

Kyoto University
2016 Autumn

KYOTOU

Research News



Contents

04 On the cover:
Backstage at the lab

Reading beyond time and across disciplines



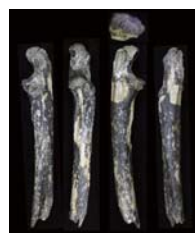
08 Personnel Profiles

Working in CiRA labs



12 Cutting edge

- 12 The search for happiness: using MRI to find where happiness happens
- 12 Fish oil helps burn fat by transforming fat-storage cells into fat-burning cells
- 13 "Seeing" black holes with home-use telescopes
- 13 To hear a pitter patter from afar: catching heartbeats with millimeter-wave radar
- 14 Genetically modified *E.coli* pump out morphine precursor
- 14 "Popular girls" have less lice – in the monkey world
- 15 Australopithecus fossils found east of the Great Rift Valley
- 15 'Slow' NZ seabed quake sheds light on tsunami-earthquake mechanism
- 16 Cancer cell immunity in the crosshairs: worth the expense?
- 16 Flipping a protein switch to illuminate brain functions
- 17 "Big mama" bonobos help younger females stand up for themselves
- 17 Did the LIGO gravitational waves originate from primordial black holes?



- 11 News from overseas centers
- 18 International activities
- 20 Student voices
- 22 Global outreach
- 23 Eternal aesthetic

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Cover

Namazué (catfish art) is a genre of *ukiyoé* prints of mythical, underground, monster catfish, which according to folklore caused earthquakes with their movements. The cover illustration is based on one such print, distributed in Edo (present day Tokyo) following the killer Ansei quake of 1855. Seismologists can be seen here using digital tools to learn from the past, as described in the cover story on page 4. (Trais/Fujiwara)

from the President

From its origins in 1897, Kyoto University's emphasis on academic freedom based on dialogue has helped cultivate a spirit of creativity that inspires its education and research. Our contributions to society aim to achieve harmonious coexistence between humanity and the ecosphere. This creativity has produced nine Nobel laureates and two Fields Medalists, among numerous other world-leading achievements, establishing our position as one of Asia's top universities.

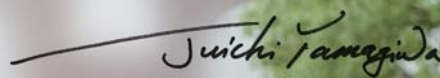
With this foundation, we have formulated the WINDOW concept to further inspire education and research in response to challenges facing the world today: an idea that the university serves as a window to the world, from which we send our students out to play leading roles on the world stage. WINDOW stands for "Wild and Wise," "International and Innovative," "Natural and Noble," "Diverse and Dynamic," "Original and Optimistic," and "Women, Leaders in the Workplace."

There are 23,000 undergraduate and graduate students studying at Kyoto University's 10 undergraduate faculties and 18 graduate schools. This includes around 2,000 international students from 106 countries and regions, who together with their Japanese classmates acquire knowledge from a broad range of general and specialized areas for which we are renowned. Armed with this knowledge, we are confident they will display leadership in a wide variety of fields in the future.

Kyoto University has 22 affiliated research institutes and centers throughout Japan, where our students can participate in cutting edge research projects from their very first year, in small-group seminars. Additionally we have more than 50 research centers overseas, engaged in a diverse range of fieldwork and joint research. We have cooperative agreements with 161 universities and institutions throughout the world, forming a basis for short- and long-term student exchange programs.

Students joining us in Japan can take part in the Kyoto Study Program, an opportunity to experience the city's more than 1,200 years of history, culture, and arts. Kyoto is home to more than 2,000 shrines and temples, many of which are designated World Cultural Heritage sites. *The Tale of Genji*, believed to be the world's oldest literary work by a female author, and *Choju Jinbutsu Giga*, a set of scrolls believed to be the world's first *manga*, also originate from Kyoto.

What is important is that the landscapes and scenes of daily life from those times can still be seen in Kyoto today. I hope you will come to Kyoto and, through your studies, experience "developing new ideas based on study of the past." We eagerly look forward to welcoming you into our community.



President, Kyoto University



Clockwise from upper left: Yamagiwa, a leading primatologist, in 2010 with a Virunga mountain gorilla; an eastern lowland gorilla; KU's symbolic camphor tree; and gorilla keepsakes in the President's office



Reading beyond time and across disciplines

One scientist working on the archives said, “A great earthquake historically occurs once every hundred to several hundreds of years in a given region. To understand earthquakes and to make use of lessons learned for future disaster prevention, one must read old literary works on past disasters.” Modern scientific research goes beyond the boundaries of traditional scientific research domains. Collaborations between scientists and humanities scholars have become more common. Digital technologies have accelerated the process of deciphering old literary works. Here we interview scientists who have gone beyond their usual fields to inquire about the impact that reading old archives has had on their research.



Yasuyuki Kano

Assistant Professor,
Research Center for Earthquake Prediction,
DPRI, Kyoto University



Yuta Hashimoto

PhD candidate, Graduate School of Letters,
Kyoto University



Seismologists and old literary works

One day in early Autumn 2015, a group was struggling with an old drawing shown on a screen under the high ceiling of the Science Seminar House on the University's North Campus. They were sitting in a U-shape, and reading brush letters written on the drawing. Because the age and gender of the group were diverse, upon first glance, it was hard to tell their purpose. They were slowly deciphering the texts, “In the eve...ning, there was...a mountainous tsu...nami...?”

The drawing vividly depicted people in a panic following a large volcanic eruption of Mt. Asama, which occurred in the third year of Tenmei, or 1783. The drawing contained explanatory texts written in brush letters, and a lecturer was teaching the group how to read the letters.

This is a snapshot taken during a camp workshop of the Old Earthquake Study Group led by Professor Ichiro Nakanishi of the Seismology Lab. The study group



meets weekly. In addition, the group holds an annual camp workshop aimed at intensively reading old literary works that describe past disasters. The group is comprised mostly of students in the sciences and researchers in disaster science, but also includes non-researchers and librarians.

One of the group members, Yasuyuki Kano, an assistant professor of the Disaster Prevention Research Institute (DPRI), explained, "I love measuring – measuring just anything. I have conducted research on changes in water level data collected by monitoring underground water, and earthquake-induced expansion and contraction of the Earth's surface."

His response begs the question, why is Kano, who is an experimental scientist, a member of a study group reading old literary works?

The answer turned out to be quite simple. "Numerical data on earthquakes have been collected since the Meiji period, but a great earthquake occurs only once every couple of hundred years.

Because data has only been collected for the last 150 years or so, knowledge about earthquakes is very limited. To improve our understanding, we must read about old earthquakes recorded in old writings."

However, old literary works pose a great challenge to modern scientific researchers. Drawings and literature describing old earthquakes are written in the *sosho* or the *gyosho* style, both of which are a style of *kuzushiji*, or deformed, cursive characters. It is therefore necessary to spend substantial time and effort to read them fluently. This reading and rewriting into modern script is called *honkoku*, or transcription. We then asked Dr. Kano, isn't it more efficient to ask students or researchers in Japanese literature or history who are supposed to be familiar with *honkoku*, to read old literary works rather than for scientists to tackle them?

He responded with an example. "For instance, suppose you find an account of a massive wave in the sea in the archives. If you are a disaster prevention science researcher, you can tell by reading the

account if the massive wave is a tsunami caused by an earthquake or a large wave caused by a typhoon."

Research on earthquakes in the distant past is not a new concept. The trailblazers of Japan's seismology, who experienced the 1923 Great Kanto earthquake firsthand, belonged to a generation that could read old literary works. In fact, they also conducted research on records of old quakes. In recent years, the extensive research done by Tatsuo Usami, a professor emeritus of the University of Tokyo, has advanced *honkoku* and the organization of earthquake accounts in old writings, which had been stored in a number of places throughout Japan. "One of the tasks of future research on old earthquakes is to read more archives to extract information, and organize this into a searchable form for future generations," said Kano. Kyoto University, which has a large collection of literature about earthquakes, is essentially an unlimited room for study.

However, the goal of earthquake research is not merely to read old literary



works; it is also to organize and analyze the data obtained through *honkoku*, and publicize the findings in a usable form. This will allow mitigation strategies against earthquakes to be prepared in the near and the distant future. When Dr. Kano was trying to find an efficient reading method, he found SMART-GS.

Innovation spawned by the Faculty of Letters

SMART-GS is a software program developed by Susumu Hayashi, a professor of the University's Faculty of Letters, in order to transcribe the handwritten notes of German Mathematician David Hilbert and trace his philosophies. Dr.

upon SMART-GS by accident. He later realized it had been developed at his same university. Kano and Hayashi, who work in completely different fields, did not have a chance to meet until early Spring 2014, when they were assigned to the same room as admission exam administrators. Their relationship has evolved since then. Hayashi and Yuta Hashimoto, a graduate student in Professor Hayashi's research group, who had been involved in the development of SMART-GS, have become frequent visitors to the Old Earthquake Study Group, leading to rapid advances in their collaboration.

How is it that this kind of software was developed at the Faculty of Letters? Professor Hayashi, the developer, is presently an expert in historical sociology,

period. Actually, it was during this project that SMART-GS evolved to incorporate a work-sharing function based on the requests of researchers involved in the project.

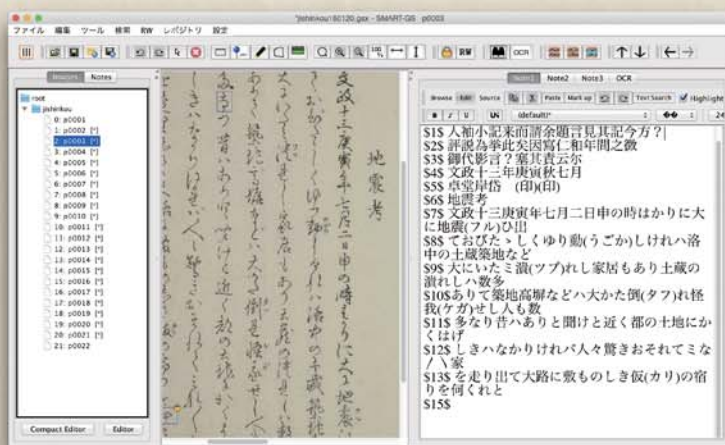
In recent years, digital humanities have received increased attention in Japan and around the world. The humanities encompass disciplines dealing with human nature, including literature, history, linguistics, art, etc. Digital humanities fuse two seemingly remote fields: digital technologies and humanities. Digital humanities emphasize questioning humanities through innovation and sharing of research methods such as letter data analysis, creation of image databases, and applications of spatiotemporal data. Kyoto University is a pioneer of this field in Japan. In September 2015, a Japan Digital Humanities Conference was held at Kyoto University, including many researchers from overseas.

The initial objective of SMART-GS development was to read the handwritten notes of Hilbert independently. However, researchers in need of this tool prompted the developer to make it sharable among researchers, realizing more fruitful collaborations. The software has further evolved via the Internet into a tool that is free from the constraints of time or distance, allowing researchers to interpret literature in depth at an unprecedented speed. The software has also enlightened researchers because mundane reading for their research has evolved into collaborations that go beyond the boundaries of academic disciplines and national borders.

"People who want to read *kuzushiji* are everywhere," said Hashimoto.

Reading beyond borders

In February 2016, a research project "Development of an International Educational Program for Japanese Historical Writings" (led by Yoichi Iikura at Osaka University), of which Hashimoto is also a member, announced the release of KuLA, a *kuzushiji* learning app for smartphones and tablet computers. This allows users to learn how to read *kuzushiji* in a quiz format, aiding not only Japanese students but also those who are studying Japanese history or Japanese classic literature overseas. Feedback from



Screenshot of SMART-GS showing an imported writing sample on an old earthquake (Courtesy of Yuta Hashimoto)

Hayashi imported Hilbert's handwritten notes, which were made available by the University of Göttingen, into a computer as image files using SMART-GS, and added his interpretations or annotations to the original notes as text data. When an illegible letter is encountered using SMART-GS, it is exported as image data and compared to similar letters by placing these side-by-side and considering the context where the letter originated. Then a conjecture is drawn about the letter. A link of the letter image can be left as supporting data for the conjecture. Additionally, the transcription and annotation can be shared with other researchers, allowing collaborations across multiple disciplines.

Kano, who was searching the internet for useful tools to advance the work of the Old Earthquake Study Group, stumbled

but he majored in mathematics as an undergraduate and graduate student. He also studied computational science and wrote books on programming. Hashimoto, who has been familiar with computers since his childhood, graduated from the Faculty of Letters, and worked in the business sector as a system engineer for three years. Because both Professor Hayashi and Hashimoto were familiar with computer science, they were able to develop SMART-GS, which caters to the needs of researchers.

Kazu Nagai, another professor in the Faculty of Letters, used SMART-GS in a *honkoku* publication project involving the handwritten diaries of Yuzaburo Kuratomi, the chairman of the Privy Council of Japan, over a seven-year period during the transition from the Taisho to the Showa



Kuzushiji learning app, KuLA

overseas researchers who want to read the original texts of old archives is reflected in its design, making it highly suitable for learning *kuzushiji*.

This application began attracting attention in social networking circles even during its development stage. Readers of this article might be somewhat surprised by the fact that those who want to read *kuzushiji* coincide with social networkers. In fact, there has been a *kuzushiji* boom among players of an online sword game, in which famous Japanese swords are personified. These gamers wanted to read and write *kuzushiji*.

It is said that more than one million writings were made by the end of the Edo period in Japan. The National Institute of Japanese Literature, which is a research institute of historical writings, heads a large database project "Construction of the International Collaborative Network on Japanese Classical Books." The objectives of this project are to digitize historical writings found throughout Japan and publicize them over the internet. If historical writings written in *kuzushiji* become easily accessible, anyone can access the wisdom and intelligence of people who lived before the Edo period. Even a *kuzushiji* non-expert can appreciate this. This project in combination with the collaborative reading functions of applications, such as SMART-GS, should facilitate collaborations among strangers, which may help decipher even dauntingly difficult *kuzushiji*.

Furthermore, there are successful examples of cloud transcription taking place overseas. For example, the University of London in England has organized a project that transcribes a huge number of handwritten notes left by Bentham, a philosopher. To date more than 350,000 people have participated.

Kano has a strong desire to read old literary works about disasters in the Old Earthquake Study Group in collaboration with people living in areas affected by such disasters, and then apply this knowledge to actual disaster prevention strategies. If *kuzushiji* learning and cloud *honkoku* become more popular, the movement will elucidate records not only of past earthquakes but also of other kinds of disasters. This will greatly contribute toward disaster prevention research today.

Hashimoto also offers another application, a "Kin-digit Reader", to facilitate reading of the "Kindai Digital Library" (for *kindai*, or modern period), in which digitized data of the National Diet Library since the Meiji period have been provided. (The Kindai Digital Library was integrated into the "National Diet Library Digital Collection" in May 2016.)

Interdisciplinary research potential at Kyoto University

In recent years, the fusion of humanities and science or interdisciplinary studies has encouraged the development of new research fields that go beyond typical areas of inquiry.

Traditionally, interdisciplinary studies have involved researchers applying a useful result in a particular field to their original area of research. "I am simply not used to the idea that everything is divided into humanities or science. I have an impression that many of the researchers in Kyoto University are like me," says Hashimoto.

One scientist in the Old Earthquake Study Group has increasingly devoted his time to the reading of *kuzushiji*. Takatoshi Sakazaki (of the Research Institute for Sustainable Humanosphere

"There is another significant point in developing this kind of digital reading-support technology," said Hashimoto, "the interpretation of data varies by time. For instance, '*Keian no Ofuregaki*', literally the *Keian* regulations (*Keian* is the period corresponding to the reign of the emperor), which can be found in history textbooks, had been taught as regulations issued by the *bakufu*, or shogunate, to control farmers. However, a new interpretation, which has been shared among researchers of late, regards '*Keian no Ofuregaki*' as local regulations originally issued by a local authority that were subsequently spread to a broader area. This new interpretation has been reflected in descriptions in recent history textbooks. If this kind of interpretation can be accumulated and saved, people 100 years from now will be able to study 'our interpretations' as historical data."

Reading archives is one research method used around the world. Reading literature with fresh pairs of eyes should produce superior results. Moreover, reading with additional eyes from overseas will advance international collaborative research and generate new findings. A new world of reading facilitated by digital technologies and the internet is just around the corner, and readers will not always have to be full-time researchers. Anyone will be able to participate in these projects.

and a research fellow of the Japan Society for the Promotion of Science), an expert in atmospheric physics, has lately been studying typhoons using old literature.

"Numerical data analysis is what I usually do, but I originally liked history. It is pure enjoyment for me to be able to read old literary works. People in those days were very attentive. They wrote very detailed accounts of weather conditions during a war. If there is no *honkoku* version, I have to read them on my own."

The approach of the Old Earthquake Study Group has no boundaries between humanities and science. Curious minds transcend traditionally established boundaries easily and effortlessly through the sheer joy of learning.

Working in CiRA labs

Ito Miyashita, Ryoko Hirohata, Yuka Kawahara, and Megumi Narita

Department of Life Science Frontiers,
Center for iPS Cell Research and Application (CiRA), Kyoto University

Induced pluripotent stem (iPS) cells show great promise for treating intractable illnesses through applications in regenerative medicine and new drug development. At Kyoto University's Center for iPS Cell Research and Application (CiRA), more than 400 personnel conduct research under the leadership of Director Professor Shinya Yamanaka. This rigorous work is made possible by the assistance of technical staff. We spoke with Megumi Narita, Yuka Kawahara, Ryoko Hirohata, and Ito Miyashita, four lab techs in CiRA's Department of Life Science Frontiers.

A desire to contribute to socially relevant research

CiRA employs a great many female lab techs. However in Japan, the proportion of women in science is still low. What inspired you to pursue science-related careers?

Narita: In elementary school, I was shocked to read about the pomato (a hybrid plant developed by cell fusion that produces potatoes in the soil and tomatoes on the branches) in a science magazine. In college, I majored in molecular nutritional science in the Faculty of Agriculture. When I graduated, it was a difficult time for job searches, and I could not find a post in science. For a time I did quality control at a metal parts manufacturer, but I could not give up on my dream. When Professor Yamanaka moved to Kyoto University, new tech positions were announced, and I started working here in November 2005.

Kawahara: My mother greatly influenced my career choice. She used to purchase and read popular scientific monthlies such as the *Newton* magazine, which I was also fond of reading. In 2003, I heard the news that the human genome had been successfully mapped, and it made me very interested in genetics. I was hoping to do something that would serve the world of the future. I joined CiRA in April 2013.

Hirohata: Oh, I didn't have a noble purpose like these two [chuckles]. I have been fascinated by dinosaurs since childhood. I entered university to study biology, thinking that it would be the fast track to dinosaur research, but later found

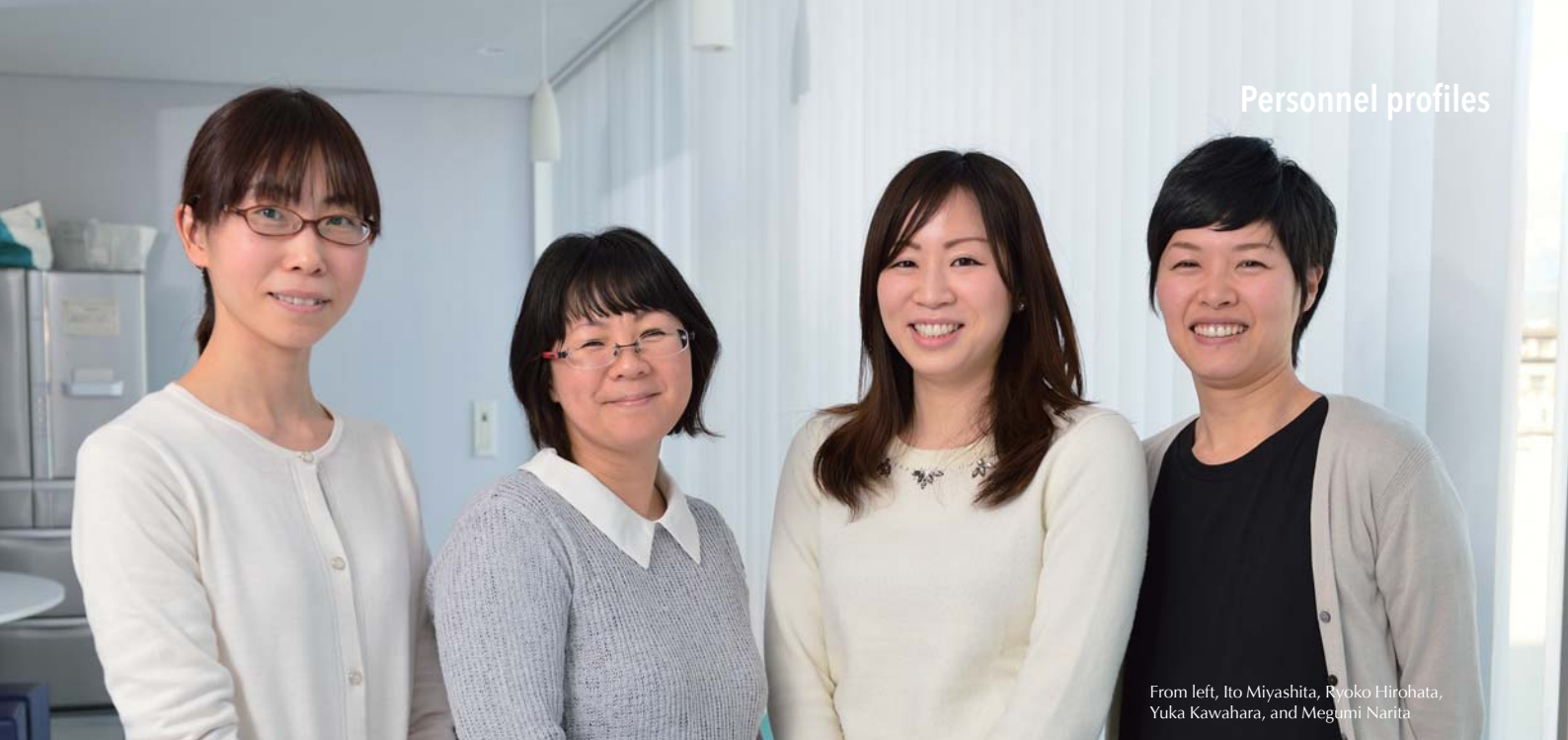
that I also needed some liberal arts credits to become a museum curator [laughs]. In the film *Jurassic Park* they mined the amber to find viable dinosaur DNA to use for cloning, a scene that intrigued me. After finishing my master's, I began working as a tech at Osaka University. While there I got married and gave birth to a baby.

Just when I was looking for a way to keep working and raising my child with the help of my parents, CiRA was established, and it advertised lab staff recruitment. I have been working here since August 2010. I was really lucky to find a job that suited my ambitions and circumstances.

Miyashita: In my case, I spontaneously developed a desire to become a researcher because my father and one of my aunts are corporate scientists. The Great Hanshin-Awaji Earthquake occurred when I was a high schooler. I witnessed food completely disappearing from shops. With Japan's low food self-sufficiency, one full-scale disaster would place this country in complete chaos, I figured. As I studied agricultural science at college, I realized that disease protection of farm products would be more effective in increasing harvest than time-consuming improvement through breeding. Consequently, I majored in plant pathology in my graduate program.

Plant pathology is different from the area where you currently work, is that right?

Miyashita: When I completed my graduate course, there were few promising job opportunities. For a while, I had temporary tech staff jobs in corporate research departments. I started working here in October 2010. As Ms. Narita was about to



From left, Ito Miyashita, Ryoko Hirohata, Yuka Kawahara, and Megumi Narita

take maternity leave, I was asked to replace her. I decided to accept the offer because I could leverage my knowledge and expertise, including molecular biology techniques.

Precision and persistence required

What does your routine tech work involve?

Narita: Ms. Kawahara, Ms. Miyashita, and I belong to the research group headed by Professor Yamanaka, the biggest lab at CiRA. I am with the subgroup working on iPS cell-derived myocardial and blood cells intended for use in transplantation. For example, I prepare plasmids (DNA fragments to be transferred into the extranuclear cytoplasmic compartment of the iPS cells that proliferate independent of the chromosome cycle) to produce myocardial or blood cells. Checking the genetic profile of differentiated cells is also my responsibility.

Kawahara: I work for the group that investigates the mechanisms underlying iPS cell formation. I am mainly involved in the chemical screening process. Its objective is to discover alternatives to specific components that will help improve the responses of a variety of cells and thereby reduce the cost of culture media. We screen thousands or tens of thousands of compounds robotically or manually.

Hirohata: You have to just do whatever comes your way, right?

Kawahara: Yes. We test an enormous number of compounds, but oftentimes we come up with no positive results no matter how many runs we may make. Sometimes, several weeks pass without any significant results, but other times, we get a sequence of positives.

Narita: I find it is sort of like betting.

Kawahara: My basic attitude is that it won't work out as easily as I wish. That's what makes me very happy when I discover a useful compound.

Will your work lead to future clinical trials?

Miyashita: I am assigned to the project team to stock iPS cells for future regenerative medicine use. I participate in quality checks to evaluate the stock cells produced in the cell preparation facility. I need to be very careful. Since my section is located downstream of the entire testing process, my schedule becomes tighter if upstream tests are delayed. There is not much I can do to prevent that, and I feel pressure to complete my part as planned because the deadlines cannot be altered.

Hirohata: I am assisting Associate Professor Knut Woltjen, whose research is focused on the use of genetic information for generative medicine. Dr. Woltjen is good at building Lego models. He designs the precise details of plasmids like Lego models, saying, "Let's have this gene illuminate green, and let's generate that protein." My responsibility is to create plasmids according to Dr. Woltjen's designs. I also conduct experiments to investigate how the plasmid-derived iPS cells differentiate in mouse models. I occasionally receive requests from members of separate groups, asking me to create certain plasmids. When I learn that an experiment was successful, or when I see pictures of the cells transfected with the plasmids I made, I am proud of what I did, knowing that my work served a purpose.

It seems that you engage in a lot of precise and sensitive operations. Do you think you are cut out for such work?

Narita: I do enjoy it.

Kawahara: I am very into it, too.

Hirohata: I am a laid-back type of person at home. My family seems to understand and accept that I need to be so at home because I must be so precise at work.

My impression is that patience and persistence are necessary traits for techs. What do you think?

Kawahara: I think I am very patient and persevering. When the results are not favorable, I keep hanging on until I obtain positive results.

Personnel profiles

Narita: When my work is not going well, I believe that there is a cause for that. I like to try out this or that option, considering a variety of available remedial measures.

Hirohata: Toughness is important; so are communication skills. Because our job is to assist the principal investigators and other senior scientists, we must not assume a “know-it-all” attitude. I communicate as frequently as possible with my boss to understand what he wants from me.

Business as usual the day after the Nobel Prize was announced

Professor Yamanaka received the 2012 Nobel Prize in Physiology or Medicine together with Professor John Gurdon. All of you were at CiRA at that time. What were your reactions to the news?

Narita: Although iPS cells were not yet in the stage of making tangible social contributions at that time, Dr. Yamanaka was awarded the prize. I was surprised, purely happy, and felt great.

Hirohata: The prize was given only six years after Prof. Yamanaka first created the cells, and such a short time interval represented the weight of expectations for iPS cells, I thought.

Miyashita: My parents, relatives, and friends told me that it was a fantastic event. Knowing that CiRA captured a tremendous amount of attention around the world, I also felt pressure and tension as one of the employees.

Were people at CiRA excited?

Miyashita: No, the atmosphere was surprisingly calm and business-like.

Narita: The announcement was made on a Sunday, and most people learned about it through spot TV news coverage. We saw that, in other countries, lab members often gather together and celebrate the prize winner with wine. On my way to work the next day, I wondered if we would hold a party like that. However, it was just another ordinary day.

Miyashita: There was hardly any merry-making.

Narita: I personally wanted it to be merrier [laughs], because I knew the cozy, family-like atmosphere of CiRA before it became the big organization that it is today.

Miyashita: Above all, Dr. Yamanaka is a very modest and low-profile person, and his down-to-earth attitude encourages us to work incessantly to seek clinical applications of iPS cell technologies.

Escherichia coli, lovable lab partners

Can you tell me about some of the special skills or habits that you have developed as techs?

Hirohata: When I take sterilized tubes out of a container, I must do so without directly touching them by the hand. By adjusting the gradient of the container and the level of physical force applied, I can pop out the exact number of tubes I need.

Narita: That is a wonderful skill. I remember that I was

measuring 500 mg worth of a chemical agent. When I poured the powder out of the container, it was just the amount I needed.

Hirohata: Everyday practice help us develop a full command of certain skills that enable us to be sensitive to abnormalities. For example, when using a micropipette to fractionate liquid, I sometimes notice that something is wrong with the fractionation, feeling that the 1 mL aliquots just prepared are somewhat different from those I commonly do. When I send the device in for maintenance, they often report malfunctioning of a spring or other parts.

Miyashita: I make it a habit to completely clean the cell culture workbench to prevent contamination by dust or microbes. Consequently, I am not satisfied at home unless I completely clean the kitchen table before eating. When the chopsticks I use for cooking touch things unrelated to cooking, I automatically think, “Oh, I am risking contamination” [laughs].

Hirohata: I often chat about *Escherichia coli* with my colleagues. Those microbes are indispensable research partners, although people in general consider them bad and ugly. When preparing plasmids, we transfer them into *E. coli* for multiplication. They are very helpful because they can proliferate rapidly.

Narita: When I hear people speak badly about *E. coli*, I am tempted to tell them that these microbes are good and that we owe a lot to them [laughs]. The *E. coli* strains we use have been developed for specific research purposes. I have a passion for them.

Hirohata: So do I.

A Mission to Meet the World's Expectations

Fast-paced research efforts are being made toward clinical applications of iPS cell technologies. What are your thoughts and future hopes?

Miyashita: I am currently involved in a project to stock iPS cells for future regenerative medicine use. I feel an enormous responsibility. It will take some more time before these technologies become clinically applicable. I am determined to do my current work correctly and precisely to see the day when iPS cells are used to cure diseases.

Hirohata: CiRA receives donations from a wide variety of supporters including patients with refractory diseases. I sometimes have the occasion to meet such patients in person, when they visit us. This renews my commitment to our work. I wish to contribute to yielding positive results by giving it all that we have.

Narita: I wish to help society by contributing to clinical applications of iPS cell technologies. Although I sometimes wonder if I have what it takes to meet expectations, I am ready to do my best to help us make a breakthrough.

Kawahara: I am giving my current work my very best. I wish to improve my technical skills so that I can help patients.

Kyoto University ASEAN Center

Historically, the ASEAN region has been pivotal in promoting cultural exchange between the East and West. Southeast Asian countries have accumulated considerable knowledge in research and education, and in promoting growth and cooperation within diverse communities.

In 1963, Kyoto University established the Center for Southeast Asian Studies (CSEAS). From its roots in area studies, the University has expanded its network and deepened its academic partnerships across ASEAN.

The Kyoto University ASEAN Center opened in June 2014 to provide support for international collaboration with ASEAN

universities and institutes by integrating various existing research and educational activities and networks. Located in central Bangkok, Thailand, the ASEAN Center acts as a vital hub to cover the entire ASEAN region. With the support of International Strategy Office, the ASEAN Center is managed by a center director, a university research administrator (URA), Japanese administrator, and local staff. Furthermore representatives from 20 faculties forms the Kyoto University ASEAN Network Committee, which meets regularly to review the Center's activities, share information, and explore opportunities.

Kyoto-ASEAN Forum

After the establishment of the center, the University began exploring new horizons in collaboration with ASEAN. Firstly in March 2015 the "Kyoto-ASEAN Forum 2015 Kickoff Meeting" was held, in which academic and government representatives from Kyoto and ASEAN countries met to identify current challenges and potential for collaboration in research, human capacity development, and social

responsibility and contributions. To make collaboration more effective and enduring, it has been institutionalized, mobilizing resources to develop a promising new Kyoto-ASEAN collaboration plan, advocating academic policy dialogue. In September 2016, the first Kyoto-ASEAN Forum will be held in Kuala Lumpur, Malaysia.



Kyoto University European Center

In May 2014, the Kyoto University European Center Heidelberg Office was opened in a historic building on the old campus of Heidelberg University. This "European Center" was established by integrating the Heidelberg office and former European representative office in London that had served as an operating base to promote industry-academia collaboration. Along with Kyoto University's international strategy, the European Center promotes research and educational exchange intended to enhance Japan's partnership with European institutions and businesses.

Research support in Europe

With many international research projects the issue of funding is critical. In Europe, various types of international funds for promoting joint

research and mobility, such as Horizon 2020 or Marie Skłodowska-Curie actions, are widely open for researchers and students. These funds provide wide opportunities for overseas researchers, including Japanese, and encourage them to jump into transnational and cutting-edge research projects. The European Center assists researchers for teaming, funding, and sustainable management of research teams within the framework of Europe-Japan relations.

HeKKSaGON: Japan-Germany six-university consortium

The European Center, as part of it international strategy, is helping expand current relationships while simultaneously nurturing new collaborations with European institutions.

The Heidelberg Office serves as the point of contact for Japanese members of

HeKKSaGON, assisting in the planning and organization of workshops, helping facilitate the smooth exchange of information.

HeKKSaGON is one of the symbolic function that serves to develop and enhance fruitful research exchanges in Europe. It is a university consortium comprised of six leading universities in Japan and Germany: Heidelberg University, Kyoto University, Karlsruhe Institute of Technology, Tohoku University, the University of Göttingen, and Osaka University. Established in 2010, several research groups with common objectives were formed. They share knowledge and technology via various workshops, student exchange programs such as a "winter school", and joint symposia.

Student Exchange

Exploring opportunities for study abroad, such as exchange



programs, summer schools, and internship programs, is also an important function of the European Center. Both Heidelberg Office and London Office participate in education fairs and visit universities to attract students from Europe to Kyoto.

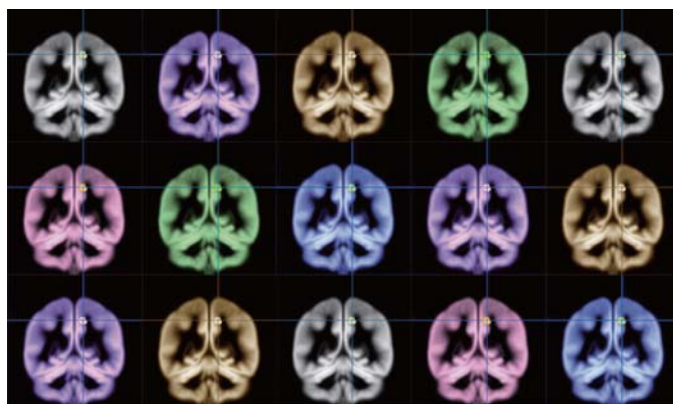
To activate our activities in Europe, we regard dissemination as an essential mission of the Center. Please check our website and "Like!" our Facebook page to know more about us.

The search for happiness: using MRI to find where happiness happens

Exercising, meditating, scouring self-help books... we go out of our way to be happy, but do we really know what happiness is?

Wataru Sato and his team at Kyoto University have found an answer from a neurological perspective. Overall happiness, according to their study, is a combination of happy emotions and satisfaction of life coming together in the precuneus, a region in the medial parietal lobe that becomes active when experiencing consciousness.

People feel emotions in different ways; for instance, some people feel happiness more intensely than others when they receive compliments. Psychologists have



found that emotional factors like these and satisfaction of life together constitutes the subjective experience of being “happy”. The neural mechanism behind how

happiness emerges, however, remained unclear. Understanding that mechanism, according to Sato, will be a huge asset for quantifying levels of happiness objectively.

Sato and his team scanned the brains of research participants with MRI. The participants then took a survey that asked how happy they are generally, how intensely they feel emotions, and how satisfied they are with their lives.

Their analysis revealed that those who scored higher on the happiness surveys had more grey matter mass in the precuneus. In other words, people who feel happiness more intensely, feel sadness less intensely, and are more able to find meaning in life have a larger precuneus.

“Over history, many eminent scholars like Aristotle have contemplated what happiness is,” lead author Sato said. “I’m very happy that we now know more about what it means to be happy.”

So how does that help us? Sato is hopeful about the implications this has for happiness training.

“Several studies have shown that meditation increases grey matter mass in the precuneus. This new insight on where happiness happens in the brain will be useful for developing happiness programs based on scientific research,” he said.

Kyoto University researchers have found that fish oil transforms fat-storage cells into fat-burning cells which help alleviate middle age spread.

The team explains in *Scientific Reports* that fish oil activates receptors in the digestive tract, fires the sympathetic nervous system, and induces fat storage cells to metabolize fat.

Fat tissues don’t all store fat. White fat cells store fat in order to maintain energy supply, while brown fat cells metabolize fat to maintain a stable

body temperature. Brown fat cells are abundant in babies but decrease in number as they mature into adults.

A third type of fat cell – called

beige cells – has recently been found in humans and mice, and has been shown to function much like brown cells. Beige cells decrease in number as people approach mid-age; without the fat-metabolizing beige cells, fat keeps accumulating for decades without ever being used.

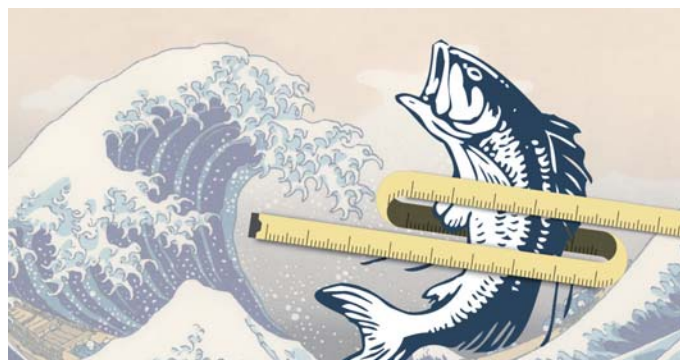
Teruo Kawada and his team investigated whether these beige fat cells could be increased by taking in certain types of foods.

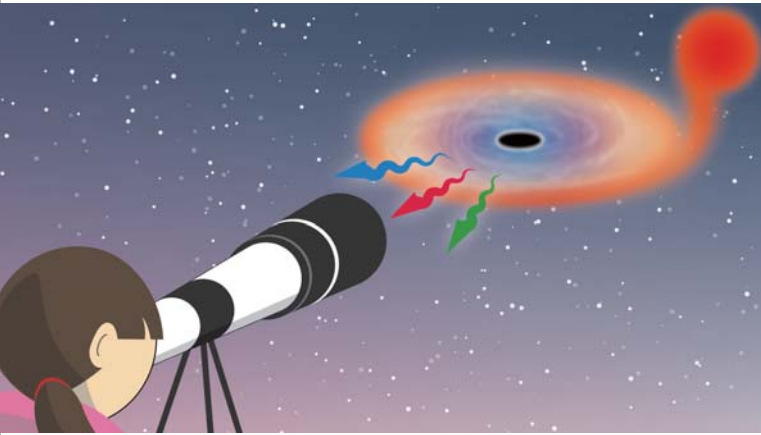
“We knew from previous research that fish oil has tremendous benefits on health, including the prevention of fat accumulation,” says senior author Kawada. “We tested whether fish oil and increase in beige cells could be related.”

The team fed a group of mice fatty food and other groups fatty food with fish oil additives. The mice that ate food with fish oil, they found, gained 5-10% less weight and 15-25% less fat compared to those that did not consume fish oil.

They also found that beige cells formed from white fat cells when the sympathetic nervous system was activated, meaning that certain fat-storage cells acquired the ability to metabolize fat.

“People have said that food from Japan and the Mediterranean regions contributes to longevity, but why it was good was up for debate,” said Kawada. “Now we have better insight into why that is.”





All you need is a 20 cm telescope to observe a nearby, active black hole.

An international research team reports that the activity of such phenomena can be observed by visible light during outbursts, and that flickering light emerging from gases surrounding black holes is a direct indicator of this. The team's results, published in *Nature*, indicate that optical rays and not just X-rays provide reliable observational data for black hole activity.

"We now know that we can make observations based on optical rays – visible light, in other words – and that black holes can be observed without high-spec X-ray or

gamma-ray telescopes," explains lead author Mariko Kimura, a master's student at Kyoto University.

Once in several decades, some black hole binaries undergo "outbursts", in which enormous amounts of energy – including X-rays – are emitted from substances that fall into the black hole. Black holes are commonly surrounded by an accretion disk, in which gas from a companion star is slowly drawn to the hole in a spiral pattern. Activities of black holes are typically observed through X-rays, generated in the inner portions of

accretion disks where temperatures reach 10 million degrees Kelvin or more.

V404 Cygni, one of the black hole binaries thought to be nearest to Earth, "woke up" after 26 years of dormancy on 15 June 2015 as it underwent such an outburst.

Led by astronomers from Kyoto University, the team succeeded in obtaining unprecedented amounts of data from V404 Cygni, detecting repetitive patterns having timescales of several minutes to a few hours. The optical fluctuation patterns, the team found, were correlated with those of X-rays.

Based on analyses of optical and X-ray observational data, Kyoto astronomers and their collaborators

the outer region of the disk, making it emit optical rays and thus becoming visible to the human eye.

The outburst observation, the researchers say, was the fruit of international collaboration across countries in different time zones.

"Stars can only be observed after dark, and there are only so many hours each night, but by making observations from different locations around the globe we're able to take more comprehensive data," says co-author Daisaku Nogami. "We're very pleased that our international observation network was able to come together to document this rare event."

The study also revealed that these repetitive variations occur at mass

"Seeing" black holes with home-use telescopes

at national space agency JAXA, national laboratory RIKEN, and Hiroshima University showed that the light originates from X-rays emerging from the innermost region of the accretion disk around a black hole. These X-rays irradiate and heat

accretion rates lower than one tenth of that previously thought. This indicates that the quantity of mass accretion rate isn't the main factor triggering repetitive activity around black holes, but rather the length of orbital periods.

Heartbeats can now be measured without placing sensors on the body, thanks to a new technology developed in Japan.

Researchers at the Kyoto University Center of Innovation, together with Panasonic Corporation, have come up with a way to measure heartbeats remotely, in real time, and under controlled conditions with as much accuracy as electrocardiographs.

The researchers say this will allow for the development of "casual sensing" – taking measurements as people go about their daily activities, for instance, when they are going to bed or getting ready to start the day.

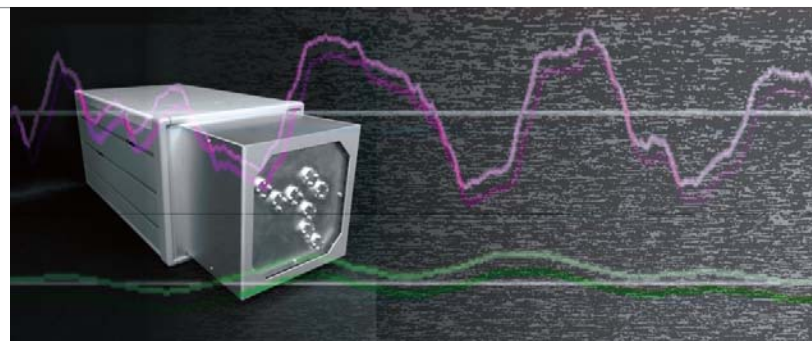
"Taking measurements with sensors on the body can be stressful and troublesome, because you have to stop what you're doing," says Hiroyuki Sakai, a researcher at Panasonic. "What we tried to make was something that would offer people a way to monitor their body in a casual and relaxed environment."

The added convenience of remote sensing, the team believes, will be an

incentive for people to monitor their health status for their own benefit.

The remote sensing system combines spread-spectrum radar technology and a unique signal analysis algorithm that identifies signals from the body.

"Heartbeats aren't the only signals the radar catches. The body sends out all sorts of signals at once, including breathing and body movement. It's a chaotic soup of information," says Toru Sato, professor of communications and computer engineering at Kyoto University. "Our algorithm differentiates all of that. It extracts waves characteristic of heart beats from the radar signal and



calculates their intervals."

The team hopes that the remote sensing system, with further experimentation, will be put to practical use in the near future.

"Now that we know that remote

sensing is possible, we'll need to make the measurement ability more robust so that the system can monitor subjects in various age ranges and in many different contexts," Sato concluded.

To hear a pitter patter from afar: catching heartbeats with millimeter-wave radar

Genetically modified *E. coli* pump out morphine precursor

A common gut microbe could soon be offering us pain relief. Bioengineers at Kyoto University and their colleagues have tweaked *Escherichia coli* genes so that they pump out thebaine, a morphine precursor that can be modified to make painkillers.

The genetically modified *E. coli* produces 300 times more thebaine with minimal risk of unregulated use compared to a recently developed method involving yeast.

"Morphine has a complex molecular structure; because of this, the production of morphine and

similar painkillers is expensive and time-consuming," said study author Fumihiko Sato of Kyoto University. "But with our *E. coli*, we were able to yield 2.1 milligrams of thebaine in a matter of days from roughly 20 grams of sugar, as opposed to 0.0064 mg with yeast."

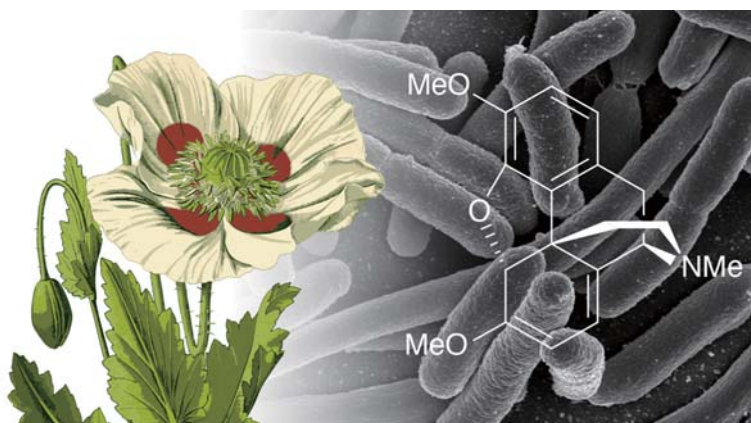
Morphine is extracted from poppy sap in a process that results in opiates such as thebaine and codeine. Other synthetic biologists have recently engineered the yeast genome so that it produces opiate alkaloids from sugar. There were ethical concerns, however, including a risk that the pain-killing molecules could be produced easily and unregulated, provided that one has access to the necessary yeast strain.

With *E. coli*, Sato says that such production risk is insignificant.

"Four strains of genetically modified *E. coli* are necessary to turn sugar into thebaine," explains Sato. "*E. coli* are more difficult to manage and require expertise in handling. This should serve as a deterrent to unregulated production."

In 2011, Sato and colleagues engineered *E. coli* to synthesize reticuline, another morphine precursor that appears earlier in the transformation process than thebaine. In the new system, the team added genes from other bacteria and enzyme genes from opium poppies, *Coptis japonica*, and *Arabidopsis*. The team credits the strong activity of enzymes in the new system for their success in making thebaine, and hopes to achieve further improvements.

"By adding another two genes, our *E. coli* were able to produce hydrocodone, which would certainly boost the practicality of this technique," Sato said. "With a few more improvements to the technique and clearance of pharmaceutical regulations, manufacturing morphine-like painkillers from microbes could soon be a reality." ■



"Popular girls" have less lice – in the monkey world

Parents know all too well the nightmare of ridding lice infestations. But for Japanese macaques at least, "popular girls" need not fret so much. In new research published in *Scientific Reports*, primatologists have found that females at the center of their social network had less lice thanks to the extra grooming they receive from their many friends.

Lice spread from person to person by direct contact. Hair combing is a preventative strategy humans use to rid louse eggs attached to the base of hair. Japanese macaques use a modified version of such "egg-picking" while grooming each other, effectively fending off parasites.

"We thought that since grooming is one of the most common types of contact that occurs between macaques, this behavior should

facilitate the transmission of lice," says lead author Julie Duboscq, who conducted the research at the University of Strasbourg and currently based at Kyoto University. "At the same time, grooming might also constrain the spread of lice because louse eggs are removed during grooming, which reduces future generations of lice."

Duboscq and colleagues observed the macaques' egg-picking behaviors over 142 days to estimate the amount of lice each individual carried. In parallel, they observed who was grooming whom and how often; with this information they built a model of the group's social network, which gave them insight into which individuals are more social, or central, in the group.

The team found that central females have less lice, and that the

effects were most profound during the most physically demanding times for females, namely during winter when macaques mate and during summer when they give birth.

But that doesn't mean that the popular girls always enjoy benefits. "The link between sociality and parasitism is not always

straightforward," says Andrew MacIntosh, a senior author of the paper and a researcher at Kyoto University's Primate Research Institute. "Increased centrality in social networks is often linked to increased parasite load and disease risk."

In a previous study, MacIntosh found that central females have a higher risk of having more parasitic intestinal worms. "For this study, however, interactions between environmental seasonality and both parasite and host biology appeared to mediate the role of social processes in louse burdens." ■



Australopithecus fossils found east of the Great Rift Valley

New fossils from Kenya suggest that an early hominid species – *Australopithecus afarensis* – lived far eastward beyond the Great Rift Valley: much farther than previously thought. An international team of paleontologists led by Emma Mbua of Mount Kenya University and Masato Nakatsukasa of Kyoto University report findings of fossilized teeth and forearm bone from an adult male and two infant *A. afarensis* from an exposure eroded by the Kantis River in Ongata-Rongai, a settlement in the outskirts of Nairobi.

“So far, all other *A. afarensis* fossils had been identified from the center of the Rift Valley,” explains Nakatsukasa. “A previous *Australopithecus bahrelghazali* discovery in Chad confirmed that our hominid ancestor’s distribution covered central Africa, but this was the first time an *Australopithecus* fossil has been found east of the Rift Valley. This has important implications for what we understand about our ancestor’s distribution range, namely that *Australopithecus* could have covered a much greater area by this age.”

A. afarensis is believed to have lived 3,700,000-3,000,000 years ago, as characterized by fossils like “Lucy” from Ethiopia.

Stable isotope analysis revealed that the Kantis region was humid, but had a plain-like environment with fewer trees compared to other sites in the Great Rift Valley where *A. afarensis* fossils had previously appeared. “The hominid must have discovered suitable habitats in the Kenyan highlands. It seems that *A. afarensis* was good at adapting to varying environments,” notes Nakatsukasa.

The team’s survey also turned



up masses of mammal fossils, including a few that probably belong to new species of bovids or baboons.

The authors write that the Kantis site was first noted in a 1991 geological survey. At that time, a farmer said that he and his family had come across fossilized bones from Kantis in the 1970s, although they did not recognize their importance. Following airing of Kenyan television programs on paleontological research, locals gradually started to appreciate the fossils. Since then, Kantis and other sites have been identified thanks to fossil notifications from the local population.

The team welcomes this achievement not only for its academic implications, but also for the benefits to the local community. “Kantis is in the vicinity of Nairobi, a major city,” said Nakatsukasa. “We hope that the discovery of the new site and the fossils will aid in increasing tourism, and in improving educational awareness of the local community.” ■

Slow earthquakes such as slow slips are drawing the attention of researchers due to their potential connection to tsunami earthquakes.

An international team of seismologists recorded a slow event in a shallow area of plate boundary at the Hikurangi margin off the northeast shore of New Zealand, showing for the first time that such slippage can occur near troughs. This implies that subduction plates may be accumulating much more stress and strain than previously believed –before they bounce back to set off tsunami earthquakes.

Authors say that the finding, published in *Science*, helps assess earthquake occurrence risk in coastal areas near subduction zones, especially at locations of shallow depth. “Slow earthquakes on the plate interface increase stress on the foci of the large earthquakes, ultimately triggering the largest inter-plate earthquakes,” says study author Yoshihiro Ito of Kyoto University. “In fact, a slow slip event was recorded one month prior to the 2011 Great East Japan Earthquake. When the main shock occurred, the plate slipped drastically about 30 meters, leading to the damaging tsunami.”

Slow slips last from a few days up to an entire year. Compared to normal earthquakes, deformation

occurs at a much more gradual pace. In the Hikurangi Trough, the Pacific plate subducts beneath the continental plate at a rate of 3-6 cm per year. Slow slips occur in 18-24-month cycles in concert with subduction of the plate.

Some of the areas in which these slow slips occurred match the epicenter of the 1947 Gisborne Earthquakes. Tsunami earthquakes like these are accompanied by waves much larger in scale than would be expected from shaking originating on land. The results from the current study imply that slow slip regions’ seismic slips are just like any other earthquake, and that they also have the potential to become the epicenter of major tsunami earthquakes.

The team, named HOBITSS (Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip), installed 24 seabed pressure gauges in the Hikurangi subduction margin in May 2014 and collected them in June 2015. A slow slip occurred in September 2014 and lasted for 10 days. Records from the seabed pressure gauges and GPS measurements on land indicated that the sea floor rose between 1.5 to 5.4 cm.

Ito elaborates that the current study revealed important clues about the role of seamounts on megathrust earthquakes. “We know

‘Slow’ NZ seabed quake sheds light on tsunami-earthquake mechanism



Ito with one of the seabed pressure gauges installed in the Hikurangi subduction margin

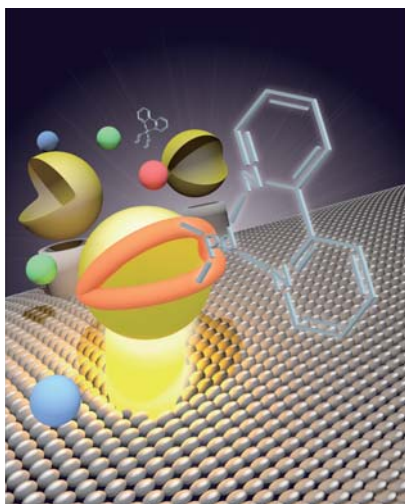
that in places like the Japan Trench and the Nankai Trough, there are some seamounts that subduct beneath the landward plate. But whether these seamounts are megathrust culprits or whether they ameliorate slips was a mystery," he says. "Since the locations of the slow slips and subducting seamounts don't match, our current study suggests that ocean mountains play a barrier-like role when slow slips occur."

"Submarine drilling is planned for 2018, in the area where we observed the current slow slip," Ito adds. "In addition, there are also plans underway for drilling with *Chikyu*, Japan's scientific drilling vessel for deep ocean research. We look forward to integrating geological and materials data from drilling with geodetic observation, which should lead us to a better understanding of the mechanisms underlying slow slips." ■

What goes on inside the brain when we learn new things? Much still remains wrapped in mystery, but scientists have found a way to examine this at the molecular level.

Researchers in Japan have engineered an artificial switch that could let scientists turn individual neurotransmitter receptors on and off. Shedding light on these receptors' role in memory formation could contribute to the development of new drugs for neurological diseases, including Alzheimer's, Parkinson's, and ALS.

Neurotransmitter receptors help relay information from neuron to neuron. "Investigating the functions



Cancer cell immunity in the crosshairs: worth the expense?

It's time to say goodbye to ineffective and costly cancer treatments. Japanese scientists have found unique genetic alterations that could indicate whether expensive immune checkpoint inhibitors would be effective for a particular patient.

Programmed-death ligand 1 (PD-L1) is a protein that tells the immune system not to kill a particular cell. Publishing in *Nature*, a recent study reports that genetic alterations affecting a part of the PD-L1 gene increases the production of the protein, allowing cancer cells to escape detection by the immune system.

"This is the first study to illustrate that a structural abnormality in the 3' untranslated region of the PD-L1 gene causes an abnormally high production of PD-L1 protein, consequently aiding cancer immune escape," says one of the lead

authors, Keisuke Kataoka, at Kyoto University. "Our study suggests that whether or not a cancer has this particular abnormality could be a good indicator of its response to immune checkpoint inhibitor drugs."

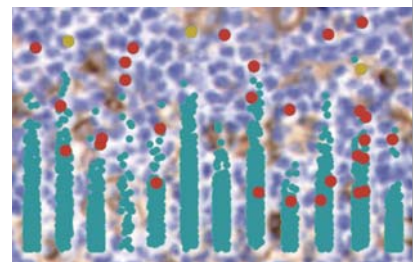
Antibodies that target PD-L1 or its receptor PD-1 have shown remarkable therapeutic effects for many cancer patients, sometimes even for those who are terminally ill. Treatment using such antibodies is extremely expensive, however, and oncologists are keen to find a biomarker that can predict the effectiveness of these drugs for individual patients.

"We identified PD-L1 structural alterations affecting the 3' untranslated region of the PD-L1 gene in 27% of patients with adult T-cell leukemia/lymphoma by analyzing next-generation sequencing data," explains senior author Seishi Ogawa.

Prompted by this initial finding, the team searched for similar structural alterations in sequencing data from a total of 10,210 samples deposited in the Cancer Genome Atlas.

"Through this analysis, we found that such abnormalities were found in many common cancer types, including malignant lymphoma, as well as stomach and cervical cancers. We also generated human and mouse cells having a similar structural alteration using the CRISPR-Cas9 genome editing system, and confirmed that these cells actually showed an elevated expression of PD-L1 protein and were able to escape the immune attack," says Ogawa.

"To test the importance of such structural alteration as a genetic marker, a phase two clinical trial is ongoing at Kagoshima University and other institutions," adds Ogawa. "Once we confirm the significance of these genetic alterations, it'll be a game-changer for immunotherapy in cancer." ■



of various neurotransmitter receptors could be immensely useful, because a majority of drugs on the market target them," says lead author Ryou Kubota of Kyoto University. "But with so many similarly-structured proteins in the membrane, it's been extremely difficult to determine which receptors do what.

"Discovering the functions of each neurotransmitter receptor in the brain could help us understand how we learn and acquire memory; to do that, it's crucial to be able to activate them selectively."

In the study, published in *Nature Chemistry*, the team succeeded in selectively activating glutamate receptors, which are pacman-shaped neurotransmitter receptors known to be involved in memory formation.

Membrane proteins change in shape when they become active. For pacman-shaped glutamate receptors, activation happens when

they "bite". The team genetically engineered glutamate receptors to include switches forcing activation and deactivation. "The switch comes in the shape of two 'clips' on what would be the upper and lower lips of pacman," explains Kubota. "When we tell the clips to bind together, we force the glutamate receptor to activate."

The current study only reports outcomes with glutamate receptors, but the authors say that their method also shows promise with other kinds of membrane receptors. "Even within glutamate receptors

there are subtypes, and within those subtypes there are further distinctions. This time we were able to distinguish and selectively activate each subtype," remarks Kubota.

"We've observed with further experiments that this method is generally applicable to other membrane receptors as well. By refining the technique, we hope that the discovery of each receptor's functions will advance our understanding of the brain's mechanisms." ■



Bullying happens in the primate world too, but for young bonobo females, big mama comes to the rescue. Japanese primatologists report in *Animal Behaviour* that older bonobo females frequently aid younger females when males behave aggressively towards them.

“We may have uncovered one of the ways in which females maintain a superior status in bonobo society,” says lead author Nahoko Tokuyama of Kyoto University.

In their study, Tokuyama and fellow researcher Takeshi Furuichi

observed a group of wild bonobos at Wamba, Democratic Republic of the Congo.

“Primate females sometimes forge partnerships to attack others.

Typically, such coalitions are formed between relatives to protect useful resources from non-relatives.” says Tokuyama. “For

bonobos, females leave their birth group during adolescence, so females in a group are generally non-relative to each other.

Despite this, they frequently form coalitions; a major research goal for us was to highlight the dynamics in which coalition-forming happens in non-relative individuals.”

Through four years of observation they found that all female coalitions were formed to attack males, usually after males behaved aggressively toward one or more females. They

also found that older females have better chances of winning when the battle is one-on-one, and when females form alliances they always win over males. What’s more, the older females don’t play favorites; whether a younger female is friendlier with the older female has no relation to whether the older

younger females join the group without fear of being attacked by males. By controlling aggression by males in this manner, females maintain overall superiority in the social hierarchy.

“It’s beneficial for the older females as well, because the younger females start spending

“Big mama” bonobos help younger females stand up for themselves

female comes to help.

Tokuyama observes that coalition-forming in female bonobos may have evolved as a way to combat male harassment. “Young females have a lower social status than males, but protection from older females seem to let

more time with them in hopes of getting protection. This way, the older female can give her son more opportunities to mate with the younger females. Such partnerships might in fact be the very factor that fosters gregariousness and promotes tolerance among females.” ■

Binary black holes recently discovered by the LIGO-Virgo collaboration could be primordial entities that formed just after the Big Bang, report Japanese astrophysicists.

If further data support this observation, it could mark the first confirmed finding of a primordial black hole, guiding theories about the beginnings of the universe.

In February, the LIGO-Virgo collaboration announced the first successful detection of gravitational waves.

“The detected gravitational waves were created from a merger of two black holes thirty times the mass of the Sun. It’s extremely rare for such massive black holes to form in the present-day universe,” says study author Takahiro Tanaka of Kyoto University.

“After this announcement, many astrophysicists started considering how such heavy black holes were created, and how such black hole

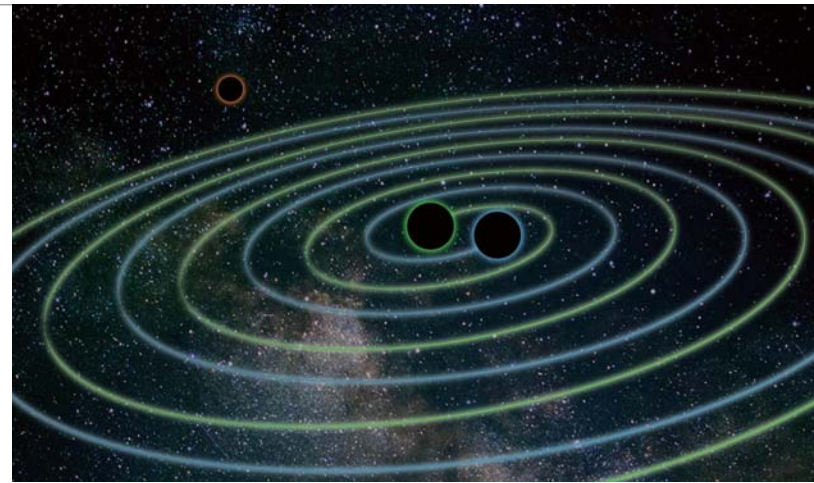
binaries were formed.”

As a starting point, the team hypothesized that primordial black holes – formed following the Big Bang – were distributed randomly in space.

“The universe was extremely hot and dense when it was first born. Primordial black holes came into being when gravitational collapse happened in regions which were especially dense,” explains Tanaka. “They have a completely different origin from black holes that form from celestial bodies.”

Based on general relativity, the research team evaluated how often black holes merge in the present epoch. They found that the LIGO-Virgo team’s observational data on merger frequencies would fall in to place if the binaries were primordial, and if they constitute a thousandth of all dark matter in the universe.

Primordial black hole binaries were discussed extensively in the 1990s; however, interest in them



waned when observations implied that their number was limited. To date, no one has found any primordial black holes, possibly making the LIGO-Virgo observations the first of their kind.

“Theoretical models about the beginnings of the universe are still hotly contested. Some models necessarily predict the existence of

primordial black holes, so their discovery could help unlock important clues about the universe’s early days,” says Tanaka.

“When enough observational data related to black hole binaries has accumulated, it will become possible to confirm whether these are truly primordial.” ■

Did the LIGO gravitational waves originate from primordial black holes?

Project

Kyoto University's Legacy with ASEAN Building long-lasting relationships and enrichment of Japan and ASEAN's potential

Kyoto University has a long-term tradition and history of mutual knowledge-creation and innovation with ASEAN and been leading interdisciplinary collaborative research for more than half a century. A broad variety of rich experience and achievements include establishment of Centers of Excellence with ASEAN.

Based on this tradition and experience, Kyoto University has been selected as a Japanese leading university to launch the Japan-ASEAN Science, Technology and Innovation Platform (JASTIP) under the framework of Strategic International Collaborative Research Program (SICORP) of the Japan Science and Technology Agency (JST). JASTIP will seek to develop a platform for diverse Japan-ASEAN science and technology cooperation centering on research into sustainable development through wide collaboration among universities and institutions from Japan and ASEAN.

The program was launched at an opening ceremony in Bangkok in February 2016, attended by over 100 participants including government officials, executive staff and researchers from partner organizations, universities, research institutions, and funding agencies.

The project has three missions to promote research toward sustainable



development based on person-to-person links.

1. Pursuit of advanced international joint research
2. Application of research results
3. Fostering human resources

In order to accomplish these missions, JASTIP will employ the network formed by its headquarters and three joint laboratories.

Energy and environment joint laboratory : National Science and Technology Development Agency (NSTDA), Thailand

Bioresources and biodiversity joint laboratory : Indonesian Institute of Sciences (LIPI)

Disaster prevention joint laboratory : Malaysia-Japan International Institute of Technology (MJIIT)

In addition to these joint

laboratories, JASTIP will establish a "JASTIP-Net" program, in which researchers from the ASEAN region and Japan who are active in fields relating to JASTIP's key topics can collaborate with diverse stakeholders on research into sustainable development goals.

Professor Yasuyuki Kono, director of Center for Southeast Asian Studies (CSEAS) and the project leader of JASTIP says that research conducted in collaboration between scholars in Japan and ASEAN countries has generated a substantial pool of knowledge and led to remarkable achievements in science and technology. Such joint efforts have also contributed to the cultivation of prominent leading researchers and young up-and-coming researchers throughout Japan and the ASEAN region.

JASTIP seeks to widely disseminate the achievements of such research endeavors

throughout the region, and also accelerate research as a driving force for the common goal of sustainable development through close collaboration between Japan and ASEAN. "In these collaborative endeavors, we believe that researchers should not confine their efforts to their own respective fields of expertise, and we encourage them to transcend the borders of academic disciplines, as well as national borders, and pursue collaborative research and human resource development in close cooperation with diverse stakeholders in sustainable development," says Kono.



Events

RIMS and IMU joint event 1 Women in mathematics

Numerous Fields Medalists and other internationally acclaimed researchers from the world's top universities have been invited to the University's Research Institute for Mathematical Sciences (RIMS) as part of KU's "Japan Gateway" Top Global Program initiative.

In conjunction, the International Mathematical Union (IMU) held its board meeting in Kyoto in April 2016, preceded by a workshop entitled "Will you not listen to women mathematicians?" on March 29, promoting the talents of female researchers. Participants included high school students from Kyoto and surrounding prefectures.

The program began with greetings from Inaba Kayo, Executive VP for gender equality, international affairs, and public relations, and from IMU President Shigefumi Mori

(Kyoto U). Overall host Motoko Kotani, President of the Mathematical Society of Japan (Tohoku U) then welcomed the speakers: Ingrid Daubechies, former IMU president (Duke U); Shihoko Ishii (U of Tokyo); Senjo Shimizu (Kyoto U); Makiko Sasada (U of Tokyo); and Asuka Takatsu (Tokyo Metropolitan U).

A lively panel discussion on challenges faced by female researchers rounded out the event, chaired by John Toland IMU Director (U of Cambridge).

At its conclusion the venue shifted to the proposed site of RIMS' international residential research facility, where institute director Shigeru Mukai opened a congenial networking event with a toast to the speakers and participants.



Ingrid Daubechies
Ex-President of the IMU



Kayo Inaba
Executive Vice-President



Motoko Kotani
President of the Mathematical Society of Japan



Shigefumi Mori
President of the IMU

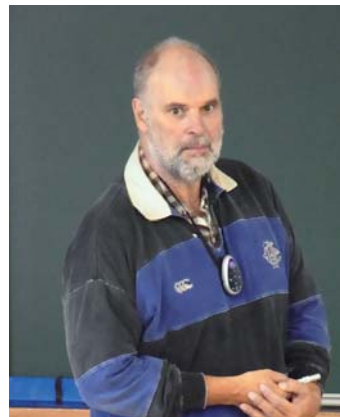
RIMS and IMU joint event 2 KTGU-IMU mathematics colloquia and seminars

Following on the Women in Mathematics workshop, a lecture series "KTGU-IMU Mathematics Colloquia and Seminars" was held by the IMU Director and participating Fields Medalists.

Colloquia were delivered by 10 members of the Executive Committee, including Fields Medalists Vaughan Jones, Distinguished Professor at Vanderbilt University (IMU VP), and Wendelin Werner, Professor at the Zurich Institute

of Technology (IMU Director). A total of nine seminars, aimed mainly at professionals, featured lively discussions taking place at each of the venues.

For participants, many of whom were young researchers and graduate students, these presented invaluable opportunities to interact directly with leading mathematicians and the most advanced research in the world.



Sir Vaughan Jones
Vice President of the IMU



Wendelin Werner
Executive Committee of the IMU

Picturing the future of Thailand in “lovely” Kyoto

Winij RUAMPONGPATTANA (3rd Year, Doctoral Program, Graduate School of Engineering)

The number of international students at Kyoto University is on the rise. Winij has been to various cities, but he loves Kyoto best. “I hope that international students will make the most of their time here and enjoy not just their studies but also life in Kyoto.”



With the submission of his doctoral thesis looming, Winij says he has been holed up in the university library for the past few days. He arrived at our meeting with a cheerful smile that showed no hint of how tired he must be from such a hard schedule. Hailing from Thailand, known as the land of smiles, and currently in his third year of study in Japan, Winij bashfully admits to be “still studying Japanese.” After his doctoral thesis is completed, he will write several more papers before returning to his hometown.

Just after nine o’clock every morning, Winij catches the shuttle bus from the Yoshida campus to his research lab on the Katsura campus, returning on the 6:30 bus in the evening. Because he spends most of the day working on his research, he says he does not have much opportunity to interact with students from outside of his lab. “But that’s okay, because I’m living at the Kyoto International Student House*. I have never felt lonely.” In the evenings after dinner, sometimes he is engrossed in writing his thesis and at other times he plays table tennis or studies Japanese with his dormitory mates.

One of Winij’s favorite pastimes is to go running along the Kamo River during breaks in his research. “The air is clear and the scenery is beautiful. When I see the people of Kyoto relaxing every day, picnicking with their families, walking their dogs, or exercising, I can relax, too.”

Winij, who grew up in the Thai capital of Bangkok, describes Kyoto as “lovely.” “It is a city where modern infrastructure such as the subway co-exists with traditional architecture. This is what a tourism city should look like.” He said that in Bangkok (which, like Kyoto, is also a popular tourist destination) rapid urban

development is starting to cause the loss of old streetscapes near the royal palace.

Winij’s field of specialization is urban management, an area of engineering that deals with the development of urban systems. However, Winij says that he is interested in much more than just the engineering aspects. “How should national budgets for infrastructure development be used? Such budgets should be invested not just in national governments but also in companies to revitalize the entire nation. To achieve this, we need to also look at the social and economic circumstances of the country.” Precisely because Thailand is still a developing nation, says Winij, “It has the chance to pursue its own path. It can choose to go down paths that have been trodden by other countries, or paths that other countries have not taken. I want to take the knowledge I have acquired in Japan and use it for the sake of my own country’s development.” A gentle but dependable light shines in his determined eyes.

*A ten-minute walk from Kyoto University’s Yoshida campus, Kyoto International Student House is a student residence for both international and Japanese students that upholds the ideologies of “Life Together” and “Encounters.” The residence receives financial assistance from the City of Kyoto and other organizations, and residents include students from other colleges, not just Kyoto University.



Winij also enjoys going on trips and playing baseball with other members of his research lab.



Winij often cooks his country’s cuisine in the residence kitchen. His favorite Japanese food is “Without a doubt, ramen!”



A variety of events are held at the residence each season.





For four and a half hours of practice, the club's members rehearse the *utai* and *mai* (dancing) over and over again. The basic method of instruction is for senior students to teach junior students one-on-one. "There are only so many things that can be conveyed with words. Ultimately, these skills will not become a part of you until you master them with your own body."



In Noh, the *ogi* is also used to represent other items, such as a sword or mirror as well as to express a variety of movements. This gesture, called *makura no ogi*, is used to portray sleep, for instance.

Ms Takeuchi plays the role of the scholar Onin in the play *Naniwa*. Onin takes the form of an old man to convey his blessings on the reign of the Emperor. Ms Takeuchi first encountered Noh soon after entering university and, determined to learn everything she didn't know, threw herself into it. She says that she is obsessed with the depth of Noh, and how nothing in Noh is straightforward.



I have been invited to a clubroom in the basement of the Box House. A majestic pine tree is depicted on the *kagami ita* at the front of the polished plain wood stage. Kanzekai's secretary, Mari Takeuchi, wearing jeans and white tabi, comes over to greet me. Holding an *ogi* of about 30 cm in length, she climbs onto the stage. She kneels facing the *jiutai*, a chorus sitting in line with their backs to the pine tree, and bows once politely. She spins around, opens her fan, and starts to chant, and the sound of her *utai* echoes deeply around the room. This is a rehearsal for the *shimai*, a simplified performance of about five minutes, which picks out only the highlights of the Noh performance. But even so, an air of tension pervades the room.

Kyoto University has four Noh clubs, each of which represents a different school of this performing art. The four groups—Kanzekai, Kongokai, Hoshokai, and Kyogenkai—share the use of this stage. Kanzekai has fifteen members who meet for practice three times a week and receive instruction from professional Noh performers several times a month. Several times a year, they hold training camps at shrines and temples, where they hone their performance skills in preparation for the Kyoto University Kanze Noh, a public performance put on by the group in November. Held at Kyoto Kanze Kaikan, which the group rents for the occasion, this is a full-scale performance in which the members don Noh masks and costumes just like the professionals. Ms Takeuchi is enthusiastic about next year's Kanze Noh, which she says will be the culmination of her efforts in the club. "I want to leave everything on that stage."

Another Kanzekai member, Sakurako Shimizu, takes out the *utaibon*, a book containing Noh lyrics and musical notations used in practice, and, in simple terms, teaches me some of the *shosa* ("basic gestures") and *kata* ("stylized forms") of Noh. There are hundreds of Noh plays and in all of them the forms the actors must take—from how they stand to the way they move their hands and feet—are all prescribed. "The actor must give the maximum performance using the minimum of simple movements. That is the depth of Noh." Compared with other Noh schools, the Kanze

In Noh performances, the *utai* (chanting), *ashibumi* (stamping of the feet), and *hayashi* (musical instruments) create a unique rhythm. "It is a completely different rhythm from Western performing arts. But it has its own harmony and it feels very good." Ms Shimizu says that it was the musicality of Noh that most attracted her to this art form.



school, in particular, uses the slightest of motions to express these forms.

Noh expressions are completely different from the kind of acting we are accustomed to seeing in television dramas and movies. Noh actors do not raise their voices to wail or laugh. With her head bowed slightly, Ms Takeuchi brings her perfectly aligned fingertips subtly in front of her eyes. "This movement, called *shiori* or, in its verbal form, *shioru*, is all that is needed to express crying. It is a gesture that condenses the emotion into its simplest form to convey sadness."

When I ask, "What do you most keep in mind in Noh?" both women reply, "It is all about doing things properly, both in practice and etiquette. Noh is like a martial art, in that daily discipline is essential. Even if you can do the forms properly, there are certain things that can only be expressed by approaching them with sincerity. That is the level we want to achieve." As the women straighten their posture and devote themselves to their practice, their voices resound with clarity across the cypress stage.



Emotional minimalism Kanzekai Noh Club

Mari Takeuchi (3rd Year, Faculty of Engineering)
Sakurako Shimizu (3rd Year, Faculty of Engineering)



Office of Global Communications

Kyoto University inaugurates office for global media outreach

With a focus on relaying the university's research output to domestic and international audiences, the university's Office of Global Communications got started in October 2015. Visit us at Public Relations in the historic Clock Tower building, or reach us via <comms@mail2.adm.kyoto-u.ac.jp> or @KyotoU_News or facebook.com/Kyoto.Univ.E



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Artwork by Kyoto University students, combined with artistic scenes as glimpsed by researchers.



ぼくたちは
点として
てんでばらばらで
つながりばかり
もとめてみたり

We are all single points,
And as points, we are
Scattered. Constantly
We seek to come together,
To find connections

Tanka Club
Shifu Nakazawa (3rd Year, Faculty of Science)

The world so overflows with people that we fear it would make no difference if we were no longer here. Yet it is this fear that leads us to seek connections with others. For if we can join our individual points together, creating lines, we may find more meaning in our lives beyond simply the place where we are now. (Paraphrased from the original.)

Professor Kazunari Shibata
(Kwasan Observatory, Graduate School of Science, Kyoto University, Japan)

Galaxies Colliding
Hubble Space Telescope (NASA)

The Milky Way is a collection of 100 billion stars. Galaxies undergo frequent collisions as they grow and expand, the result of universal gravitation. Perhaps there is an invisible “gravitation” between people as well. People come together and a family is born. Families come together and a village is born. Villages come together and a nation is born.



Guitar Club
Hanami Kanamaru (4th Year, Faculty of Letters)


Title: Fantasia Composer: John Dowland

In the first half of the piece, the various voices are scattered. In the second half, they come together into a single chord to create a “line.” As sounds seek connections, they grow progressively larger through an “invisible gravitation.” Thus, a work of music comes into being.



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