INSTITUTE FOR ADVANCED RESEARCH

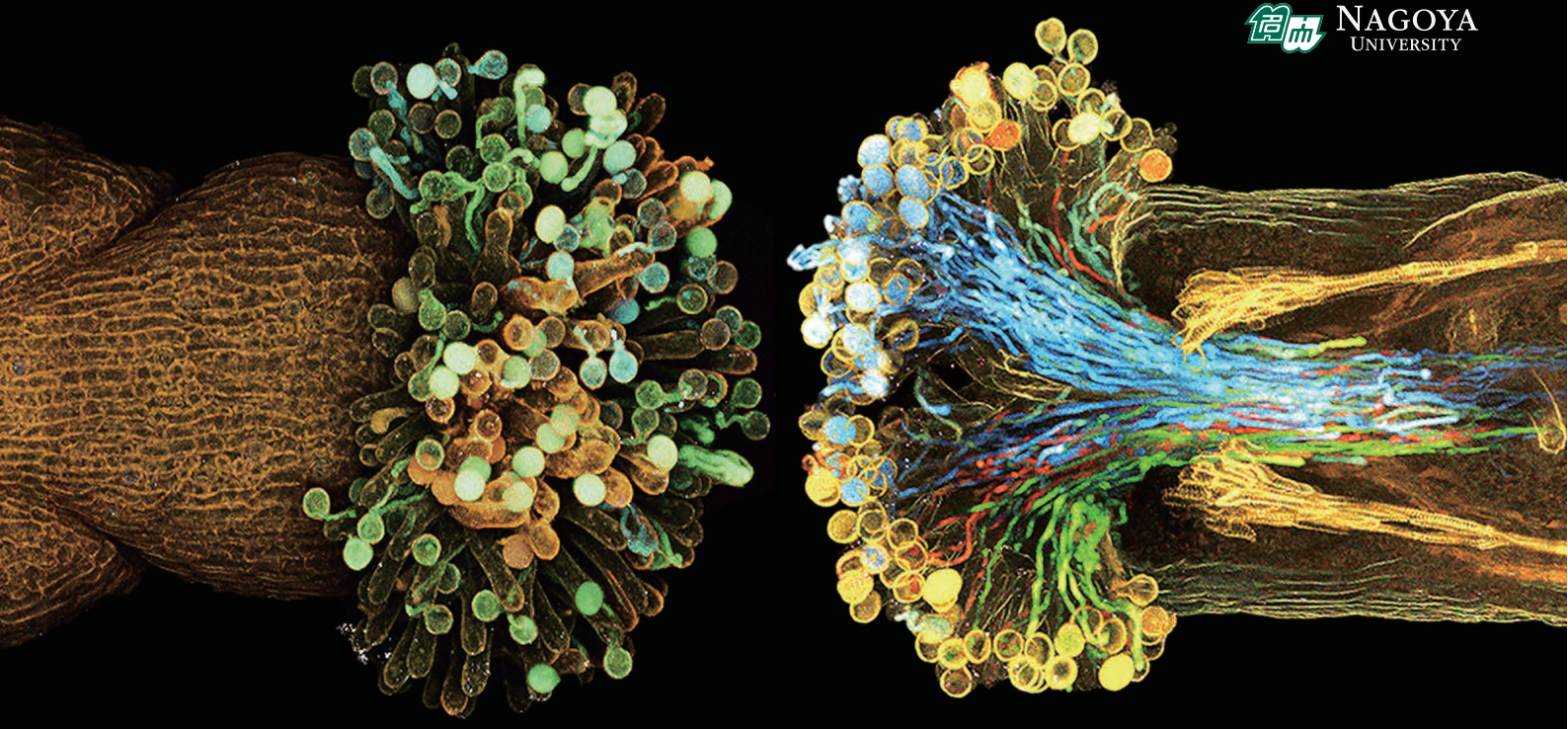
LETTER

March 2020 Vol. 18

Special Interview

Investigating the laws of physics that governed the universe right after the Big Bang.

—— Toru IIJIMA



Research Highlights

Toward a fruitful dialogue on interdisciplinarity and academic collaboration

For a long time, the age of majority in Japan had been set at 20 by the Civil Code. Recently, however, the Japanese government decided to lower it to 18. Since the Institute for Advanced Research at Nagoya University was established in 2002, it will now enter adulthood in 2020 in accordance with this new law. Needless to say, becoming an adult means taking on greater responsibility in pursuing the fundamental objectives of the institute not only within Nagoya University but also in wider academia around the world.

The primary mission of Nagoya IAR since its establishment has been to identify distinguished scholars of our university worthy of international recognition, and to further support their research to enable them to demonstrate their academic excellence to the world. At the same time, we have been hosting IAR lectures and seminars, most notably the Nagoya University Lectures, delivered by outstanding scholars, to whom the president of Nagoya University awarded special lectureship, for the purpose of sharing the highest academic accomplishments with society at large. Last year, it was our great honor to hold the Nagoya University Lecture with Dr. Masanori Aoyagi as the awardee, an eminent Roman archaeologist who has been working in Italy for almost half a century. Furthermore, encouraging early-career researchers through interdisciplinary collaboration is becoming a key mission of our institute. To this end, we are responsible for the implementation of the Young Leaders Cultivation (YLC) Program, appointing around eight prominent early-career researchers of various fields every year as designated assistant professors in five-year terms. In 2020, nine highly promising young researches will join this program through a rigorous selection process.

One of the most important duties of the director of Nagoya IAR is to serve as a member of the steering committee of the international consortium of UBIAS (University-Based Institutes for Advanced Study). The members of UBIAS are expected to hold joint activities on a certain topic called "Topic of the Year." The 2020 Topic of the Year is "Dialogue," which we have proposed together with the Nanjing IAS. We sincerely hope that "Dialogue" may further strengthen the partnerships among the UBIAS members and with other institutes of leading research universities in order to promote future academic advancement.

Yoshi SUTO
Director, Institute for Advanced Research

Director
SUTO, Yoshiyuki

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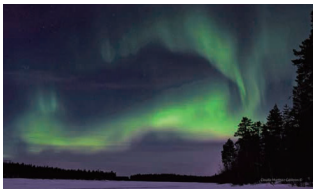



Cover Picture :
Multicolor two-photon imaging of *Arabidopsis* pistils.
(Photograph by Yoko Mizuta, YLC assistant professor. See page 13.)

Special Interview

Toru Iijima

Dr. Iijima was born in 1964 in Ashiya, Hyogo Prefecture, Japan.
He is a professor at the Kobayashi-Maskawa Institute for the Origin of Particles and the Universe (KMI), Nagoya University. He also serves as professor at the Graduate School of Science, Nagoya University. As a particle physicist and leader of experiments with accelerators, Dr. Iijima is working to elucidate the origin of matter and the origin of the universe. He graduated from the Faculty of Science, Kyoto University in 1987 and received his doctorate (in science) from the university in 1995. He became a Research Fellow of the Japan Society for the Promotion of Science in 1992, an Assistant at KEK in 1994, and an Associate Professor at the Graduate School of Science, Nagoya University in 2002, before taking on his current positions in 2010. Since June 2019, Dr. Iijima has been the spokesperson for the Belle II experiment with the SuperKEKB accelerator.

Investigating the laws of physics that governed the universe right after the Big Bang.

—— When did you become interested in elementary particle physics?

IIJIMA: Sometime in high school. At first, I did not like studying physics. I remember well that I failed my midterm exam in the first term of my first year in high school (laughs). I preferred genetics of biology. I was deeply impressed by the fact that heredity was explainable at the level of molecules, such as DNA. However, I changed my mind after studying Newton's law in high school mechanics class. Mechanics explains many things from free fall, such as the fall of an object from a tree, and a parabolic motion, to astrological phenomena. With physics, you can even "predict" things. I found physics interesting because it can express a phenomenon in the world with a single formula.

I think it was in my third year in high school, I learned about a research in particle physics when I read a newspaper article. It said that CERN (European Organization for Nuclear Research), an accelerator facility in Europe, had discovered a theoretically predicted particle called the "weak bosons", by colliding proton and antiproton beams in an accelerator. I was surprised to learn that CERN had dug a huge tunnel with a diameter of 2km and a circumference of 7km to make the accelerator to collide the particles with each other, and that the new particles had been discovered as predicted. I thought both the theory and the experiment were wonderful.

—— I hear that you were inspired by Dr. Yukawa and Dr. Tomonaga, two legendary theoretical particle physicists at Kyoto University, to enter the university.

IIJIMA: Yes. However, theoretical particle physics labs were harder to join than any other physics lab at Kyoto University. Some students at the university were so smart that I thought theoretical physics would be above me. I saw some experiment devices during a tour of accelerator laboratories, and I felt I was better suited for working on experiments than on theories. That is why I joined a lab that focused on experiments. I also liked messing around with machines quite a bit.

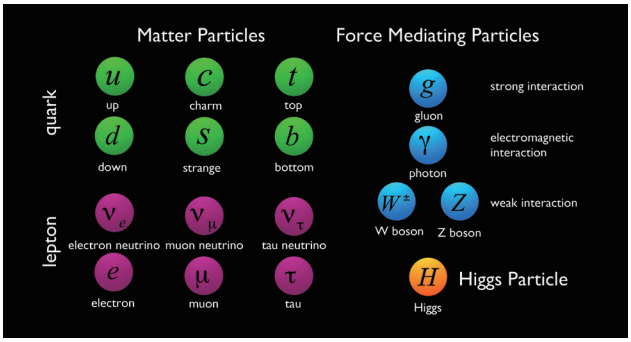
In my undergraduate years, I belonged to a yacht club at the university and didn't study much. So I didn't do well in the postgraduate exam. I was certain I had failed it, but I hadn't. I guess I was admitted for my perseverance and potential (laughs). In the autumn of my first year of the master's program, I joined the project of an experiment to find the "H-dibaryon", an unknown particle made of six quarks.

—— There are six types of quarks, aren't there?

IIJIMA: That's right. [See diagram] H-Dibaryon is predicted to be a particle made of six quarks: u, u, d, d, s, and s. I joined experiments for finding this particle at the KEK (High Energy Accelerator Research Organization) in Tsukuba, Ibaraki Prefecture, Japan, and the BNL (Brookhaven National Laboratory) in the U.S.

Both KEK and BNL arranged accommodations for me on the premises. From around my second year of the master's program to my third year of the doctoral program, I spent my entire time performing experiments. It was incredible fun. In the end we failed to find the H-Dibarion, but in retrospect, my experience in those days of devoting myself to experiments meant a lot to me. I acquired a wide range of ideas and techniques, got to know many researchers, and learned at a deep level how to move my research forward.

When I finished writing my doctoral thesis, construction of the B Factory for the so-called Belle experiment was about to begin at KEK back in Japan. The experiment was intended to measure the CP violation predicted by the Kobayashi-Maskawa theory and to check whether or not the prediction was correct. I had an opportunity to participate in the new project as an assistant professor hired by KEK.



Standard Model of Particle Physics. "Elementary particles make up the Universe"

—— What were you responsible for?

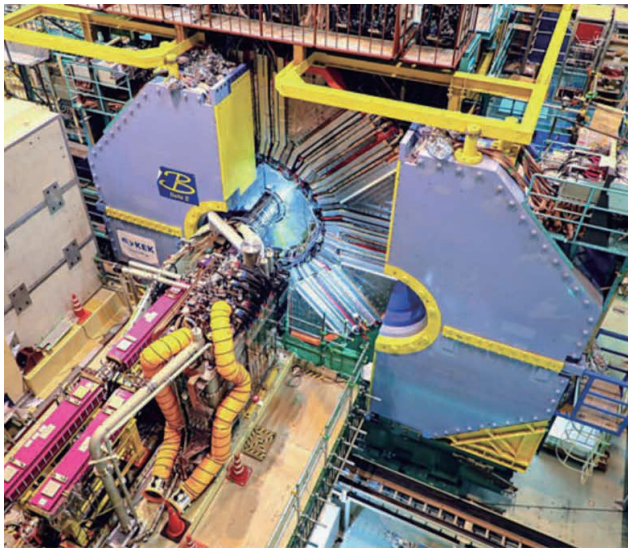
IIJIMA: In the Belle experiment, I investigated the difference between particles called "B mesons" and their antiparticles called "anti-B mesons" in the way in which they decay. B mesons contain the second heaviest quark, called "bottom quark (b)." When B mesons decay, they convert into several much lighter particles. These light particles travel at almost the speed of light into the detector. We developed a Cherenkov detector, which measures such slight difference in speed.

Basically, in particle physics experiments, only an accelerator is operated by the host laboratory. Then, researchers develop experimental devices and bring them into the site. If you want to gain the world's first results in physics experiments, you need to develop detectors of the highest performance ever. This is a challenge, but also a real pleasure for experimental scientists like me. We developed a rather unusual material called "silica aerogel" with a manufacturer, and had a photomultiplier tube manufacturer build optical sensors. It took us about four years to develop this Cherenkov detector.

—— What is interesting about studying particle physics?

IIJIMA: The study of particle physics involves thinking through the most basic elements that make up the universe and what rules they follow. That means investigating the laws that governed the universe right after the Big Bang, 13.8 billion years ago in the history of the universe. Isn't it exciting to prove the origin of all creation, dating back to 13.8 billion years ago, in an experiment today with an accelerator on the earth?

Observation of the CP violation in the experiment means verification of the theory that governed the universe right after the Big Bang. When we actually measured and proved the violation in the B Factory experiment, I was absolutely thrilled. To borrow someone's phrase, I felt like I was touching the hand of God.



BelleII Detector

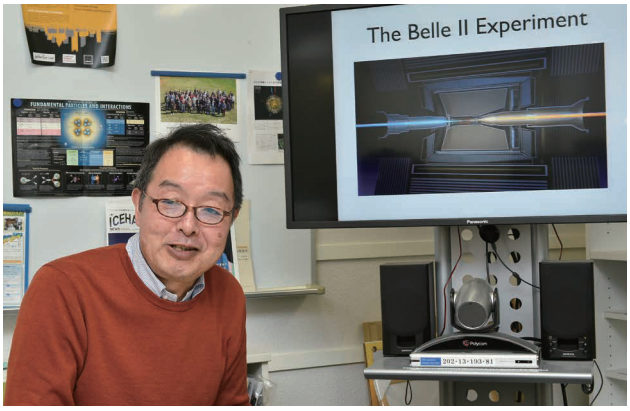
—— In those days, the news was reported as a great achievement, and I felt excited like many other people. After the B Factory experiment, how did the research go?

IIJIMA: Although we managed to prove the Kobayashi-Maskawa theory, a fundamental mystery still remains: why is the universe made up of matter alone? Why is there no antimatter in the universe? The Kobayashi-Maskawa theory is not sufficient to explain the reason why. You need a new theory that goes beyond the Standard Model.

The new theory concerns new elementary particles that are still unveiled. Which means, discovering new particles is a current major goal of particle physics. If you conduct an experiment with an even higher beam intensity, you are likely to discover something that deviates from the prediction made by the Standard Model (the Kobayashi-Maskawa theory).

—— That is, the Belle II experiment being conducted with the Super KEKB accelerator, am I correct?

IIJIMA: That's right. I have been involved in its construction. This year, we finally started the experiment on a full scale. Last June, I was appointed spokesperson (representative of the collaborative experiment team). Although we are conducting the experiment at KEK, the experiment team is independent from KEK and comprises researchers from all over the world: about 150 from the U.S., 400 from Europe, 210 from Asia, and 160 from Japan. Currently, a total of about 980 researchers from 118 research institutions in 26 countries and regions are participating in the project. We monitor the experiment in real time, give instructions to researchers around the world, and discuss with them. If something concerns us, we discuss it via internet, using tools like Skype.



—— How ingenious is the equipment for the Belle II experiment?

IIJIMA: We proposed to raise the beam intensity of the accelerator to 40 times higher than that for the B Factory experiment. To increase the frequency of electron-positron collisions, we also reduced the width of the colliding beam from about 100μm to tens of nanometers. In the beam, bunches made of about 10 billion electrons and positrons intersect with each other. Most of the electrons and positrons slip without being hit, but if you narrow the beam, the density increases and they are hit more easily.

The work of detector fabrication was divided among the researchers participating in the experiment. Our lab was responsible for fabricating a detector that measures the speed of particles, called the "TOP counter." For accurate measurement of the speed of particles, we ensured higher time resolution and data processing capacity than those of conventional detectors. We worked with a manufacturer to develop a microchannel plate photomultiplier tube, which boasts a time resolution high enough to detect light traveling a distance of 1.2cm. The tube has area of 2.5 × 2.5cm², and we place 512 of them in the detector. This photomultiplier tube can measure one photon. It has such a high sensitivity that, if you turn on a flashlight on the moon's surface, the light that reaches the earth can be measured by the microchannel plate. This high-sensitivity measurement is made at a high-enough resolution to detect light traveling a distance of 1.2cm. You don't need this in your everyday life, but don't you think this is amazing?

—— It sure is amazing. Have you already achieved any results in the Belle II experiment?

IIJIMA: The experiment has three phases: accelerator commissioning, a preliminary collision experiment, and the full-scale start. The third phase began in March 2019. Accelerators are not the type of device that instantly delivers a good performance when you press a button. You need to make fine adjustments repeatedly to the accelerator to improve its performance. So it takes over two years to exceed the performance level of the accelerator in the B Factory.

—— Is there any theory you would like to prove in this Belle II experiment?

IIJIMA: This time, I would like to form a new physical theory based on the results of this experiment, rather than proving any particular theory. The Kobayashi-Maskawa theory has been proved, and the Higgs boson has been discovered. The time for experiments to prove theories is over. Now we are moving on to the next step: to discover new phenomena based on the results of experiments. This is the time when we experimental scientists should give it all we have.

As I just mentioned, there are things that cannot be explained by the Standard Model. To give a specific example, there is something called "dark matter." The rotation speed of the galaxy is inconsistent with the amount of detectable mass, and there must be more mass. Dark matter is called dark

because it is unobservable. Dark matter is considered another kind of elementary particle, but in the Standard Model, there is no particle that can be interpreted as dark matter. I would like to discover new particles and also close in on the mystery of dark matter.

—— It seems like you are going to obtain exciting results. However, isn't it tough to lead almost 1,000 people in the team and move the research forward?

IIJIMA: We develop detectors, proceed with the experiment on schedule, collect data, and organize it into research papers. We need a variety of skills to do such things, but the same is true for any other field of study, isn't it? What is peculiar about us is that we comprise many researchers who share the same goal, who get together to form a team and work on a single project together and encourage each other. In other fields of study, many teams aiming at the same goal compete with each other. When it comes to particle physics, experiments are so large in scale that the sheer cost of competition among many teams would be global in scale. Instead, researchers get together and discuss equipment, measurement methods, and data analysis. We sometimes compete and select the best choice.

In this environment, I think consensus is important. What are the biggest problems in proceeding with the project? What are the solutions to these? We share issues and work together to resolve them. Researchers think scientifically. So, as long as they discuss in a fair manner, they all accept whatever conclusion they arrive at. This is because they engage in research out of sheer desire for discovery.

—— What do you think of the ILC (International Linear Collider), which is planned to be built in Iwate Prefecture, Japan?

IIJIMA: There are two ways to achieve the next breakthrough in particle physics: to directly create new heavy particles by colliding particles with high energy, or to measure particles accurately. While the Belle II experiment examines the effect of new particles on the bottom quark and the tau lepton, the ILC targets the Higgs boson. In other words, the ILC will be intended to measure the properties and reactions of the Higgs boson accurately. The ILC is a significant project that elementary particle researchers would definitely like to get involved in.

I expect that the ILC will also offer economic benefits to the area in Iwate Prefecture, where the equipment is planned to be constructed. Infrastructure and a community will be built for researchers coming from overseas to live there. The project will be funded by the government. So it is important to earn proper understanding from the public, but sufficient understanding has not yet been obtained. It is necessary to make efforts to convince researchers in other fields and the public of the importance of this project.

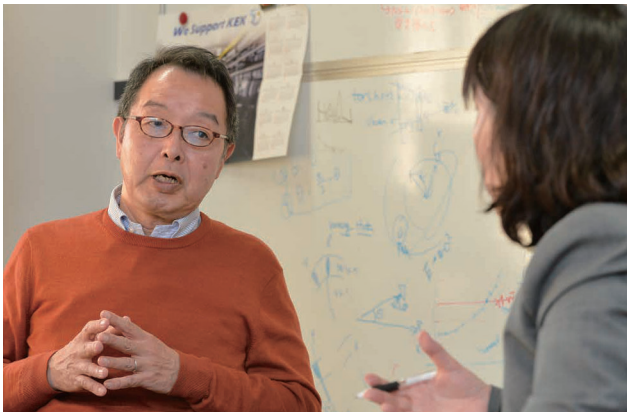
—— To conclude, could you give a brief message to young people?

IIJIMA: The best part of scientific research is that you can change people's common perceptions. Looking back, there have been some moments of dramatic progress in people's common perceptions. An old example is the shift from the geocentric theory to the heliocentric theory.

People often ask me how particle physics is useful. It does not show immediate utility. However, if you only conducted scientific studies to make your life easier tomorrow, human society would not have made such great progress, don't you think? The foundations for the invention of semiconductor and computers can be traced back to the discovery of electrons and also there were achievements of quantum mechanics. Some scientific studies that do not show immediate utility may turn out to improve our standard of living many years into the future.

I believe that efforts to plan and conduct basic science experiments such as elementary particles also develop the abilities of researchers. You can live your daily life just fine without a technology that can detect 1 cm of light travel. Still, I believe that this technology is essential for cutting-edge scientific research and has enhanced the abilities of humans who have striven to make the technology a reality. Sometime in the future, the technology will be of some practical use.

So, I would like you young people to keep yourselves open to anything that may arouse your curiosity. Then, once you find some research subject interesting, do not be dissuaded by the temporary trends of the world or whether or not the subject is of practical use. Just dive to the bottom of the subject.



Interview with Dr. Iijima was done by Nagoya IAR faculties and C. Ashihara (Chunichi Shimbun Co., Ltd). This interview article was written by C. Ashihara and translated to English under the responsibility of Nagoya IAR.

Exploring social changes and reconsidering "development" based on fieldwork in Bangladesh and Saudi Arabia

Conducting fieldwork in rural Bangladesh in the rainy season

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I have conducted fieldwork in rural Bangladesh since 2007, and explored the social changes and current situations of Bangladeshi village society. Here I would like to introduce two research projects of mine. i) One of my research projects seeks to explore the mechanism of socio-spatial and inner spiritual Islamization in rural Bangladesh. I focus on Bangladeshi migrants and pilgrims in Saudi Arabia, and examine how their living experiences in Saudi Arabia affect the religious knowledge and practice of the Bangladeshi migrants and how their home communities exert an influence on their religious discipline in that country. ii) Another research project attempts to reveal the negative impacts of industrialization and existing rural development programs on local society, and evaluate local and indigenous technical knowledge in rural Bangladesh. This project critically reconsiders the concept and practice of "development," and seeks the possibility of pluralism in economics and alternative development there.

BANGLADESHI MIGRANTS IN SAUDI ARABIA AND TRANSNATIONAL NETWORKS OF ISLAMIC REVIVAL

This study explores the socio-economic backgrounds of Bangladeshi migrants (including migrant workers and pilgrims) in Makkha (Mecca), and examines the impacts they have on the politico-economic and socio-cultural spheres in their home communities in Bangladesh.

I have conducted fieldwork in several villages in Tangail district in Bangladesh since 2007. I have traced the process of Islamization in terms of landscape and population in the study area from the early 20th century to the present (Sugie, 2014, 2017). During this time, I have observed that religious activities such as the construction and maintenance of mosques, and the organization of Islamic conferences have become increasingly prosperous even while the other functions of local communities have been declining (Sugie, 2017). Local Muslim elites have sought to preach about prayer and fasting in their communities. Moreover, the tendency to regard playing musical instruments and saint worship as forbidden in Islam has

arisen recently not only the villages the villages in Tangail district but also in other parts of the country (Sugie, 2016). Such tendencies have been widely reported and have spread among Muslim communities worldwide since the 18th century; they have been reinforced in recent Islamic revival movements from the latter half of the 1970s. However, it is not clear how an Islamization that orientates people to be "more Islamic" has been brought to and spread in rural Bangladesh.

Previous South Asian studies have stated that such a spiritual, inner Islamization at the local and national levels has been brought about by the historical and colonial construction of religious differences on the subcontinent. Although such aspects of Islamization could be seen in the exclusive religious identity and practice among local people (e.g., Sugie, 2016), how the recent tendency of Islamization has been brought to and spread in rural Bangladesh needs to be examined in terms of its relationship and/or commonality with worldwide Islamic revivalism. To deal with these issues, Sugie (2019) provides a model of Islamization using the concept of "Islamic locale," and examines the mechanisms of Islamization that are specific to Bangladesh and its connections, as well as the similarities with and differences from Islamic revivalism worldwide. This study found that significant triggers of the spread of Islamic knowledge are the achievement of a certain degree of economic status, modern Islamic education, and work by Islamic intellectuals including those who have returned from Saudi Arabia.

In this study, Bangladeshi villages are considered a social space, which is composed of a transnational network connecting regions and the flow of people, things and knowledge. In this flow, I focus on Bangladeshi migrant workers and pilgrims in Middle Eastern countries; among them, I selected Saudi Arabia based on statistical data on Bangladeshi migrant workers and the abovementioned research results (Sugie, 2019). Although the contribution of overseas migrants to the individual household and the Bangladeshi national economy has received considerable attention, the cultural and social impacts of migrants on Bangladeshi society cannot be ignored because there are a huge number of migrants in the Gulf States, particularly Saudi Arabia, who are from various classes and areas. However, little attention has been paid to their cultural and social impacts except by a few studies. Moreover, due to very limited access to Saudi Arabia, previous studies on overseas migrants in the country have been based only on statistics or interviews of those who have returned to their home countries. Among the cities of Saudi Arabia, Makkha is the most important religious site for Muslims. However, the current situation of migrants in the city has not been unveiled, because it is a prohibited area for non-Muslims. In my fieldwork, I found that at least 700 Bangladeshi migrant households were living in a concentrated area near the Halam Mosque in Makkha, and that they made a significant contribution to religious activities in the city as well as in their hometowns in Bangladesh. Therefore, this study seeks to examine their roles and positions in the city, their hometowns, and transnational networks of Islamic revival. This study is a pioneer work on Islamic revivalism based on intensive fieldwork in Makkha.

Figure 1. The Kaaba in Halam Mosque in Makkha

PLURALISM IN ECONOMICS AND ALTERNATIVE DEVELOPMENT

Academic discussions and social movements that seek alternative or pluralistic economic systems, such as a solidarity economy or a community economy, have increasingly gained momentum since the evils of neoliberalism have been unveiled. Based on the theory of Karl Polanyi, the basic thought and practice of this movement is to re-embed the economy into society and nature. However, it is broadly believed that foreign-capital-led and export-oriented industrialization is the only way for the rapid and successful economic development of developing countries such as Bangladesh. Moreover, a microcredit-oriented development scheme has advanced a neoliberal social process and restructuring at both the macro and micro levels, rather than pluralizing the market-oriented economic system (Sugie, 2019, forthcoming). Is there no alternative to a dependence on the global market economy and financialization that expects prosperity to trickle down from wealthy capitalists at the expense of local solidarity and the natural environment?

Rural Bangladesh features indigenous social customs such as redistribution of wealth in the form of "begging" and alms-giving (Sugie, 2013) and resource use that is eco-friendly and favorable to the poor, although these practices have been marginalized in the market-oriented economic system. By exploring and evaluating these practices, this study seeks and discusses the possibility of a pluralistic economic system and an alternative way of development, where reciprocity and solidarity among people as well as between people and nature are prioritized over market economy success.

Acknowledgements

I would like to express my gratitude to the residents of the Bangladeshi villages and Makkha, which I visited during my fieldwork, for their warm cooperation. My work was supported by the JSPS under Grant Number 16J05363.

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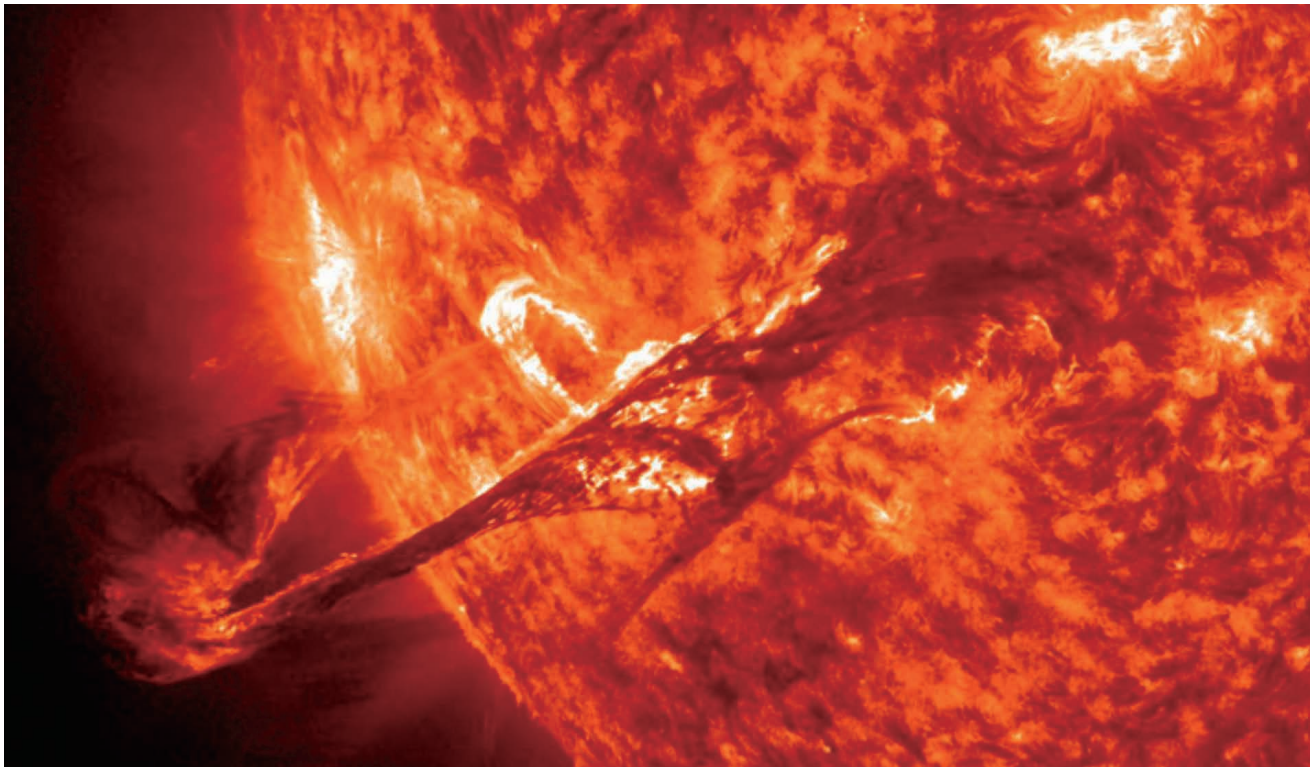
Exploring Triggers of Solar Eruptions from Satellite Observations



A solar eruption observed by NASA's satellite "Solar Dynamics Observatory"

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The Sun, on which depends the very existence of life on the Earth, sometimes threatens human activities due to disturbance of the space environment around the Earth by eruptive phenomena such as storms. "Space weather forecasts," which predict storms in space caused by solar activity, are vital for modern society developing high-tech infrastructures and for human advancement into space. Thus, it is necessary to understand the physical process of solar eruptions and to predict when and where solar eruptions will occur, and how large they will be. In our study, we discovered the characteristic magnetic field structures that trigger solar eruptions and that have never previously been discovered. We have also discussed some precursory phenomena of solar eruptions. From the discoveries of our study, the development of an algorithm that automatically calculates the probability of solar eruption for each region on the solar surface by using our findings is expected in the near future.

INTRODUCTION

The Sun sometimes releases its magnetic energy, which is accumulated in the solar atmosphere, as solar eruptions. These phenomena are called "solar flares" and "coronal mass ejections (CMEs)," for which magnetic energy is mainly released, respectively, as thermal or kinetic energy. Solar eruptions sometimes impact to the space environment around the Earth by ejecting high-energy particles, radiations, plasma, and magnetic fields. Some serious impacts from solar eruptions are feared: such as radiation exposure of human bodies in the International Space Station and on polar aircraft routes, interruption of HF communication, electrical outages, errors in global positioning systems, and damage to spacecraft and satellites. Therefore, it is required to understand and forecast when and where solar eruptions will occur, and how large they will be, in order protect our infrastructures from space disasters.

SOLAR ERUPTION TRIGGER PROBLEM

Solar eruptions generally occur in the solar atmosphere over a sunspot, a so-called solar active region (Figure 1a). In an active region, magnetic fields connect sunspots and are often helically sheared and twisted by the motion of their root sunspots. These sheared, twisted magnetic fields accumulate

magnetic energy that drives solar eruptions and is released by such eruptions. A bundle of helically twisted magnetic fields known as a "magnetic flux rope (MFR)" is formed by the reconnection of sheared magnetic fields in an active region by some trigger, and this phenomenon is what we identify as a solar eruption, including flares and CMEs. As summarized in Figure 2, one of either MFR formation by magnetic reconnection or evolution by magnetohydrodynamics (MHD) instability first takes place, and these two processes mutually reinforce each other. The MFR erupts after it has grown sufficiently by this reinforcing process, and causes a flare or CME (or sometimes both). However, the "trigger" that leads the sheared magnetic fields to enter the reinforcing process of magnetic reconnection and MHD instability has not yet been revealed.

DISCOVERY OF A TRIGGER OF SOLAR ERUPTIONS

We discovered small-scale magnetic field structures that can serve as a trigger of actual major solar eruptions (Figure 1b) from detailed analysis of observational data by Japanese HINODE satellites [1]. The discovered magnetic field structures quantitatively satisfy geometrical conditions that are proposed as "trigger magnetic fields" by a theoretical model based on numerical simulations [2]. There are two types of trigger magnetic fields that characterize entrance into of the reinforcing process in Figure 2, depending on which physical phenomenon first takes place: magnetic reconnection or MHD instability. We discovered both types of trigger magnetic fields for solar eruptions occurring in different active regions. There have been huge numbers of studies that qualitatively discuss solar eruption processes from observational or numerical approaches; however, our findings are the first in the world to quantitatively and directly identify suspected triggers of solar eruptions. Our results are also significant in terms of observational verification of the theoretical model in the sense that we directly measured geometrical parameters that characterize trigger magnetic fields (i.e., solar eruption onset conditions) from observational data.

Moreover, we found that there should be an additional condition for solar eruption onset [1], although this has not been mentioned in the theoretical model. This is suggested by our data analysis results indicating that a solar eruption does not immediately occur even when a trigger magnetic field appears in an active region. Therefore, we conducted additional data analysis and found a new condition of "magnetic flux of a trigger magnetic field," which indicates when solar eruptions occur. A trigger magnetic field is able to work to invoke the reinforcing process when it gains sufficient magnetic flux.

PRECURSORY PHENOMENA OF SOLAR ERUPTION

We further discovered precursory phenomena of solar eruption. For instance, "precursor brightening" is intermittently observed in the relatively lower solar atmosphere over trigger magnetic fields, generally from a few hours to a few minutes before a solar eruption onset. Transient but significant plasma flow in the solar atmosphere was simultaneously observed with precursor brightening for several major solar eruptions [3, 4]. It can be interpreted that these plasma flows are caused by plasma ejection by small-scale magnetic reconnection over the trigger magnetic field, by its features such as temperature and velocity. This small-scale magnetic reconnection leads the reinforcing process in Figure 2, and the precursor brightening and plasma flows can be considered as proxies of interaction between a small-scale trigger magnetic field and pre-existing sheared (twisted) magnetic fields.

Moreover, another precursory phenomenon was observed in the higher solar atmosphere: pre-existing magnetic fields, which are larger in scale than trigger magnetic fields, expanded from few hours before the eruption onset, relating to the appearance of trigger magnetic fields and precursor brightening [5]. The expansion of large-scale magnetic fields indicates that the magnetic fields will be unstable, that is, this observed result suggests that a small-scale trigger magnetic field works to destabilize larger-scale magnetic fields in an active region.

CONCLUDING REMARKS AND FUTURE PROSPECTS

We have discovered that small-scale characteristic magnetic field structures can be a trigger of solar eruptions. However, the appearance of such trigger magnetic fields is not a necessary condition but merely a sufficient condition of solar eruption onset. Solar eruption requires both magnetic energy accumulation in both large-scale sheared magnetic fields and small-scale trigger magnetic fields. Our studies show the whole picture of the solar eruption process including its trigger, which have never been discovered before, such as summarized in Figure 2. Some important precursory phenomena in the solar atmosphere, which should be observed to predict solar eruption, have also been discovered. As a next step, we should attempt an experiment of solar eruption forecasting by developing an automatic detection method of trigger magnetic fields and precursory phenomena for newly appeared active regions on the solar surface. In this way, we are also able to evaluate and optimize parameters that characterize trigger magnetic fields and precursory phenomena. In near future, a forecasting algorithm that automatically calculates the probability of solar eruption for each active region on the solar surface is expected to be developed.

Furthermore, it is necessary to predict if the MFR will come to the Earth after it is ejected from the Sun in order to forecast the influence of solar eruptions to the Earth and humankind in a true sense. Impacts from solar eruptions such as those mentioned in the introduction are caused by the interaction of magnetic fields between MFR from the Sun and the Earth's magnetosphere. Therefore, understanding and forecasting both solar eruption onset and the propagation of ejected MFR are necessary to establish practical "space weather forecasting," which can predict disturbances in the space environment around the Earth due to solar activities.

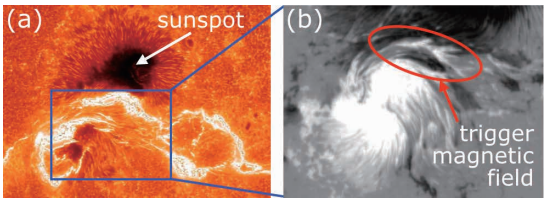

Figure 1. A solar flare in an active region (a) and its trigger magnetic field (b).

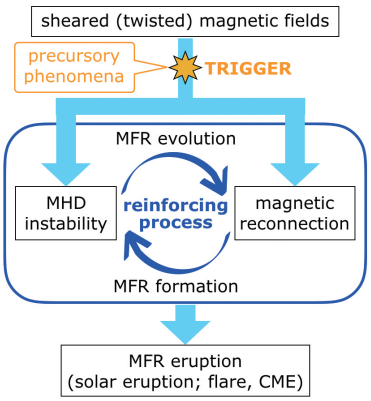

Figure 2. Schema of the solar eruption onset process

Acknowledgements

I would like to express my sincere appreciation to the co-authors: Prof. Kusano, Dr. Imada, Dr. Inoue, Dr. Lee, Dr. Yamamoto, and Dr. Okamoto. I also appreciate the satellite development/operation teams of HINODE and SDO.

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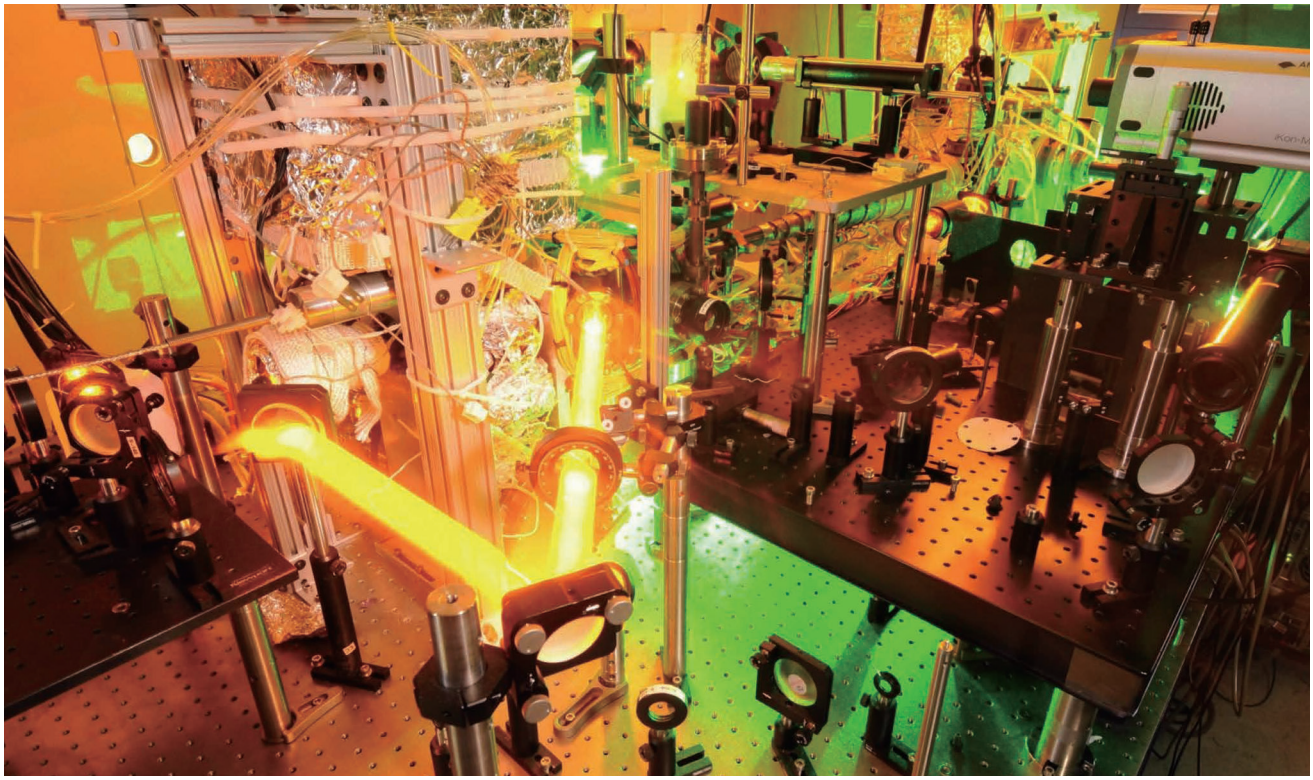
Non-equilibrium phenomena in ultracold quantum gases



Experimental setup for ultracold quantum gases courtesy of Prof. Chandra Raman at Georgia Institute of Technology

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Recent progress of experimental technology allows one to investigate non-equilibrium quantum phenomena in a highly controllable manner. One of the most promising playgrounds is an ultracold quantum gas, which has played an essential role in uncovering the fundamental quantum physics behind complicated dynamics over decades. Employing ultracold quantum gases, I have theoretically studied the universal aspects of non-equilibrium phenomena. This article introduces my recent works concerning turbulence and relaxation dynamics.

INTRODUCTION

Many natural phenomena around us, such as the turbulent flow of a river or a leaf falling from a tree, display highly complicated dynamics. Despite being familiar with these kinds of dynamic phenomena, we have not satisfactorily understood universal principles to describe them. This situation is in stark contrast to that of equilibrium physics, and the construction of a unified framework for non-equilibrium phenomena has been one of the most essential issues for many years. Historically, great efforts in previous literature have uncovered universal aspects of non-equilibrium physics in classical systems such as critical dynamics in various fluids [1]. On the other hand, in quantum systems, several difficulties in experiments had hindered the investigation of non-equilibrium phenomena for a long time.

This situation changed after the realization of an ultracold quantum gas. The system is a kind of atomic vapor cooled in the order of 10~100nK, and behaves as a quantum many-body system due to its ultralow temperature [2]. Furthermore, modern optical technology allows the control of atomic gases with great accuracy, and enables the study of non-equilibrium quantum phenomena in a highly controllable manner. In fact, many works have discovered fundamental properties of quantum dynamics. Typical examples include thermalization in integrable models, many-body localization, and the Kibble-Zurek mechanism.

Using ultracold quantum gases, I have theoretically studied universal

dynamics in quantum systems. Here, I will describe two research topics: one is relaxation phenomena and the other is turbulence.

UNIVERSAL RELAXATION DYNAMICS

One of the prominent features of ultracold quantum gases is isolation from environments (heat baths). This assures that the system is well regarded as a microcanonical system, and poses a fundamental question concerning the basis of statistical mechanics: "How does an isolated quantum system thermalize?" In contrast to open quantum systems, von Neumann entropy conserves in time, and thus it is interesting to study thermalization in isolated quantum system. Many theoretical and experimental works have in fact tackled this issue, uncovering interesting phenomena such as prethermalization and many-body localization [3].

Against this backdrop, I have studied scale-invariant aspects of relaxation dynamics. Such invariance usually emerges close to a second-order phase transition point, and the universality has been unveiled using renormalization group analysis [1]. However, previous literature has found the emergence of scale-invariant relaxation dynamics even without or far from a second-order phase transition point, and the universality has been recently discussed from the perspective of non-thermal fixed points (NTFPs) [4]. Very recently, such universal dynamics has been experimentally observed in ultracold quantum gases [5, 6].

My recent work [7] considers relaxation dynamics in an antiferromagnetic spin-1 Bose gas in a one-dimensional system, and has found a novel mechanism for the emergence of an NTFP. Due to the antiferromagnetic nature, the order parameter in this system is a nematic tensor rather than a spin vector, and it can capture how the relaxation promotes in time. I have theoretically demonstrated that the nematic order grows in the course of the relaxation process through the annihilation of magnetic solitons and then exhibits dynamic scaling, which is a hallmark of the NTFP.

To observe the scale-invariant relaxation process experimentally, I collaborated with Prof. C. Raman of the Georgia Institute of Technology, and we observed a signature of the magnetic soliton [8], which is a key ingredient for the relaxation dynamics. The top photo on the first page shows an experimental setup in the Raman group. Currently, we have yet to observe the scale-invariant dynamics, but I believe that this international collaboration will open an important avenue for uncovering universal dynamics in an isolated quantum system.

TURBULENCE

Turbulence is a strongly disordered and unpredictable non-equilibrium phenomenon, and have been a long-standing problem in modern physics. Over the centuries, many researchers have tackled the difficult issue, but our understanding of turbulence has remained unsatisfactory. Thanks to great efforts in previous literature, however, we know that a correlation function for the turbulent velocity field exhibits a scale-invariant behavior arising from a uniform energy transfer from large to small scales. This energy-cascade description is the basis of turbulence theory, which has been originally developed in classical fluids.

This kind of complicated hydrodynamics emerges even in quantum systems, and plays an important role in understanding non-equilibrium quantum phenomena. An utracold quantum gas is recently becoming a promising system for investigating universal aspects of turbulence in quantum systems.

I have theoretically studied weak wave turbulence in an ultracold quantum gas, and have found the scale-invariant dynamics consistent with a constant wave-energy cascade [9], where Bogoliubov excitations interact with each other through three-wave interactions. Figure 1 shows my numerical result for the density profiles in the turbulence, and it is seen that fine structures are excited in time. This is a signature of a turbulent cascade. To investigate such a turbulent cascade experimentally, I collaborated with the experimental group led by Z. Hadzibabic of Cambridge University. As a result, we observed cascade dynamics consistent with the turbulence where the single-particle kinetic energy is transferred through four-wave interactions [10]. This collaboration work experimentally demonstrated that the turbulent cascade description still holds in the quantum system.

CONCLUDING REMARKS

My research interest is universal aspects of non-equilibrium quantum phenomena, and I have theoretically studied relaxation dynamics, turbulence, fluctuation growth, and quantum chaos, mainly in ultracold quantum gases. In this article, I introduce the former two topics including the international collaborations with the experimental groups. In future, I will further pursue universal quantum dynamics from a theoretical viewpoint while endeavoring to work with international groups.

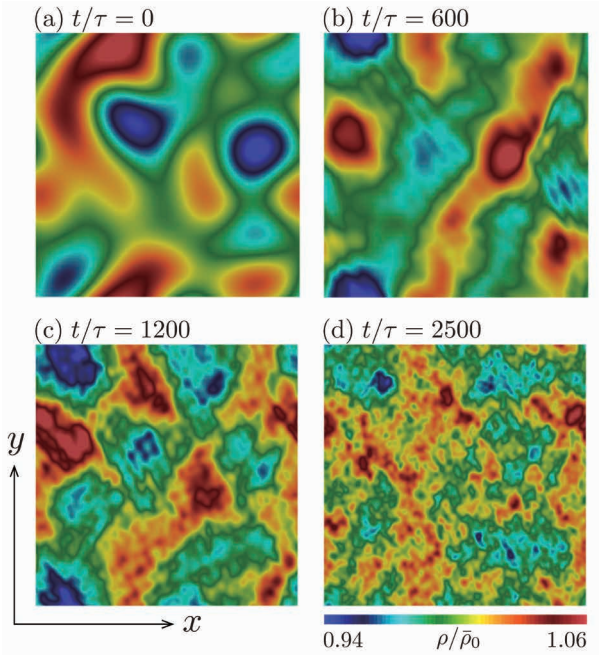

Fig. 1 Numerical results for time evolution of density profiles
Time evolution of the density profiles in the x-y plane are shown. The panels exhibit that fine structures grow in time, and this is a signature of the energy cascade from large to small scales. [Reprinted figure with permission from K. Fujimoto and M. Tsubota (2016) Phys Rev A 93, 039901. Copyright (2016) of the American Physical Society]

Acknowledgements
I would like to thank C. Raman for granting permission to use the top photo.

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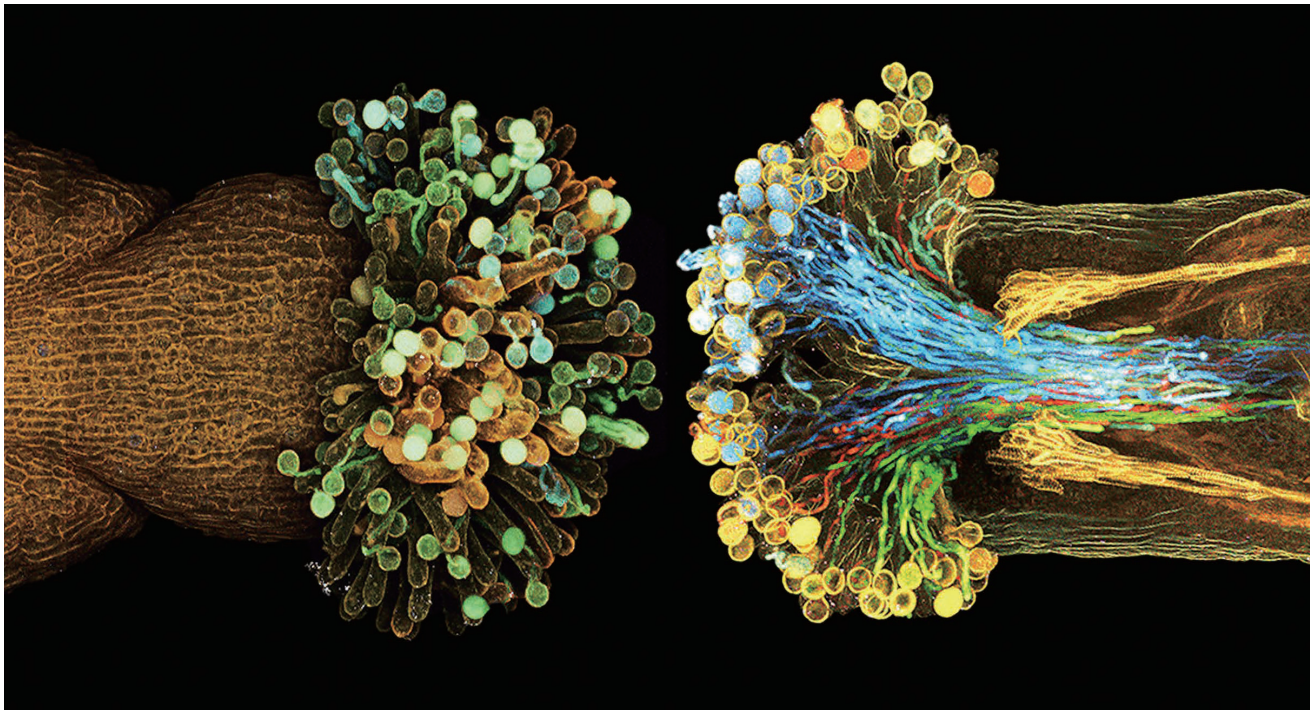
The secret life of plants –Diving deep inside the flower–



Multicolor two-photon imaging of *Arabidopsis* pistils (female reproductive parts of a flower). Pistils were pollinated with pollen expressing fluorescent proteins. The pistil on the left is non-treated, while that on the right is treated with ClearSee (plant clearing solution). Each pollen tube is clearly visible inside the transparent pistil on the right, which helps us track precisely how fertilization occurs deep inside a flower.

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Successful fertilization is important for flowering plants to be able to leave their progeny, i.e., their seeds. Pollen tube guidance is a unique plant navigation system that is necessary for male and female germ cells to meet inside a flower. The female plant gamete, or egg cell, is enclosed in an ovule, which is deeply embedded inside the flower' s pistil. However, the male plant gametes, the sperm cells, are non-motile. Thus, a pollen tube germinated from pollen grows inside the pistil and has to deliver its non-motile sperm cells to the egg cell as cargo. In many angiosperms, male and female gametes fertilize on a one-to-one basis, even when a pistil possesses many pollen tubes and ovules. Precise pollen tube guidance toward each ovule is essential for such one-to-one coupling in multiovular plants. However, a full overview is still unknown, since plant fertilization occurs deep inside the flower. To overcome this challenge, two-photon imaging techniques and pollen tube-mediated genome modification technology have been developed. These studies will elucidate the molecular mechanism of pollen tube guidance, and promote the study of plant reproduction.

INTRODUCTION

Flowering plants, also known as angiosperms, are estimated to comprise more than 295,000 species, and are found in almost every habitat on the earth [1]. In flowering plants, fertilization occurs in the flower to make seeds. Thus, successful fertilization is important for flowering plants to be able to leave their offspring. Seed formation and plant development are essential not only for the plants themselves, but also for human life, in terms of food production, oxygen release, lumber supply, the water cycle, and so on.

One of the major differences between the fertilization of flowering plants and animals is the method of delivering the male gamete to the female gamete. In flowering plants, the male gametes, or sperm cells, are included in the pollen. Unlike in almost all animals, plant sperm cells are non-motile, so they need to be delivered through the pollen tube to the egg cell. However, the female gamete, or egg cell, is enclosed in an ovule, which comprises several cell layers. Additionally, the ovules are almost always deeply embedded inside the female reproductive organ, the pistil, to avoid various external stresses and

damage. Thus, the pollen tube must grow through the inside of the pistil and reach the ovule to deliver precisely its enclosed sperm cells. During this process, a plant-specific navigation system called "pollen tube guidance" has evolved to enable the pollen tube to reach the ovule [2].

Pollen tube guidance is needed to facilitate the successful fertilization of flowering plants. In some flowering species, such as Brassicaceae, one pistil includes multiple ovules (these are known as "multiovular plants"). In one species of Brassicaceae, Arabidopsis thaliana, one flower contains around 60 ovules and 100 pollen tubes. If multiple pollen tubes are attracted to the same ovule, the number of pollen tubes will be insufficient, resulting in the production of fewer seeds. Indeed, in nature, multiple pollen tubes are rarely attracted to a single ovule, occurring in less than 1% of instances [3]. Such precise one-to-one coupling between a sibling ovule and pollen tube is intriguing. Do pollen tubes compete with or help each other? When, where and how is the attraction or non-attraction of pollen tubes determined? A full-overview of such molecular mechanisms is still unknown, because plant fertilization occurs deep inside the opaque flower, impeding visualization of the process. Thus, in vitro experiments have been usually used to observe pollen tube guidance (Figure 1). The relationship between one pollen tube and one ovule can be observed by this method (Figure 2). Pollen tube attractant peptides and their receptors have also been identified this way [4-7]. However, in this method, some female reproductive tissues are removed by dissection, and ovular alignment is lost. Thus, it cannot mimic natural pollen tube guidance in the pistil. In vivo analysis of pollen tube guidance in a fixed pistil has also been performed. However, it is difficult to distinguish individual pollen tubes by staining them with dyes. These issues create barriers to the analysis of pollen tube guidance.

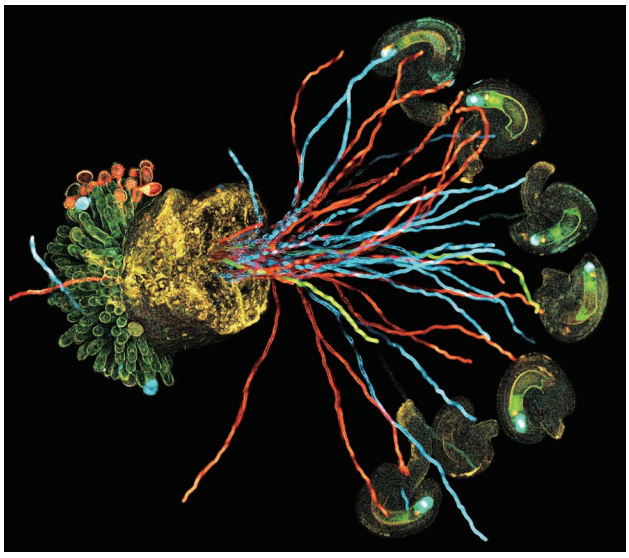

Figure 1. In vitro assay to analyze pollen tube guidance. A cut pollinated pistil (left) and seven dissected ovules (right) of an *Arabidopsis* are placed and cultured on an agarose plate. Colored pollen tubes expressing fluorescent proteins become elongated and are attracted to the ovules. This assay reveals how individual pollen tubes are guided to each ovule.

APPROACH AND TOOLS

We have been developing plant-adapted live and in vivo imaging techniques to overcome such plant-specific issues. Two-photon excitation microscopy (2PEM) is laser-scanning microscopy using multiphoton excitation. This microscopy offers less-invasive and deeper penetration imaging of living organisms. Suitable fluorescent proteins and excitation wavelengths are also important for imaging of deep plant tissues [8]. Live-imaging by 2PEM is a useful tool to observe the same pollen tubes and ovules under a microscope for several hours or days. A plant clearing solution, ClearSee, has also been developed for in vivo imaging of PTs deep inside the pistil [9]. This is a powerful tool for whole imaging of the intact morphology of the pistil (title figure). These methods will help accelerate the discovery of new phenomena in not only plant reproduction but also plant biological research. Additionally, we have developed pollen tube-mediated genetic modification technology [10]. As mentioned above, pollen is a vector that carries male gamete cells. We are trying to establish an efficient biolistic delivery system of genome modified tools into pollen, which is directly pollinated to the pistil.

Live and in vivo imaging with these techniques will provide important insights into plant reproduction in nature. Such spatiotemporal information is needed to elucidate the molecular mechanism of pollen tube guidance in vivo. Further analyses using these tools will promote the study of plant biology including plant reproduction.

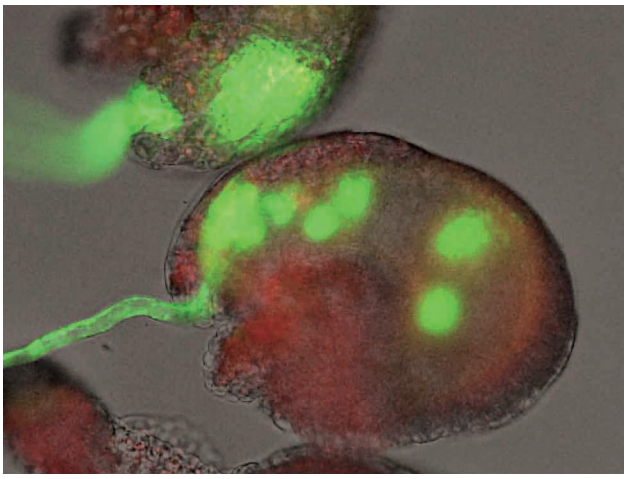

Figure 2. Fertilized *Arabidopsis* ovule by in vitro assay. A pollen tube expressing green fluorescent proteins is attracted to and enters the micropyle of the ovule. The green nucleus signals in the ovule indicate that fertilization and seed development have occurred.

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Surviving between East and West: An exiled Byzantine Empire in the thirteenth-century Eurasian context

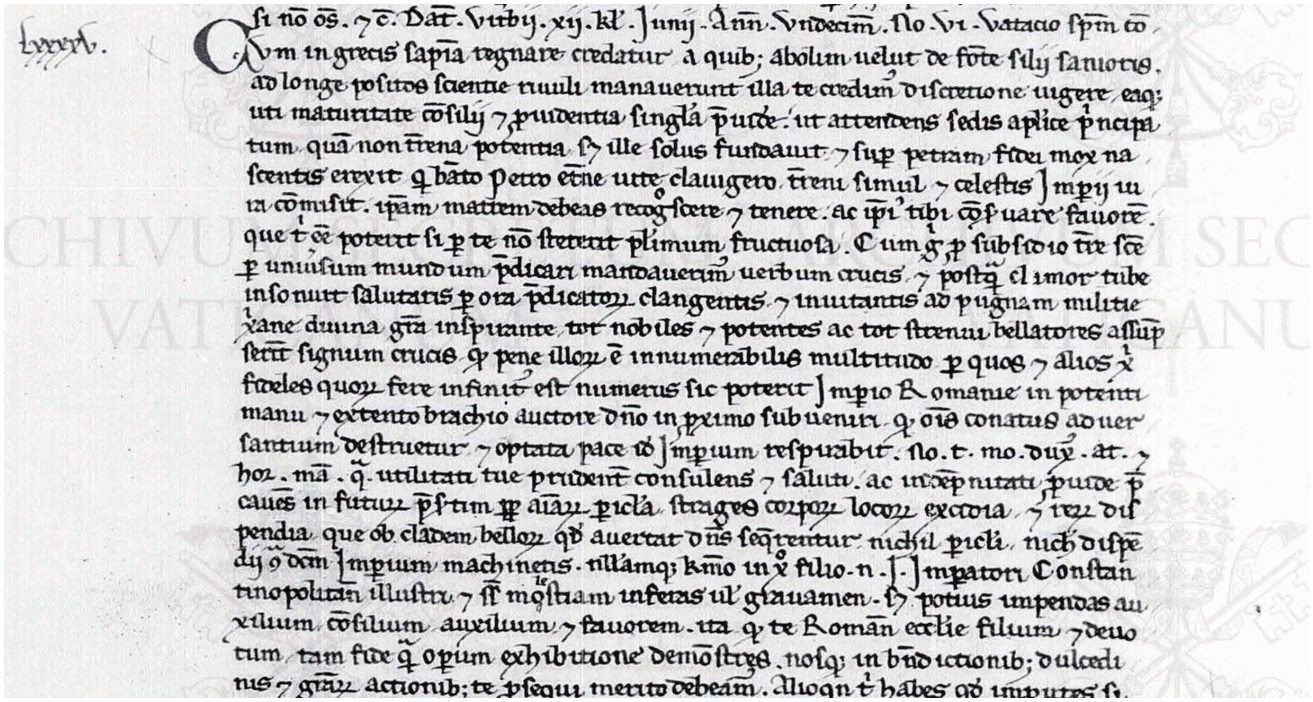

Figure 1: Copy of a letter from Pope Gregory IX (1227–1241) to John III Batatzes (1221–1254), issued on May 21, 1237, recorded in the *Registro Vaticano* (official register of the papal chancery in the Vatican) 18 (folio 291 recto).

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The purpose of this study is to analyze the diplomacy of the thirteenth-century Byzantine Emperor John III Batatzes (1221–1254) with foreign polities from multilateral perspectives, which has thus far tended to be analyzed in a bilateral framework, and to place the individual foreign policies in the general diplomatic strategies of John III. At that time, the Byzantine Empire was in exile having lost its capital, Constantinople, and its influence in international politics has been considered to be fairly limited. However, recent research has revealed that Byzantium during the reign of John III was able to exert influence not only in

INTRODUCTION

As is known, Constantinople, the capital of the Byzantine Empire, was captured by the Fourth Crusade in 1204, following which the Byzantines established two separate governments in exile in Asia Minor and the Balkans. The two exiled empires, the Despotate of Epiros based in the southern Balkans, and the Empire of Nicaea based in western Asia Minor, competed to be the legitimate successor of the Byzantine Empire. Gradually, Nicaea prevailed and finally recaptured Constantinople from the Latins, declaring the restoration of the Empire in 1261. The Byzantine Empire in this period of exile is usually mentioned as a precursor to the history of the restored late Byzantine Empire (1261–1453).

The state of research began to change around the 1970s when several researches centered on political and social history of the Empire of Nicaea emerged. These studies revealed that the exiled government in Nicaea paid keen attention to its diplomatic relations with the surrounding polities such as the Latin Empire of Constantinople, the Despotate of Epiros, the Bulgarians, the Rum Seljuks, and several Italian city-states, and that Nicaea still conducted active diplomacy and operated as an important actor in the Eastern

Mediterranean world despite its small size. Furthermore, recent research has shown that the Empire during the reign of John III Batatzes (1221–1254) was able to influence not only the Eastern Mediterranean but also the wider Eurasian continent, including the Papacy and the Mongol Empire.

Figure 2: Exiled Byzantium in the first half of the thirteenth century (from J. Haldon, *The Palgrave Atlas of Byzantine History*, London: Palgrave, 2005, 119).

Previous research on John III's foreign policy, however, mostly discussed bilateral negotiations between the Empire of Nicaea and a single other polity. The majority of discussions tended to emphasize that most of the emperor's diplomatic negotiations were for the purpose of recapturing Constantinople, based on the historical fact that the Empire of Nicaea finally recaptured the capital in 1261. The problem with these earlier studies is that they regard the political intentions of the Nicaean government a posteriori and from a specific point of view. I consider that individual foreign policy is not always carried out with a single other polity in mind, and must be viewed in the context of a more complex network of multilateral relationships. This perspective will enable us to articulate the foreign relations between exiled Byzantium and other polities, and reveal John III's diplomatic policy. In such a discussion, it is also important to consider these relations, setting aside the historical fact that the Byzantines later recaptured Constantinople.

The question posed by this research project will elucidate previously unknown or underestimated aspects of Nicaean foreign policy.

Figure 3: Portrait of John III Batatzes, Emperor of the Empire of Nicaea (from codex mutinensis gr. 122, folio 294 recto, Biblioteca Estense Universitaria, Modena).

RESEARCH FOCUS

The purpose of this study is to analyze the diplomatic negotiations between the exiled Byzantine Empire in the reign of John III and other polities from multilateral perspectives, and to place the individual diplomacy in the context of John III's overall foreign policy. As the results of recent research have shown, the diplomatic partners of John III were not limited to the Eastern Mediterranean world, but encompassed more distant polities across eastern and western Eurasia. In this study, we will analyze these individual diplomatic negotiation processes in an integrated manner and reexamine their intentions and historical significance within the framework of Eurasian history. This will reveal the consistency of or change in John's foreign policy strategy. Furthermore, close examination of the relations among the various polities in Eurasia including the Byzantine Empire during the reign of John III is expected to posit the Byzantine Empire in the Eurasian context enjoying an unprecedented scale of international relations. Although limited to a short period of time, this research has the potential to draw a new picture of thirteenth-century global history from the Byzantine perspective, a period that has been much discussed in recent years but that has been focused on the Mongols and Western Europe.

SOURCES AND METHODS

Due to the limitations of historical sources, it is impossible to investigate every relationship that the Byzantines had with other polities. Rather, I focus on relations among states that are relatively well recorded in narrative and documentary sources, paying attention to lost sources. In order to reveal the multilateral aspects of foreign relations, it is also necessary to consider diplomatic relations among other polities that established relations with the Empire of Nicaea.

In considering the foreign policy of John III, it is essential to analyze the diplomatic documents exchanged between him and other polities. The total number of documents that have been transmitted and that have been lost but some parts of which are known through other sources is about thirty (in Greek, Latin, Persian, etc.). In addition, a number of narrative materials such as chronicles, letters, travel accounts and merchants' records compiled in Byzantium and other polities, and by the Crusaders and tourists, make up for the lack of documentary sources. As no systematic analysis has yet been made on this issue, it is necessary to compile a register of diplomatic negotiations between Byzantine and other forces in chronological order. In this way, the context of political negotiations conducted by John III with individual powers will be clarified to some extent. For example, at the end of his reign, John frequently made expeditions to Bulgaria and Epiros in the Balkans, but while carrying out these expeditions he also negotiated on peaceful relations with the more distant Mongol Empire by dispatching his envoy from Nicaea to Karakorum, the Mongol capital.

Acknowledgements

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Gentle algebras and surface combinatorics

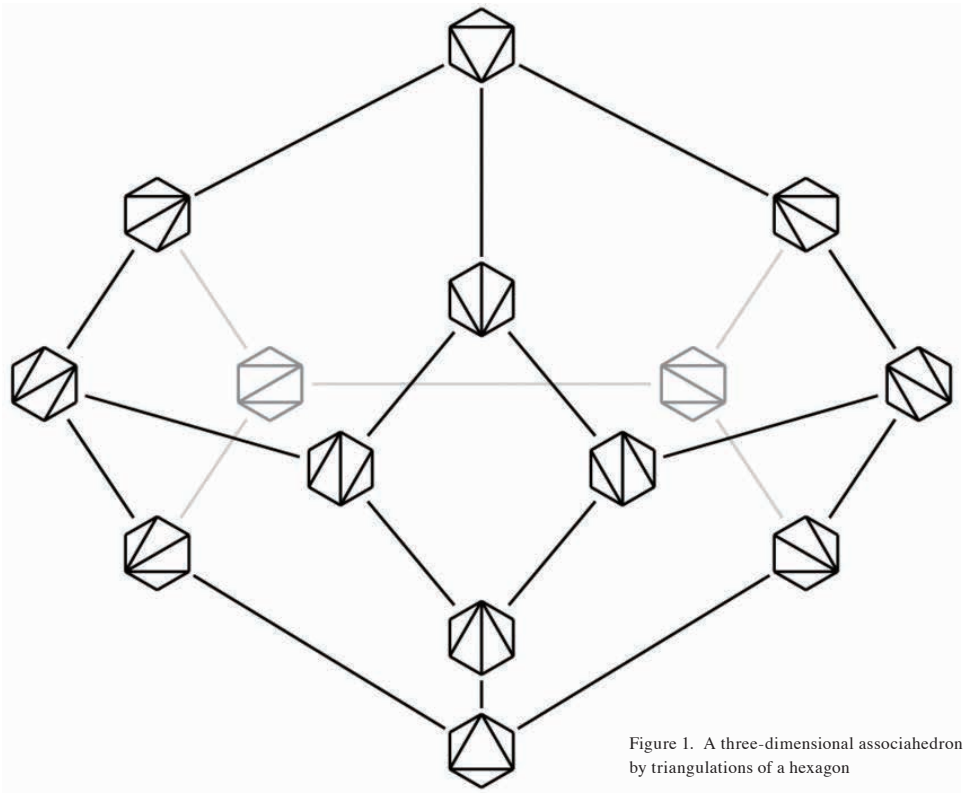

Figure 1. A three-dimensional associahedron given by triangulations of a hexagon

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We are interested in a certain class of mathematical objects called "gentle algebras." They have been around in representation theory for quite some time, but recent advances in geometry indicate that many of the representation-theoretic properties of such algebras are intimately related to an associated compact orientable real two-dimensional surface. As one of the many consequences, certain particularly homologically well-behaved collections, called "functorially finite torsion classes" , of representations over a gentle algebra are found to correspond to certain collections of curves, called "laminations" , of the associated surface. Our aim is to extend this correspondence to general torsion classes. In the following, we give a layman's explanation of this bijection.

REPRESENTATION THEORY

The philosophy behind what we call "representation theory" in abstract algebra is a simple one. Suppose you are given a Rubik's cube and wish to describe it to a blindfolded partner who does not know what such a thing is. How would you go about it? Perhaps you would start by saying that it is a cube with each face divided into a 3×3 box pattern, and that you can rotate the faces, etc. The essence of representation theory is precisely this process whereby we describe smaller pieces of well-understood information in order to gain a better grasp of something more complex.

Representation theory does not only show you static snapshots, but also how all possible manipulations of the object change the snapshot—somewhat like describing how the rotation of each face changes the Rubik's cube. You can imagine, in the example above, that a representation to the audience is like a movie recording how different rotations of the Rubik's cube change a single facet. In addition, we are interested in the relations (called "morphisms" in mathematics) between different recordings. For example, it would be helpful to say that the yellow-colored face is adjacent to the white-colored one, etc. Putting representations and their morphisms together form what we call a "category." Now, we can distinguish between different Rubik's cubes by looking at their associated categories of representations.

TORSION CLASSES

The categories of representations are often much too big to handle, and one way out is to look at certain nice subcategories. Those of interest to us are

called "torsion classes." Defining these for a general audience is impossible, but it turns out that certain nice torsion classes, namely so-called "functorially finite torsion classes", can be generated (in a very specific sense which we will omit) by just a very few representations contained therein. Moreover, distinct torsion classes give rise to distinct generating representations, and vice versa.

TRIANGULATIONS

Let us recall the notion of triangulations before continuing with the exposition. For simplicity, let us focus on the case of (regular convex) polygons. By definition, a triangulation is a maximal collection of pairwise non-crossing arcs that connect one corner of a polygon to another. The naming is due to the fact that if we cut the polygon along the arcs, then we break down the polygon into triangles. For example, there are 14 triangulations for a hexagon, which are all shown in Figure 1.

Note that we have also drawn an edge connecting two triangulations if they differ only by one arc. We will omit the representation-theoretic meaning of these edges, but remark that the large "solid" formed by taking vertices as triangulations of a polygon with edges as shown is called an "associahedra". The combinatorics underlying this is called "Catalan combinatorics", which is arguably one of the most interesting theories and appears in hundreds of areas of mathematics.

GENTLE ALGEBRAS AND SURFACES

Recent advances tell us that if we look at the category of representations over a gentle algebra, we can interpret the generating representations of a functorially finite torsion class as certain well-behaved curves on a marked surface (i.e., a compact orientable real two-dimensional surface equipped with a set of distinguished isolated points called "marked points") uniquely determined by the algebra.

To be slightly more precise, we can specify a gentle algebra by the following data: a marked surface and a maximal collection of pairwise non-crossing arcs (i.e., having no intersections except at the marked points) connecting the points. Triangulations of a polygon provide the simplest class of examples.

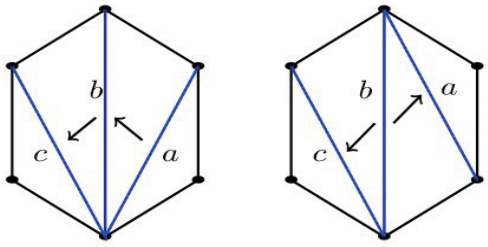

Figure 2. Turning arcs

The governing objects, called "projective modules", of the representations over a gentle algebras are in correspondence with the non-boundary arcs in the defining collection. The morphisms between these projective modules are completely determined by how the arcs are connected in the surface. Namely, there is a morphism from one arc to another if we can obtain it by turning (half of) it around one of its ends in the counterclockwise direction. In Figure 2, we show two triangulations of a hexagon to demonstrate that we can turn arc b to arc c in both cases, but only arc a to arc b in the left-hand case, and vice versa in the right-hand case. Note that in the left-hand case, the turning from arc a to arc c is equivalent to turning from arc a to arc b, and then to arc c; this is indeed how we can understand the composition operation between morphisms of projective modules.

REPRESENTATIONS, CURVES AND LAMINATIONS

We have only described a very small class of representations (projective modules) in the previous section. Nevertheless, general (finite dimensional linear) representations behave in more or less the same way. To skip over the technicalities, let us simply mention that representations of a gentle algebra can be interpreted as curves on the associated marked surface.

Recall that if a torsion class is functorially finite, then it can be generated by a certain collection of representations. It turns out that interpreting such a collection on the associated marked surface yields a lamination. In fact, this yields a one-to-one correspondence between laminations and functorially finite torsion classes.

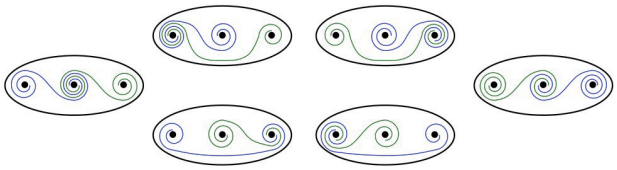

Figure 3. Laminations of a disk with three interior marked points

A lamination on a marked surface is yet another type of maximal collection of curves which encodes the topology of the said marked surface. In fact, if none of the marked points is on the boundary of the surface, then it is equivalent to a maximal non-crossing collection that has been mentioned previously. However, if there are interior marked points, then instead of having the curves shoot directly into the marked points, we require them to whirl around the marked points indefinitely. See Figure 3 for some examples.

GOING INFINITE

If the gentle algebra of interest is defined by a triangulation on a surface, then every self-non-crossing curve that is not itself a loop appears as a member of some lamination. As we start questioning what would happen if loops were allowed in a lamination, we notice that such a generalized lamination allows us to obtain some torsion classes that are not functorially finite. In Figure 4, we show an example of a generalized lamination. The surface in this case is an annulus (a cylinder without its top and bottom faces) with a single marked point on each boundary, and the three curves shown in color are the members of a generalized lamination. Notice how the blue and pink curves, unlike those in a triangulation, start from one marked point but continue infinitely around the loop (colored in green).

Our goal, in a simplified sense, is to demonstrate that this combinatorics that extends the classical laminations gives rise to a complete classification of all torsion classes for gentle algebras.

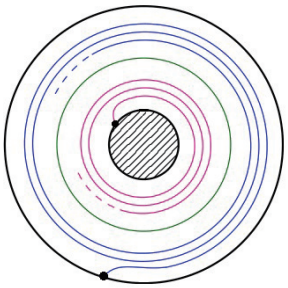

Figure 4. A generalized lamination in an annulus containing a simple closed curve

Acknowledgements

The material explained in this article is based on an on-going joint work with Laurent Demonet.

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ELF and VLF magnetospheric plasma waves: How to better understand the near-Earth environment

Photograph of aurora taken during a research trip to the Sodankyla Geophysical Observatory in Sodankyla, Finland, March 2018

Claudia MARTINEZ-CALDERON

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In space, electromagnetic plasma waves of various frequencies and intensities are naturally present around the Earth. In the frequency range between 3 Hz and 30 kHz, these are known as Extremely Low and Very Low Frequency (ELF/VLF) waves. They are believed to be generated at the geomagnetic equator, after which they can propagate in the magnetosphere and, under the right conditions, pass through the ionosphere and reach the ground. These waves interact with energetic electrons (~100 keV) causing their acceleration or loss, playing a fundamental role in radiation belt dynamics, but also on ionospheric phenomena such as the aurora. VLF/ ELF waves are thus efficient tools to study the physics of the different plasma processes in both the magnetosphere and the ionosphere. My work is based on conjugated or simultaneous observations showing the same waves, with or without one-to-one correspondence, detected by satellites in space and by VLF receivers located on the ground.

INTRODUCTION

The Earth has a magnetic field that creates a cavity called the magnetosphere where particles from the solar wind are trapped in the radiation belts. These belts surround our planet like donuts filled with energetic particles, ions and electrons, with energies ranging from a few keV to several MeV. This population of particles can be harmful to both human life and electronics in space. A majority of the lifespan of a satellite is spent in these regions where sudden changes of the plasma composition might result in catastrophic failures. The magnetosphere is not only filled with particles but electromagnetic plasma waves are also present, such as the naturally generated ELF/VLF emissions. These waves can interact with energetic particles through resonant interactions (Fig. 1), resulting in electrons being accelerated or pushed into the loss cone, causing their precipitation into the atmosphere. Electron precipitation is one of the mechanisms behind the existence of the wonderful and visually impressive auroras, but it can affect other processes in the ionosphere, which are also of interest. In our quest to develop human activities in space, it has become of vital importance to understand this environment to safely send humans and satellites beyond our atmosphere. Developing protection mechanisms for both humans and satellites in the magnetosphere requires that we comprehend the role that ELF/VLF waves play in the environment around the Earth.

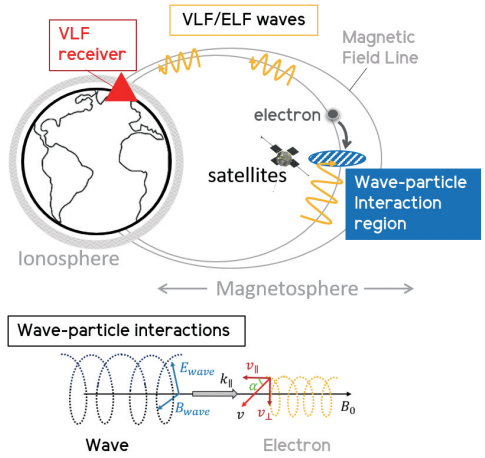

Figure 1. Wave-particle interactions that can occur between ELF/VLF plasma waves and electrons

GROUND-BASED STUDIES

Our work started using VLF receivers located at ground stations (Fig. 2) to study the properties of ELF/VLF emissions particularly at subauroral latitudes, slightly below the auroral oval. We studied the temporal and frequency properties of waves on the ground. Based on several cases detected during an observational campaign, we used polarization analysis to discover the properties of ELF/VLF waves at subauroral latitudes [1]. Then we performed a statistical analysis using a full year of ELF/VLF wave observations on the ground. We studied their occurrence rate, as a function of MLT and ongoing substorm and storm activity. We also considered their types and frequency features [2].

GROUND-SPACE STUDIES

To gain a better understanding of how ELF/VLF waves propagate in the magnetosphere, we then studied conjugated events between the ground and satellites. We defined these events as those where we are observing the same waves (with the same temporal, spectral and frequency variations) simultaneously on the ground and on board the satellite in the inner magnetosphere (Fig. 3). These kinds of events are rather rare, and are covered by only a handful of published papers. By studying one event, we experimentally determined the importance that density plays in wave propagation, which was crucial in understanding how the waves propagated from their source region to the ground [3]. Furthermore, two additional events observed on opposite sides of the magnetosphere revealed the relationship between magnetic field variations and the spectral features of the waves [4].

Figure 2. Example of a VLF receiver located at the ground station of Athabasca, Canada, showing the instrument set up (top) and during auroral activity (bottom)

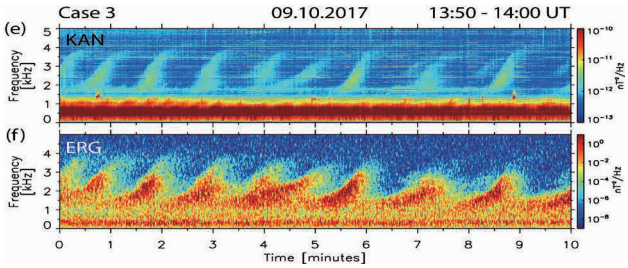

Figure 2. Example of a one-to-one conjugated event observed between the ground station of Kannuslehto, Finland (top) and the Arase satellite (bottom)

LATEST RESULTS

Thanks to the recent availability of several new data sets—both on the ground, like the PWING project, and in space, with the Japanese Arase satellite—we have increased our detection of conjugated events. We have analyzed 13 cases in a multi-event study where we have also found new information on the ionospheric exit point of the waves, probably affected by plasma background density [5]. We are currently working on a methodology to increase the number of conjugated events in order to gather more information on how the waves propagate from their generation region to the ground. While these studies have given us important information on the properties of ELF/VLF waves, they have also raised new questions. We hope that by continuing with this work we will be able to solve some of these questions, such as: How do ELF/VLF wave propagate under different geomagnetic conditions? What are the parameters that affect their generation and propagation, and is it possible to quantify them? Would we be able to predict the path of the waves knowing the magnetospheric conditions? How does their path affect their interaction with electrons, and under which conditions?

Acknowledgements

This work was supported by Grants-in-Aid for Scientific Research of the Japan Society for the Promotion of Science, and by the JSPS International Research Fellowship. We thank Prof. Kazuo Shiokawa and Prof. Yuto Katoh for their continued support, as well as their respective research groups in Nagoya and Tohoku Universities.

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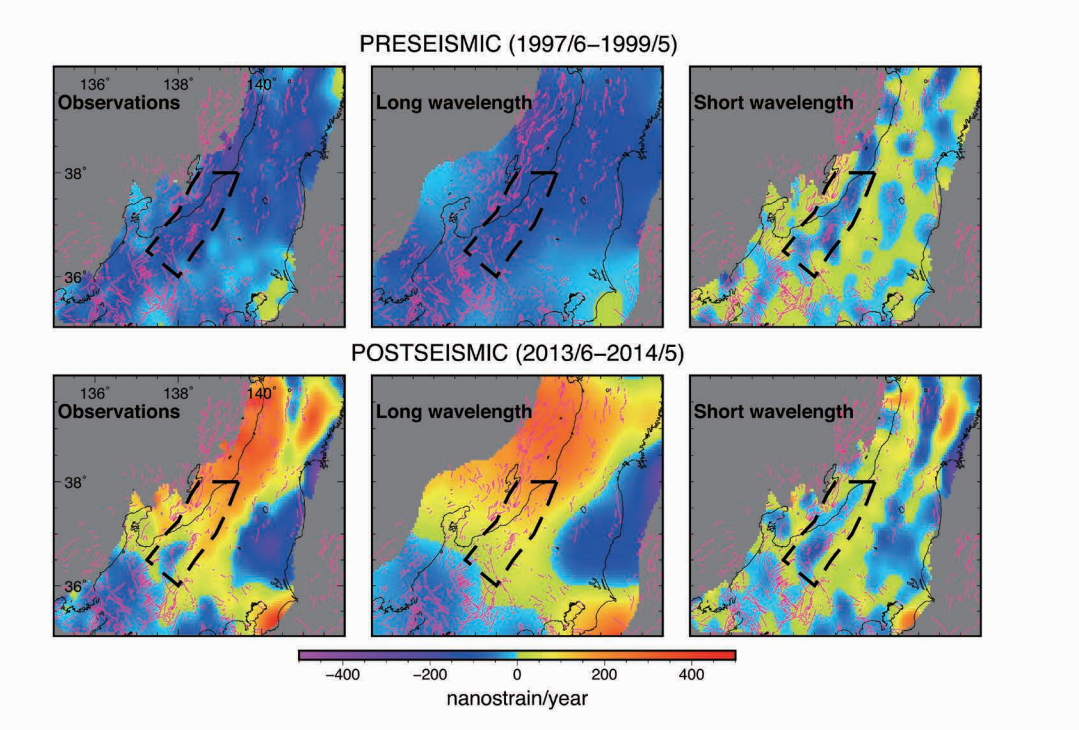
Elastic and inelastic deformation in the crust from geodetic observations



E-W strain rate distributions in Central Japan before (top row) and after (bottom row) the 2011 Tohoku-oki earthquake based on GPS observations. The middle and right columns are the long and short wavelength components of the strain rate distributions, respectively. Persistent localized contraction is revealed in the Northern Niigata-Kobe Tectonic Zone (the area enclosed by broken lines) in the short wavelengths, while the reverse motion is seen in the long wavelengths.

Angela MENESES-GUTIERREZ

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Disaster Mitigation Research Center/ Institute of Advanced Research, Nagoya University
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I study crustal deformation through the analysis of geodetic data. Here, I discuss deformation in the Niigata-Kobe Tectonic Zone, and the distinction between elastic and inelastic deformation within the zone. Such distinction has been difficult to establish due to the lack of dense observation through the different stages of the earthquake cycle. Utilizing the crustal response on the NKTZ to enforced deformation due to the M_w9.0 Tohoku-oki earthquake, I explored this topic and found that a large part of the deformation within it is inelastic.

INTRODUCTION

Crustal deformation can be classified macroscopically into elastic and inelastic deformation. Elastic deformation represents reversible processes, where tectonic motion causes strain changes proportional to stress changes. Such elastic strain is repeatedly released in the form of large earthquakes, like the 2011 M_w9.0 Tohoku-oki earthquake. On the other hand, inelastic deformation represents an irreversible process, in which strain accumulates over geological time to form a geomorphological landscape, like the Yoro mountain range. The distinction between elastic and inelastic properties of the crust is fundamental to understanding strain accumulation in the crust, and has important implications for seismic hazard evaluation.

THE NIIGATA-KOBE TECTONIC ZONE (NKTZ)

Northeastern Japan had been under steady east-west contraction before 2011, mainly due to the subduction of the Pacific plate. In this area, particular attention has been drawn to the NKTZ, a deformation belt in the eastern margin of the Japan Sea where large east-west geodetic contraction has been reported. Various hypotheses have been proposed to explain the origin of the

contraction in the area, whether elastic or inelastic. However, observation limited to the interseismic period has made it difficult to find a unique interpretation.

NATURAL ROCK EXPERIMENT

The M_w9.0 Tohoku-oki earthquake struck eastern Japan on March 11, 2011. This seismic event caused instantaneous E-W extension and significant postseismic deformation over Northeast Japan, including the NKTZ.

Crustal deformation in different stages of the earthquake cycle at a plate boundary can be considered as a natural rock deformation experiment with distinct boundary conditions. Elastic and inelastic sources are expected to have characteristic responses to the loading and unloading associated with large earthquakes, such as the Tohoku-oki earthquake (Figure 1). Before the earthquake, NE Japan was under steady contraction. In this situation, general elastic contraction is expected, as well as contraction for local elastic and inelastic sources. At the moment of the earthquake, an instantaneous elastic extension was observed, since inelastic sources of deformation do not have instantaneous responses. After the earthquake, the extension continued through NE Japan. If there exist inelastic sources of deformation, their effects should appear as contraction even under the general extension of NE Japan. Thus, by close examination of the deformation responses before, during and after a large earthquake, it is possible to separate elastic and inelastic contributions, allowing us to investigate detailed properties of the crust.

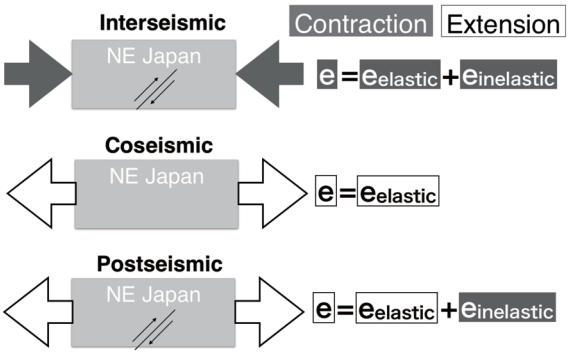

Figure 1. Mechanical response of Northeast Japan to different boundary conditions generated by the 2011 Tohoku-oki earthquake. e indicates the strain/strain rate.

ELASTIC AND INELASTIC DEFORMATION IN THE NKTZ

Crustal deformation is recorded on the Earth's surface, and geodetic techniques, such as Global Positioning Systems (GPS), are used to monitor such deformation. Spatial decomposition of strain rate distributions based on GPS data from the GNSS Earth Observation System (GEONET) before and after the 2011 Tohoku-oki earthquake show preseismic contraction and postseismic extension in the long wavelength component. This pattern represents elastic deformation due to the earthquake release. Meanwhile, persistent localized contraction in Northern NKTZ in the short wavelength component was revealed (Cover figure). The persistency of the localized contraction suggests that such deformation reflects an inelastic process accumulating over geological time. The short wavelength component is consistent with geological studies, demonstrating the extraction of long-term deformation from the short-term geodetic observation, and also providing a new interpretation of inland strain concentration (Meneses-Gutierrez and Sagiya, 2016). Nonetheless, detailed strain distribution and their mechanical characteristics have not been fully resolved with the available data.

A CLOSER LOOK: MID-NIIGATA

In 2010, the Association for the Development of Earthquake Prediction (ADEP), in collaboration with Nagoya University, constructed 20 continuous GPS sites in the Mid-Niigata area for crustal monitoring. Analysis of this data showed that although persistent contraction can be seen in the NKTZ in Mid-Niigata before and after the Tohoku-oki earthquake, the amplitude and horizontal location of the contraction is different (Figure 2). I found that these differences represent the coexistence of an ongoing inelastic process, concurring with my previous results, as well as elastic heterogeneities within the crust acting in a different sense before and after the 2011 Tohoku-oki earthquake (Meneses-Gutierrez et al., 2018). This demonstrates the importance of dense observation in the analysis of crustal deformation.

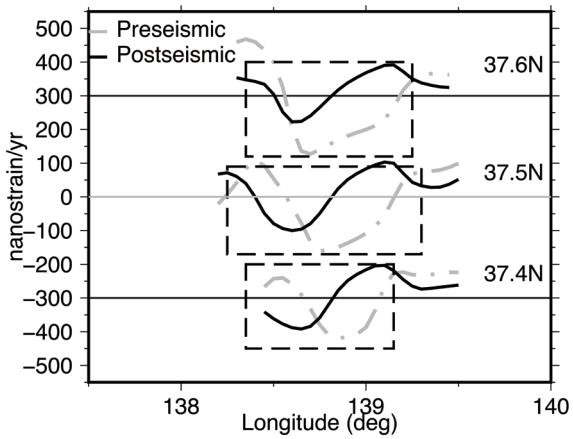

Figure 2. Longitudinal profiles across Mid-Niigata for the E-W short-wavelength strain rates before (gray) and after (black) the 2011 Tohoku-oki earthquake

CLOSING REMARKS AND FUTURE PROSPECTS

My findings give a new insight into the evaluation of the seismic potential of fault zones within Japan. Previous studies assumed that the geodetic data in Japan were a direct measure of the elastic strain accumulation due to interplate locking. My research shows that a large portion of the contraction in the NKTZ is inelastic, and direct interpretation of the strain rate as seismic moment accumulation leads to an overestimation of its seismic potential.

My analysis is the first to present a distinction between elastic and inelastic deformation in Central Japan. However, both studies are purely kinematic and do not offer a quantitative physical approach to breaking down the data. In the future, I would like to work toward providing reasonable three-dimensional models considering different elastic properties of the crust.

Acknowledgements

This research was conducted in collaboration with professor Takeshi Sagiya of the Disaster Mitigation Research Center, Nagoya University, and Shutaro Sekine of the ADEP. We are grateful to the Geospatial Information Agency of Japan for the GPS data for this analysis.

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IAR Core Faculty Committee

The IAR Core Faculty Committee is composed of the Institute Director, Deputy Directors, Full-Time Faculty Members, and member of the clerical staff, who promote the Institute's activities, and make proposals to the IAR Committee.

Yoshiyuki SUTO
Director

Affiliation : Director of Nagoya IAR/ Professor of the Graduate School of Humanities
Research Interests : Ancient Greek History

Research Project

My research interests include Aegean Archaeology, Ancient Greek History, and especially the study of contact and interaction between Greek and Egyptian culture in the Hellenistic period. As a member of Akoris Archaeological Project I have been working in Middle Egypt for the purpose of elucidating the history of local society under the Ptolemaic rule.

Hitoshi SAKAKIBARA
Deputy Director

Affiliation : Deputy Director of Nagoya IAR/ Professor of the Graduate School of Bioagricultural Sciences
Research Interests : Molecular Plant Physiology, Phytohormone

Research Project

My research interest is to understand how plants manage their growth and development under abiotic stress conditions, such as nitrogen limitation. Plant orchestrates a number of cues including phytohormone actions and metabolic responses to coordinate its development and metabolism at a whole-body level. I am studying molecular basis of this topic with focusing on nitrogen-dependent regulation of phytohormone biosynthesis and signaling.

Ichiro TERASAKI
Deputy Director

Affiliation : Deputy Director of Nagoya IAR/ Professor of the Graduate School of Science
Research Interests : condensed matter physics (experiment)

Research Project

Ichiro Terasaki synthesizes new materials, investigates their transport and magnetic properties, and develops functions hidden there. His major research activity has been devoted to the thermoelectric properties of transition-metal oxides including the layered cobalt oxides, and recently extended to giant nonlinear conduction in strongly correlated systems such as conducting organic salts and layered ruthenates. His recent interest extends to exotic magnetic materials such as room-temperature ferromagnetic semiconductors and spin-liquid candidates.

Hiroko TAKEDA
Deputy Director

Affiliation : Deputy Director of Nagoya IAR/ Professor of the Centre for Asian Legal Exchange
Research Interests : Political Sociology, Politics

Research Project

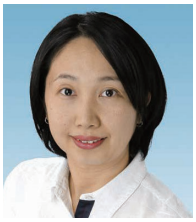
My research can be mapped out in an intersection of the following three major elements; political sociology, gender and Japan/UK. Political Sociology is my disciplinary background. In particular, I developed a keen interest in the studies on governmentality. As for gender, I have long been interested in gender issues and the core of academic questions that I have continuously explored in my extant work--the ways in which the world of the everyday life is linked with the state system --was formulated as an outcome of my effort to examine gender issues with reference to governmentality. Finally, Japan has been my primary source of case studies and recently, I also started to explore the British cases.

Yukinori
KAWAE
Full-Time Faculty

Affiliation : Associate Professor at Nagoya IAR
Research Interests : Egyptian Archaeology, Pyramid, 3D Survey

Research Project

My research interests lie in the field of Egyptian archaeology, particularly in 3D surveys of ancient megalithic structures and excavations of ancient settlements. My academic career started the excavation of the Lost City of the Pyramids at Giza. Soon after the introduction of 3D technology in Egyptian archaeology, I began conducting an interdisciplinary research project to complete 3D surveys of pyramids. Recently, I expanded the collaborative research to include a television production company as Open Innovation Project. My use of 3D data challenges the unprecedented empirical analysis approach to understanding the mystery of the pyramids' construction.



Satomi
KANNO
Full-Time Faculty

Affiliation : Associate Professor at Nagoya IAR
Research Interests : Plant Physiology, Plant nutrients

Research Project

My research interest is understanding plant growth adaptation mechanisms according to environmental nutrients conditions. Plant senses internal and external ion level and controls the ion transport system to optimize their growth. I am working on these mechanisms focusing on phosphate, one of the macronutrients for plant growth, by using molecular biology technics and imaging technologies to trace ions in the living plants.

Atsushi
J. NISHIZAWA
Full-Time Faculty

Affiliation : Designated Lecturer at Nagoya IAR
Research Interests : Observational Cosmology, Astronomy

Research Project

My research interest ranges from theoretical aspects of cosmological model that explains accelerating expansion of the Universe, to the theory of galaxy formation. To reveal such problems in the Universe, large astronomical data obtained by telescope is used. Recently I am working on the photometric redshift that determines the distance to galaxies. The redshift of galaxies are of particular importance for doing both cosmology and astronomy. I am also interested in the methods of data analysis including machine learning.

IAR Steering Committee

The IAR Steering Committee plan, discuss, and decide on the Institute's academic activities.

Masahide TAKAHASHI
Steering Committee

Affiliation : Trustee and Vice President of Nagoya University/ Professor of the Graduate School of Medicine
Research Interests : Experimental Pathology, Tumor Biology

Research Project

Our group has been studying the molecular mechanisms of cancer development and invasion. In particular, We are focusing on the roles of Ret oncogene and Girdin family genes in cancer cells. We are also studying the roles of these genes in organogenesis including the development of the nervous system.

Mitsuru SUGIMOTO
Steering Committee

Affiliation : Professor of the Graduate School of Mathematics
Research Interests : Partial differential equations

Research Project

Various phenomena of nature can be treated mathematically by describing them in the language of partial differential equations (PDE). Through the analysis, I aim to extract new principles which comprehend concrete phenomena. As a methodology of PDE, many properties of the solutions to PDE can be deduced from their characteristics, and I employ this idea to investigate quantitative properties of solutions like size, regularity, and so on. Simultaneously I proceed with the study of Fourier analysis as an important tool for such analysis.

Tetsuya OKAJIMA
Steering Committee

Affiliation : Professor of the Graduate School of Medicine
Research Interests : Biochemistry, Glycobiology

Research Project

My research has focused on biochemical and biological analyses of O-glycan modification on glycoproteins. Previous studies revealed that unique glycans such as O-fucose and O-GlcNAc regulate Notch signaling and Notch-dependent biological processes. Currently, I am investigating how O-glycan modification is coordinated to fine-tune Notch signal strength essential for developmental control and homeostasis. Given that Notch signaling pathway is associated with many human diseases, elucidation of molecular mechanisms how O-glycans control Notch activity will be of great pharmaceutical interest.

Takahiro SEKI
Steering Committee

Affiliation : Professor of the Graduate School of Engineering/Director of Center for the Studies of Higher Education
Research Interests : Photoresponsive polymer thin films

Research Project

Photoresponsive organic and polymeric materials are attracting much attention due to great potential in next-generation photonics technologies. My major research interest is to study photoresponsive (mostly photochromic) thin films of polymeric liquid crystals. The alignment control of liquid crystal that is essential in liquid crystal photonics can be achieved by irradiation with linearly polarized light to the surface photoresponsive layer on a substrate or a free surface. Based on this phenomenon, we are extending the possibilities of photoalignment process for orientation control of various functional materials.

Yoshinobu
BABA
Steering Committee

Affiliation : Professor of the Graduate School of Engineering/ Director of Institute of Nano-Life-Systems
Research Interests : nanobioscience, biomedical engineering

Research Project

The research efforts in my laboratory have been focused on the development of nanobiodevices for biomedical applications and healthcare, including single cancer cell diagnosis for cancer metastasis, circulating tumor cell (CTC) detection by microfluidic devices, nanopillar devices for ultrafast analysis of genomic DNA and microRNA, nanopore devices for single DNA and microRNA sequencing, nanowire devices for exosome analysis, single-molecular epigenetic analysis, AI-powered nano-IoT sensors, quantum switching *intra vital* imaging of iPS cells and stem cells, and quantum technology-based cancer theranostics.

Sayaka
OKI
Steering Committee

Affiliation : Professor of the Graduate School of Economics
Research Interests : History of Science and Technology

Research Project

History of Science in the 17-18th century of France, especially on the relationship between the government and academic institutions of science; Concept of "Economy" and its relationship with natural sciences in the latter half of the 18th century

IAR
Visiting Professor & Designated Professor

Takaho
ANDO
Visiting Professor

Affiliation : Visiting Professor at Nagoya IAR/ Professor at Chubu University
Research Interests : Hiistory of Social Thoughts

Research Project

Research on History of Social Thoughts, especially on French Enlightenment and Liberalism.

Yasuro
ABE
Visiting Professor

Affiliation : Invited Professor
Research Interests : Medieval Japanese Culture and Texts

Research Project

My research focuses on the religious texts of medieval Japan, emphasizing their context as objects of religious cultural heritage. I have strived to demonstrate how religious texts, images, and other objects have been used, transmitted, and understood from the Middle Ages through the present day. Through the analysis of concrete examples—such as the cult of Prince Shōtoku, and various conceptions of the "sacred" in medieval Japan—I have demonstrated that these texts mutually interact not only with each other, but also with external works of literature, performative arts, and iconography.

Dapeng CAI
Visiting Associate Professor

Affiliation : Visiting Associate Professor at Nagoya IAR/ Associate Prodessor at Nanzan University
Research Interests : International Economics

Research Project

An increasing number of challenges facing humanity today, such as the reduction of the emission of the greenhouse gases, or the protection of global commons, all require intensive cooperation by many countries. My research aims at analyzing the international negotiation processes that are underlying the formation of the needed international cooperation. Besides the issue of emission reductions, I also examine other issues that require international negotiations - in particular, those between the North and the South - such as the protection of intellectual property rights, as well as the setting of investment rules or production standards.

Miki KAWACHI
Visiting Associate Professor

Affiliation : Visiting Associate Professor at Nagoya IAR
Research Interests : Plant Physiology, Zinc Biology

Research Project

My research mainly concerns the transport of micro-nutrients in living organisms. All organisms need elements like zinc or manganese in very minute amounts, however, even a small excesses can be harmful. Specialized transport proteins are the principal means of nutrient movement within and between cells. I am interested in the structure of those proteins and how structural differences might affect their function. I am working with diverse model organisms ranging from microbes to all the way to fruit trees.

Takaki HAYASHI
Designated Professor

Affiliation : Designated Professor at Nagoya IAR / Nagoya University Global Science Campus Coordinator

YLC Program Faculty

YLC Faculty members are promising young researchers recruited under the Nagoya University Young Leaders Cultivation Program (YLC Program).

Akira ICHIKAWA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Letters
Research Interests : Mesoamerican archaeology

Research Project

Ichikawa Akira is an archaeologist. His research centers on the interactions in Prehispanic Southeastern Mesoamerica, from a long-term perspective, the correlation between natural disasters (especially volcanic eruption) and human society, and community-based archaeological practices. He is currently director of the San Andrés and Cara Sucia archaeological projects. This project examines the social process of Southeastern Mesoamerica (actually El Salvador) in different environmental settings from the Preclassic to the Postclassic period (ca. 600 B.C. - A.D. 1200) and clarifies the dating of the gigantic eruption of Ilopango and its impact on the ancient society.

Sachiko KUROYANAGI

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Cosmology with gravitational waves

Research Project

Einstein's general relativity predicts propagation of space-time distortion, which is called "Gravitational waves". The detection was finally made by Advanced-LIGO on September 14, 2015, 100 years after the general relativity was published. One of the important benefits of analyzing GWs is that they carry "clean" information, since they interact with matter very weakly. This property allows us to directly observe the very early Universe. I make theoretical predictions to extract information on the origin and history of the Universe using future gravitational wave experiments. I am also extending my research to include development of data analysis technique for upcoming experiments.

Hidetoshi SANO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Radio Astronomy, High-Energy Astrophysics

Research Project

To understand high-mass stars from birth to death is essential in exploring the origin of galaxies and human beings. Strong UV radiation from high-mass stars promotes the galaxy evolution. A supernova explosion that signals the death of high-mass star ejects various elements into the interstellar space, which is a process to produce elements consisting our bodies. Moreover, shock waves from the explosion generate high-energy particles filling the interstellar space, so-called cosmic-rays. My research themes are to explore the formation mechanism of high-mass stars and the origin of cosmic-rays by analyzing the astronomical data taken at multi-wavelengths.

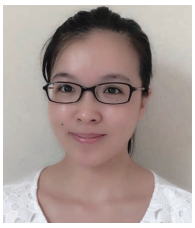
Takahiro HORIBE

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Engineering
Research Interests : Organic Chemistry, Development of Catalyst

Research Project

Dr. Takahiro Horibe specializes in organic chemistry, and organometallic chemistry. He is particularly interested in the development of novel catalyses for increasing process efficiency, controlling reaction selectivity, and reducing byproducts in organic reaction. Merging metal catalysts and charge transfer interaction, he is developing novel catalysts for novel reaction and anomalous selectivity.



Chun LI

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Molecular biology

Research Project

Study of axon regeneration is crucial for developing methods to restore the severed axons caused by accidents or surgeries. Caenorhabditis elegans has recently emerged as a tractable model for studying regenerative responses in neurons. Recent studies using C. elegans have revealed that JNK and p38 MAP kinase (MAPK) pathways are important for axon regeneration. I have been demonstrated that the C. elegans SVH-1 growth factor and its receptor, SVH-2 tyrosine kinase, regulate axon regeneration via the JNK MAPK pathway. Now I aimed to investigate the upstream and downstream factors of these pathways to understand how these pathways are activated and how they regulate axon regeneration.

Tomohiro ABE

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Kobayashi Maskawa Institute (KMI)
Research Interests : elementary particle physics

Research Project

My interest lies in physics beyond the standard model of elementary particles. One of my research topics is the muon anomalous magnetic moment that shows a discrepancy between the standard model prediction and the observed value. This discrepancy implies the existence of new particles coupling to muon. I have completed analyzing a model with new leptophilic particles as a solution of this anomaly. I also have been working on models for dark matter and the origin of the Higgs potential with focusing on various ongoing and planned experiments in future.

Shingo KOBAYASHI

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Engineering
Research Interests : Condensed matter physics (theory)

Research Project

Several interesting physical phenomena emerge in solids due to many-body effects of electrons. During recent years, I have studied the physical properties of electrons with a non-trivial topological number in solids, which lead to new physical phenomena beyond the conventional condensed matter physics. Here, the concept of topological invariants is introduced from topology in mathematics. In three decades ago, the integer quantum Hall effect was discovered as an example that the topology of electrons plays an important role. Triggered by the discovery of topological insulators in 2000s, topology has become a new guiding principle in condensed matter physics.

Masaru TAKEUCHI

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Engineering
Research Interests : Micro-nano manipulation

Research Project

My research interests are micro-nano manipulation, microfluidics and optoelectronic devices for biological applications. Especially, developments of small devices for three dimensional assembly of cell structures using self-assembly process has been conducted. Micromanipulation devices using solid-liquid phase change were also developed to handle single cells, or actuate small amount of liquid. The assembled 3D cell structures by the developed devices will be used as in vitro models of our organs.

Mio HORIE

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Letters
Research Interests : Anthropology, Area Studies

Research Project

Since the Open-Door Policy, China's economic growth has brought new domestic population flow. The developed coastal area has attracted many people from rural area because of widening regional economic gap, both labor migration and women's chain-marriage migration from the peripheral area to the developed area is remarkable. The current population flow is one of the cross points of several issues which is important to understand modern China society. I focus on such changing mobility from one of the ethnic group named Lahu who lives in southwestern China border and discuss how such population flow has changed the local way of life.

Kazuhide SATO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Medicine
Research Interests : Respiratory Medicine, Oncology

Research Project

Lung cancer is the most common cause of cancer-related deaths, and the cure rate of lung cancer is still under 20%, therefore, there is urgent need for new treatments. I aim to develop new innovative cancer therapy with a concept "less toxic, more anti-tumor effect". Along with different approaches from conventional cancer therapies, I have been studying about photo-activated cancer therapy in order to destroy only cancer cells inside body. I would like to develop new technologies that could cause effects only on the cancers with a multidisciplined approach.

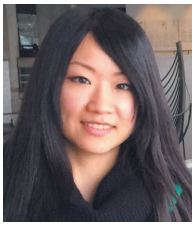
Tsutomu FUKUDA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Particle Physics, Astrophysics

Research Project

A fundamental particle "neutrino" is a key for revealing the origin of the matter dominated universe. I have carried out accelerator based neutrino experiments with nuclear emulsion detector. So far we provided the final evidence of nu_mu -> nu_tau neutrino oscillation with tau neutrino appearance in a muon neutrino beam from CERN in the OPERA experiment. Then I have established and am promoting a new experimental project (NINJA Experiment) to measure neutrino interactions precisely at J-PARC as the PI. Precise measurement of neutrino-nucleus interactions is essential for observing the neutrino-CP violation which is an important hint for matter-antimatter asymmetry in our universe.



Yuri FUJII

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Astropysics, Planetary Science

Research Project

I am working on the formation theory of planets and satellites in our solar system and also in extrasolar systems. Planets form in gaseous disks called protoplanetary disks, which are the leftover of star formation. Recent observations show wide variety of structures in protoplanetary disks including the clue of ongoing planet formation. I perform magneto-/radiation hydrodynamic simulations to investigate the dynamics of protoplanetary disks and the manner of the gas flow onto a planet in the disk. These simulations provide the formation environments for planets and satellites. I am also interested in chemical evolution of protoplanetary disks, modeling of circumplanetary disks, and orbital evolution of satellites.

Hidenori TAKEUCHI

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Institute of Transformative Bio-Molecules (ITbM)
Research Interests : Molecular biology in plant reproduction

Research Project

Fertilization between male and female gametes of the same species is fundamental for seed production and species maintenance in higher plants. My research interests are in species-specific male-female recognition mechanisms, including prezygotic pollen tube guidance and postzygotic chromosome maintenance. I will especially try to identify key factors involved in these processes. I finally aim to understand the species-specific mechanisms in plant reproduction, which could lead to technologies for generating useful hybrid plants.

Henrik BACHMANN

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Mathematics
Research Interests : Number theory

Research Project

I am interested in various subjects related to the theory of multiple zeta values and modular forms. In particular I am studying multiple Eisenstein series, which can be seen as a mixture between classical Eisenstein series and multiple zeta values. These objects also have a connection to q-analogues of multiple zeta values and I am interested in their algebraic structure and connection to other areas in mathematics such as enumerative geometry and combinatorics.

Hironao MIYATAKE

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Cosmology, Weak Gravitational Lensing

Research Project

My research interests lie in observational cosmology. Cosmic acceleration discovered in the late 1990s is one of the most mysterious phenomena in physics and astronomy, which indicates the existence of dark energy or the modification to general relativity. I have been working on exploiting weak lensing observables, the subtle distortion in the shapes of distant galaxies due to massive foreground structures, to extract the nature of cosmic acceleration from big imaging data taken by Hyper Suprime-Cam (HSC) at the Subaru Telescope. I am also involved in upcoming international galaxy surveys such as Large Synoptic Survey Telescope (LSST) and NASA's Wide Field Infrared Survey Telescope (WFIRST).

Shingo KAZAMA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Kobayashi-Maskawa Institute (KMI)
Research Interests : Particle Physics, Astroparticle Physics

Research Project

Despite the overwhelming evidence for dark matter from astronomical and cosmological indications at various scales, a clear evidence of a particle which explains these observations remains absent. I'm involved in the XENON project to search for the low-energy interactions of galactic dark matter with nuclei. The XENON collaboration has built the XENON1T detector, the most sensitive detector ever built, but no clear evidences of dark matter have been found. We are currently upgrading the XENON1T detector by enlarging the target xenon mass from 2 to 6 tonnes. The new experiment will start its operation in 2019, and this will allows us to explore promising parameter spaces towards a first discovery.

Yukiko KAWAMOTO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Humanities
Research Interests : Ancient History, Classics

Research Project

My research has focused on Roman architectural, cultural, and social history, using textual and archaeological evidence. My research project explores the designs of Roman gardens and how they influenced later European gardens. It is believed that Roman gardens are the origin of formal gardens adorned with clipped trees (topiary) and plants arranged in geometrical patterns (e.g. Versailles). However, both archaeological and textual evidence show that Roman gardens seem to have aimed at a natural appearance. This project examines various types of evidence and explores how the Roman gardens looked, and why people have started to consider Roman gardens to be the origin of formal gardens.

Teppei KITAHARA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Kobayashi-Maskawa Institute (KMI)
Research Interests : High energy physics, Flavor physics

Research Project

I am interested in searching for physics beyond the standard model through precision measurements of the properties of standard model particles, and especially my main focus is on flavor physics. I am going to improve the standard model predictions of B-meson decays and also investigate CP violation in rare kaon decays. I am broadly interested in testable physics of various experiments, and I hope to stimulate interactions between theory and experiment.

Yuki SATO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Interests : Quantum gravity

Research Project

Modern physics incorporates Einstein's general relativity and quantum mechanics. The former associates gravity with the bending of spacetime, and the latter explains characteristic properties of matters at short distances. According to general relativity, the spacetime curves due to the existence of matters, and matters indicate quantum characteristics at short distances. Therefore, gravity is supposed to show quantum mechanical effects, and those effects would become important around the Planck scale. The theory that describes quantum effects of gravity, quantum gravity, is my field of research. I mainly study discrete approaches to quantum gravity.

Natsuki
TAKADA-
TANAKA

Young Leaders
Cultivation Program
Faculty
(YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Bioagricultural Sciences
Research Interests : Plant Molecular Physiology, Biochemistry

Research Project

Plants live in a frequently changing environment from which they cannot escape and have signaling mechanisms to adapt to new conditions. Calcium, lipid and protein are involved in the signaling pathways. However, limited information on signal transduction between different signaling systems is available. I focus on a new type signal transducer PCaP1 which can convert $Ca2^{+}$ signal to phospholipid signal on plasma membrane. Thus I investigate PCaP1-related physiological processes, such as stomata closure and root hydrotropism, to reveal a novel mechanism to adapt a new environmental conditions.

Yongchao
CHENG

Young Leaders
Cultivation Program
Faculty
(YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Humanities
Research Interests : International Relations in 17-19th century East Asia

Research Project

By putting Joseon Korea as a mediator between Tokugawa Japan and Ming - Qing China, which have not established formal diplomatic relation in 17-19th centuries, I demonstrate and empirically analyze, that China and Japan had mediated political connections, aiming to rebuild the history of East Asia by using the approach of global history. Instead of just adding up of several bilateral relations, such as Japan- Korea and Korea-China, I am putting the historical pieces scattered in Chinese, Japanese, Korean documents together and confronting simultaneously the trilateral relation of countries, to illuminate the entanglements and interactions among early-modern East Asian countries.

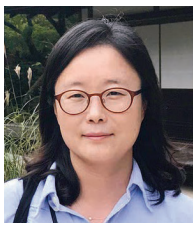
Hiroki
FUJINO

Young Leaders
Cultivation Program
Faculty
(YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Mathematics
Research Interests : complex analysis, function theory

Research Project

My research topic is on the global properties of the infinite dimensional Teichmuller spaces. In particular, I am mainly interested in degeneration phenomena of Riemann surfaces on the boundaries of the Teichmuller spaces. The Teichmuller space is a space which parametrizes all quasiconformal deformations of a given surface. If the given surface is of finite type, the degenerations to nodal surfaces appear as a dense subset of the boundary. However, in the case of infinite type surfaces, various degeneration phenomena are obtained besides the degenerations to nodal surfaces.



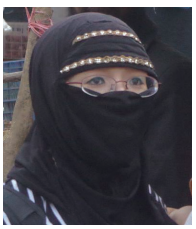
Soon-Ki
HAN

Young Leaders
Cultivation Program
Faculty
(YLC)

Affiliation : Designated Assistant Professor at Nagoya IAR and Institute of Transformative Bio-Molecules (ITbM)
Research Interests : Plant stomata development

Research Project

Plant stomata are cellular valves surrounded by a pair of guard cells that impact plant growth, sustenance, and atmospheric environment. Stomatal stem cells are produced and transiently amplified on the leaf surface, and their stem cell activity is terminated before differentiation. I aim to understand the direct roles of transcription factors in a dynamic alteration of gene expression that is responsible for stomatal differentiation especially in maintenance and termination of stomatal lineage stem cells.



Ai
SUGIE

Young Leaders
Cultivation Program
Faculty
(YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Environmental Studies
Research Interests : Human Geography, Areal Studies

Research Project

Bangladeshi Migrants in Saudi Arabia and transnational networks of Islamic Revival. This study explores the socio-spatial structure and socio-economic backgrounds of Bangladeshi migrants in Makkha and examines their social-cultural impacts on Islamic revival movements in the city and their hometowns in Bangladesh. Research 2: Pluralistic economy and alternative development. This study discusses the possibility of an alternative development based on a pluralistic economic system that reciprocity among people and between human and nature are prioritised over market economy success. Research 3: Water resources problems in Rohingya refugee camp areas in Bangladesh.

Yumi BAMBA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Division for Integrated Studies, Institute for Space-Earth Environmental Research
Research Interests : Solar Physics, Space Weather

Research Project

Solar eruptions, such as "solar flares" and "coronal mass ejections (CMEs)" are sometimes impact to space environment around the Earth. However, onset mechanisms and propagation processes of those phenomena are not yet revealed. Therefore, our ability of "space weather forecast", which predict disturbances of space environment near the Earth, does not satisfy requirements from modern society, which rapidly promote space development. I aim to understand the onset and propagation processes of solar eruptions by comparison of various observational data and numerical modelings.

Kazuya FUJIMOTO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Department of Applied Physics, Graduate School of Engineering
Research Interests : Condensed matter physics (theory)

Research Project

Non-equilibrium phenomena emerge in various length-scales ranging from small atomic and molecular clusters to fluid dynamics in our daily life. I have been interested in universal aspects of non-equilibrium phenomena, and have recently studied relaxation dynamics, wave and vortex turbulence, and chaos in ultracold quantum gases. The system is a vapor of several atomic species at very low temperature, and is recognized as one of the promising playgrounds for studying such non-equilibrium phenomena in quantum many-body systems.

Yoko MIZUTA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Institute of Transformative Bio-Molecules (ITbM), Nagoya University
Research Interests : Molecular biology, Plant reproduction

Research Project

In the flowering plants, sexual reproduction occurs in a flower. In the flower, pollen lands on the female tissue, and pollen germinates pollen tube and deliver the sperm to the egg cell. After that, fertilization occurs. During this process, it is necessary to fertilize without waste both males (pollen tubes) and females (ovules) to produce more seeds in nature, but the whole picture of such precise plant fertilization mechanism is unclear. To understand this mechanism, two-photon imaging, expression and phylogenic analyses will be performed. I developed deep-and live-imaging technics using two-photon microscopy. The pollen tube mediated gene modification technology is also developed.

Koji MURATA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Institute for Advanced Research / Graduate School of Humanities
Research Interests : History, Byzantine Studies, Diplomatics

Research Project

I am interested in various subjects related to Byzantium, the Medieval Roman Empire (ca. 4th Century to 1453). My current research explores social functions of byzantine documents issued by emperors and state officials in the 13th and 14th centuries. In particular I am investigating to what extent written documents were utilized to regulate relationships between Byzantium and other polities.

Aaron CHAN

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Mathematics
Research Interests : Representation theory, category theory

Research Project

My field of research is the representation theory of algebras (and related structures). An algebra is a vector space equipped with a linear associative multiplication map, meaning that one can perform operations like "addition", "scalar multiplication", as well as "vector multiplication". An example is the set of matrices over a fixed field of a given size, equipped with the usual matrix multiplication. Representation theory studies "linear approximations" of algebras, i.e. vector spaces equipped with linear transformations on itself that are compatible with the algebra's multiplications.

Claudia MARTINEZ-CALEDERON

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Institute for Space–Earth Environmental Research
Research Interests : Magnetosphere and Space Plasma Physics

Research Project

My research project focuses on VLF/ELF emissions, their physical properties, generation and propagation. Currently my focus is on ground and satellite simultaenous and conjugated VLF events. I'm also an active member of the VERSIM workshop group and co-founder of their Journal Club.

Angela MENESES-GUTIERREZ

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Disaster Mitigation Research Center
Research Interests : Crustal deformation

Research Project

I study crustal deformation through geodetic observations (Global Navigation Satellite Systems (GNSS), Interferometric Synthetic Aperture Radar (InSAR), etc.), focusing on the analysis of earthquake-related processes. I am interested in distinguishing strain accumulation due to elastic processes in the Earth, released in the form of large earthquakes, from inelastic processes which are irreversible and cause strain to accumulate over geological time.

The Nagoya University Lecture 2019

The Nagoya University Lecture 2019, titled “Excavation Roman Civilization," was held at the University's Toyoda Auditorium on September 14, 2019 co-organized by Nagoya University and the Chunichi Shinbun. This lecture series is one of the essential lecture events organized by Nagoya University. It is designed, as a public lecture, to provide citizens with opportunities to learn state-of-the-art scientific knowledge from outstanding researchers in their respective academic disciplines. Lectures were awarded the title "Nagoya University Lecture," the University's most prestigious title, together with a recognition plaque. This year, the lectureship was awarded to Dr. Masanori Aoyagi, an honorary professor of The University of Tokyo. He also won the Medal with Purple Ribbon (2006), The Order of the Sacred Treasure, Gold and Silver Star (2017), and Ordine al merito della Repubblica Italiana from Italy for his achievements in the discovery of Roman culture. The 2019 Nagoya University Lecture began with an opening address by Nagoya University President Seiichi Matsuo. In the first half of the lecture session, Dr. Yoshiyuki Suto (Director of Institute for Advanced Research (IAR), Nagoya University) delivered a lecture titled “Introductory Encomium of Dr. Aoyagi and His Archaeological Activities in Italy,” and introduced Dr. Masanori Aoyagi’s work. In the second half of the lecture session, Dr. Aoyagi gave a lecture titled “50 years of excavation in Italy.” He spoke about the hard and long road to his discovery of historic sites of Pompeii and Sicily, and the importance of archaeological monuments. More than 900 people attended the event.

Prof. Dr. Aoyagi (left) at the Lectureship award ceremony

Celebration symposium for the foundation of NAIAS

Since October 1, 2019, the Institute for Advanced Research (IAR), the Kobayashi Masukawa Institute (KMI), and the Institute of Transformative Institute Bio-Molecules (ITbM) have been consolidated into a new organization as Nagoya University Institute for Advanced Study (NAIAS). The celebration symposium was held at the University's Sakata Hirata Hall on November 15, 2019. Dr. Hiroshi Ooguri, Director of the Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU), gave a commemorative lecture for the new institute. Nagoya NAIAS aims to promote leading state-of-the-art research and the development young leaders in science.

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1. Poster, 2. Dr. Hiroshi Ooguri at the Celebration symposium, 3. Committee member of NAIAS and guests

UBIAS 2019 Topic of the Year workshop "Migration and Cultural Spaces"

On November 21–22, 2019, Nagoya IAR held a two-day-long international workshop jointly with the Waseda Institute for Advanced Study (WIAS) and the Institute for Advanced Studies in Humanities and Social Sciences, Nanjing University Institute for Advanced Studies

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1. Presenters in the workshop, 2. Agreement for the research exchange, 3. Dr. Suto at the workshop

in Humanities and Social Sciences (IAS), at the Yifu Building on Nanjing University's Gulou Campus. Twenty-one speakers from the field of humanities and social sciences gave talks related to the UBIAS 2019 Topic of the Year "Migration and Cultural Spaces" and exchanged interdisciplinary ideas.Nagoya IAR and Nanjing University IAS concluded an agreement to become partners in research exchange.

UBIAS 2019 Topic of the Year event "Migrations: Movement of People, Ideas and Goods"

On October 16–17, 2019, The Waseda Institute for Advanced Study (WIAS) and Nagoya IAR co-organized the UBIAS Topic of the year spin-off event "Migrations: Movement of People, Ideas and Goods." The symposium was managed by young WIAS research fellows who are expected to be the next leaders in academia. Sixteen speakers presented their excellent works and engaged in active discussions.

Workshop at WIAS

IAR Symposium

All presenters in the panel discussion

IAR Symposiums are aimed at communicating the established, novel and cutting-edge research of Nagoya University to all of its members. We set two different fields: literature and social science, and natural science and engineering. The first IAR Symposium in the literature and social science field was held on June 13, 2019, titled "Challenge." Eight professors selected as representatives of each faculty gave a lecture on their respective specialty. The symposium on natural science and engineering was held on January 14, 2019, titled "On the border between Speciality and Interdisciplinary research." Seven researchers were selected from the natural science and engineering field.

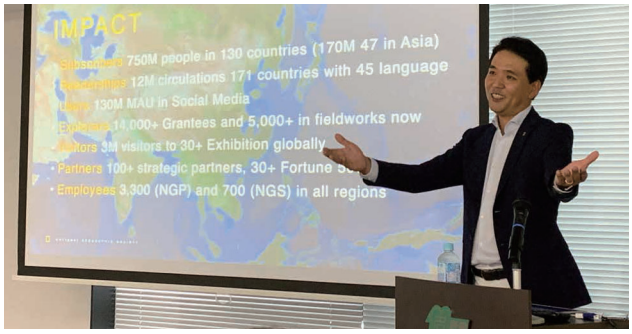
Academic Salon, Discussion with Dr. Noyori

The "Live till night: real-time discussion with Dr. Noyori," starting from 2017, is a salon where participants can freely discuss various topics with Dr. Ryoji Noyori, one of the Nobel Laureates in Chemistry in 2001. In the academic year 2019, the fifth session of the Academic Salon was held. The topic was, "What is a scholar? To be an authentic specialist." A report compiled by the participants is available on the IAR website. n addition to this, there was a special salon organized at National University of Mongolia in August. 10 outstanding young researchers in Mongolia participated and discussed about the future of the Mogolia and the world.

Dr. Noyori with participants

National Geographic Grants Seminar

National Geographic Society, a global nonprofit organization based in the United States, was established in 1888. The NatGeo provides research grants for researchers, explorers and photographers. Mr. Jey Lee, director of the Asia office, introduced grants for researchers in Asian countries. Dr. Yukinori Kawae (Associate professor of Nagoya IAR), who was selected as an Emerging Explorer by National Geographic Society in 2016, gave a lecture titled "Structural analysis of Ancient Egyptian pyramids with the latest technology."



Mr. Jey Lee, director of the Asia office

2019 Young Leaders Cultivation Program

The Young Leaders Cultivation (YLC) Program is a strategic program of Nagoya IAR based on the premise that it is crucial to secure an appropriate quantity and quality of young researchers, in order to sustain the development of outstanding education and research in the future. Nagoya IAR recruits and trains young faculty members regularly and systematically. In academic year 2019, Dr. Ai Sugie (Grad. Sch. of Environmental Studies), Dr. Yumi Bamba (Grad. Sch. of Earth and Planetary Science), Dr. Kazuya Fujimoto (Grad. Sch. of Engineering), Dr. Yoko Mizuta (Institute of Transformative Bio-Molecules), Dr. Koji Murata (Grad. Sch. of Humanities), Dr. Aaron Chan (Grad. Sch. of Mathematics), Dr. Claudia Martinez-Calderon (Grad. Sch. of Earth and Planetary Science) and Dr. Angela Meneses-Gutierrez (Disaster Mitigation Research Center) were newly employed as designated assistant professors of the YLC program.

YLC Seminar

The YLC seminar is aimed at providing members with opportunities to understand the research interests of each YLC member, in order to assist interdisciplinary collaboration between members. The 20th YLC seminar was held on July 1, 2019. Dr. Tsutomu Fukuda (YLC Assistant Professor of Nagoya IAR / Grad. Sch. of Science) discussed “A particle detector named ‘Nuclear Emulsion’— Counterattack of analog devices,” while Dr. Hidenori Takeuchi (YLC Assistant Professor of Nagoya IAR / Institute of Transformative Bio-Molecules) talked about “Understanding and manipulation of species-specific mechanisms in plant reproduction.” The 21st YLC seminar was held on December 18, 2019. Dr. Koji Murata (Grad. Sch. of Humanities) talked about “Painted Official Documents on Walls of Churches in the Late Byzantine Empire (1261–1453).” Dr. Satomi Kanno (Associate Professor of Nagoya IAR / Institute of Transformative Bio-Molecules) talked about “Imaging Analysis of Plant Nutriment in Living Plants—How do plants absorb and translocate Phosphorus ? ”

The 20th YLC seminar

YLC Salon

The YLC Salon was launched in 2019 with the aim of expanding YLC members’ knowledge beyond their own area of expertise. Two professors were invited to this salon and gave lectures on their latest research. At the first YLC Salon held on May 21, 2019, Dr. Riccardo Olivito (Prof. of Scuola Alti Studi Lucca) gave a talk titled “Between private and public." The second salon was held on July 31, 2019, at which Dr. Kazuhiko Kume (Prof. of Nagoya City University) discussed “Frontiers of Sleep Research."

Dr. Olivito in the YLC Salon

IAR Freshmen Lecture Series

Targeting first-year students of the University, this lecture series includes lectures delivered by members of the Academy, IAR Faculty members, IAR Fellows, and researchers of Nagoya University. It was aimed at communicating the fun of academic research. In the academic year 2019, the following 14 lectures were given:

1.“Are chemically reacting molecules ‘visible’?”
Prof. Akiyoshi Hishikawa (Research Center for Material Science)

2.“The research history of particle physics,”
Prof. Makoto Kobayash (Director of the Kobayashi Maskawa Institute, 2008 Nobel Laureate in Physics)

3.“Creating enzymes: The boundary between chemistry and biology,”
Prof. Yoshito Watanabe (Grad. Sch. of Science/Vice President)

4.“The dark universe,”
Prof. Naoshi Sugiyama (Grad. Sch. of Science/Deputy Director of Nagoya IAR)

5.“The present in historical studies: Excavate the Hellenism civilization,”
Prof. Yoshiyuki Suto (Grad. Sch. of Letters)

6.“How to use contemporary economics,”
Prof. Jiro Nemoto (Grad. Sch. of Economics)

7.“Fascination with an introduction to the history of thought,”
Prof. Takaho Ando (Chuo University / Sixth Director of Nagoya IAR)

8.“To analyze democracy,”
Prof. Hiroko Takeda (Grad. Sch. of Law, Deputy Director of Nagoya IAR)

9.“Children in Islam: Different cultures seen from education,”
Prof. Mina Hattori (Grad. Sch. of Education and Human Development)

10.“Science starts from seeing,”
Prof. Sumio Iijima (Meijo University/Distinguished Invited Professor of Nagoya University)

11.“The huge puzzle of the brains of tiny animals,”
Prof. Ikue Mori (Grad. Sch. of Sciences)

12.“How is the brain formed? Research on cell development,”
Prof. Takaki Miyata (Grad. Sch. of Medicine)

13.“Genome breeding to solve the food crisis,”
Prof. Makoto Matsuoka (Grad. Sch. of Bioagricultural Sciences)

14.“Development of a terahertz-wave source and application for non-destructive inspection,” Prof. Kodo Kawase (Grad. Sch. of Engineering)

IAR Freshmen Lecture Series

Nagoya IAR, Short-term Fellowship Program

In order to facilitate international scientific cooperation, this program supports short research visits of overseas researchers (max. four weeks), including related activities such as holding a symposium. In the academic year 2019, five proposals were selected for this program. The first, Dr. Katsutoshi Shimizu (Prof. of Grad. Sch. of Economics) invited Dr. Kim Cuong Ly (Prof. of University of Nottingham) and organized Dr. Ly’s lectures titled “New Financial Regulations in Global Financial Markets." The second proposal came from Dr. Atsushi Natsume (Prof. of Grad. Sch. of Medicine). He invited Dr. Gary S. Goldberg (Prof. of Rowan University), Dr. Julie Rayes (Prof. of University of Birmingham), and Dr. Song Fan (Prof. of Sun Yat-sen University), and organized the NLS seminar “Cell Communication Disorders leading to Cancer and Other Diseases.” Dr. Goldberg discussed the topic “PDPL is a culprit and a target for cell communication disorders leading to cancer and other diseases." Dr. Rayes talked about “Platelet ITAM receptors in inflammation and vascular integrity,” while Dr. Song Fan discussed "Pan-histone deacetylase inhibitor SAHA promotes antitumor efficacy of B7-H3-specific CAR T cells in solid tumors in vitro and ex vivo." The third proposal was from Dr. Ryo Kohsaka (Prof. of Grad. Sch. of Environmental Studies). He invited Dr. Cornelia B. Krug (Prof. of University of Zurich) and Dr. Manfred Klein (Director of BfN). Dr. Kohsaka organized Future earth symposium. In the symposium, Dr. Krug lectured “SDGs and the future of Earth-related activities in Europe,” and Dr. Klein gave talk about the topic. The fourth proposal was from Dr. Takatoshi Kiba (Associate Prof. of Grad. Sch. of Life Science and Agriculture), who invited Dr. Gabriel Krouk. Dr. Krouk talked about “Frontiers in plant environmental response research: local signaling, long-distance communication, and memory for developmental plasticity” in international symposiums and workshops on plant nutritional responses. The fifth was from Dr. Kentaro Takagi (Associate Prof. of Grad. Sch. of Engineering), who invited Dr. Michael Sinapius (Prof. of Braunschweig Technical University) and organized Dr. Sinapius‘s lecture.

Foreign PI Fellowship Program

The Foreign Principal Investigator (PI) Fellowship Program is a program inviting excellent researchers from foreign countries with outstanding research achievements for three-to-four-months’ fellowship, to promote the University's academic research. In the academic year 2019, Dr. Guy Le Lay (Prof. of Aix-Marseille University) and Dr. Ueli Grossniklaus (Prof. of University of Zurich), were selected for this fellowship. While they were visiting Nagoya University, they discussed collaborative research with PIs at Nagoya University. They also contributed to the education of young researchers by giving advice and lectures. Dr. Lay gave a lecture titled “ITER: The fusion project implemented in Cadarache, France," and Dr. Grossniklaus gave a seminar titled "The mechanical basis for the snapping of the Venus flytrap, Darwin's most wonderful plant in the world.”

Dr. Guy Le Lay

Dr. Grossniklaus

Awards

Dr. Ichiro Terasaki (Professor of Grad. Sch. of Science/ Deputy Director of Nagoya IAR) won the Academic Award of the Thermoelectrics Society of Japan (Jan. 2019).

Dr. Kazuhide Sato (YLC Assistant Professor of Nagoya IAR/ Graduate School of Medicine) won the Research Award, Japanese Society for Photomedicine and Photobiology (Aug. 2019), the President’s Award, Japan Society for Laser Surgery and Medicine (Oct. 2019), the Research Award, Nagoya University Medical Association (Jan.2020) and Wakashachi Award, AICHI Prefecture (Jan.2020).

Dr. Masahide Takahashi (Professor of Graduate School of Medicine) won the Medical Award of The Japan Medical Association (Nov. 2019).

Dr. Hidetoshi Sano (YLC Assistant Professor of Nagoya IAR/ Graduate School of Science) won the Nagoya University Ishida Award (Nov. 2019).

Tsutomu Fukuda (YLC Assistant Professor of Nagoya IAR/ Graduate School of Science) won the Konica Minolta Photographic Science Encouragement Award (Jul. 2019).

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