Welcome to a paradise for science geeks!

iTHEMS

# directors

*—How did the Universe begin?*

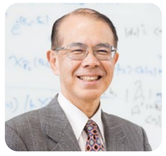
*—What is the origin of life?*

*—Will artificial intelligence ever be able to surpass the human brain?*

*—What will be the mathematics of the 22nd century?*

*—What is the future of humanity?*

The RIKEN interdisciplinary Theoretical Mathematical Sciences (iTHEMS) program is an international research platform applying mathematics as a common language in collaborations at the forefront of research in physics, chemistry, biology, medical science, engineering, information science, computational science and mathematics. Our mission is to develop fundamental ideas based on free thinking.

Scientific Advisors
**Yoh Iwasa**
Research Fields: Mathematical Biology

Scientific Advisors
**Motoko Kotani**
Research Fields: Geometry

Scientific Advisors
**Makoto Kobayashi**
Research Fields: Theoretical Particle Physics

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**Shigefumi Mori**
Research Fields: Mathematics, Algebraic Geometry

Looking a hundred years into the future

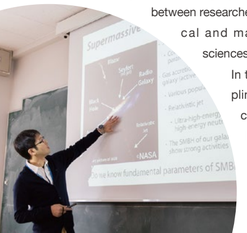
iTHEMS

# overview

## Encouraging interdisciplinary research

The natural sciences are split into various fields such as physics, chemistry, and biology, and the level of specialization is constantly growing, leading to ever finer divisions of research areas. Different disciplines also choose their research subjects and methods for attacking problems differently. Furthermore, technical terms are used in different ways, making it difficult for researchers in different fields to communicate with one another.

However, if we look at the logical structures of different fields, we are often struck by a commonality of ideas and concepts. In practice, when researchers in different fields talk to one another, it becomes apparent that mathematical methods for solving problems can be used beyond fields. The RIKEN Interdisciplinary Theoretical and Mathematical Sciences Program (iTHEMS) aims to make breakthroughs by exchanging scientific ideas between researchers in theoretical and mathematical sciences.



In the Interdisciplinary Theoretical Science Research Group (iTHES), the predecessor of iTHEMS, which operated between 2013 and 2017, researchers from different fields had intensive interactions and produced a number of interdisciplinary research outcomes. One example is a collaboration between theoretical physicists and theoretical biologists to examine the dynamical pattern formation of photoreceptor cells in fish retina, something which has been a long-standing mystery in biology. Another example is a joint work by a theoretical nuclear physicist and theoretical biologists to clarify the mechanism of chromosome segregation in eukaryotic cells.

## Utilizing modern mathematics

At iTHEMS, we are working toward the full-scale utilization of modern mathematics to actively promote interdisciplinary research.

Currently, most of the mathematics used in theoretical science was created in the 19th century to the first half of the 20th century. Mathematics has become extremely abstract since the middle of the 20th century, and has accumulated powerful techniques and methods. This abstract framework has the potential to solve many open problems in natural science. Moreover, the abstract framework of modern mathematics may lead to yet unknown mathematical connections among phenomena in physics, biology, and other areas.

Mathematics is a common language of theoretical studies. Gathering together researchers in natural and mathematical sciences can make the future of science richer by providing new perspectives and ideas.

## Flexible organization

Scientists within iTHEMS carry out high-level research independently based on their own interests. Rather than having a solid team or group structure, iTHEMS uses new platform called the "Research Cell". A cell is like a small roundtable with a challenging theme.

Currently, we have four cells: "Extreme Universe", "Life and Evolution", "Mathematics and AI" and "Future Geometry". Researchers can join any of the cells they are interested in and interact with others from different disciplines. Additionally, cells can be created, divided, or fused together. The most important element of iTHEMS is the ideas of individual researchers who drive the evolution of cells, iTHEMS and the future of science.

## Facilitating daily interactions

Collaboration among researchers beyond disciplines is a challenging task. Sometimes the technical terms used in a field may sound like a foreign language to researchers in other fields, creating a barrier to effective communication.

One way to overcome these barriers is to have a place for researchers to interact on a daily basis and talk about each other's research in easy-to-understand terms. One of the efforts to create such an environment is the coffee meeting which is held every Friday at noon. At the coffee meeting, we ask one iTHEMS member to give a 15-minute presentation, followed by free discussion over lunch. Since the researchers are from different fields, the presenters needs to explain their work in plain terms. Getting a clear understanding of each other's research can lead to collaborative projects.

At iTHEMS, researchers at the forefront of various fields stimulate one another and try to develop new ideas that will become the foundation for science a century from now. Stay tuned to see what kind of science emerges from iTHEMS!

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**RIKEN Interdisciplinary Theoretical and Mathematical Sciences Program**

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# Coffee Time!

iTHEMS is an international research center where researchers conduct activities beyond disciplines using mathematics as a common language.
iTHEMS has a new type of research platform called a "Research Cell", where researchers from various fields discuss challenging research themes. At the weekly coffee meeting, you can see that experts from different fields engage in heated debates.