Hokkaido University Spotlight on Research

Hokkaido University Symbol Mark

The Hokkaido University Symbol Mark is a stylised design of a Trillium (Liliaceae, lily family), a perennial which grows wild on campus.
The petals and sepal which make up the six directions (East, West, South, North, Heaven, and Earth) symbolize the dissemination of information from Hokkaido University to Japan and to the world.

Research Development Section,
Office for Enhancing Institutional Capacity
and the Office of International Affairs
Hokkaido University

Kita 21, Nishi 10, Kita-ku, Sapporo, JAPAN, 001-0021
Inquiries: ura@cris.hokudai.ac.jp

HOKKAIDO UNIVERSITY

HU RESEARCH:

Research Press Releases
https://www.oia.hokudai.ac.jp/blog/category/news/research-press-release/

Research Blog:
https://www.oia.hokudai.ac.jp/blog/category/news/research-blog/

Contributors' Information

Elizabeth TASKER
tasker@astro1.sci.hokudai.ac.jp
Text for articles 1, 2, 4-10
Photo for article 6
Researcher's photo for articles 4 & 6

Alex PETTITT
alex@astro1.sci.hokudai.ac.jp
Text for article 3

Huang ZHENG
zhenghuang1988@gmail.com
Researcher's photo for articles 1, 2, 4, 5, 7-10
Photo for articles 2, 7, 9

Our Arctic Research Center

HU President Keizo Yamaguchi delivers a speech at the 2016 Arctic Science Summit Week reception, an annual gathering of international scientists and policymakers who advance Arctic research.

Eighty years ago, Hokkaido University professor, Ukichiro Nakaya, created the world's first artificial snowflake. Nakaya referred to snowflakes as "letters from the sky" since their tumbling descent brought information about the conditions in the upper atmosphere. This research on glaciology marked the start of Hokkaido University's interest in the Arctic.

While Japan is not an Arctic country, it is strongly affected by the environmental changes in the polar region. As the Arctic sea shrinks, the summertime sees the Northern Sea Route open for longer stretches, allowing cargo ships to pass between Europe and Asia. At the mouth of the passage's Asia side, sits Japan. In 2012, the first freighter sailed from Europe to Japan using the Northern Sea Route. The commercial and environmental consequences give Japan a strong interest in Arctic changes and in May 2013, Japan became an "Observer" on the Arctic Council; an international organisation to assist in Arctic issues.

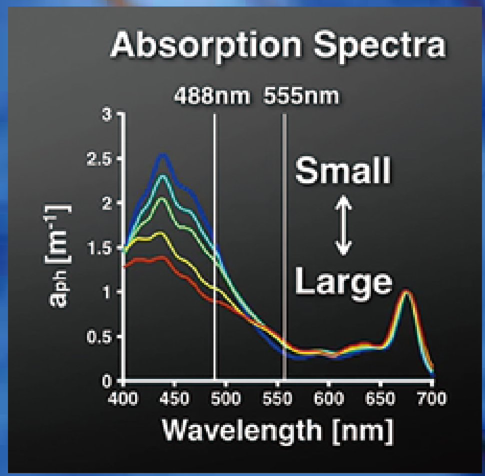
Japan has three national centers focussed on Arctic activities. Two of these, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and the National Institute of Polar Research (NIPR) focus primarily on the natural science viewpoint of Arctic change. But environmental change is a very human problem, both in its cause and the consequences for economic activities and the livelihood of the Arctic communities. For this reason, the Arctic Research Center at Hokkaido University was started in April 2015 to bring together research in social science, humanities and natural science to explore the consequences of Arctic change.

Research at the Arctic Research Center is divided into six subcategories:

Interdisciplinary study group meeting

1.The Atmosphere and Hydrosphere Research Group, which focuses on climate change, sea ice and the marine ecosystems.
2.The Terrestrial Research Group, where members examine the permafrost and the genetic diversity in mammals, fish and plants.
3.The Cryosphere Research Group, with a special interest in the Greenland ice sheets and Arctic glaciers.
4.The Practical Research Group, which looks at engineering aspects of utilising the Northern Sea Route and takes advantage of Hokkaido's snowy weather to investigate architecture suitable for cold climates.
5.The Social Science and Humanities Group that focuses on the impact of environment and economic change on the people living in the Arctic and the social-economic impact of changes to the Northern Sea Route.
6.The Satellite Observation and Modeling Research Group which is concerned with modelling climate change and mapping out the future.

One example of a recently funded project explores the balance between permafrost and human activity in Yakutia in eastern Siberia. The region has been experiencing rapid economic growth, leading to larger requirements for winter heating. The result has both economic and environmental consequences. An increase in demand escalates the price of fuel to unaffordable levels for the local people. Meanwhile, the rise in carbon dioxide from fuel combustion cannot be compensated by the permafrost, which acts as a key sequester of that greenhouse gas in the Siberian ecosystem. The project aims to find possible ways to tackle both the unaffordable cost of living and the carbon dioxide emission.



The optical properties of phytoplankton change with size. Smaller phytoplankton absorb more strongly at small wavelengths, while size makes little difference at longer wavelengths.

Oshoro-maru, the Hokkaido University research training vessel

These trans-disciplinary research areas are complemented by plans for exchanging information through education and international conferences. A new initiative in Japan, the Japan Arctic Research Through Network (J-ARC Net), is headed by the Arctic Research Center to foster the community of Arctic researchers within Japan through regular symposia and meetings. The centre also has short and long-term programs to send faculty and students to Arctic countries for between two weeks to one year. Hokkaido University is also a member of the University of the Arctic, which is a coalition of higher education institutes focussed on research and education on Arctic activities.

The sea ice linchpin for ecosystems

The director of the Arctic Research Center is Professor Sei-Ichi Saitoh. His recent research has explored the spread of phytoplankton microscopic organisms as a measure for Arctic ocean conditions. At the bottom of the food chain, the abundance of phytoplankton controls the populations of larger predators from zooplankton like krill to larger fish species.

Two types of phytoplankton that are found in the Arctic ocean are the *Haptophytes*, which are 0.002 mm across, and the larger *Chaetoceros socialis* at 0.14 mm across. While both tiny, the relative size difference between these microorganisms is equal to that of a common clown fish and a killer whale. Working on the Hokkaido University's research training vessel, the Oshoro-maru, Saitoh discovered that the distribution of the two species can be measured from space due to the differences in their optical properties.

The green chlorophyll in the phytoplankton partially absorbs the incident sunlight and scatters the rest. The smaller *Haptophytes* phytoplankton absorb more strongly at small wavelengths around 488 nm (cyan) compared to the larger *Chaetoceros socialis*. By contrast, light at 555 nm (green) is absorbed and scattered equally by both types. Saitoh developed a model to estimate the ratio between the two phytoplankton types based on the absorption data collected from satellites. He found that the smaller phytoplankton were distributed equally over the seas around the globe, but the larger species clustered densely along costal regions. While comparing satellite images from 1978 and the present day, Saitoh turned his attention to the Arctic region.

In the Chukchi Sea between Alaska and Siberia, the period when the water is frozen with sea ice has been shortening. With its reduction, the ratio between the large and small phytoplankton has tipped against the larger *Chaetoceros socialis*. Conversely, just south of the Chukchi Sea, the Bering Strait has seen an increase in the duration of sea ice and this has been accompanied by an increase in the *Chaetoceros socialis*. This suggests that high levels of sea ice appear to favour the larger *Chaetoceros socialis* phytoplankton.

The reason for this stems from where the phytoplankton live. The large *Chaetoceros socialis* are sometimes referred to as 'ice algae' due to their favourite location at the bottom of sea ice. Take away the sea ice and you destroy their habitat. The knock-on effect up the food chain is that where sea ice is plentiful, krill collect to feed. This brings in larger creatures such as whales. The sea ice is also used by polar bears to hunt seals. The loss of sea ice therefore marks the destruction of a large ecosystem.

Global warming is drastically shifting the marine ecosystems in the Arctic ocean. The decrease of sea ice affects the balance of phytoplankton, disrupting the food chain.

Warming ocean temperatures also move cooler-loving organisms further north in search of colder waters. But for those already in the Arctic, there is no where to go. Not only is the loss of marine life tragic, but such movement presents serious economic consequences for the countries that depend on the fisheries.

Concerns for the future

Not all changes in the Arctic conditions have a short-term negative impact on the economy and that in itself presents problems. The Arctic region is thought to contain a significant amount of untapped natural gas and petroleum resources. As the sea ice recedes, these areas become accessible, promoting fears that the fresh abundance of fossil fuels will accelerate carbon dioxide emissions and cause still more global warming.

The Arctic Research Center at Hokkaido University aims to be working at the heart of these issues. The new centre currently has twenty-two faculty with another ten to be hired before April 2016. This is an international initiative to match the international problem, with both permanent research staff and postdoctoral fellows from around the world.

Stratigraphic observation of Ice Core

Researcher Details

Sei-Ichi SAITOH
Professor / Director of the Arctic Research Center

E-mail: ssaitoh@arc.hokudai.ac.jp

Dr.Tanaka (second from right)

Shingo TANAKA
Assistant to Director of the Arctic Research Center / Senior Research Manager, Research Development Section, Office for Enhancing Institutional Capacity

E-mail: tanaka-s@cris.hokudai.ac.jp

Arctic Research Center
http://www.arc.hokudai.ac.jp/en/

Journal paper:
Fujiwara et al., *Biogeosciences Discuss.*, vol.12, 2015

Hokkaido University's GiFT public lecture:
http://sustain.oia.hokudai.ac.jp/gift

Does this surgical mask make me look cute?

How wearing a mask affects perceived attractiveness

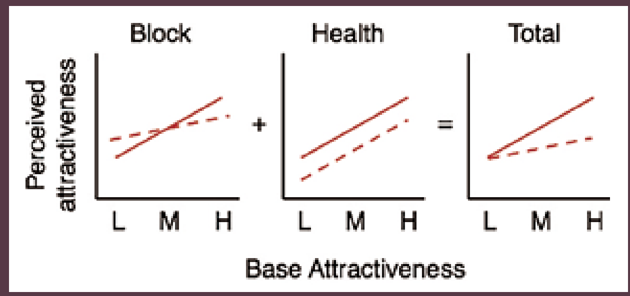
Walk down any street Japan and you could be forgiven for thinking you have stepped onto the set of a medical disaster movie. Surgical masks are frequent accessories, worn to protect against colds, allergies or even to conceal a lack of make-up. Yet for Jun Kawahara[1], the mask also has an additional effect.

"Many students wear masks while I teach. I don't like this, since I can't tell if they understand the class."

Concealing part of your face under a mask obscures many social cues, including intention and emotion. From Kawahara's research field in the psychology of human attention, this led to the question of what effect the mask had on our perception of the wearer.

With a trend for Japanese women to don masks when not wearing make-up, Kawahara focussed on the mask's impact on attractiveness. A database of sixty-six male and sixty-six female faces was divided into 'low', 'middle' and 'high' categories of attractiveness using the opinions of thirty-one student volunteers. Sets of twenty-two faces either with or without masks were then shown to different groups who repeated the rating.

When the results rolled in, those in the 'high' category for attractiveness were perceived as far less attractive while wearing a mask.



The predicted effect of wearing a mask.
Solid line shows the perceived attractiveness of faces with a low (L), medium (M) and high (H) attractiveness level. The dashed line is the result when a mask is worn. 'Block' is the impact of obscuring part of the face while 'Health' is the perception of a person's well being.

Meanwhile, the 'low' category group saw no perceptible difference, with the 'middle' category showed a small drop. In short, the more attractive you were, the less attractive the mask made you appear.

Kawahara's hypothesis is that the mask affects two main factors linked to attractiveness. The first is health. Wearing a mask is often a sign that the person is unwell. It also has associations with medical facilities such dentists and hospitals, none of which are particularly positive. This affects everyone equally and reduces the perceived attractiveness of every face.

The second factor depended on the individual. While attractiveness is difficult to precisely quantify, several features are generally deemed negative. These include cracking lips, pimples or other skin blemishes. A person suffering from these inflictions might benefit from concealing this with a mask. On the other hand, a person with flawless skin would lose this advantage by hiding their face.

Combining these two effects leads the mask having a detrimental effect that increases with a face's attractiveness. It was precisely the opposite of the widely-held opinion that a mask was better than no make-up.

To test this result further, Kawahara performed the experiment using a notebook rather than a surgical mask. The same fraction of the face was obscured, but the covering object was clearly different. The result was a smaller drop in perceived attractiveness for the 'high' attractive category and a slight rise in the perceived attractiveness for the 'low' and 'middle' groups. The reason was that a notebook has no health connotations, removing that factor from people's judgement.

When presenting this work at a conference in Japan, the results caught the eye of the surgical mask manufacturer, Unicharm. After talking with Kawahara, the company decided to produce a new mask; one that was pink. The idea was to off-set the negative effects of obscuring the face with a pleasing colour. Such a theory was not implausible; previous research had indicated that clothing colour plays a large role in perceived attractiveness. But did this hold when using a mask?

Kawahara selected a group of female faces to test this theory. He found that the pink colour bypassed the association with bad health, giving all categories a boost compared to the white mask.

The conclusion is that if you are sick, but do not want to look it, select a pink mask. However, it is very hard to beat your own face.

[1] This research was conducted in collaboration with Dr. Yuki Miyazaki of Chukyo University

Japanese drug stores carry a wide variety of face masks

Researcher Details

Jun KAWAHARA
Associate Professor
Human Sciences / Psychology
Graduate School of Letters

E-mail: jkawa@let.hokudai.ac.jp

Journal paper:
Miyazaki & Kawahara,"The Sanitary-Mask Effect on Perceived Facial Attractiveness", *Japanese Psychological Research* , vol. 58 No.3 2016

Press release:
https://www.oia.hokudai.ac.jp/blog/the-color-of-your-mask-impacts-how-attractive-you-appear/

Fighting cancer with particle beams and motion tracking systems

There is little doubt that the field of oncology, the study and treatment of cancerous tumors, is of paramount importance in the modern day. Current treatments vary in their effectiveness and invasiveness, and there is (as of yet) no clear 'magic bullet' approach. The three main approaches are: operating to directly remove the tumor, chemotherapy or radiotherapy. Of these, radiotherapy is possibly the least invasive of the three, if used efficiently. Hiroki Shirato and his team at the Hokkaido University Hospital are dedicated to advancing the field of radiotherapy, and ultimately saving lives.

Radiotherapy normally involves firing high energy ionizing X-rays into tumors to damage the DNA of the cancerous cells, leading to eventual cellular death. The unfortunate by-product is that the X-ray beam can irradiate nearby healthy cells, both in the immediate area surrounding the beam and as it exits through the body. This is especially problematic for tumors larger than roughly 5 cm, which require such high doses that the damage to surrounding healthy tissue becomes dangerous.

Shirato's Quantum Medical Science and Engineering (QMSE) group are instead focused on the use of proton beams (positively charged subatomic particles). Protons are accelerated to a specific energy and directed into the body. Due to the massive nature of protons (X-rays instead have zero mass), their paths are much harder to deviate, reducing the exposure to surrounding tissue by scattering within the body. They also have a very well defined stopping distance determined by their initial energy (a point known as the "Bragg peak"), allowing the beam to stop at the tumor and deliver the majority of the dose at that location. X-rays in comparison continue to irradiate cells on their route out of the body and deliver stronger dosages before they reach the tumor.

Interior of the treatment room

This much more precise approach makes proton beam therapy a considerably more attractive option than X-rays, especially when the target area neighbours other vital organs. Japan has become one of the world leaders in the field of proton therapy, with currently more than ten proton beam facilities (second only to the USA[1]) out of only fifty to sixty facilities worldwide.

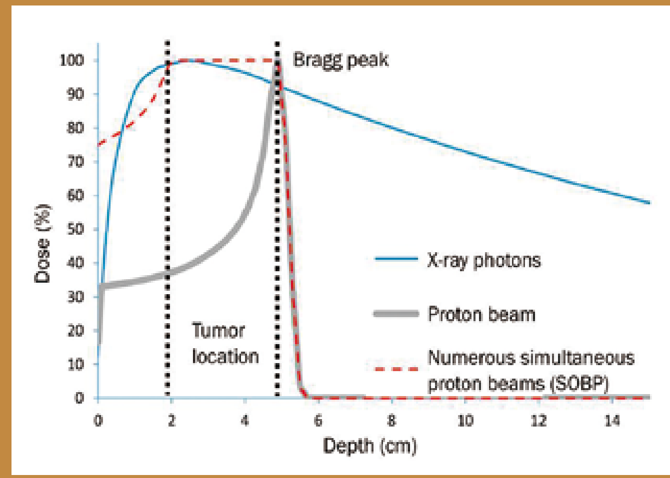


Figure showing the radiation dose of different radiotherapy techniques at increasing depths within a target tissue*. X-rays deliver considerable dosage in the area surrounding the tumor, whereas the proton beam has a much slower increase and allows for a strong concentration at the target area with almost non-existent dosage after the tumor. Using numerous simultaneous proton beams of different energies you can create a spread out Bragg peak (SOBP) and irradiate the entire length of the tumor.

*Adapted from Figure 1 of Berman, James & Rengan 2015, *Cancers*, 7, 1178.

With such a refined radiation beam, it is extremely important to identify the location of the tumor. The body is a dynamic and shifting system, with cardiac, respiratory and digestive systems continually moving. This causes the location of tumors to move from 5 mm to 2 cm even when the patient is stationary, and predicting such motion is very difficult. To tackle this issue, QMSE has developed a real-time tumor tracking system to locate the tumor at any given time. First a 2 mm golden tagging marker is placed upon the tumor, and then tracking systems allow for the 3-dimensional position of the tumor to be determined thirty times every second. The proton beam then waits for the tumor to move into the firing range and then delivers the radiation to the required depth. While such tumor tracking systems have been utilized for X-ray therapy in the past, its implementation with proton beam therapy was pioneered by the team at Hokkaido University. Their proton beam facility is a joint construction project by the University's own engineers and those at Hitachi, with strong science collaborations with Stanford University in the USA. Treatments with this system began just a year ago, with two other departments (Kyoto Prefectural University hospital and John Hopkins hospital) deciding to install similar proton beam with real-time tracking facilities.

Proton beam therapy is still relatively new compared to X-ray therapy, having only moved on from a theoretical field ten years ago. One difficulty is attaching the marker to the tumor in the least intrusive way possible. The QMSE group is working on cutting edge research that aims to remove the invasive marker implanting procedure entirely, for example, using an injected liquid marker that then transforms into the small gold marker when it reaches the tumor.

While successful proton-based radiotherapy treatment is already showing excellent promise compared to alternative therapies, Shirato and the researchers at QMSE are continuing to make the already low-risk treatment a minimum-risk one, by the use of highly refined and directed proton beams and real-time tumor tracking technology.

[1] See http://www.ptcog.ch/index.php/facilities-in-operation for further information

Outlook of Proton Beam Therapy Center

Researcher Details

Hiroki SHIRATO
Professor
Global Station for
Quantum Medical Science and Engineering

E-mail: shirato@med.hokudai.ac.jp

Global Station for Quantum Medical Science and Engineering's webpage:
http://gi-core.oia.hokudai.ac.jp/gsq/

Proton Beam Therapy Center,
Hokkaido University Hospital
http://www.huhp.hokudai.ac.jp/proton/english/

HU Hospital on Medical Excellence Japan

Artist impression of the Hayabusa2 spacecraft touching down on the asteroid
Copyright: Akihiro Ikeshita / JAXA

The search for the beginnings of life:

The Hayabusa2 mission

On the afternoon of December 3rd 2015, all eyes in Japan were turned to the sky. Exactly one year ago, the Japanese Aerospace Exploration Agency (JAXA) had launched their asteroid mission, Hayabusa2. One year later, the spacecraft was back; but it was not staying around.

Hayabusa2 is travelling to asteroid Ryugu, a one kilometre sized space rock that is orbiting the sun between the Earth and Mars. It is an example of a 'C-type' asteroid, a class of objects thought to have changed very little since the formation of the solar system 4.56 billion years ago. This makes it a rocky leftover from the time our planet was born.

The Earth's early days are packed with questions, but perhaps none is more relevant to humans than the origin of life. It is a quandary intricately tied to our oceans, since life on Earth is always found wherever there is water. Yet, our planet was most likely born a dry world.

So close to the sun, the dust grains that collided to build up the Earth were too warm to contain ice. Instead, the oceans of our planet must have been delivered by icy boulders that formed in the colder outer reaches of our solar system before striking the Earth as meteorites. The rocks that travelled inwards but did not hit a planet survived to become asteroids.

Image of the Earth taken by Hayabusa2's ONC-T camera after the Earth gravity assist. Copyright: JAXA

Examining the preserved survivors from this epoch can tell us what was delivered to our infant world. While the arrival of water is exciting, it may not be all that the meteorites contained. Meteorite samples that show evidence of once having contained water are packed with organic molecules, including the amino acids that form our proteins and the nucleobases of our DNA. This means that the rocks that struck the young Earth may not just have delivered the liquid medium for life; they may have also sent its first seeds.

While its size means Ryugu is too small to currently contain liquid water, an observation from Earth has suggested the asteroid contains clays; minerals that cannot be formed without water. It is most likely that Ryugu was once part of a larger asteroid in the Asteroid Belt that broke apart during a collision, sending a fragment towards the Earth. This makes Ryugu a probable twin to the meteorites that struck the young Earth, and its content was also that delivered to our planet.

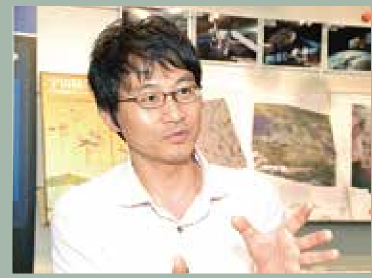
Hayabusa2's recent approach to Earth was for a gravity assist. This manoeuvre used the Earth's mass to swing the spacecraft's trajectory towards Ryugu. It will arrive at the asteroid in 2018 to begin a challenging analysis. Unlike the Rosetta comet mission, Hayabusa2 is a sample retrieval mission. It will land a staggering three times on the asteroid's surface, gathering material from different locations to bring back to Earth. At the third landing site, Hayabusa2 will fire a 2 kg bullet at the asteroid's surface to form a crater from which to gather sub-surface material. The spacecraft will also leave behind a lander and three rovers, enabling exploration of the low gravity environment. Then in 2020, Hayabusa2 is due to arrive back at Earth.

In the Department of Natural History Sciences, Shogo Tachibana is eagerly watching Hayabusa2's progress. Tachibana is the Principal Investigator for the sampling and the sample analysis and it will be his job to examine the rock samples that Hayabusa2 brings back to Earth with researchers from around the world.

Along with the international team of scientists at JAXA, Hayabusa2 has a memorandum of understanding that links the mission with NASA's OSIRIS-REx: a second asteroid mission due to launch in 2016. The two teams will be working closely during the projects and sharing samples upon the spacecrafts' return to Earth.

"International collaboration is very important for space missions," Tachibana says. "For the future, we don't want to be closed. We want to make the best team to analyse the samples."

Researcher Details



Shogo TACHIBANA
Associate Professor
Department of Natural History Sciences
Faculty of Science

E-mail: tachi@ep.sci.hokudai.ac.jp

Hayabusa2 website:
http://www.hayabusa2.jaxa.jp/

It's (literally) Rocket Science:

Making the first dust in the universe

The evening of Friday September 11th 2015 rolled in warm and clear above Japan's Uchinoura Space Centre. The slender rocket sitting on the launch pad was the S-520-30; a scientific research rocket designed to perform experiments in the extremely weak gravity of space.

At 8 pm, the rocket launched, gaining over 300 km in height to take it to just 100 km below the orbit of the International Space Station. Less than a minute after lift-off, an electric current automatically started the on-board experiment as the rocket sailed far above the Earth's surface. In ten minutes, it was all over in an ocean splash-down, 300 km off the coastline.

As their experiment disappeared beneath the waves, Yuki Kimura and Kyoko Tanaka at Hokkaido University's Institute of Low Temperature Science, were triumphant. They now had a measurement for how the first dust particles formed in the universe.

From helium through to iron, the chemical elements of our world are born by fusing atoms in the cores of stars. When the star dies, these elements are thrown outwards to cool into solid particles of dust.

The role of dust in our universe is hard to underestimate. Suspended in star-forming gas clouds, dust provides a surface for complex chemistry, including creating the first organic molecules. It heats the galaxy by warming in the ultraviolet light from the stars and when condensing around young stars, it marks the beginning of the planet formation process.

Yet how did the first dust form and why is a rocket needed to find out?

Laboratory experiments are plagued by two problems: gravity and the container. As the gas is heated to mimic conditions around the dying star, gravity creates a convection cycle where hot gas rises to cool, sink and be reheated. This regular motion prevents the gas being evenly distributed through the experiment chamber, instead producing uniform clumps that make it easier for similar kinds of dust particles to form. Moreover, the easiest way for a vapour to change into a solid is on a surface. Like mist condensing into ice crystals on a cold windowpane, the edge of the container forms the perfect site for dust grain production. The result is the creation of dust under very different conditions from those in space.

Using a rocket pulls the experiment out of the Earth's gravity, removing the problem with convection. To deal with the container wall, the chamber is filled with argon gas. Being inert, argon is reluctant to undergo any chemical reactions. Instead, the vaporised elements bounce off the argon atoms to increase the time it takes to reach the container wall. By the time any non-argon atoms reach a surface, they have already cooled to form dust.

Dust was detected using interferometry. This compares the waves from two identical lasers, one of which travels through the experiment chamber, while the other passes through the outside vacuum. While no dust exists, the two waves remain identical with their crests and trough arriving simultaneously. But once dust has formed, the laser passing through the container is scattered by the solid particles. This lengthens its path and the twin waves slide out of sinc. At this signal, conditions in the experiment are measured to find how efficiently the dust has formed and how easily it sticks to create larger grains.

It is an experiment that has already yielded surprises. While the newest data is now being studied, an earlier experiment to create iron dust in 2012 uncovered big surprises.

In the laboratory, iron particles easily stick together on a surface. However, in the microgravity of space, the probability of iron grains sticking was lower by a whopping factor of 10,000.

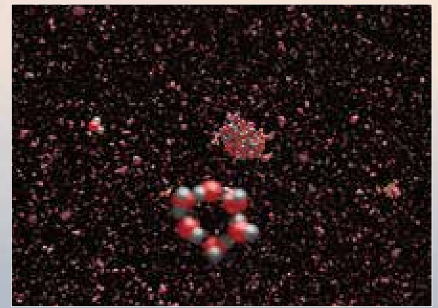
"Iron dust nucleation (first condensation into dust) is difficult," Kimura explains. "But once you have the particle and it provides a surface, growing is much easier."

This explains why the dust around dying stars rarely contains a lot of iron; the first grains are very difficult to form.

Such results tell scientists about what dust surfaces are present in interstellar gas. These details control the reactions that will occur, affecting the observation and production of stars through to the creation of life's elements themselves.

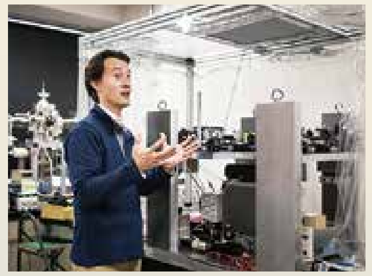
Launching the S-520 sounding rocket
Copyright: JAXA

Experimental apparatus that flew inside the sounding rocket. The silver cylinder is the Argon-filled chamber where the dust nucleated.



Kyoko TANAKA simulates the dust formation investigated in the rocket experiments. This image shows an example of the nucleation process, in this case, for a water molecule. Her work highlights the importance of measuring the sticking probability of molecules on dust accurately.

Researcher Details



Yuki KIMURA
Associate Professor
Institute of Low Temperature Science

E-mail: ykimura@lowtem.hokudai.ac.jp

Kyoko TANAKA
JSPS Research Fellow
Institute of Low Temperature Science

E-mail: kktanaka@lowtem.hokudai.ac.jp

The Dinosaur Hunter

Putting a body on the ‘unusual horrible hand’ dinosaur

Deep tracks - courtesy Perot Museum of Nature and Science

Situated on the southern coast of Hokkaido in Japan, the town of Mukawa is known for its saltwater fish. Until recently, it was not known for its dinosaurs. But then, Yoshitsugu Kobayashi has a reputation for hunting in unusual places.

The dinosaur in question is thought to be the remains of a “hadrosaur” or “duck-billed dinosaur”; a four-legged herbivore that lived 86 to 66 million years ago, toward the end of the Cretaceous period of the Mesozoic era. The fossilised specimen found in Mukawa belonged to a creature about 8 metres long and weighing in at a hefty 6350 kg. When Kobayashi’s team complete the evacuation, it is likely they will reveal the best preserved dinosaur ever found in Japan.

Kobayashi’s dinosaur hunts focus on the Pan Pacific region, predominantly covering Alaska, Mongolia, China and Canada. The discovery of remains in such frigid locations point to a picture of the dinosaurs that is very different from the giant reptiles displayed in movie blockbusters.

“Dinosaurs are like us,” Kobayashi explains. “They are advanced enough to live anywhere on all continents.”

The finds stifle the idea that dinosaurs were cold blooded. To survive harsh winters, these giants of the past needed to be able to generate their own body heat. This makes them a closer relative to warm blooded birds than crocodiles or alligators. By comparing the fossils found in Alaska with different dinosaur groups elsewhere in the world, Kobayashi found that the dinosaurs were immensely adaptable. The same species was capable of living in a wide range of environments, without developing genetic variations to survive the different climates.

Mid-sized hadrosaur track - courtesy Perot Museum of Nature and Science

“People often picture the dinosaurs having small brains,” Kobayashi says. “But the same dinosaurs lived in very different places. They were intelligent and adaptable.”

Such adaptability may indicate that it is unlikely that a catastrophic meteorite impact could alone annihilate the dinosaurs. The dark and cold world that would have been created by the impact debris obscuring the sun would finish a cold blooded species, but not a warm blooded adaptable one. Kobayashi believes it more likely that a string of events was jointly responsible. Two possibilities include prolonged volcanic activity and changes in the sea level permitting more cross-breeding and a resultant lower resistance to disease.

The hike from camp to the site - courtesy Perot Museum of Nature and Science

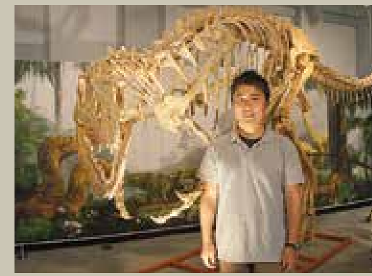
Kobayashi completed his doctorate at Southern Methodist University in Texas with a dissertation on Ornithomimosauria: dinosaurs that superficially resemble the modern ostrich. It is an interest that led to a breakthrough for one of the world’s most mysterious dinosaurs.

In 1965, a pair of clawed three-fingered arms were found in Mongolia’s Gobi desert. For the next fifty years, no other specimens of this dinosaur were found, earning it the name “*Deinocheirus mirificus*” from the Greek for “unusual horrible hand”. At 2.4 metres long, the size of these forelimbs suggested a formidable creature, but exactly how big depended on the dinosaur’s bodily proportions. Were the missing hind-legs similarly sized?

In November 2014, the continual searches in the Gobi region finally paid off. Publishing in the journal *Nature*, Kobayashi’s team (led by Young-Nam Lee at Seoul National University) announced the discovery of two entirely new specimens. While poachers at the quarry sites where the fossils were found had removed a few of the bones, both skeletons were largely complete.

The finds revealed that the *Deinocheirus mirificus* was a giant member of the Ornithomimosauria, similar in size to the tyrannosaurids. The largest specimen extended to 11 metres in length and would have weighed 6,358 kg. Despite its size, the *Deinocheirus* had a toothless, duck-like bill and fed mainly on fish and soft plants. A deep cheek cavity suggests a massive tongue for sucking up plants cropped from the bottom of streams and lakes. The stomach of one specimen also contained 1,400 stomach stones, suggesting these were used instead of teeth to grind food down as for modern herbivorous birds. Its discovery not only closes the door on a half-century mystery, but the record size of this Ornithomimosaur shows that no amount of experience can prevent surprises.

Researcher Details

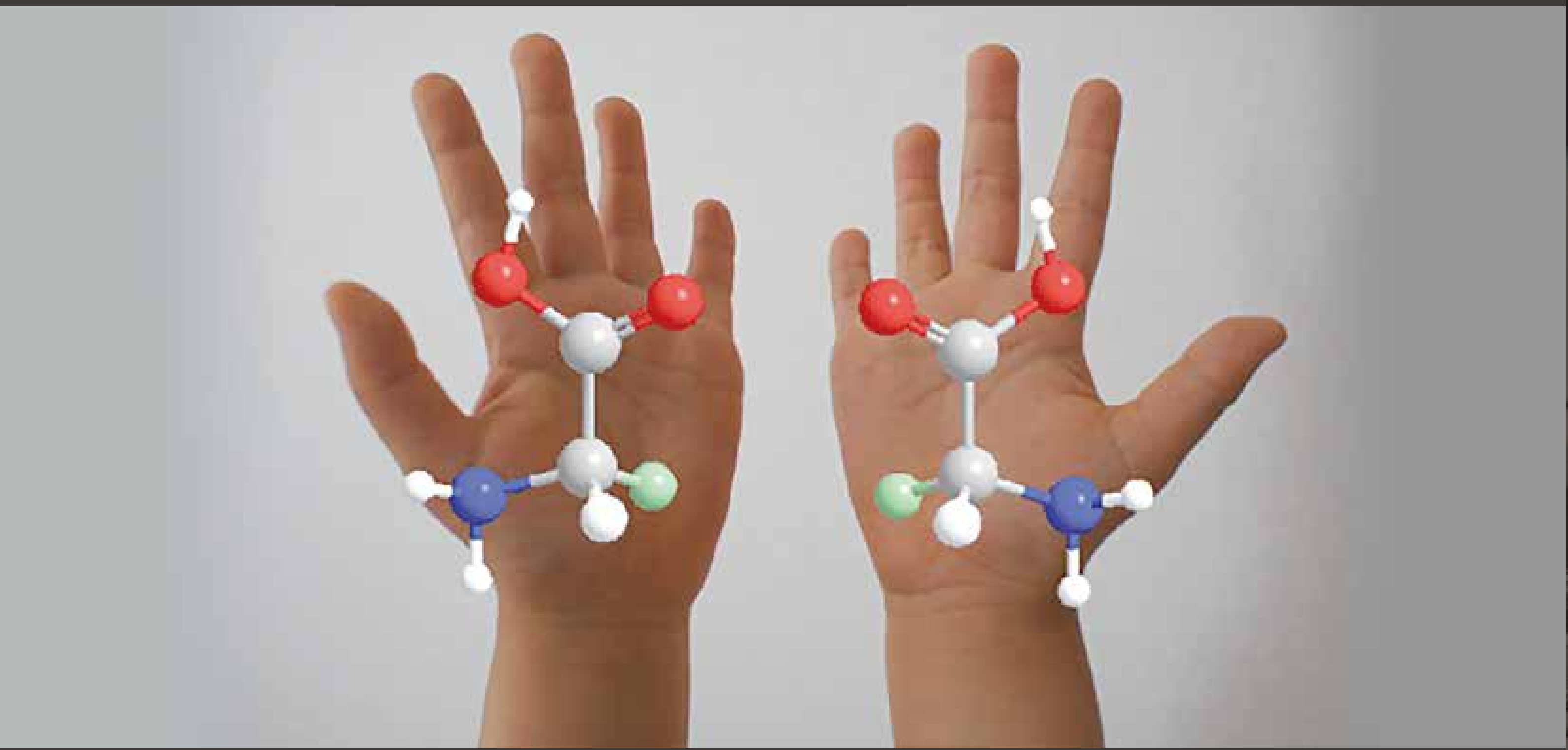


Yoshitsugu KOBAYASHI
Associate Professor
Hokkaido University Museum

E-mail: ykobayashi@museum.hokudai.ac.jp

Journal paper:
Lee et al., *Nature* vol. 515, 2015
dos:10.1038/nature13874

Press release:
https://www.oia.hokudai.ac.jp/blog/61/



Left and right-handed structures of chiral molecules cannot be superimposed in three dimensions (image shows chiral deuterium-substituted glycine $NH_2CHDCOOH$).

Why is life left-handed?

While most humans are right-handed, our proteins are made up of lefties. In the same way your left and right hands mirror one another, molecules can assemble in two reflected structures. Life prefers the left-handed version, which is puzzling since both mirrored types form equally in the laboratory. New research suggests the reason may stem from the creation of the first biological molecule, made before our sun was even born.

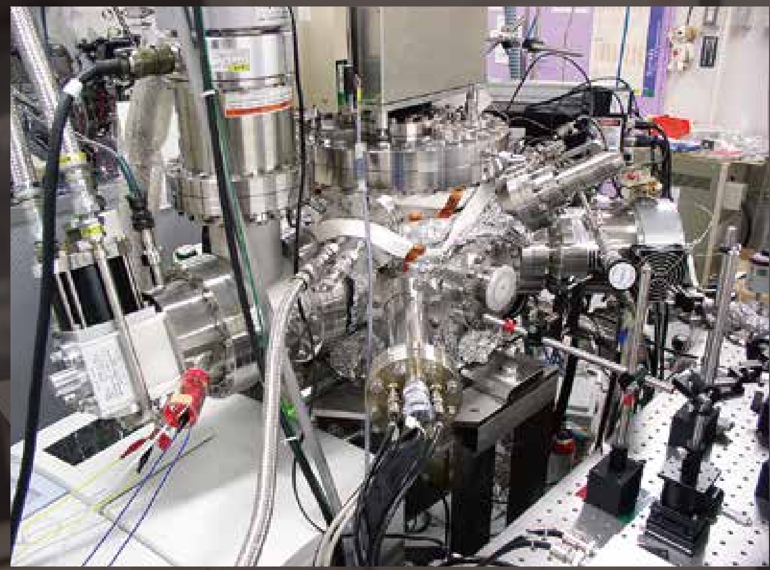
In 2004, NASA's Stardust spacecraft swept through the nebulous halo surrounding a comet. What it found was the simplest of life's building blocks, the amino acid glycine. Comets are frozen remnants from the earliest days in our solar system. Their material is therefore not made in planets, but likely originates in the natal gas cloud that formed our sun.

In the Institute of Low Temperature Science, Yasuhiro Oba and Naoki Watanabe have been recreating the freezing conditions inside such a star-forming cloud. They believe that on the surface of dust grains suspended in this chilly gas, glycine may have undergone a change that made it left-handed.

At the core of the glycine molecule is a carbon atom with four bonds. If two of these bonds attach to hydrogen atoms, then the molecule is symmetric and neither right nor left handed. However, swap a hydrogen for another atom and this symmetry is broken. The molecule can then form two mirrored versions giving it handedness or 'chirality'.

Oba and Watanabe's experiments suggest that a glycine hydrogen atom could be displaced by an atom of deuterium. Deuterium is a heavier version of hydrogen that contains an extra neutron in its nucleus, doubling its weight. It is abundant inside star-forming clouds, which are observed to contain many deuterium-enriched species, including heavy water. Once a deuterium atom has replaced a hydrogen, it is very hard to dislodge. The fraction of chiral glycine therefore steadily increases, until the main species of glycine inside the cloud shows left or right handedness.

Chiral glycine is very similar to the original glycine, but with an important extra property. Laboratory experiments have shown that chiral glycine is a catalyst for other chiral molecules. That is, it promotes the production of other species with the same handedness as itself. The result is that if glycine became a left-handed molecule, then future biological molecules would also be predominantly left-handed. When life developed on Earth, it would therefore build from a pool of left-handed molecules, giving it the bias we observe today.



Inside the low temperatune laboratory

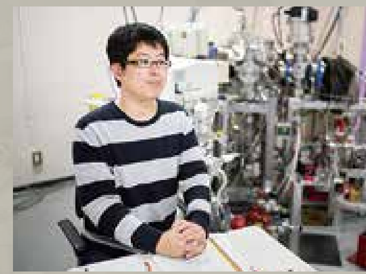
"I believe chiral glycine has the potential to give us left-handed life," Oba says.

This discovery potentially resolves another issue. While glycine is expected to be abundant inside star-forming clouds, it has never been observed. However, searches have been looking for the symmetric version of glycine, not its handed twin. If most of the glycine was left-handed, then it would have been missed.

It is an exciting idea, but many questions still remain. In the laboratory, the scientists can tell deuterium has replaced hydrogen to form chiral glycine, but the quantities are too small to see which mirrored version has formed. It could be that the dust grain structure favours left or right handedness. Alternatively, both types could form but one might be more easily destroyed. The answer to this would tell us if life beyond our own Solar System is expected to share our left-handed bias.

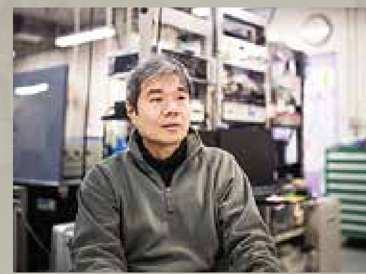
"Nobody cared about the production of a chiral molecule in a cold cloud before now," Watanabe elaborates. "But we opened the door to this possibility."

Researcher Details



Yasuhiro OBA
Assistant Professor
Institute of Low Temperature Science

E-mail: oba@lowtem.hokudai.ac.jp



Naoki WATANABE
Professor
Institute of Low Temperature Science

E-mail: watanabe@lowtem.hokudai.ac.jp

Journal paper:
Oba et al., *Chemical Physics Letters*, vol. 634 2015

Media:
The Conversation,
https://theconversation.com/why-is-life-left-handed-the-answer-is-in-the-stars-44862

Weighing invisible planets:

How gaps in planet-forming discs can reveal the mass of young, new worlds

Twenty years ago, the first extrasolar planet around a sun-like star was detected. The discovery threw open the door to worlds beyond our own solar system and simultaneously destroyed our ideas of how planets form.

The problem was that this newly detected world was the size of Jupiter, but it orbited so close to its star that a year took only four Earth days. In such a hot environment, there is no way to build such a massive planet.

Planets form in dusty, gaseous discs that circle young stars. Buffeted by the gas, sand-sized grains collide and stick together. The process is akin a massive Lego assembly project, with bigger structures connecting until they have enough mass to pull in an atmosphere from the surrounding gas. The star then evaporates the disc and a planet is born.

To build up the bulk needed to attract the giant atmospheres of the Jupiter worlds, the planet needs to form far from the star. In these colder regions, ice can condense to help boost the planet mass. These gas giants therefore cannot form near the star where ice would melt. So how did they get there?

The most likely answer is they migrated. Once a planet reaches the size of Mars (roughly one-tenth Earth), its gravity begins to pull on the surrounding gas disc which drags back. The gas drag can cause the planet to slow, tugging it inwards towards the star. As the planet continues to grow, its gravitational pull on the gas increases. This forces the gas surrounding the planet to change speed, pushing the gas onto new orbits that creates a gap at the planet's position.

While we suspect this migration process occurs, it is very hard to catch it in action. However, that is about to change.

The HL Tau planet-forming disc taken with the ALMA radio telescope

In 2015, the Atacama Large Millimetre Array (ALMA) released a spectacular image of a planet forming disc. Known as HL Tau, the dust circling the star showed multiple dark bands marking out gaps in the disc. The origin for these gaps has been one of the most hotly debated topics over the last year. Are they the smoking gun of migrating planets; young worlds in the process of becoming closely orbiting Jupiters? Or are they simply structures formed by the disc's own gravity?

A key to this puzzle would be to measure the size of planet needed to create these gaps. For this, Hidekazu Tanaka and his postdoctoral associate, Kazuhiro Kanagawa, think they have an answer.

Tanaka's recent work has found a link between the gap depth and width and the hidden planet mass. Because a more massive planet has stronger gravity, it pulls harder on the surrounding gas and creates a larger gap. Tanaka's group have used this fact to form a simple equation that estimates the planet mass based on measurements of the disc temperature. HL Tau's temperature comes from its emitted infrared radiation. How much radiation passes through the dust versus how much is absorbed depends on the dust thickness and the radiation wavelength. By comparing the temperature at different wavelengths, the researchers were able to estimate the depth of the dust and therefore, the depth of the observed gaps. Then using their relation, the planet mass could be found. For HL Tau, the disc gap that sits at 30 AU (thirty times the Earth to Sun distance) from the disc centre could be a planet with a mass larger than one-third Jupiter.

"Measuring planet properties from observations of discs would enable us to monitor planets forming for the first time." Tanaka says.

In their latest work, Tanaka's group have used computer simulations to relate the more easily measured quantity—gap width—to the planet mass. The result is a second simple formula to uncover these hidden worlds.

Artist impression of the HL Tau planet-forming disc
Credit: ESO/L.

Researcher Details

Hidekazu TANAKA
Associate Professor
Institute of Low Temperature Science

E-mail: hide@lowtem.hokudai.ac.jp

Journal paper:
Kanagawa et al., *The Astrophysical Journal*, vol. 806, 2015

The vacuum cleaner that can tweet it can't fly

Nestled under the desk in Rafal Rzepka's laboratory is a Roomba robotic vacuum cleaner with a Twitter account. When there is a spillage in the laboratory, one tweet to 'Twimba' will cause her to leap into life for a rapid clean-up.

Twimba's abilities may not initially seem surprising. While Twitter is a novel way of communicating, we are all familiar with automated telephone systems and voice operated assistants such as Apple's Siri. Yet, Twimba is not like either of these two systems. Rather than having a list of words she understands, such as 'clean', Twimba looks for her answers on the internet.

If Twimba receives a tweet saying the lab floor is dirty, her search through people's tweets would uncover that dirty floors are undesirable and the best action is to clean. She then performs this task. Even though not everyone has the same reaction to a situation (a few may love a completely filthy room), Twitter's huge number of users ensures that Twimba's most common find is the expected human response.

This method gives Twimba a great deal of flexibility in the language she can handle. In this example, it was not necessary to specifically say the word 'clean'. Twimba deduced that this was the correct action from people's response to the word 'dirty'. A similar result would have appeared if the tweet contained words like 'filthy', 'grubby' or even more colloquial slang. Twimba can handle any term, provided it is wide enough spread to be used by a significant number of people.

Of course, there are only so many problems that a vacuum cleaner is equipped to handle. If Twimba receives a tweet that the bathtub is dirty, she will discover that it ought to be cleaned but she will also search and find no examples of robotic Roombas like herself performing this task.

"A Roomba doesn't actually understand anything," Rzepka points out. "But she's very difficult to lie to. If you said 'fly', she'll reply 'Roombas don't fly' because she would not have found any examples of Roombas flying on Twitter."

The difficulty of lying to one of Rzepka's machines due to the quantity of information at its disposal, is the key to its potential. By being about to sift rapidly through a vast number of sources, the machine can produce an informed and balanced response to a query more easily than a person.

But how about assessing more subtle human behaviour? Rzepka cites the example of 'lying with tears', where a person might cry not through sorrow, but from an ulterior motive. Humans are aware of such deceptions and frequently respond suspiciously to politicians or other people in power when they show public displays of emotion. Yet can a machine tell the difference?

Rzepka's research suggests it is possible when the computer draws parallels between many similar, but not identical, situations. While the machine cannot understand the reasons behind the act, it can pick out the predicaments in which a person is likely to cry intentionally.

This ability to apply knowledge across related areas allows a more human-like flexibility in the artificial intelligence. Yet, if a machine correlates events too freely, there can be problems.

For example, while eating dolphins is abhorrent in most cultures, a computer would discover that eating pigs was generally popular. In Japanese, the Kanji characters for dolphin are '海' meaning 'sea' and '豚' meaning 'pig'. A machine examining the Japanese word might therefore decide that dolphin and pigs were similar and thus dolphins were a good food source.

Such problems highlight the issue of 'machine ethics' where a computer must choose based both on logic and morals. It is the type of problem that self-driving cars will soon be facing. However, these problems can be handled if the machine clearly states the reasons for a choice.

"Knowing why a machine makes a choice is paramount to trusting it," Rzepka states. "If I tell the Roomba to clean and it refuses, I want to know why. If it is because there is a child sleeping and it has discovered that noise from the Roomba wakes a baby, then it needs to tell you. Then you can build up trust in its decisions."

If we are able to get the ethics right, a machine's extensive knowledge base could be applied to a huge manner of situations.

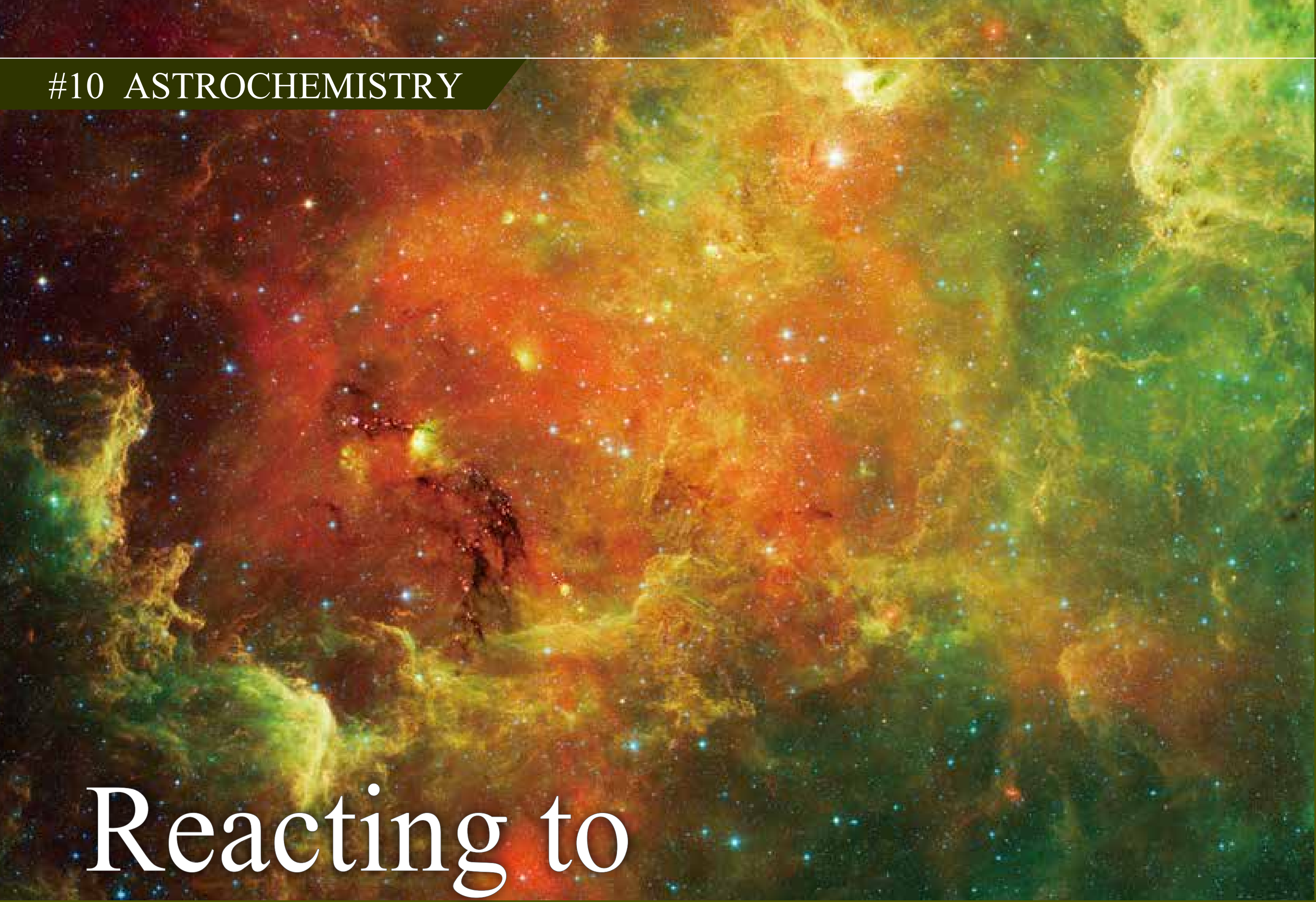
"Your doctor may have seen a hundred cases similar to yours," Rzepka suggests. "A computer might have seen a million. Who are you going to trust more?"

Researcher Details

Rafal RZEPKA
Assistant Professor
Graduate School of Information Science and Technology

E-mail: rzepka@ist.hokudai.ac.jp

Journal paper:
Takagi, Rzepka and Araki, "Just Keep Tweeting, Dear: Web-Mining Methods for Helping a Social Robot Understand User Needs", *Proceedings from AAAI 2011 Spring Symposia(SS-11-05)*



The star-forming North American Nebula
Copyright: NASA/JPL-Caltech

Reacting to the coldest place in the Universe

Quantum tunnelling explains the chemistry in star-forming clouds

Within the coldest depths of our galaxy, Naoki Watanabe explores chemistry that is classically impossible.

At a staggering -263°C (10K), gas and dust coalesce into clouds that may one day birth a new population of stars. This makes the chemistry of these stellar nurseries key to understanding how stars such as our own sun were formed.

While the cloud gas is made primarily from molecular (H_2) and atomic (H) hydrogen, it also contains tiny dust grains suspended like soot in chimney smoke. It is on these minute surfaces that the real action can begin.

Most chemical reactions require heat. In a similar way to being given a leg-up to get over a wall, a burst of energy allows two molecules to rearrange their bonds and form a new compound. This is known as the 'activation energy' for a reaction. The problem is that at these incredibly low temperatures, there is very little heat on offer and yet mysteriously reactions are still happening.

In the laboratory, Watanabe has set-up experimental apparatus that can lower temperatures down to the depths of the galactic clouds. Dust grains in the clouds are observed to be covered with molecules such as ice, carbon monoxide (CO) and methanol (CH_3OH). Some of these can be explained easily: for instance, carbon monoxide can form from a positively charged carbon atom that is known as an ion (C+). The charge on the ions make them want to bond to other atoms and become neutral, resulting in no activation energy being required. A second possible mechanism is by a carbon atom (C) attaching to a hydroxyl molecule (OH): a particularly reactive compound known as a 'radical' due it possessing a free bond. Like the charge on the C+, this loose bond wants to be used, allowing the reaction to proceed without an energy input. These paths allow CO to form in the cloud even at very low temperatures and freeze onto the dust.

However, methanol is more of a mystery. Since the molecule contains carbon, oxygen and hydrogen (CH_3OH), it is logical to assume that initially CO forms and then hydrogen atoms join in the fun. The problem is that to add a hydrogen atom and form HCO requires a significant activation energy, and there is no heat in the cloud to trigger that reaction. So how does the observed methanol get formed?

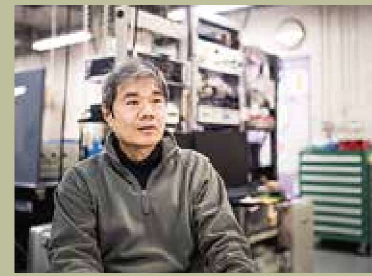
Watanabe discovered that while the low temperature prevented HCO forming through a thermal (heat initiated) reaction, it was that same coldness that opened the door to a different mechanism: that of quantum tunnelling. According to quantum mechanical theory, all matter can behave as both a particle and a wave. As a wave, your position becomes uncertain. Your most likely location is at the wave peak, but there is a small chance you will be found to either side of that, in the wave's wings.

Normally, we do not notice the wave nature of objects around us: their large mass and energy makes their wavelength so small this slight uncertainty goes unnoticed. Yet in the incredibly cold conditions inside a cloud, the tiny hydrogen atom starts to show its wave behaviour. This means that when the hydrogen atom approaches the carbon monoxide molecule, the edge of its wave form overlaps the activation energy barrier, giving a chance that it may be found on its other side. In this case, the HCO molecule can form without having to first acquire enough heat to jump over the activation barrier; the atoms have tunnelled through.

Such reactions are completely impossible from classical physics and the chance of them occurring in quantum physics is not high, even at such low temperatures. This is where the dust grain becomes important. Stuck to the surface of the grain, reactions between the carbon monoxide and hydrogen atom can occur many many times, increasing the likelihood that a hydrogen atom will eventually tunnel and create HCO.

After measuring the frequency of such reactions in the lab, Watanabe was then able to use simulations to predict the abundance of the molecules over the lifetime of a galactic cloud. The results agreed so well with observations that it seems certain that this strangest of mechanisms plays a major role in shaping the chemistry of the galactic clouds.

Researcher Details



Naoki WATANABE
Professor
Institute of Low Temperature Science

E-mail: watanabe@lowtem.hokudai.ac.jp

Journal paper:
Kuwahata et al., *Physical Review Letters* vol. 115, 2015

Oba et al., *The Astrophysical Journal*, vol. 749, 2012

Watanabe & Kouchi, *Progress in Surface Science* vol. 83, 2008 (review paper)

Media:
Chemistry World,
http://www.rsc.org/chemistryworld/node/3283

Even More Researchers!

HU Reseach Press Releases:
https://www.oia.hokudai.ac.jp/blog/category/news/research-press-release/

Research Blog:
https://www.oia.hokudai.ac.jp/blog/category/news/research-blog/

Detailed information on the researchers below can be found at *Research Frontier's* webpage:
http://kkyoka.oeic.hokudai.ac.jp/frontier/en/

First Name	Last Name	Title	Affiliation	Research Areas	Research Keywords
Nobuo	KURATA	Prof.	Grad. Sch. of Letters	Applied Ethics (Bioethics, Environmental Ethics, Ethics of Science and Technology), Normative Ethics, Metaethics, History of Philosophy	philosophy, risk, duty, good, happiness, meaning of life
Toru	SASAKI	Prof.		Museum Management, Cultural Anthropology	museum, curator, management, evaluation, cultural anthropology
Katsunori	TAKASE	Assoc. Prof.		Prehistoric Archaeology	archaeology, Kuril Ainu, Kuril Islands, Kamchatka Peninsula
Shoju	IKEDA	Prof.		Japanese Linguistics	linguistics, data base, Kanji, dictionaries, electronic texts
Takeshi	OSHINO	Prof.		Modern Japanese Literature, Cultural Studies, Subculture Studies	literary theories, modern art theories, media mix, mystery
Tohru	IKEDA	Prof.		Conservation Ecology, Wildlife Management, Regional Science	ecology, biodiversity, alien species, environmental conservation, fieldwork
Tomonori	ISHIOKA	Assoc. Prof.	Faculty of Education	Sociology of Sport, Cultural Studies	sports, body culture, poverty
Hiromichi	KATO	Assoc. Prof.		Developmental Psychology	adolescence, problem behavior, development
Yasutaka	MACHIMURA	Prof.	Grad. Sch. of Law	Civil Law	trial, information laws, consumer laws, gender
Yoko	SATO	Assoc. Prof.		Criminal Law	criminal law, consent of victim, consent of patient, right of self-determination, euthanasia
Yuichi	MURAKAMI	Assoc. Prof.	Faculty of Public Policy	Public Administration, Public Management, Technology Policy	from government to governance, role of government, international regulations, science and technology, administrative reform
Ken	ENDO	Prof.		International Politics	national sovereignty, security, European integration, East Asia, citizenship
Yuuji	SAKAGAWA	Prof.	Grad. Sch. of Econ. and B.A.	Commercial Science, Marketing	market orientation, marketing, retailing
Akira	SAKAI	Assoc. Prof.	Faculty of Science	Probability Theory, Statistical Mechanics	mathematical model, phase transition, critical behavior, lace expansion
Shinpei	KOBAYASHI	Assoc. Prof.		Mathematics	differential geometry, integrable systems
Masaaki	KIMURA	Assoc. Prof.		Nuclear Physics	nuclear structure, nuclear reaction, nuclear force, first principle calculation, unstable nucleus
Tetsuya	TAKETSUGU	Prof.		Theoretical Chemistry, Computational Chemistry	photochemical reaction, physical property, computational chemistry, element strategy, catalyst
Ryuichi	MASUDA	Prof.		Zoogeography, Molecular Phylogenetics	biodiversity, evolutionary biology, molecular phylogeny, ancient DNA, brown bear study
Masaaki	WATAHIKI, K.	Assoc. Prof.		Plant Physiology, Plant Morphology	plant physiology, plant hormone, auxin, gene expression, luciferase
Hisashi	HAGA	Prof.	Faculty of Adv. Life Sci.	Cell Biology, Tumor Biology	cell biology, protein, cell movement, cancer cell invasion
Shin-Ichiro	NISHIMURA	Prof.		Bioorganic Chemistry (Glycotechnology, Medicinal Chemistry)	lycans, medicinal chemistry, protein, biopolymers, disease-specific antigen, antibody drug
Yukihiro	TAKAHASHI	Prof.	Faculty of Science	Earth and Planetary Science	solar system, remote sensing, natural disaster science, forestry science, climate change
Atsushi	KAWAMOTO	Prof.		Solid-State Physics, Molecular Science, Magnetic Resonance	organic superconductivity, strongly-correlated electron system, low-dimensional electron system, nuclear magnetic resonance
Kei	MURAKOSHI	Prof.		Physical Chemistry, Electrochemistry, Catalytic Chemistry, Photochemistry and Nanostructure Chemistry	boundary surface, scanning probe microscope, monomolecular layer, electrode catalyst and optical functional material

First Name	Last Name	Title	Affiliation	Research Areas	Research Keywords
Masato	FURUYA	Prof.	Faculty of Science	Geodesy, Geophysics	space geodesy, Synthetic Aperture Radar (SAR), earthquake, volcano, glacier
Yusuke	OHBA	Prof.	Grad. Sch. of Medicine	Cell Physiology, Bioimaging	cell biology, general physiology, fluorescent protein, signaling
Satoshi	HIRANO	Prof.		Digestive Surgery (Upper Gastrointestinal Tract, Biliary Tract, Pancreas)	surgery, radiotherapy, vaccines
Yoshiro	MATSUI	Prof.		Cardiovascular Surgery	surgery, heart failure, left ventricular reconstruction, VAD, heart transplantation
Naoya	SAKAMOTO	Prof.		Medicine, Internal Medicine, Digestive Diseases	virus hepatitis, liver cancer, drug, virology
Utano	TOMARU	Assoc. Prof.		Medical, Pathology	pathology, experimental pathology, immunology, aging
Hiroshi	NISHIHARA	Specially Appointed Prof.		Cancer Pathology	cancer, personalized diagnosis, experimental pathology, genome science, molecular biology
Michitaka	OZAKI	Prof.	Faculty of Health Sci.	Transplant Surgery, Digestive Organ Surgery	liver patho-physiology, stress, bioimaging, surgery, cell biology
Tadayoshi	ASAKA	Prof.		Neurophysiotherapy	postural control, motor control, rehabilitation
Shigeru	YOSHIDA	Lecturer		Genetic Test Studies, Clinical Technology	standardization, HIV, drug-resistant HIV, genetic test studies, clinical technologist
Eri	HIRATA	Assist. Prof.	Grad. Sch. of Dental Medicine	Prosthodontics, Dental Material Science	carbon nanotubes, regenerative medicine, nanobioscience
Mari	SATO	Assist. Prof.		Bone Metabolism, Oral Biochemistry	bone, bone cells, sensory organ
Yasuhiro	MATSUDA	Assist. Prof.		Dental Preservation Treatment, Tooth Decay, Genetics	genetic/genome dynamics, microbeam, fluoride
Toshiharu	SUZUKI	Prof.	Faculty of Pharm. Sci.	Cellular Neurobiology, Biochemistry	Alzheimer's disease, intercellular vesicular trafficking, genes, aging
Mitsuru	SUGAWARA	Prof.		Pharmaceutics, Pharmacokinetics	pharmacokinetics, drug metabolism, digestive tract, pharmaceutical production, medical sociology
Hiroshi	ABE	Assoc. Prof.		Bioorganic Chemistry, Synthetic Organic Chemistry, Nucleic Acid Chemistry	nucleic acid, fluorescence, drug discovery
Seiji	MIURA	Prof.	Faculty of Engineering	Metallic Materials Science	physical metallurgy, strength, alloy design, lightweight material, super-heat resistant material, energy science
Naoyuki	FUNAMIZU	Prof.		Sanitary Engineering	sanitation, recycling society, developing country, environmental engineering
Tsutomu	UCHIDA	Assoc. Prof.		Crystal Growth, Glaciology, Biophysics	ice, water, gas hydrate, biophysics, crystal
Tamotsu	KOZAKI	Prof.		Energy Environment System, Radioactive Waste Disposal Engineering	nuclear power, radioactive waste, decommissioning of nuclear facilities, environmental remediation
Shinichiro	SATO	Assoc. Prof.		Physical Chemistry, Quantum Chemistry, Polymer Chemistry	laser, photochemistry, quantum beat, quantum phase control, polymer chemistry
Mikito	UEDA	Prof.		Electrochemistry, Surface Treatment	molten salts, ionic liquids, recycle, fuel cell system
Shinya	HONDA	Assoc. Prof.		Composite Material Engineering, Vibration Engineering, Optimal Design	fiber-reinforced composite material, structure optimization, smart structure, physical properties, algorithm
Reina	KAJI	Specially Appointed Assist. Prof.		Optical Properties of Semiconductors	semiconductor, quantum dot, spin, laser, quantum information

First Name	Last Name	Title	Affiliation	Research Areas	Research Keywords
Hisashi	SATOH	Assoc. Prof.	Faculty of Engineering	Water Environmental Engineering	water resource, analytical chemistry, organic chemistry, sensor
Tomoko	OTA	Assist. Prof.		Environmental Dynamics & Radioactivity	environmental radioactivity, sustainable recycling society, environmental conservation
Kikuo	UMEGAKI	Prof.		Quantum Beam Application Engineering, Medical Physics	radiotherapy, quantum beam, nuclear medicine diagnosis
Yasuhiko	SATO	Assoc. Prof.		Concrete Technology	infrastructure, concrete, performance, design, maintenance
Taichiro	OKAZAKI	Assoc. Prof.		Structural Engineering	buildings, steel structures, earthquake, structural analysis, seismic design
Taro	MORI	Assoc. Prof.		Building Environment	environmental engineering, renewable energy, indoor environment, simulation, passive design
Yasunori	WATANABE	Assoc. Prof.		Coastal Engineering, Fluid Dynamics	ocean, waves, breaking wave, turbulence, multiphase flow
Masahito	KURIHARA	Prof.	Grad. Sch. of Info. Sci. & Tech.	Software Engineering, Artificial Intelligence	software, programming, intelligent information processing, computing system
Akihisa	TOMITA	Prof.		Quantum Information Science, Quantum Optical Engineering	quantum cryptography, quantum computer, atom, molecule, quantum electronics
Jun	NISHIKAWA	Assoc. Prof.		Neuroengineering, Audition and Vocalization	brain, brain-machine interface, multielectrode, LSI Chip, restoring brain function
Ryoichi	HARA	Assoc. Prof.		Power Systems Engineering	power systems, renewable energy, battery, smart grid
Yoshinori	DOBASHI	Prof.		Computer Graphics	rendering, simulation, sound
Takashi	HIRANO	Prof.	Research Faculty of Agriculture	Eco-informatics, Ecosystem meteorology	ecosystem monitoring, climate change, carbon cycle, environmental disturbances, CO2 flux
Tatsuhiro	EZAWA	Assoc. Prof.		Plant Physiology, Microbiology	plant, microorganism, symbiosis, mycorrhiza, gene, degraded land
Hiroshi	SAKAZUME	Prof.		Food and Agricultural Marketing	farm product distribution, food safety and security, supermarkets, food-service industry
Satoshi	KOIKE	Assoc. Prof.		Animal Nutrition, Gut Microbiology	herbivorous livestock, gut microorganisms, cellulose degradation, genome
Makoto	HASHIMOTO	Assoc. Prof.		Chemical Biology, Synthetic Organic Chemistry	organic chemistry, protein, bioactive compound, biomolecule, structure-activity relationship
Osamu	INANAMI	Prof.	Grad. Sch. of Vet. Med.	Radiobiology	radiation treatment, apoptosis, cellular biology, magnetic resonance imaging
Kenji	HOSOYA	Assoc. Prof.		Comparative Oncology	radiation, treatment, chemotherapy, lymphoma
Osamu	ICHII	Assoc. Prof.		Veterinary Anatomy, Molecular Morphology	animals, kidney disease, urine, biomarkers, cellular biology
Takashi	MATUISHI	Assoc. Prof.	Faculty of Fisheries Sci.	Fisheries Stock Assessment, Cetology	cetaceans, bycatch, cetacean research group, stranding
Munetaka	SHIMIZU	Lecturer		Fish Physiology, Comparative Endocrinology	salmonid fish, life history, hormone, biomarker, biodiversity
Koji	YAMAZAKI	Assoc. Prof.		Food Microbiology, Food Hygiene	microorganisms, aquatic food, seafood, food poisoning, microbial control, food safety
Hiromichi	UENO	Assoc. Prof.		Physical Oceanography	weather/ocean, climate change, marine ecosystems, ocean mesoscale eddies, ships

First Name	Last Name	Title	Affiliation	Research Areas	Research Keywords
Takafumi	FUJIMOTO	Assoc. Prof.	Faculty of Fisheries Sci.	Fish Developmental Biotechnology, Genetics and Breeding of Aquatic Species	embryonic development, hydrosphere, clone, genome, hybrid
Junji	YAMAMOTO	Assoc. Prof.	Hokkaido University Museum	Geochemistry	Earth's interior, mantle, terrestrial materials, rocks, minerals, solar system
Atsushi	TAKABAYASHI	Assist. Prof.	Institute of Low Temperature Science	Plant Physiology, Plant Biochemistry, Molecular Biology	photosynthesis, protein, bioinformatics
Yoko	MITANI	Assoc. Prof.	Field Science Center for Northern Biosphere	Marine Mammal Biology	ecology, environment, behavioral ecology, marine ecology, marine mammals, bio-logging
Takako	NABESHIMA	Assoc. Prof.	Research Faculty of Media and Communication	International Politics, African Studies	political sociology, international relations, rural community, acculturation, critique of modernity
Masashi	OHARA	Prof.	Faculty of Env. Earth Sci.	Plant Ecology, Conservation Ecology	plants, ecology, evolution, life history, field, biodiversity
Toshiyuki	NAKAGAKI	Prof.	Research Institute for Electronic Science	Mathematical Physics, Cell Biology, Physical Ethology, Non-Linear Dynamics, Bioinformatics	protist, mathematical model, perception and recognition, algorithm, mathematical physics
Hideo	KAIJU	Assoc. Prof.	Research Institute for Electronic Science	Materials Science, Magnetic Engineering	spintronics, nanoscale junctions, energy saving
Jun-ya	HASEGAWA	Prof.	Catalysis Research Center	Theoretical Catalytic Chemistry	quantum chemistry, computational chemistry, catalytic chemistry, biomolecular science
Masaharu	MUNETOMO	Prof.	Information Initiative Center	Information Engineering	cloud computing, intelligence informatics, algorithm
Ichizo	YAGI	Prof.	Faculty of Env. Earth Sci.	Electrode Catalysts, Interface Physical Chemistry, Environmental Science	fuel cell, energy conversion nanomaterials, laser spectroscopy
Yoshimasa	MATSUSHIMA	Assist. Prof.	Institute of Low Temperature Science	Physical Oceanography	climate system, coupled ocean-sea ice system, numerical simulation, high-performance computing
Yoichiro	HOSHINO	Assoc. Prof.	Field Science Center for Northern Biosphere	Horticulture	biodiversity, crop cultivation, breeding, Haskap (Lonicera caerulea)
Makiko	HORITA	Assoc. Prof.	Research Faculty of Media and Communication	Modern Art and Culture	modern art theory, sociology of local community, depopulation, identity
Junichi	UCHIDA	Assoc. Prof.	Center for Adv. Tourism Studies	Tourism Management	business administration, marketing theories, brand, regional industry
Tomohiko	UYAMA	Prof.	The Slavic-Eurasian Research Center	Central Eurasia Studies, Comparative History, Comparative Politics	Russia, Islam, empire, oriental history, western history
Jun	KAMENO	Assoc. Prof.	Institute for the Adv. of Higher Edu.	Human Resource Development, Career Education, Pedagogy, Labor Policy	occupation, education, human resource development, labor problem, economic policy
Yoshinori	NISHINO	Prof.	Research Institute for Electronic Science	Optics	X-ray, laser, microscopy, nanobioscience, data analysis
Hironori	SASADA	Assoc. Prof.	Office of International Affairs	Politics, International Political Economy	political economy, political history, institutional development
Yasuhiko	SUZUKI	Prof.	Research Center for Zoonosis Control	Bacteriology, Protein Engineering	zoonotic diseases, infectious diseases, bacteria, genetic diagnosis, drug resistance
Takeshi	HORINOUCHI	Assoc. Prof.	Grad. Sch. of Env. Earth Sci.	Meteorology and Climatology	weather, climate, geophysical fluid dynamics
Tetsuro	HIROSE	Prof.	Institute for Genetic Medicine	Molecular Biology, Cellular Biology, RNA Biology	RNA, genome science, cellular biology, disease-related protein, neurodegenerative disease