PhD Program in Mathematics for Key Technologies − Attempt of Kyushu University

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Long-term Internship Program

In Japan, when I was a Math. student…

・To enter into Doctoral Course was almost equivalent to a **career path to Academia**.
・Only very few students got jobs in **Industry**, and they were considered to be "**losers**".

Unfortunately, this kind of a "culture" persists in Japan…

On the other hand, **Department of Mathematics, Kyushu University** was founded in 1939, and since its establishment, applied Mathematics, including statistics, have been considered to be very important, which is exceptional in Japan.

Faculty of Mathematics & Graduate School of Mathematics, Kyushu University

21st Century COE Program (2003—2007)
"*Mathematics of High Functionality*" **Functional Math. Course**
PhD students' long-term internships (**3 months or more**)

New course, in which long-term internship in Industry is mandatory

➤ Any student, independent of his/her research area, he/she can participate in this course.
➤ All faculty members can supervise students of this course.

Effect of long-term internships

Students who participated in internships were very **active**.
In Japanese R&D sectors, there are very few researchers whose back ground is Mathematics.
Even a doctoral student could make essential contributions to the company.
They came back to graduate school **with a lot more motivations**: much happier than before!

Furthermore,

Companies started to recognize the importance and power of Mathematics.
They started to hire **Math. PhD students**.
They also began to be interested in performing **collaborative researches** with us.

These essentially led to the establishment of **IMI**, in my opinion.

IMI = Institute of Mathematics for Industry
MI = Mathematics for Industry

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Establishment of IMI

Graduate School of Mathematics, Kyushu University

Global COE Program (2008－2012)
"Education & Research Hub for Math-for-Industry"
Forum "Math-for-Industry, Collaboration with Industry

2011 **Institute of Mathematics for Industry (IMI)**

2013 Joint Research Center for Advanced and Fundamental Math-for-Industry
2nd Math. **MEXT Joint Use Center** in Japan after RIMS (Kyoto Univ.)

Study Group Workshop (2010－, for the first time in Japan）
Math. graduate students participate

Study Group Workshops   2010－

Participating companies share their problems with the audience consisting of industry engineers, <u>Math. grad. students</u> & professors.

Wednesday ⇒ Friday (IMI, Kyushu Univ.)

Each problem is worked out in a group of interested participants in a separate room for a few days.

Saturday & Sunday : Programming & Trip to Tokyo

Each study group reports its results to the overall meeting at the end of the week-long workshop.

Monday & Tuesday (Univ. Tokyo)

Study Group Workshop 2018

July 25-27, Institute of Mathematics for Industry, Kyushu University
Faculty of Mathematics, Kyushu University
Graduate School of Mathematics, Kyushu University
July 30-31, Guraduate School of Mathematical Sciences, The University of Tokyo

☛ **Partial/full solutions**
☛ **Hints to solutions**
☛ **Opportunities for gaining new perspectives**
☛ **Opportunities for career path & recruiting**

Study Group Themes

| Year	Industrial Partners	Themes
2017 (July 26 - August 1)	Nippon Steel	Algebraic analysis of direction relations formed by crystal phase transitions
	Sony Semiconductor Manufacturing	Regression modelling for predicting number of image sensor defects
	IBM Research Tokyo	Societal simulation of consumers walking around shopping malls and their action model
	DAIKIN Industries	Estimation of autonomic nerve indices using bio-sensing data
	Sumitomo Heavy Industries	Mathematics that arise in film deposition systems using plasmas
	Faculty of Design, Kyushu Univ.	Mathematical modelling of human reactions caused by music listening
2018 (July 25–31)	Nippon Steel	Mathematics related to crystal lattices and various problems in materials
	Itoshima City Hall	Solving regional and/or political issues by using Mathematics
	Murata Manufacturing	Application of Mathematical methods to super-ionic transmission materials
	Toshiba R&D Center	Non-linearity of public key encryptions
	The University of Tokyo Hospital	Image processing of medical images by using Mathematical methods

Forum "Math-for-Industry"

FMI2010	FMI2011	FMI2012	FMI2013	FMI2014	FMI2015	FMfI2016	FMfI2017	FMfI2018
Fukuoka	Honolulu, US	Fukuoka	Fukuoka	Fukuoka	Fukuoka	Brisbane, AU	Honolulu, US	Fudan Univ., China
Oct.21-23	Oct.24-28	Oct.22-26	Nov. 4-8	Oct.27-31	Oct.26-30	Nov.21-23	Oct.23-26	Nov. 17-21
Information Security, Visualization, and Inverse Problems, on the basis of Optimization Techniques	TSUNAMI - Mathematical Modelling Using Mathematics for Natural Disaster Prediction, Recovery and Provision for the Future -	Information Recovery and Discovery	The Impact of Applications on Mathematics	Applications + Practical Conceptualization + Mathematics = fruitful Innovation	The Role and Importance of Mathematics in Innovation	Agriculture as a metaphor for creativity in all human endeavors	Responding to the Challenges of Climate Change: Exploiting, Harnessing and Enhancing the Opportunities of Clean Energy	Big Data Analysis, AI, Fintech, Math in Finances and Economics
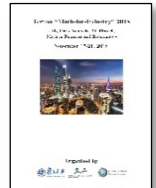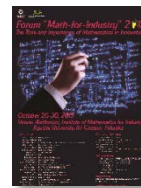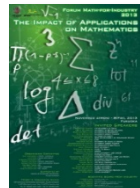
Poster Sessions in FMfI

Students and young postdocs present their posters together with short presentations (2 to 3 minutes).
This was effective for presentation trainings for students.
Best and excellent poster awardees are financially supported for their overseas stays for 1 to 4 weeks.

Post-graduation careers of poster session awardees

Fujitsu Lab., Softbank Mobile, NTT data, Mitsubishi Heavy Industries, Tome Lab., Saiensu-sha Publishers, Toshiba, Faculty of Math. (Kyushu Univ.), Faculty of Arts and Science (Kyushu Univ.), PD (Osaka Univ.), PD (Univ. of Tokyo), PD (Nagoya Univ.), Massachusetts Univ., Zhejiang Normal University, Brawijaya University, etc.

Leading PhD Program of Mathematics for Key Technologies
（2014－）

After the **Global COE program**, we applied for a MEXT grant, Program for Leading Graduate Schools.
Unfortunately, our proposal was not approved by some reason.
However, the proposal was so good that the **Kyushu University** decided to support the program by its own funding.

This program is designed to nurture doctors in mathematics, referred to as "**Mathematics Navigators**", who lead the development of future key technologies in the globalized world.
The main feature is participation in **overseas internships**.

Program Characteristics

5-year PhD program featuring

Mathematics Navigator

**_Mathematics_
English Communication Skills
Leadership**

"Mathematic Navigators" will be leaders of contemporary mathematics. They will use abstraction and generalization skills, analyze actual data and construct mathematical models to lead the technology of our future by providing refined solutions to face possible issues at the Research and Development Sections.

Nurturing Mathematics Navigators

Institute of Mathematics for Industry
Kyushu University

Kyushu Univ

Mathematics Navigator

PhD Examination System
・Participation of Industrial Delegates
・Publications in International Journals

**Study Groups Abroad
Organizing Student MI Seminars**

Contemporary Mathematics
Statistics, Probability, Computations (Numerical and Algebraic)
English

**QE1
MI basic report**

**QE2
MI interim report**

MI Doctoral Course
Long-term overseas internship Soft-landing

PhD (Functional Mathematics)
Certificate of Leading PhD program in Mathematics for Key Technologies

QEE Selection

MI Master Course
Participation in collaborative researches with Industry

Pure Mathematics Programming, Statistics, Probability

PhD supervision in specific areas

Industrial Researchers

Long-term Overseas Internship

Soft-Landing (4th year)

Soft-Landing

3 months stay in Academia

Overseas Liaison Institutions

Internship in Overseas Companies or Participation in Joint Project with Industry (for 3 months or more)
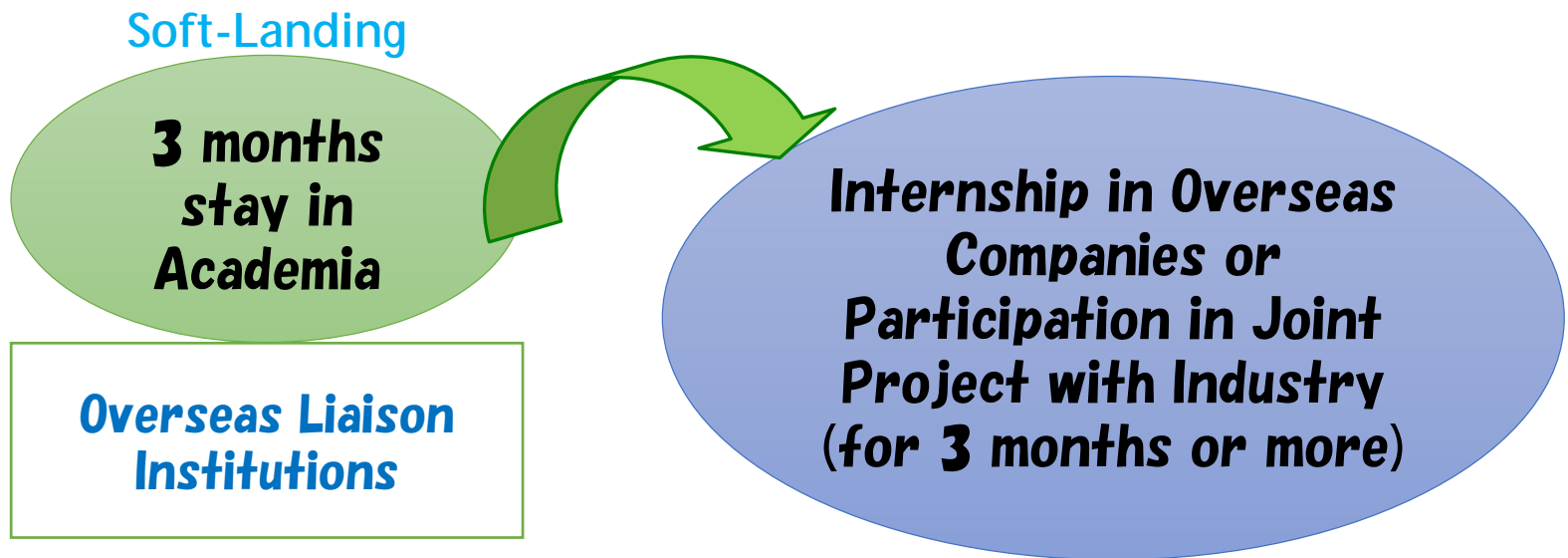
Supported by APCMfI   (Asia Pacific Consortium of Mathematics for Industry)

➢ Matching with Internship Companies is supported by faculty members of IMI.

➢ Thorough preparation prior to the internship, including English trainings, overseas short stays, etc.

Soft-landing for staying abroad & Long-term overseas internship

Student A (D1-D2)

2015.2.1～3.27 **La Trobe University（Melbourne）** **Prof. Grant Cairns** Representation Theory, Geometry	**2015.6.1～8.25** **Philips Research Eindhoven（Holland）** Fitting 'average face' data with scanned images

Student B (D2)

2016.7.15～8.9 **Kaiserslautern T. U.（Germany）** **Prof. Gerhard Pfister** Algebraic Geometry	**2016.9.26～12.16** **Fujitsu Laboratories of America, Inc. (USA)** Post quantum cryptography, Public key encryption

Student C (D2)

2016.5.23～7.15 **Oxford University（UK）** **Prof. Philip Maini** Mathematical Biology	**2016.10.3～12.16** **Hitachi Asia Singapore（Singapore）** Controlling robots

Soft-landing and Long-term overseas Internships

Student D   Auckland Univ. (NZ)
  ⇒   Center for Research in Security and Privacy（Germany）
   Postdoc position in Univ. Tokyo

Student E   Trento Univ.（Italy）
  ⇒   Fujitsu Laboratories of America, Inc.（USA）
   Fujitsu Laboratories

Student F   Tilburg Univ.（Holland）
  ⇒   Hitachi Asia Ltd.（Singapore）
   NTT data

Student G   Berlin Free Univ.（Germany）
  ⇒   Berlin Free Univ., Charite Univ. Hospital（Germany）

Student H   Radboud Univ.（Holland）
  ⇒   ISARA Corporation（Canda）

Total 8+2 students

Future Education Platform of MI

Number of Math. PhD students is not increasing in Japan.

There are some social issues.
- Financial support for PhD students is very limited and in very low level.
- There are very few positions available in academia and in Industry.

In order to reform such situations, we are trying to establish a new educational platform of Mathematics for Industry. (This year, our proposal was not approved, but we will continue to try!)

If you have any good idea, please let us know!

THANK YOU FOR YOUR ATTENTION!