Algebras)

- International Congress on Industrial and Applied Mathematics (ICIAM), Beijing, China, 2015
  - SHEN Zuowei

- International Congress of Mathematicians (ICM), Seoul, South Korea, 2014
  - BAO Weizhu (Mathematics in Science and Technology)
  - GAN Wee Teck (Number Theory)
  - SHEN Weixiao (Dynamical Systems and ODE)
  - YU Shih-Hsien (Partial Differential Equations)

- SIAM Conference on Optimization, Darmstadt, Germany, 2011
  - SUN Defeng

- International Congress of Mathematicians (ICM), Hyderabad, India, 2010
  - SHEN Zuowei (Numerical Analysis and Scientific Computing)

- SIAM Annual Meeting, Pittsburgh, USA, 2010
  - TOH Kim Chuan