STUDY IN FRANCE

RESEARCH IN MATHEMATICS

"More than any other city on the planet, Paris is the world's center for mathematics..." **A unique mathematics community has once again been confirmed and outstanding with the announcement of the 13th French winner of the Fields Medal in 2014 and the Abel Prize in Mathematics awarded to Yves Meyer in 2017.**

An observation made by French mathematician Marcel Berger, the internationally recognized expert in differential geometry, who has spent part of his working life in America and Japan, was confirmed in a survey carried out by the open web resource ScienceWatch in 2005. With the Institute of Advanced Scientific Studies (IHES, 5 Fields Medals), *École Normale Supérieure* (ENS, Paris), and the universities of Paris-Sud (3 Fields Medals), Sorbonne Université, Paris Diderot (Paris 7), Paris-Dauphine, and Paris-Est Créteil Val-de-Marne (UPEC), Paris and its surrounding area still represent the largest concentration of mathematicians in the world. Also of great importance are the universities of Bordeaux, Grenoble, Lyon, Marseille, Nice, Strasbourg, and Toulouse, with around forty shared research laboratories with the National Center for Scientific Research (CNRS) and the National Institute for Research in Computer Science and Automation (INRIA).

A LONG TRADITION OF MATHEMATICS

The century of Louis XIV was also that of Descartes, Fermat, and Pascal. At the time of the Revolution, Laplace, Lagrange, Legendre, Condorcet, d'Alembert, and Monge were the leading figures in mathematics. They, in turn, were followed by Fourier, Cauchy, Galois, Poncelet, and Chasles – a line of succession just as impressive, if less often invoked, as that linking France's writers. We forget that at the outset of the 19th century more renowned foreign scholars arrived in Paris for its scientific culture than for its literary dazzle. By the end of the century and into the early 20th century, the capital hosted prominent personalities such as Jordan, Borel, Lebesgue, and Lévy, among others or a genius such as Poincaré, whose portrait photographed by Smith was first published in October 1889 in the *American Journal of Mathematics*.

" Over 4 000 mathematicians work in the academic sector in France "

The 1930's saw the founding of the Bourbaki group, which revolutionized Mathematics, preparing the way for the prodigious expansion of the 1950's and beyond. The reasons for that expansion are many: an increase in the theoretical research that underpins practical applications in every economic sector, in parallel with the explosion of computer science and robotics; the "*mathematicization*" of economic analysis; the flexibility and diversity of the system of mathematical research, which had been freed from some of the constraints of the university system by the emergence of other sources of financing; the autonomy of mathematical researchers, who are less dependent on large budgets than researchers in some other disciplines; the arrival in France of Russian mathematicians; the prestige in France of pure intellectual research; and the commitment of great mathematicians to the freedom of thought and criticism such as Alexandre Grothendieck (1928-2014), who was stateless for a long time before being made a French national in 1971 and who was trained and worked in France.

Over 4 000 mathematicians work in the academic sector in France, and around 10% are researchers in public research organizations such as the National Center for Scientific Research (CNRS), the National Institute for Research in Computer Science and Automation (INRIA), and the National Institute for Statistics and Economic Studies (INSEE).

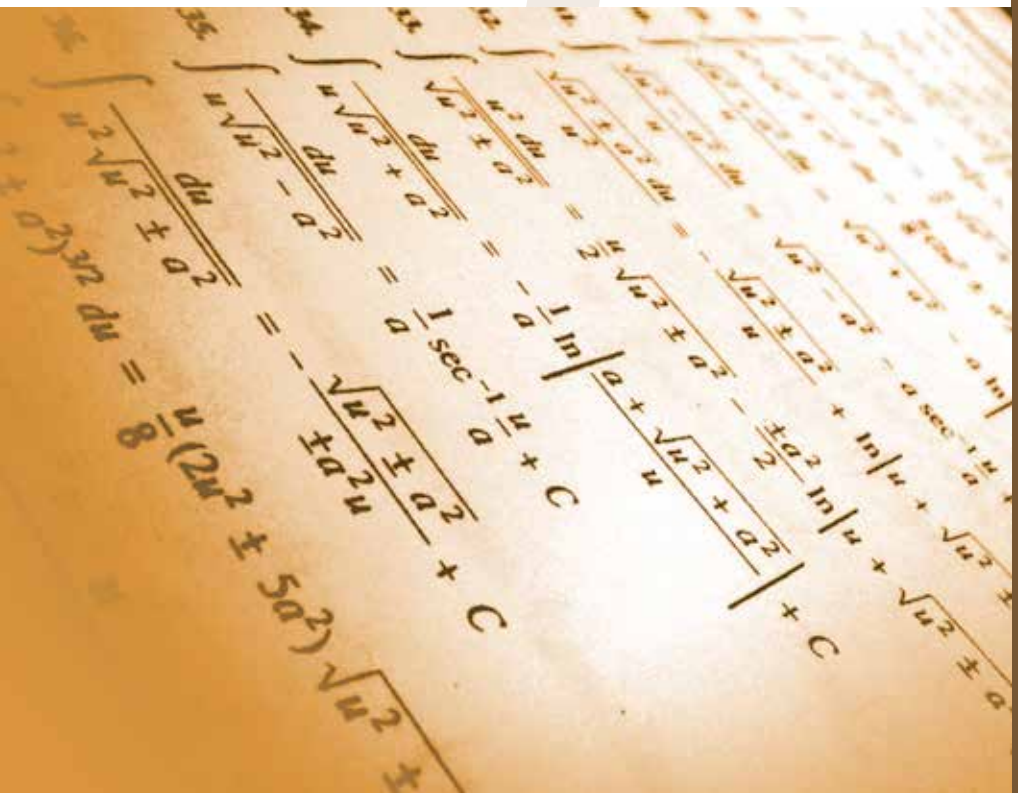
INTERACTIONS BETWEEN MATHEMATICS AND ITS NEW FIELDS OF APPLICATION

As in many other fields, the distinction between pure and applied science has lost much of its validity: the chaos theory of Poincaré, the risk theory of American Frank Knight, and probability and statistical theory are of widespread and compelling interest to economists, political decision makers, insurance companies, military planners, and business leaders. No one in a position of major responsibility can afford not to take the careful look that mathematics makes possible. The mathematical approach and its methods can be used in various scientific disciplines, including automation, computer science, electronics, physics, engineering, and information, communication technologies, social sciences and health.

PARTIAL DIFFERENTIAL EQUATIONS

MODEL PHENOMENA IN CLIMATOLOGY, POPULATION DYNAMICS, ECONOMICS, ENVIRONMENT, FINANCE, DIGITAL, AND ARTIFICIAL INTELLIGENCE.

- A French-American study demonstrated that the spread of epidemics can be better understood by using mathematical models for air transportation.
- Meteorologists use Mathematics to understand atmospheric mechanisms and to analyze and anticipate changes in the weather and the climate.
- Advances in Physics, are inconceivable without high-level mathematics. The geometry of the universe poses fundamental problems, as do applications of chaos theory in Astrophysics.
- Crystal symmetries may be explained by very sophisticated algebraic theories. Biology uses attractors similar to those defined by the dynamical systems of chaos theory. Mathematical models in Ecology (predators and preys) reveal interactions that lie at the origin of species.



THE FIELDS MEDAL: 13 OF THE 60 WINNERS ARE FRENCHS

The Fields Medal is the most prestigious international honor in mathematics, awarded every four years since 1936 to mathematicians under the age of 40. The first French mathematician to receive the award in 1950 was Laurent Schwartz, alumnus of *École Normale Supérieure* and professor at *École Polytechnique*. More recent medalists serve as proof of continued excellence in French mathematics, including Laurent Lafforgue (2002), an alumnus of *École Normale Supérieure (ENS)* and professor at the Institute of Advanced Scientific Studies (IHES), Wendelin Werner (2006), professor at Paris-Sud 11 University and *École Normale Supérieure*, Cédric Villani, director of the Henri Poincaré Institute in Paris (*Sorbonne Université - CNRS*) and professor at *École Normale Supérieure* in Lyon, and Ngô Bảo Châu, professor at Paris-Sud University. On August 13, 2014, the Fields Medal was awarded to the French-Brazilian mathematician Artur Âvila, director of research at the Jussieu-Paris Rive Gauche Institute of Mathematics (*CNRS - Paris Diderot University - Sorbonne Université*) and working at the Rio de Janeiro Institute of Pure and Applied Mathematics. His award thus confirms France's place on the international podium, second only to the United States (15 winners).

CREATED IN 2003, THE ABEL PRIZE HAS ALREADY BEEN AWARDED TO FOUR FRENCH MATHEMATICIANS:

In 2017, the Norwegian Academy of Sciences and Letters recognized Yves Meyer of the École Normale Supérieure Paris-Saclay for his important role in the development of the mathematical theory of wavelets.

Jean-Pierre Serre of *Collège de France* (2003), who also won the Fields Medal at the age of 28, Jacques Tits (2008), joint laureate with the American John Griggs Thompson of *Collège de France*, and Franco-Russian Mikhail Leonidovich Gromov (2009), professor at the Institute of Advanced Scientific Studies (IHES).

STATISTICS AND DATA PROCESSING

Statistics plays a role in many research domains. It is defined as "the collection and representation of data" (constructing categories and naming them) and is used most extensively in surveys carried out in France by major national institutions such as INSEE and INED. Descriptive (or exploratory) statistics works on raw data to try and extract meaning, structures, patterns, and laws. Inferential statistics is based on the notion of a probabilistic model for developing mathematical tools with which to compare a scientific model or hypotheses and experimental or observational data.

Statistics is situated both within mathematics, from which it borrows many tools (geometry, analysis, calculus, algebra) while also creating its own mathematical objects, and outside of mathematics, with applications in many fields (biology, physics, economics, social sciences). The specificity of statistics is that it also attempts to model induction, although some mathematicians do not regard statistics as being within the realm of mathematics (*Patrice Bertail, «Statistique et recherches en France: Quelques perspectives,» Insee-CREST, Courrier des Statistiques, 117-119, 2006*).

Statistics has made major advances in French universities and research institutions, a development linked to a considerable demand for statistics and probability, which are strongly represented in French research and enjoy a flourishing and internationally recognized reputation. Researchers from applied research institutions such as INRA or INSERM thus have a dual competence, and higher education institutions such as ENSAE, ENSAI, and ISUP train students in specific domains of application.

Labex Ecodec is a laboratory of excellence that gathers together research professors in economics and statistics: **http://labex-ecodec.fr**

> Center for Secure Data Access (CASD): **http://casd.eu**

The CASD offers researchers a facility designed for working on highly detailed individual data. Access to the data is usually subject to a confidentiality agreement and is provided under optimal conditions of high security. More than 500 researchers participate in over 200 research projects.

> Center for Research in Economics and Statistics (CREST): **www.crest.fr**

> National School of Statistics and Economic Administration (ENSAE ParisTech): **www.ensae.fr**

> National School of Statistics and Information Analysis (ENSAI): **www.ensai.fr**

> ENSAI-ENSAE Further Training (CEPE): **www.lecepe.fr**

> National Economics and Statistics Schools Group (GENES): **www.groupe-genes.fr**

> National Institute of Demographic Studies (INED): **www.ined.fr**

> National Institute of Statistics and Economic Studies (INSEE): **www.insee.fr**

> UPMC Institute of Statistics (ISUP): **www.isup.upmc.fr**

THE CNRS NATIONAL INSTITUTE OF MATHEMATICAL SCIENCES AND THEIR INTERACTIONS (INSMI)

INSMI's mission is to promote excellence in French mathematics built on a solid basis consisting of:

> 50 shared Research and Service Units (principally university laboratories);

> 13 Research Federations (regional associations of laboratories);

> 9 International Mixed Units, 9 International Associate Laboratories, 7 groups combining international research;

> 3,600 researchers and research professors and 1,500 doctoral and 200 postdoctoral researchers.

www.cnrs.fr/insmi

USEFUL LINKS

LEARNED SOCIETIES (*SOCIÉTÉS SAVANTES*)

These associations gather together the majority of mathematicians in France for various activities, projects, colloquiums, discussions, thematic group meetings, publications, and prize-givings and collaborate with research organizations:

- Society of Applied and Industrial Mathematics (SMAI): **http://smai.emath.fr**
- French Mathematical Society (SMF): **http://smf.emath.fr**
- French Statistical Society (SFdS): **www.sfds.asso.fr**

FEDERATIONS

- ARC Mathématiques (Amiens) : **http://arcmath.math.cnrs.fr**
- Bézout Research Federation (Labex Bézout): **http://bezout.univ-paris-est.fr**
- CentraleSupélec, Paris Central School Mathematics Federation (Chatenay-Malabry): **www.centralesupelec.fr**
- Denis Poisson Federation (Orléans) : **www.fdpoisson.fr**
- FCH, Charles Hermite Automation, Computer Science, and Mathematics Federation of Lorraine (Metz, Nancy): **www.fr-hermite.univ-lorraine.fr**
- FLMSN, Lyon Modeling and Digital Sciences Federation (Lyon): **https://flmsn.univ-lyon1.fr**
- FRMNPC, Nord Pas-de-Calais Mathematical Research Federation(Lille): **http://federation-math.univ-lille1.fr**
- FRMPL, Pays de Loire Mathematical Research Federation (Angers, Le Mans, Nantes): **www.fpl.math.cnrs.fr**
- FRMRAA, Rhône-Alpes-Auvergne Mathematical Research Federation (Clermont-Ferrand, Grenoble, Lyon): **http://frmraa.math.cnrs.fr**
- FRUMAM, Marseille Mathematical Units Research Federation: **http://frumam.cnrs-mrs.fr**
- Inner Paris Mathematical Sciences Research Federation: **www.sciencesmaths-paris.fr**
- NM, Normandy Mathematics Federation (Caen, Le Havre, Rouen): **http://normandie.math.cnrs.fr**

KEY ORGANIZATIONS AND INSTITUTIONS

- CAMS, Center for Social Analysis and Mathematics (Paris): **http://cams.ehess.fr**
- CERMICS, Teaching and Research Center for Mathematics and Scientific Calculus (Marne-la-Vallée): **https://cermics-lab.enpc.fr**
- CIMPA, International Center for Pure and Applied Mathematics (Nice): **www.cimpa.info**
- CIRM, International Center for Mathematical Engagement (Marseille): **www.cirm.univ-mrs.fr**
- CMAP, Center for Applied Mathematics (Palaiseau): **www.cmap.polytechnique.fr**
- CMLA, Center for Mathematics and its Applications (Cachan): **www.cmla.ens-cachan.fr**
- CMLS, Laurent Schwartz Mathematics Center at École Polytechnique (Palaiseau): **www.centremaths.polytechnique.fr**
- ENS, École Normale Supérieure, Paris, Department of Mathematics and Applications: **www.math.ens.fr**
- ICJ, Camille Jordan Institute (Lyon, Saint-Étienne): **http://math.univ-lyon1.fr**
- IECL, Élie Cartan Institute of Lorraine (Vandoeuvre-lès-Nancy): **http://iecl.univ-lorraine.fr**
- IHES, Institute of Advanced Scientific Studies: **www.ihes.fr**
- IHP, Henri Poincaré Institute – Home of Mathematics and Theoretical Physics (Paris): **www.ihp.fr**
- IMB, Bordeaux Institute of Mathematics: **https://www.math.u-bordeaux.fr/imb/**
- I2M, Marseille Institute of Mathematics: **https://www.i2m.univ-amu.fr**
- I3M, Montpellier Institute of Mathematics: **www.mathfds.univ-montp2.fr**
- Jacques Hadamard Mathematics Research Library (Orsay): **https://bibliotheque.math.u-psud.fr**
- INRIA, National Institute for Research in Computer Science and Automation: **www.inria.fr**
- INSMI, National Institute of Mathematical Sciences and their Interactions (Paris): **www.cnrs.fr/insmi**
- IRMA, Institute of Advanced Mathematical Research (Strasbourg): **http://irma.math.unistra.fr**
- Lagrange Laboratory (Nice): **https://lagrange.oca.eu**
- LAMA, Laboratory of Applied Analysis and Mathematics (Marne-la-Vallée): **http://umr-math.univ-mlv.fr**
- LaMME (Évry Laboratory of Mathematics and Modeling): **http://www.math-evry.cnrs.fr/doku.php**
- LAMA, Laboratory of Mathematics (Annecy, Chambéry): **www.lama.univ-savoie.fr**
- LJK, Jean Kuntzmann Laboratory (Grenoble): **www-ljk.imag.fr**
- LMAP, Laboratory of Mathematics and its Applications (Pau): **http://lma-umr5142.univ-pau.fr**
- LMBA, Bretagne Atlantique Laboratory of Mathematics (Brest, Vannes): **www.lmba-math.fr**
- Toulouse Institute of Mathematics: **www.math.univ-toulouse.fr**
- UMPA-ENSL, Unit of Pure and Applied Mathematics (Lyon): **www.umpa.ens-lyon.fr**

OTHER SITES

- Directory of the French mathematical community: **http://annuaire.emath.fr**
- Directory of mathematical research laboratories and units: **https://portail.math.cnrs.fr/annuaire/Laboratoires/**
- E-math.fr, the website for mathematics in France: **www.emath.fr**
- MATEXO, pedagogical resources for higher education mathematics professors: **http://matexo.smai.emath.fr**
- M4TH, Portal dedicated to members of the higher education mathematics teaching and research community: **https://www.portail-math.fr**
- European Mathematical Information Service: **http://emis.u-strasbg.fr**

FRENCH RESEARCH PORTAL

WWW.CAMPUSFRANCE.ORG/EN/RESEARCHER

A UNIQUE, **ONLINE-ACCESS INFORMATION POINT** FOR LOCATING RESEARCH PROJECTS

UNDERSTANDING FRENCH RESEARCH

> Understanding how PhDs operate in France;
> Knowing how to start and finance a PhD;
> Applying to international research programs (Hubert Curien Partnerships, *Make Our Planet Great Again*).

DIRECTORY OF DOCTORAL INSTITUTIONS

Point of entry for starting a PhD and the 270 doctoral institutes organizing and supervising doctoral training.
> Search by key words, regions, and disciplines;
> Comprehensive information on doctoral institutions: Research areas, criteria and points of contacts for admission, welcome mechanisms, proposed topics, current financing, international dimension, and points of contacts for associated research laboratories;
> Access to fields offered by each doctoral institutions.

14 doctoral schools in mathematics, accessible at:
https://doctorat.campusfrance.org

PhD TOPICS, LABORATORY INTERNSHIPS, AND POST-DOCTORAL STUDIES:

> Offers financed through doctoral contracts, Industrial agreements for training through research (CIFRE), and specific offers devoted to programs financed by foreign governments;
> Offers for internships for experience in laboratory research;
> Post-doctoral offers for work in French laboratories;
> A detailed financing mechanism for each research offer (PhD topics, post-docs, and internships);

Almost 50 offers made public in Mathematics each year, accessible at:
https://doctorat.campusfrance.org/phd/offers
> «Maths» in «Domains and Disciplines»

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