Graduate School of
MATHEMATICAL SCIENCES
THE UNIVERSITY OF TOKYO

April 2013

THE UNIVERSITY OF TOKYO

Contents

A Message from the Dean

Takashi TSUBOI
Dean of the Graduate School of Mathematical Sciences
The University of Tokyo

The Graduate School of Mathematical Sciences was established in 1992 in order to foster a culture of mathematics and mathematical sciences from an international standpoint, as well as to contribute to the overall development of society. It is a unified graduate school for mathematics and related areas, and the Graduate School of Mathematical Sciences is in full charge of mathematics education at the University of Tokyo.

We accept each year 53 graduate students for our Master program and 32 for the Ph.D. program. The courses of the Graduate School are given in all fields of mathematical sciences, from algebra, geometry, and analysis to applied mathematics. The courses and seminars are in English when there are students who do not speak Japanese. Besides these courses, we invite many researchers from businesses and private universities to teach application-oriented subjects including economics, finance and information technology. We have courses to train students in actuarial and statistical sciences, which are directly connected to real world experience. Students conduct research in an independent and fulfilling environment, supported from time to time by their thesis advisors. They study as independent scholars with free and ample access to various facilities. For example, the library of the Graduate School of Mathematical Sciences is one of the best libraries in mathematics in the world. The graduates of the School work at universities and colleges, research institutes, government ministries, finance and insurance institutions, information technology companies, and so forth. They actually contribute the development of society in many fields.

The Leading Graduate Course for Frontiers of Mathematical Sciences and Physics (FMSP) started in 2012. This is qualified as a "Program for Leading Graduate Schools, Japan Society for the Promotion of Science and Ministry of Education, Culture, Sports, Science and Technology". This course is run by the Graduate School of Mathematical Sciences in close collaboration with the School of Science and the Kavli Institute for the Physics and Mathematics of the Universe. FMSP aims to foster global leaders who will be able to develop the mathematical sciences as well as to apply them to other sciences or industry and thus to contribute to society as a whole.

The Graduate School grew out of two independent departments of mathematics that existed within the University of Tokyo: one in the Faculty of Science on the Hongo campus and the other in the College of Arts and Sciences on the Komaba Campus. All the faculty members of these two departments joined in the new graduated school in 1992. Hence, the year 2012 was the 20th anniversary of the establishment of the Graduate School of Mathematical Sciences. We have our building of the Graduate School of Mathematical Sciences at the southeast edge of the Komaba Campus since 1995.

Presently, the number of tenured professors and associate professors of the Graduate School of Mathematical Sciences is about 55. Besides tenured professors and associate professors, we have visiting professors and overseas visiting professors. Members of the Graduate School conduct leading-edge research in all fields of mathematical sciences, from algebra, geometry, and analysis to applied mathematics. The long tradition of advanced scholarly research since before the merger of the two departments of mathematics helps the Graduate School of Mathematical Sciences function as an international research center. We host over 150 researchers from around the world each year and there are many overseas exchange students in the Graduate School. Thus we are truly an international mathematics hub. In 2005, we established the Tambara Institute of Mathematical Sciences in Gunma Prefecture, a mountain villa devoted to seminars and summer schools with a full hostel service, as a venue for international researchers to meet and interact.

Even in these 20 years, we experienced a new stage in the evolution of mathematics. There has been tremendous progress in areas where pure mathematics and other branches of sciences collude, and mathematical knowledge has become the backbone of various sciences like physics, biology, chemistry, information theory, engineering, economics, etc. These developments show the importance of collaborations with other branches of sciences as well as with the society. To accelerate the collaborations, the Interdisciplinary Center for Mathematical Sciences (ICMS) is established in the Graduate School in 2013.

As is already mentioned, we are intimately collaborating with the Kavli Institute for the Physics and Mathematics of the Universe (Kavli-IPMU) which is the first institute in Todai Institutes for Advanced Study (TODIAS). It was founded in 2007 by the World Premier International Research Center Initiative (WPI) of the Japanese government. It received a very high international evaluation and it became a member of the Kavli institutes in this year 2012.

Within the University of Tokyo, the department of mathematics has a long history. It was founded in 1881 and it has always managed to keep its long tradition of sustaining a high academic level. It has maintained a rich library collection, a common research room, and it succeeds in sending graduates to fulfill a wide variety of roles in society. In keeping with these fine traditions, the Graduate School of Mathematical Sciences aims at fulfilling its social duty by offering excellent education and by producing outstanding research results. All members of the Graduate School of Mathematical Sciences will make every effort to meet these exciting challenges.

Brief History

April 1877
The University of Tokyo is established, and the Department of Mathematics, Physics and Astronomy is placed in the Faculty of Science.

September 1881
The Department of Mathematics, Physics and Astronomy is divided into three separate departments.

May 1949
The College of Arts and Sciences is added to the University of Tokyo, in which a separate Department of Mathematics is established.

March 1953
The present-day Graduate School is formed, in which the members of the Department of Mathematics in the Faculty of Science and the Department of Mathematics in the College of Arts and Sciences begin educating graduate students.

April 1962
The Department of Pure and Applied Sciences is established in the College of Arts and Sciences.

April 1992
A new Division of Mathematical Sciences of the Graduate School is formed, consisting of a single Department of Mathematical Sciences combining all the mathematics faculty in the University.

August 1995
The first phase of the construction of a new building for the Department of Mathematical Sciences is completed.
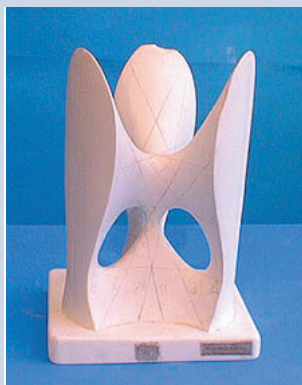
March 1998
The second phase of the construction of the new Mathematical Sciences building is completed.

April 2004
All National Universities were transformed into National University Corporations, including The University of Tokyo.

April 2013
The "Interdisciplinary Center for Mathematical Sciences" was established at the Graduate School of Mathematical Sciences.

Faculty

Professors and Associate Professors

Name	Field of Interest	Keywords
ARAI, Hitoshi	Frame Theory	Applications of frames
ASUKE, Taro	Differential Topology	foliations, geometric structures, characteristic classes
FUNAKI, Tadahisa	Probability Theory	hydrodynamic limit, stochastic partial differential equations
FURUTA, Mikio	Low Dimensional Topology, Global Analysis	4-dimensional manifold, gauge theory
FUTAKI, Akito	Differential Geometry	Kähler geometry, geometric analysis, symplectic geometry, contact geometry
GIGA, Yoshikazu	Nonlinear Analysis	Navier-Stokes equations, calculus of variation, viscosity solutions, level set method, nonlinear parabolic partial differential equations, crystal growth
HASEGAWA, Ryu	Theoretical Computer Science	lambda calculus, type theory, category theory, proof theory
HAYASHI, Shuhei	Dynamical Systems	hyperbolicity, homoclinic bifurcations, ergodic theory
HIRACHI, Kengo	Differential geometry, Several complex variables	parabolic geometries, CR geometry, conformal geometry, Bergman kernel, strictly pseudoconvex domains
HOSONO, Shinobu	Mathematical Physics	Calabi-Yau manifolds, mirror symmetry
ICHII, Shingo	Computer Science	computer network, distributed computing, Internet technology and operation
IMAI, Naoki	Arithmetic Geometry	Galois representation, moduli space
INABA, Hisashi	Mathematical Population Dynamics, Mathematical Biology, Mathematical Demography	structured population dynamics, mathematical models for demography and epidemiology
ISHII, Shihoko	Algebraic Geometry, Singularities	jet schemes, arc spaces, log canonical singularities, multiplier ideals
KANAI, Masahiko	Geometry	rigidity of foliations and group actions
KATAOKA, Kiyoomi	Partial Differential Equations, Hyperfunctions, Microlocal Analysis	pseudodifferential operators, microfunctions, boundary value problems
KATO, Akishi	Mathematical Physics	conformal field theory, string theory, integrable systems
KAWAHIGASHI, Yasuyuki	Operator Algebras	von Neumann algebras, subfactors, algebraic quantum field theory
KAWAMATA, Yujiro	Algebraic Geometry	Kodaira dimension, classification theory, minimal model
KAWAZUMI, Nariya	Differential Topology, Complex Analysis	moduli spaces of Riemann surfaces, mapping class groups, Goldman-Turaev Lie bialgebras
KOBAYASHI, Toshiyuki	Lie Theory, Representation Theory, Geometric Analysis	unitary representation, discontinuous groups, homogeneous spaces, visible actions on complex manifolds, minimal representations, branching laws, semisimple Lie group, algebraic analysis

Faculty

Name	Field of Interest	Keywords
KOHNO, Toshitake	Topology, Mathematical Physics	braid groups, quantum groups, conformal field theory
KUSUOKA, Shigeo	Probability Theory and its Application	stochastic analysis, mathematical finance
MATANO, Hiroshi	Nonlinear Partial Differential Equations	qualitative studies of nonlinear partial differential equations -- mainly elliptic and parabolic equations -- that arise in physics, biology and other fields of science and geometry, with emphasis on the global and dynamical structure of solutions
MATUMOTO, Hisayosi	Representation Theory	Whittaker vectors, generalized Verma modules, unitary degenerate series
MATSUO, Atsushi	Groups, Lie Algebras and Integrable Systems	infinite-dimensional Lie algebras, vertex operators, monstrou moonshine, conformal field theories, quantum groups
MIYAMOTO, Yasuhito	Nonlinear Partial Differential Equations	nonlinear parabolic and elliptic partial differential equations, bifurcation analysis, qualitative studies of solutions
MIYAOKA, Yoichi	Algebraic Geometry, Complex Manifolds	algebraic varieties, vector bundles, characteristic classes
NAKAMURA, Shu	Differential Equations, Mathematical Physics	Schrödinger equations, scattering theory, spectral theory
ODA, Takayuki	Number Theory	automorphic forms, discontinuous groups, arithmetic homotopy, Hodge structures
OGATA, Yoshiko	Mathematical Physics	quantum statistical physics
SAITO, Takeshi	Arithmetic Geometry	étale cohomology, ramification, local fields
SAITO, Norikazu	Numerical Analysis, Applied Analysis	finite element method, finite difference method, nonlinear partial differential equation
SAITO, Yoshihisa	Representation Theory, Mathematical Physics	infinite dimensional Lie algebras, quantum groups
SAKAI, Hidetaka	Special Functions, Integrable Systems, Ordinary Differential Equations	Painlevé equations, difference equations
SAKASAI, Takuya	Topology	mapping class groups, moduli spaces of Riemann surfaces, 3-dimensional manifolds
SEKIGUCHI, Hideko	Non-Commutative Harmonic Analysis	semisimple Lie groups, unitary representations, Penrose transforms
SHIHO, Atsushi	Arithmetic Geometry	crystals, p-adic cohomology, rigid geometry
SHIMOMURA, Akihiro	Partial Differential Equations	nonlinear dispersive evolution equations
SHIRAISHI, Jun' ichi	Solvable Lattice Models	elliptic quantum groups
TAKAGI, Hiromichi	Birational Geometry	minimal model program, Fano varieties, flips
TAKAGI, Shunsuke	Commutative Algebra, Algebraic Geometry	Frobenius splitting, F-singularities, multiplier ideals, singularities of the minimal model program
TAKAYAMA, Shigeharu	Complex Geometry	adjoint bundle, singular Hermitian metric, multiplier ideal sheaf

Faculty

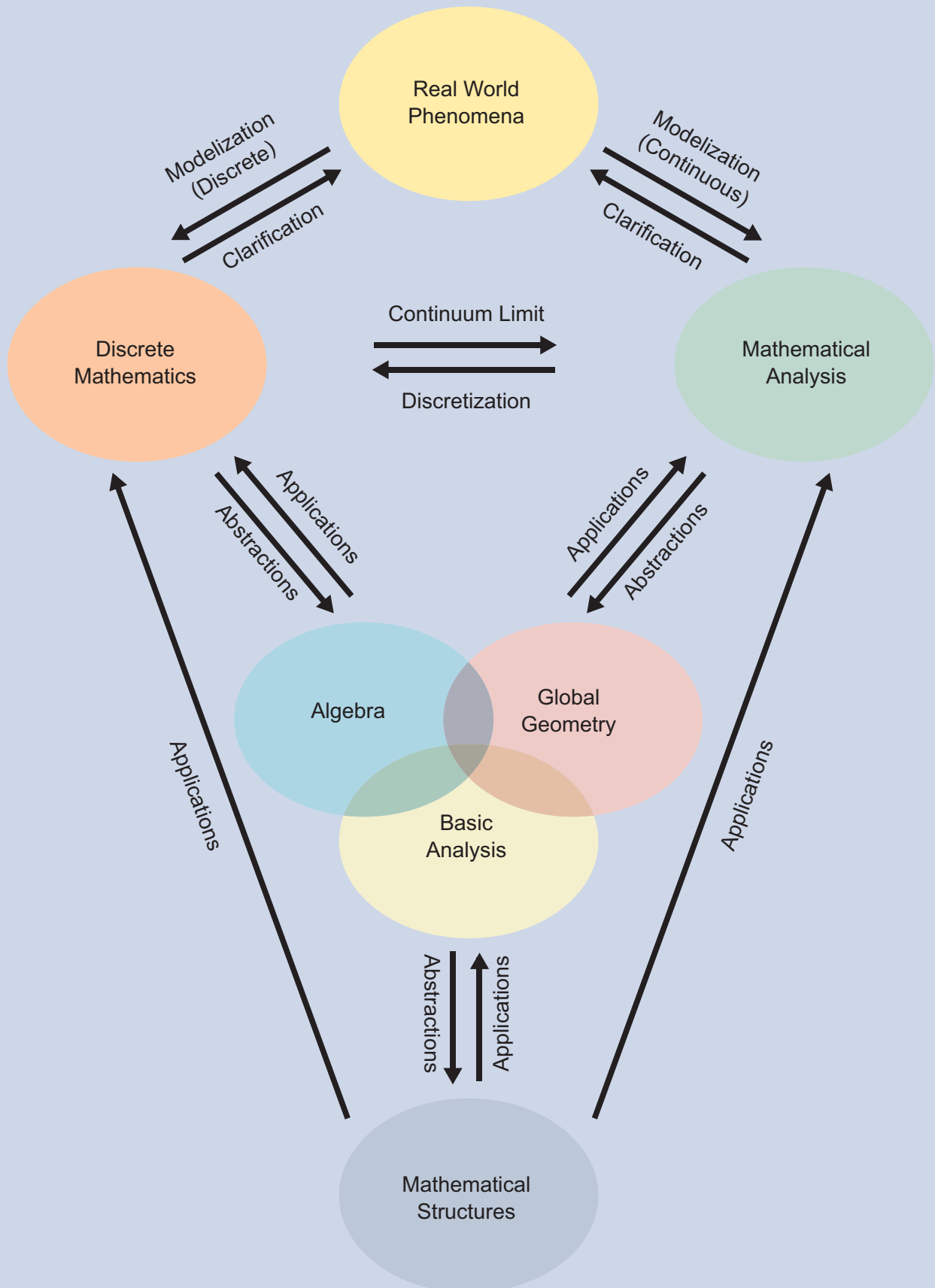| Name	Field of Interest	Keywords
TERADA, Itaru	Algebraic Combinatorics	Young diagrams, Robinson-Schensted correspondences, group representations
TERASOMA, Tomohide	Algebraic Geometry	cohomology of algebraic variety, Hodge theory
TOKIHIRO, Tetsuji	Mathematical Physics, Applied Mathematics	integrable systems, solitons, cellular automata, ultradiscrete systems
TSUBOI, Takashi	Topology	foliations, diffeomorphism groups
TSUJI, Takeshi	Number Theory, Arithmetic Geometry	p-adic Hodge theory, p-adic representation, log algebraic geometry
WILLOX, Ralph	Mathematical Physics, Integrable Systems	integrable discrete systems, Darboux transformations, Painlevé equations, integrable reductions
YAMAMOTO, Masahiro	Inverse problems, Industrial mathematics	uniqueness and conditional stability for inverse problems, regularization methods, numerical approach, mathematical solutions for problems in industry, collaboration with industry
YOSHIDA, Nakahiro	Theoretical Statistics, Probability Theory	limit theorems for semimartingales, asymptotic expansion, Malliavin calculus, statistics for stochastic differential equations, asymptotic decision theory, higher-order asymptotic theory, nonsynchronous estimation, statistical computing
YOSHINO, Taro	Geometry of Lie groups and Lie algebras	Clifford-Klein forms, discontinuous groups proper action, topological blow-up

Faculty

Assistant Professors

Name	Field of Interest	Keywords
ASOU, Kazuhiko	Mathematics Education	e-Learning, video-on-demand, instructional design
GOCHO, Toru	Differential Geometry	topological field theory, symplectic manifolds
KATAOKA, Toshitaka	Number Theory, Representation of Finite Groups	Galois extensions, characters
KIYONO, Kazuhiko	Topology	group action, gauge theory, Atiyah-Singer index theorem
GONGYO, Yoshinori	Complex and Algebraic Geometry	Birational Geometry, Minimal Model Program, Abundance Conjecture, (Anti-) Canonical bundle, Canonical bundle formula, Adjunction formula, Fano variety, Calabi--Yau variety, Birational automorphism, Modulo p reduction, F-split variety

The Six Sections of the Graduate School of Mathematical Sciences

Real World Phenomena

Modelization (Discrete)

Clarification

Modelization (Continuous)

Clarification

Discrete Mathematics

Continuum Limit

Discretization

Mathematical Analysis

Applications

Abstractions

Applications

Abstractions

Applications

Applications

Algebra

Global Geometry

Basic Analysis

Abstractions

Applications

Mathematical Structures

Interdisciplinary Center for Mathematical Sciences (ICMS)

The center was established in April 2013 with the aim of promoting and facilitating interdisciplinary research and education in mathematics, in cooperation with all industrial and other scientific fields.

Mathematics is often said to provide a common language for all scientific disciplines. It also, however, offers very effective tools that scientists, in an enormous variety of fields, can use in their endeavour to describe the world at large. As a result, the mathematical sciences have become indispensable as the foundation for any scientific and technological nation. The symbiotic relationship between mathematics and its various areas of application is ever expanding, as more and more areas of science and industry become dependent on new mathematical tools and especially on mathematically trained scientists. The purpose of the ICMS is to conduct mathematical research, for applications, and to develop educational programs with this aim in mind, in cooperation with experts from various scientific disciplines and industry.

The ICMS comprises two sections: the scientific cooperation section and the industrial cooperation section. Each section is composed of a number of faculty members of the Graduate School of Mathematical Sciences as well as of other graduate school of the University of Tokyo.

Some of the research programs, centers and conferences supported by ICMS in 2013, are listed below.
(1) The Leading Graduate Course for Frontiers of Mathematical Sciences and Physics
(2) The Institute for Biology and Mathematics of Dynamical Cell Processes
(3) The Kavli Institute for the Physics and Mathematics of the Universe
(4) The "Coop with Math Program"
(5) The "JSPS Asian Science Seminar: Discrete Mathematics and its Application"
(6) The "Symposium on Mathematics for Various Disciplines 10"
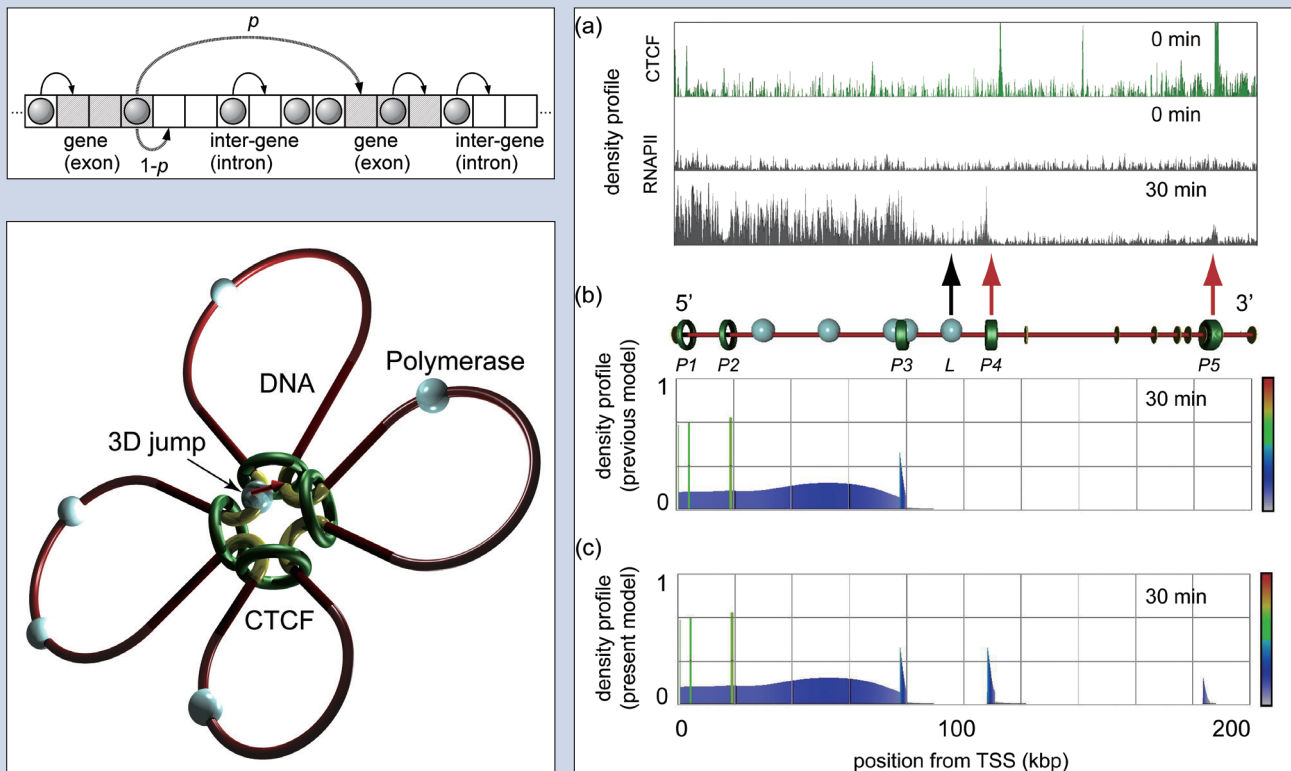
Path-preference cellular-automaton model for traffic flow through transit points and its application to the transcription process in human cells
Yoshihiro Ohta, Akinobu Nishiyama, Yoichiro Wada, Yijun Ruan, Tatsuhiko Kodama, Takashi Tsuboi, Tetsuji Tokihiro, and Sigeo Ihara

Leading Graduate Course for Frontiers of Mathematical Sciences and Physics

Program for Leading Graduate Schools

1. About FMSP

The Leading Graduate Course for Frontiers of Mathematical Sciences and Physics (FMSP) is part of the MEXT "Leading Graduate School Doctoral Program," which aims to "revolutionize graduate school education by developing world-class, quality-controlled academic degree programs, where learning is achieved with no walls separating academia from industrial and governmental sectors, and with coherency between the Master's and Doctoral programs, in order to turn competent students into perceptive and creative global leaders in all realms of industry, academia and government.

The FMSP program is provided through the joint efforts of the Graduate School of Mathematical Sciences, the Department of Physics and the Department of Earth and Planetary Science of the Graduate School of Science together with the Kavli Institute for the Physics and Mathematics of the Universe, the University of Tokyo and was approved in the "only-one" category on October 1, 2012.

To join the FMSP program, one must be a graduate student belonging to one of the following three departments:
- Graduate School of Mathematical Sciences, the University of Tokyo,
- Department of Physics, Graduate School of Science, the University of Tokyo,
- Department of Earth and Planetary Science, Graduate School of Science, the University of Tokyo.

The enrollment in the FMSP program starts, in principle, in October of the first year of the Master Course. There is an additional recruitment of students enrolling in the first year of the Doctor course.

We aim to establish a new interdisciplinary learning environment based on training in advanced mathematics.
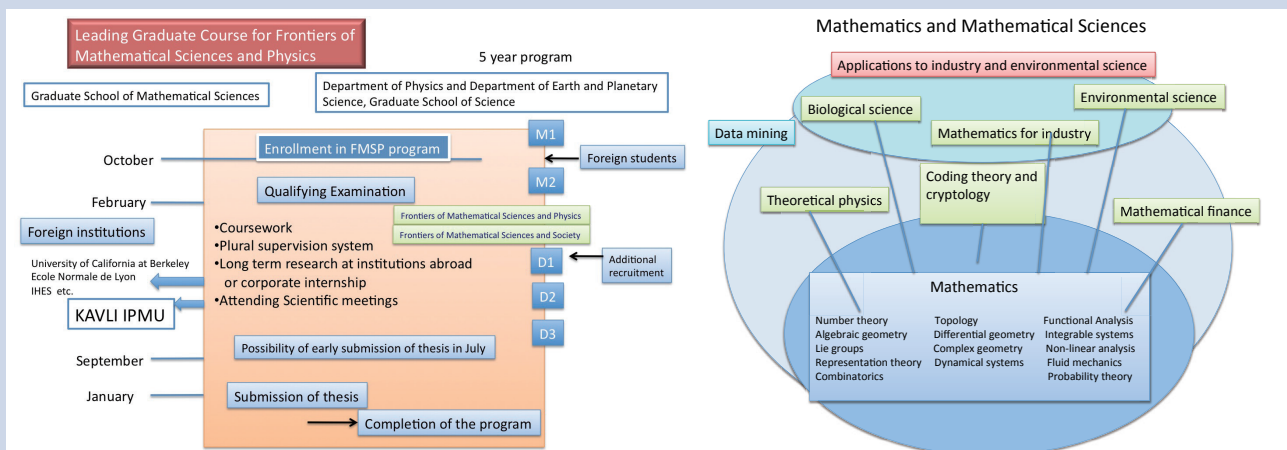
2. Features of the FMSP program
(i) The plural supervision system

Each student in this program is assigned a secondary supervisor, in addition to their main supervisor. Thanks to this system FMSP students are able to get advice about their research from wider viewpoints.

(ii) Financial supports of FMSP students

FMSP students receive a monthly grant of 150,000 yen, beginning in the latter half of their first year in the Master's program until the end of the Master's program and a monthly grant of 200,000 yen from the beginning of the Doctor's program. The grant will continue to be given until each student receives their PhD degree, provided that their period of benefit during their Doctoral studies does not exceed three years.

(iii) Qualifying Examination

FMSP students will submit their master thesis in January in the second year of the Master course and take a Qualifying Examination, whereupon those to be accepted in the FMSP course for their Doctoral years will be selected.

(iv) Required activities for the Doctoral years

To complete the FMSP course, students must take part in one of the two activities listed below:

- Research at institutions abroad
- A corporate internship

3. Coursework and activities beyond the boundaries of research areas

For the purpose of acquiring depth and width in the synergy between mathematics and various sciences, we need to have a global viewpoint, beyond the boundaries of research areas. From this point of view, in the FMSP program we organize course works "Frontiers of Mathematical Sciences and Physics" and "Frontiers of Mathematical Sciences and Society". We also organize seminars and tutorial workshops, removing traditional boundaries between disciplines. We set up various occasions such as "study groups", where students learn about problems in industry and work together on these problems.

The 9th East Asian School of Knots and Related Topics, Jan. 14 - Jan. 17, 2013

Kavli IPMU-FMSP Tutorial Workshop "Geometry and Mathematical Physics", Jan. 22 - Jan. 25, 2013

4. Fostering talents that are competitive at the international level

We have been supporting students studying abroad by various programs. There are about 150 visitors each year at Graduate School of Mathematical Sciences. The Kavli IPMU has a satellite at the University of California, Berkeley. By making use of such international network, we support FMSP students to pursue research at institutions abroad for a long period. We will organize international workshops and seminars by inviting researchers from abroad by the FMSP program. FMSP offers an international research environment and it will be a gateway to international experience for FMSP students to attend such activities and to discuss with researchers from abroad.

Discussions with visitors stimulate young researchers.

Lectures and Seminars

Lectures

Algebra	Introduction to Algebra, Algebraic Geometry, Number Theory, Automorphic Functions, Analytic Number Theory, Applied Algebra
Global Geometry	Introduction to Global Geometry, Differential Geometry, Topology, Global Analysis, Complex Manifolds, Dynamical Systems
Basic Analysis	Introduction to Basic Analysis, Linear Differential Equations, Spectral Theory, Algebraic Analysis, Stochastic Analysis, Functional Analysis
Mathematical Structures	Introduction to Mathematical Structures, Algebraic Structures, Group Structures, Lie Algebras, Infinite Dimensional Structures, Representation Theory
Mathematical Analysis	Introduction to Mathematical Analysis, Nonlinear Analysis, Stochastic Processes, Numerical Analysis, Mathematical Statistics, Mathematical Control Theory
Discrete Mathematics	Introduction to Discrete Mathematics, Mathematical Logic, Foundations of Mathematics, Information Theory, Computational Mathematics, Combinatorics
Others	Special Lectures on Mathematical Sciences

Seminars

Master's Program:

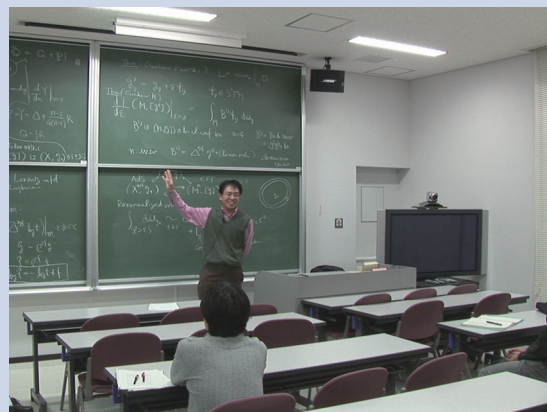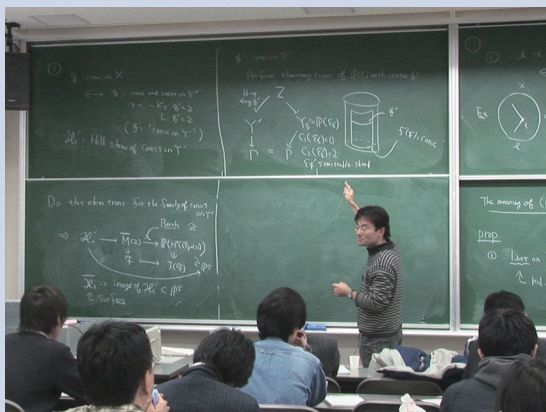Interdisciplinary Seminar, Basic Seminar, Advanced Seminar, Multi-Disciplinary Seminar

Ph.D. Program:

Ph.D. Seminar on Mathematical Sciences, Special Advanced Seminar

Degrees

M.S. (Mathematical Sciences)

Ph.D. (Mathematical Sciences)

Facilities

Library
●The present collection includes:

about **162,000** volumes and **1,700** periodicals.

The library is used by a large number mathematicians from all over the world.

International Exchange
●Foreign visitors between April 2010-March 2013

Long-term (more than one month) **31** visitors

Short-term (less than one month) **475** visitors

From

Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Chili, Canada, China, Denmark, France, Germany, Greece, Hungary, India, Iran, Israel, Italy, Korea, Malaysia, Mongolia, Morocco, Netherlands, Norway, Poland, Romania, Russia, Saudi Arabia, Serbia, Singapore, Spain, Sweden, Switzerland, Taiwan, Tunisia, United Kingdom, U.S.A., Vietnam

Number of Students (per year)
●Undergraduate students : **45**

●Master's program : **53** (with at least **6** foreign students)

●Ph.D. program : **32** (with at least **3** foreign students)

Publications
●Journal of Mathematical Sciences

●Preprint series

●Lecture Notes in Mathematical Sciences

●Annual Report
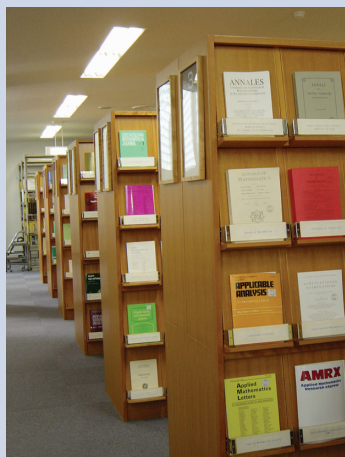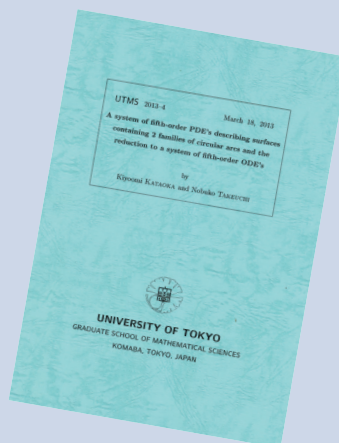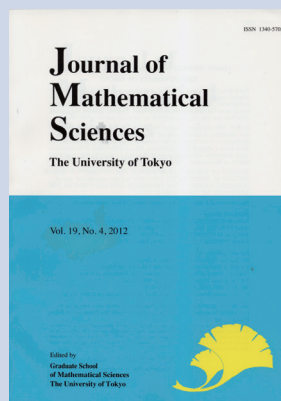
Seminars for Researchers

The Departmental Colloquium is held once every month. It had a long history as the "Friday Colloquium" before the formation of the new department. Speakers include distinguished experts in various areas of mathematical sciences as well as members of the department. The talks are expected to be accessible to non-specialists in the field and students are encouraged to attend to broaden their mathematical background.

In addition, the following research seminars are organized by the staff of the department according to their specialties. Most of them are held on a weekly basis and last for an hour or two. They provide opportunities for mathematicians in the Tokyo area to meet and talk face to face. Currently these include the seminars listed below.

- ●Algebraic Analysis
- ●Algebraic Geometry
- ●Analysis
- ●Applied Analysis
- ●Applied Mathematics
- ●Arithmetic of Automorphic Forms
- ●Classical Analysis
- ●Demography and Mathematical Biology
- ●Functional Analysis
- ●Geometric Complex Analysis
- ●Geometry
- ●Integrable Systems
- ●Kavil IPMU Komaba Seminar
- ●Lecture Series on Mathematical Sciences in Society I & II
- ●Lie Groups and Representation Theory
- ●Mathematical Finance
- ●Mathematical Past of Asia
- ●Mathematics for Various Disciplines
- ●Number Theory
- ●Numerical Analysis
- ●Operator Algebra
- ●PDE Real Analysis
- ●Probability and Statistics
- ●Real and Harmonic Analysis
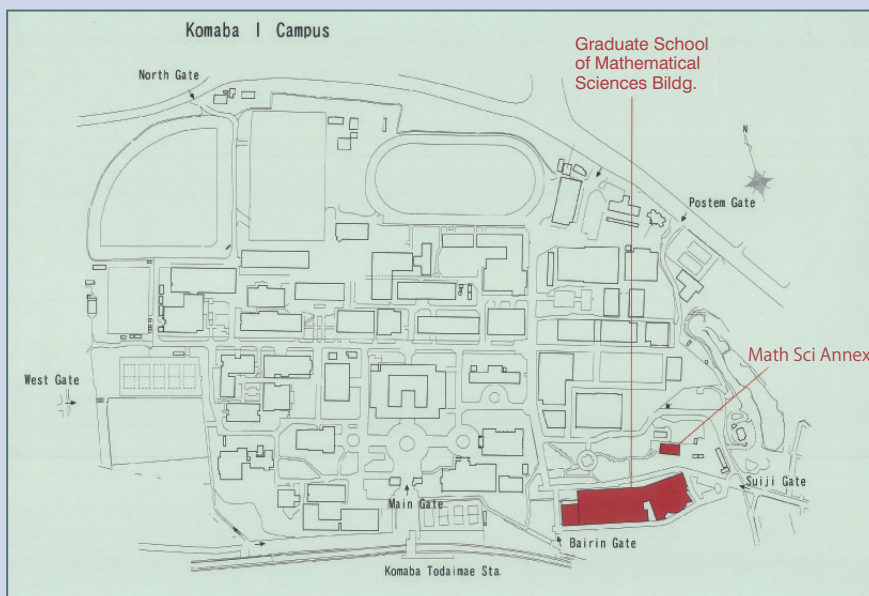- ●Topology
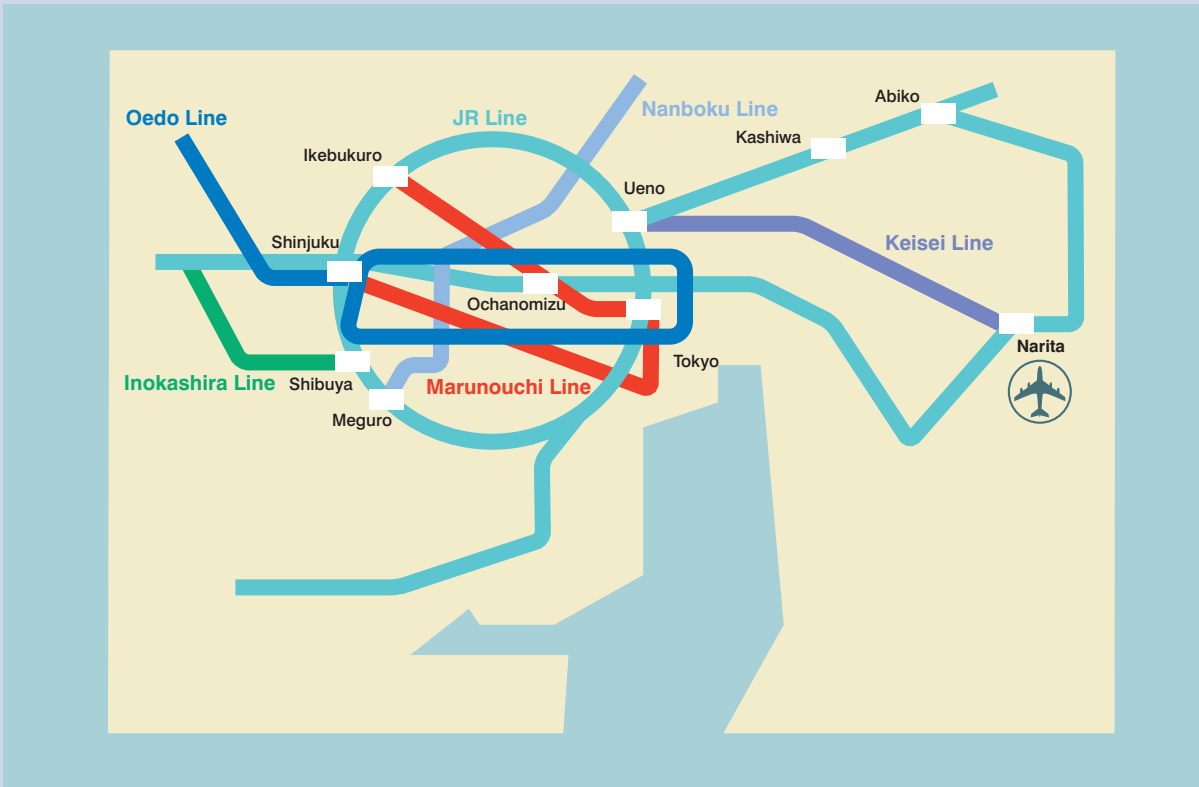- ●FMSP Lectures
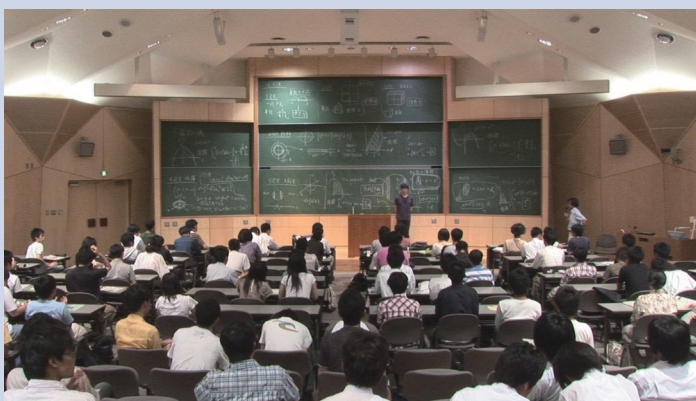
Access

Komaba Campus

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3-8-1 Komaba Meguro-ku Tokyo 153-8914 JAPAN

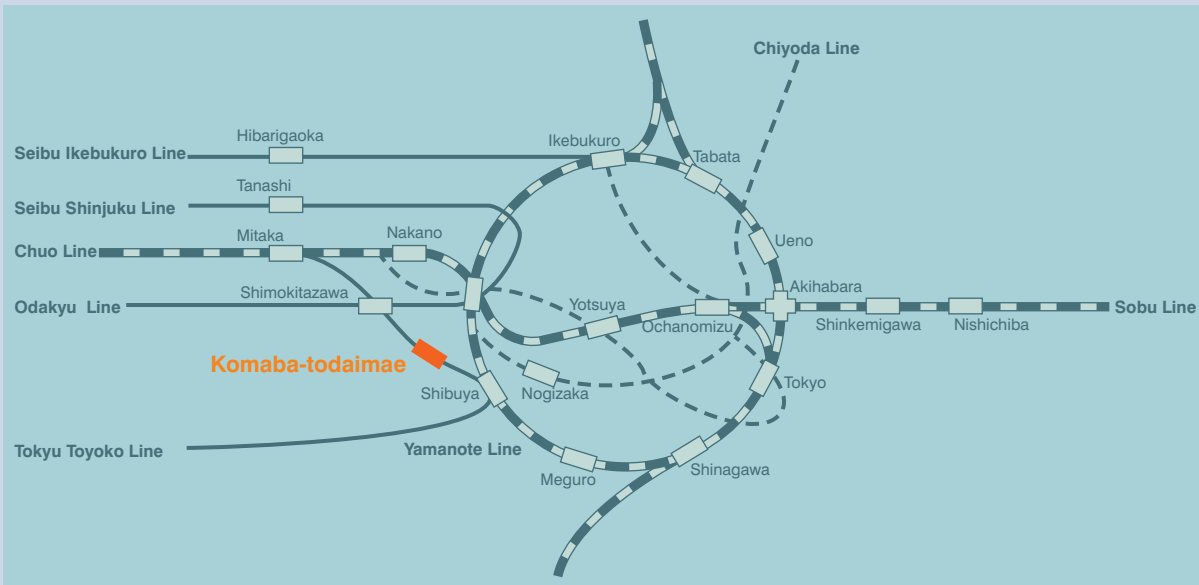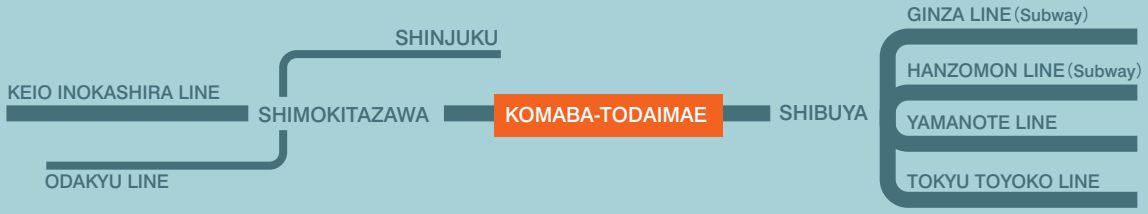**Tel**: 03-5465-7000

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Fax: 03-5465-7010

(from overseas: +81-3-5465-7010)

Location: Mathematical Sciences Building

2 min. walk from Komaba-todaimae Station

(Keio Inokashira Line)

Komaba I Campus

North Gate

Graduate School
of Mathematical
Sciences Bildg.

Postem Gate

N

Math Sci Annex

West Gate

Suiji Gate

Main Gate

Bairin Gate

Komaba Todaimae Sta.

Oedo Line
JR Line
Nanboku Line
Abiko
Ikebukuro
Kashiwa
Ueno
Shinjuku
Keisei Line
Ochanomizu
Inokashira Line
Shibuya
Marunouchi Line
Meguro
Tokyo
Narita

KOMABA CAMPUS

SHINJUKU

GINZA LINE（Subway）

KEIO INOKASHIRA LINE

HANZOMON LINE（Subway）

SHIMOKITAZAWA

KOMABA-TODAIMAE

SHIBUYA

YAMANOTE LINE

ODAKYU LINE

TOKYU TOYOKO LINE

Chiyoda Line

Seibu Ikebukuro Line — Hibarigaoka — Ikebukuro — Tabata

Tanashi

Seibu Shinjuku Line — Ueno

Mitaka — Nakano

Chuo Line — Akihabara

Shimokitazawa — Yotsuya — Sobu Line

Odakyu Line — Ochanomizu — Shinkemigawa — Nishichiba

Komaba-todaimae — Tokyo

Shibuya — Nogizaka

Tokyu Toyoko Line — Yamanote Line — Shinagawa

Meguro

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