INSTITUTE FOR ADVANCED RESEARCH
LETTER
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Special Interview

"The personal is political"
– Focusing on society from the perspective of political sociology –

—— Hiroko TAKEDA

Research Highlights

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Exploring the Connections between Hearing, the Circadian C lock, and Mating in Mosquitoes / Matthew Paul SU
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INSTITUTE FOR ADVANCED RESEARCH
NAGOYA UNIVERSITY
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WELCOME FROM THE DIRECTOR

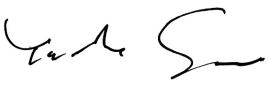
May it be better in all ways than 2021! This must have been the most popular message of greetings worldwide at the beginning of 2022. The threat of COVID-19 pandemic has not yet passed, and we cannot tell its end amid the recurrent surge of its new variants globally. But here in Nagoya, we have also a bright prospect; 2022 is the opening year of the new Period for the Medium-term Objectives for the national universities in Japan. It is our great pleasure that we are going to embark on this new era with Dr. Sei-ichi Matsuo, former President of Nagoya University, as the re-elected head of Tokai National Higher Education and Research System and Dr. Naoshi Sugiyama, who had long been Deputy Director of IAR, as the new President of Nagoya University (see the previous issue of our Letter for the interview with Dr. Sugiyama). I firmly believe that we can overcome these unprecedented difficulties and to further strengthen the research and educational activities of our university with their outstanding leadership and intelligent management. I am very excited to know what wonderful things will happen under this new regime in the near future.

Needless to say, the current pandemic drastically changed our academic life. As we all know, one of the most prominent changes is the almost total transformation of in-person conferences and meetings into virtual ones. But what exactly is the intrinsic impact of this change for us and how should we evaluate its consequences?

Recently I had an opportunity to read a highly stimulating article, which systematically analyzed the demographics of participants in the international academic conferences from the viewpoint of social sustainability (Skiles, M., Yang, E., Reshef, O. et al. Conference demographics and footprint changed by virtual platforms. Nat Sustain (2021). https://doi.org/10.1038/s41893-021-00823-2). The result may not come to us as a surprise, but the pros and cons of online events are worth considering. The analysis revealed that the elimination of the travel and cost burdens with the virtual format resulted in a large increase in attendance in academic events. The participants are more geographically diverse for the same reason. It also indicates that more and more students and female researchers, particularly, participate in virtual conferences, who are frequently faced with the decision of choosing between work and family. The virtual conference format is now well received and helped to shift negative perceptions to more positive views toward this format. Generally, the virtual format can provide an excellent venue to offer DEI (Diversity, Equity and Inclusion). Of course, the article does not overlook the limitation of virtual conferences. Many people feel that networking with breakout rooms is inauthentic and contrived. Although virtual networking technology has improved considerably, there is a substantial need for further development. Another limitation, that is, time difference, is also an obvious obstacle for us in Japan to join a meeting held in the late afternoon in Europe.

However, I believe that the most serious problem of virtual conferences is, to put it somewhat ironically, that it is virtual and it is quite foreign to real physical experience. Participating in in-person conferences in remote places has been a real sensation and adventure in our academic life. It may cost us much in terms of time and money, but it often refreshes our mind totally and makes it possible to see things in a different light. Furthermore, you encounter several interesting people with different ideas at lunchtime, during coffee breaks, or at midnight after a banquet, whom you may even fall in love with at once. I am rather skeptical that virtual conferences assume a role that is the same as that of in-person conferences in these aspects.

Anyway, the pandemic certainly gave us a good chance to challenge the conventional idea of conferences and meetings and to make them more diverse in style with the help of ICT. I am most grateful if this new development makes it much easier for us to join the events of IAR from various remote places all over the world.



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SUTO, Yoshiyuki

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INSTITUTE FOR ADVANCED RESEARCH

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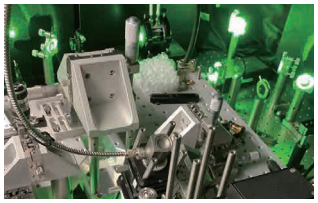
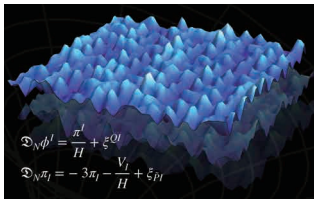

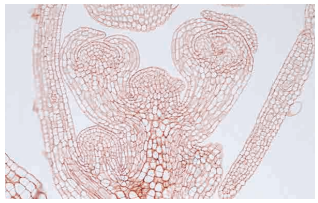
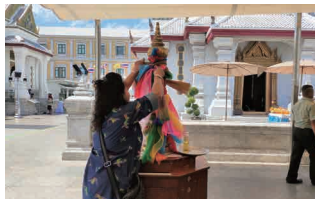

Cover Picture :
Interior 3-D model of Hagios Iōannēs (St. John) Chrysostomos in Geraki, Greece, recorded by photogrammetry.
The rights to the depicted monument belong to the Ministry of Culture and Sports.
The Church of Hagios Iōannēs Chrysostomos in Geraki is within the domain of the Ephorate of Antiquities of Lakonia.
Hellenic Ministry of Culture and Sports / Hellenic Organization of Cultural Resources Development.
(Photograph by Ryo Higuchi, YLC assistant professor. See page 17.)

Special Interview

Hiroko Takeda

Dr. Takeda is a professor at the Graduate School of Law Department of the Combined Graduate Program in Law and Political Science Core Law and Political Science. She also has been deputy director of Institute for Advanced Research since January 2019. She is one of the leading researchers in the field of political sociology, focusing on gender and family issues. In recent years, she has been actively engaged in research on political analysis focusing on the discourse and language. Her activities do not stop at the university, and she is also active as a member of the Gender Equality Council of Nagoya City, while contributing a monthly column to the Chunichi Shinbun (Newspaper). She received her doctorate (Social science) from University of Sheffield in 2002. She designated a Lecturer at Cardiff Japanese Studies Centre, Cardiff University in 2001, Lecturer at School of East Asian Studies, University of Sheffield in 2004, Research Cluster Director 'Social Changes and Transition in East Asia', National Institute of Japanese Studies at White Rose East Asia Centre in 2006, a Project Associate Professor at Komaba Organization for Educational Excellence, Tokyo University in 2011, and a Project Associate Professor at Graduate School of Arts and Sciences in 2013, before taking on her current positions in 2016.

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—— Prof. Takeda, for many years you have been researching gender issues, which are drawing increasing attention in society today. Could you tell us about your research?

TAKEDA: Within the discipline of Political Science, I have been specializing in Political Sociology for a long time now. In this research area, we examine what has not traditionally been considered as the political by expanding its sphere of implications. Politics conventionally tends to be associated with elections, legislative procedures, and the like, but I try to identify the political in various phenomena taking place in society.

In particular, I have been focusing on gender

and family issues. I have had doubts about the view of mainstream political scientists that dismisses certain themes as not being relevant to the studies of politics. When I was an undergrad in the Faculty of Law and Political Science of Rikkyo University and became interested in Political Science, having and raising children and nurturing and educating future generations were considered to be outside the political realm, though they actually do have important political and economic dimensions, as the term "reproductive politics" suggests. I have felt ever since that my mission is to counter that view.

In the 1960s, the second-wave feminism maintained that "the personal is political." More recently, we have been seeing politics being implicated more and more in people's decisions around having and raising children. Government policies implicitly carry specific ideas and images of what "the family" and "women" should be like. Some women do want to perform such images. So in reality, how people live their lives is quite strongly influenced by politics.

—— You first entered the Faculty of Law. How did you turn to Political Science?

TAKEDA: To tell the truth, I initially wanted to do something completely different. During my last year of high school, I began to feel, rather suddenly, that I wanted to go into medical school. When I told my parents about my wish to change my course of study, they told me frankly, "You're a girl. We won't let you spend an extra year trying to get into college. If you fail the entrance exam at your first attempt, you should go to a vocational training school instead." Since I wanted to be a college student, I felt that I had no other choice but to go to Rikkyo University on recommendation. I chose the Faculty of Law because I thought that would allow me to gain some kind of career down the line. Since I was interested in history and literature and enjoyed reading and writing, I thought I could perhaps try to be a journalist later.

During my first year at Rikkyo, I happened to take a course in Political Science. It was about what politics was, what power was, and how they worked. In the course, I was taught that power can be viewed as essentially a physical force that makes you do what you don't want to do. However, in the Political Sociology seminar that I took later, I learned a different understanding of power that human beings shape and modulate their actions as they consider others' positions, restraining themselves, and submitting themselves to the influence of various interactions in society. I found it extremely interesting to study different ways in which power manifests in terms of how people choose certain actions amid various interrelations. I read many books, including Escape from Freedom by the German social psychologist Eric Fromm and The History of Sexuality by French Philosopher Michel Foucault, and discovered a world I had never known before, and felt deeply moved. I went on to read more books, and before I knew it I realized I was already in my fourth year. I said to myself, "OK, why not go on to grad school?" So I decided to continue on to graduate school.

—— What was your childhood like?

TAKEDA: My father worked for a TV station, and his job required us to move often. I had difficulty forming new relationships in new places and felt it much easier to read books alone. So, I read a lot. I particularly liked children's history encyclopedias because I was interested in the different histories of different places and societies. I also enjoyed writing. So basically, I am now doing what I enjoyed as a child. I also like cooking, and I think this is largely because I had to handle the housework, including cooking, when my mother was hospitalized for a month when I was in an upper elementary grade. Right now, I am learning to cook Italian dishes from an Italian friend. I really enjoy learning how people live in countries I am not very familiar with. When I travel, I enjoy going to local supermarkets and looking at local foodstuffs.

—— You are interested in places that are new to you and how people live there. And you yourself went to the UK to study and lived there for 13 years.

TAKEDA: I only made a formal decision to become a researcher after I had gone to the UK. In Japan, there is a hierarchy of law faculties. As a doctoral student at a private university, I knew that my prospects for getting an academic post in Japan were limited. Around that time, I had a child

with my British partner, and we decided to move to the UK together. In the UK, people tend to think it is not right for people who are capable of working to stay at home and not work, irrespective of gender. I wondered what I could do as a non-native English speaker in British society. I figured that I could do something in the field of Japanese Studies, since my strengths were my Japanese language and my research in Japanese politics.

Quite smoothly, in 1999, I was able to enter a doctoral course at the University of Sheffield, which has Japanese Studies courses, with a teaching assistant's post and an exemption from tuition fees. I taught Japanese to master's students while carrying out my research. Later, I also worked as an instructor at Cardiff University, teaching courses in Japanese society and politics in English. I obtained my doctorate in 2002.

—— Being a non-native English speaker, as you said, didn't you have any trouble teaching at a university? Had you thought of studying abroad before?

TAKEDA: In Japan, I had been unable to speak English at all, but I had always read books and articles in English. In the UK, I managed to improve my English through my work and other activities, although at first, I sometimes made the mistake of using very intellectual words that are not usually used in daily conversation. As a graduate student in Japan, I had been seriously interested in British Critical Theory, whereby you examine the effects of power by analyzing discourse. I had been thinking about going abroad because I was not satisfied with just studying literature in Japanese, but I had never had the opportunity.

I was able to enrich my research by going to the UK. The French philosopher Michel Foucault developed the concept of "governmentality,"

arguing that the conduct of government has exerted an increasingly stronger impact to discipline people's behaviors and care about people's health and welfare as we have approached modern times. Foucault's disciples have further developed this concept and produced a series of publications in English. In Japan, there was resistance to using the concept of governmentality in political analysis, but British academia was more open to the idea of merging different disciplines. This tolerant environment was beneficial to my research.

—— Your research was progressing, and you had a full-time post in the UK. So why did you return to Japan?

TAKEDA: In the UK, I was teaching within the framework of a Japanese Studies program, whereas my area of specialization was Political Sociology. Discussing politics and how power works with students who were there basically because they loved Japan or were interested in things Japanese did not go down very well, in the end. It was difficult to strike a balance between what I wanted to do and what the students were seeking. I felt that I needed to solidly develop my research in my own domain.

In addition, young students who had never been to Japan often looked to me as a kind of spokesperson for Japan, but as I was away from Japan from the late 1990s through the 2000s, I wasn't able to explain what had happened in Japan during that period, such as the random killings, nor did I understand the backgrounds to those events very well, when my students asked me about them. I became less and less confident and felt that I had to gain a deeper understanding of Japanese society myself.

At that time, the Ministry of Education, Culture, Sports, Science and Technology launched the Global 30 Project (aimed at the internationalization

of Japanese universities), and the University of Tokyo's English-medium course in the College of Arts and Sciences (PEAK) made an open call for limited-term instructors in Social Sciences of Japan. I applied and got a post as a project associate professor for a period of three years starting from 2011. Initially I was planning to return to the UK after my appointment, but I missed my timing because it had become harder to find an academic post in the UK due to the country's austerity policy. Then, I received an offer from Nagoya University and was appointed Professor at the Graduate School of Law in 2016.

—— How do you find Nagoya University? Do you find that your research and educational activities are affected by the COVID-19 pandemic?

TAKEDA: Nagoya University is a little like the University of Sheffield, in that both are full universities with strong science departments. Both have Nobel laureates in science, so the Humanities and Social Science faculties and students feel

somewhat small at both universities. At Nagoya, many students come from the three prefectures of the Tokai region, and the distinction between the former Owari and Mikawa provinces within Aichi Prefecture seems like a big deal to them, which those of us coming from outside the region have some difficulty grasping. But talking with students is quite interesting since there is so much we can teach and offer one another, filling in the gaps in our knowledge.

Since I returned to Japan, I have been developing my research in a new direction by analyzing British politics using the Political Science and Political Sociology theories. So I am rather frustrated by the fact that I can't easily travel to the UK now. I did return to observe the General Election in 2019, which gave me the impression that the political situation has been deteriorating fast. Moreover, because of the time difference, I have not been able to fully participate in academic conferences, especially sessions held during night hours Japanese time. The breadth of discussions I can have has considerably narrowed. So I find my research activities seriously affected.

My educational activities are equally seriously affected. At Nagoya, the English-medium course of the School of Law usually has 6-9 international students each year. This year, two students have left the program. Newly enrolled students have not been able to come to Japan because the government does not issue visas to self-financed foreign students. It is difficult for students to remain motivated when they only have online classes. I really wish that the government would issue visas to students who are formally accepted by a university. Our international students have chosen Nagoya from among the many universities available. They feel attached to Nagoya and want to study Japanese, Japanese politics and other subjects. In the future, they are likely to become allies and supporters of Japan. What kind of policy is it to deliberately frustrate such students? For academic research at a university, it is better to have a wider range of possibilities. International students and researchers with diverse backgrounds can definitely be the university's assets.

—— At Nagoya University, the appointment of female researchers is in progress. What do you think are the remaining challenges to be tackled?

TAKEDA: Not only at universities but also in governmental organizations and other places, there is a tendency for fully qualified women to not grab opportunities for promotion or to hesitate to do so. Women tend to set the bar very high for themselves. Many such women are highly competent and conscientious about their work. So much so that they pass up promotion because more responsibilities at work would keep them from fulfilling their family duties in a satisfactory manner. Such diligence is admirable, but I think they should also learn to be a little bolder. In this regard, I try to talk to my students about the gender gap they are likely to encounter especially upon finishing college, and how to overcome gender-related obstacles. Personally, I am more inclined to stay at home and read books, but I try not to turn down requests and invitations to speak on these subjects, such as one for an IAR Letter interview, because the training and promotion of female researchers is an important challenge facing Nagoya University as well.

I actively try to talk about gender issues on all sorts of occasions. Ruth Davidson, who was the Leader of the Scottish Conservative Party until 2019, wrote in her autobiography that when John Major was appointed Prime Minister following Margaret Thatcher's resignation, Davidson had asked if a man could also be Prime Minister. I think this is a symbolic story. Usually, you would think the other way around.

Nagoya University seems determined to increase the number of female researchers, and there are many other things that should be done. For example, we must reexamine the way we work. How should we view researchers who are dedicated to their research and who return to work to resume their research before the end of their childcare leave, entrusting their children to day care? We must find a solution that enables researchers to perform both their parenting and research duties to the full. If a female researcher must work like a man to make significant research achievements, that would drive her into a corner. Therefore, in addition to simply increasing the number of female researchers, it is also necessary to make substantial changes in the ways researchers work.

—— What would you like to do in your future research?

TAKEDA: There is so much I want to do. There is still a persistent gender disparity despite the politics of gender equality and institutional reforms since the 1990s. Our society, founded on the principle of gender-equal opportunities, has so far treated childbirth and parenting as things that are outside the capitalist system. But I think they must be viewed as being fully integrated. The problem of the declining birthrate also lies there. The pressure placed on women to work is increasingly growing, but childcare responsibilities are also still dumped on women in many cases. It is becoming unrealistic to expect society to continue like this. I would like to identify the real problems and demonstrate what kind of politics and policies should be practiced in the future to realize a living environment in which both women and men are economically secure and enjoy their everyday family lives. In addition, I would also like to conduct political analysis with a focus on discourse and words, in response to the current political development in which the British Conservative Party strategically uses deception to win the 2019 General Election.

—— What is your message to young researchers?

TAKEDA: One thing I can say is that even if you run up against a wall here and there, you often end up learning to perform better research after repeated trial and error. It is better to persevere because failures are natural. If you remain flexible and look at things from a different angle, failures can turn out to be something more positive. There are many opportunities and places where you can turn your uniqueness to your advantage. I am here today because the work I have done elsewhere has been recognized. I encourage young researchers to put themselves in a new environment if they ever get the opportunity, moving outside of their familiar settings and acquiring multiple perspectives.

Aerosol Formation Processes Missing in the Atmosphere

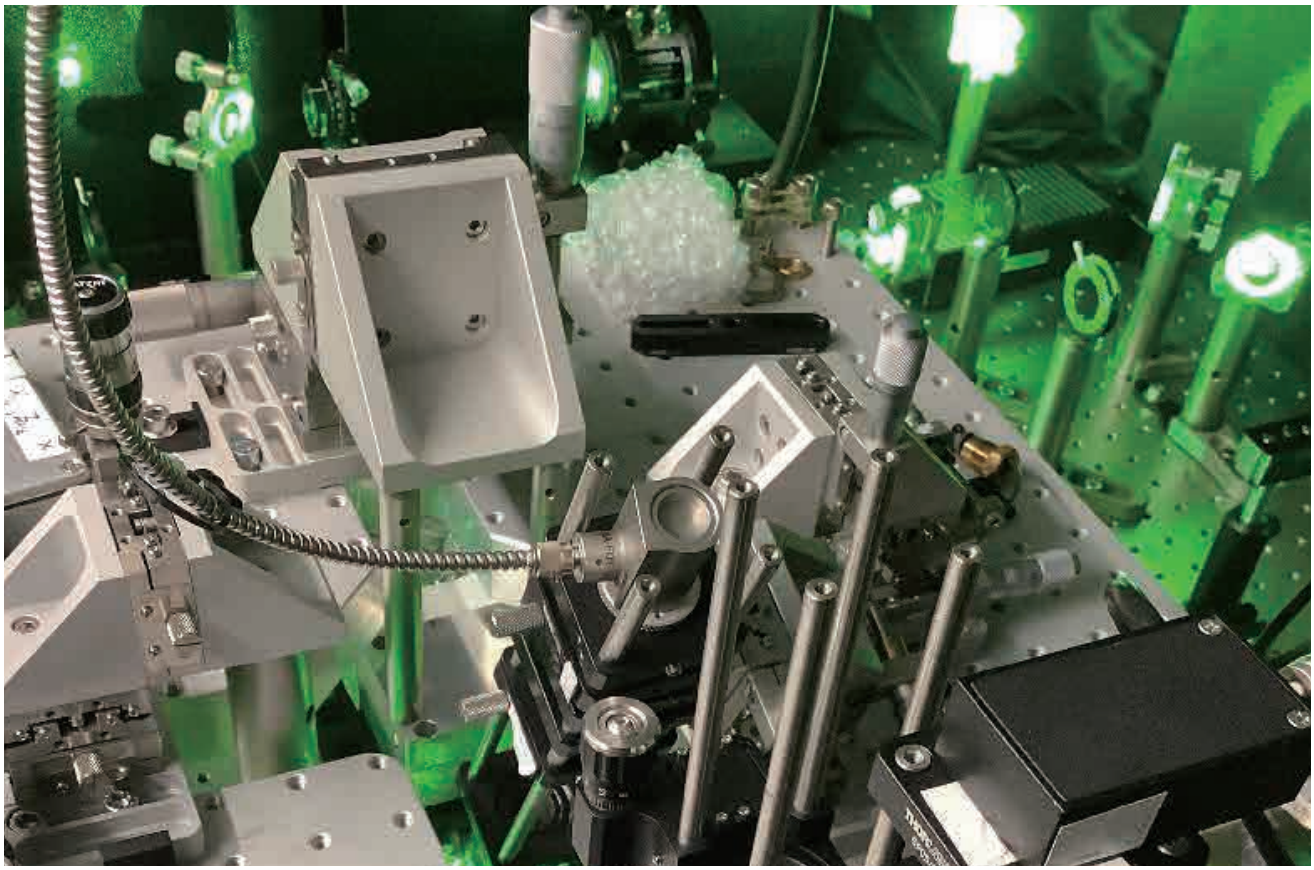

Figure 1: Optical system for single submicrometer aerosol trapping at Signorell Lab at ETH Zurich, Switzerland.

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Nano to submicrometer-sized aerosols ubiquitous in Earth' s atmosphere impact the climate system by light absorption and scattering and promote cloud formation. Recent experiments showed anomalous chemical reactivity of microdroplets associated with reactions at the air–solution interface in contrast to that of the bulk. The specific chemistry of microdroplets that would be critical to size, number density, chemical composition, phase, and shape remains elusive. I study tiny characters of atmospheric aerosols leading to different material properties from the bulk and chemical reactions at the interfaces by using and by developing novel experiments.

BACKGROUND

Nano to submicrometer liquid / solid phase aerosols in the atmosphere play central roles in the climate system. A large fraction of global submicrometer aerosol is organic aerosol formed from biogenic and anthropogenic organic gases. They are the key elements acting as seeds for cloud droplet formation. However, the global budget of organic aerosols is underpredicted in atmospheric models, implying missing processes that promote the formation of organic aerosols. Multiphase reactions, including reactive uptake of organic molecules onto surfaces, subsequent reactions at the air-solution interface, and inhomogeneous bulk medium, are the candidates.

Specific Oligomerization of Biogenic Gases at the Air-Water Interface

Chemical species at the boundary between the gas and liquid phases react differently from bulk. Various reactions are accelerated, involving reactions that are not available in the bulk phase. Although the air-water interface would act as a unique reaction medium for nucleation, growth, and

degradation of atmospheric aerosols, the molecular-level mechanism is not fully elucidated. I investigated the reactive uptake of various organic gases to acidic (pH < 4) water microjets by direct detection of ionic intermediates using spray ionization mass spectrometry (Fig. 2).

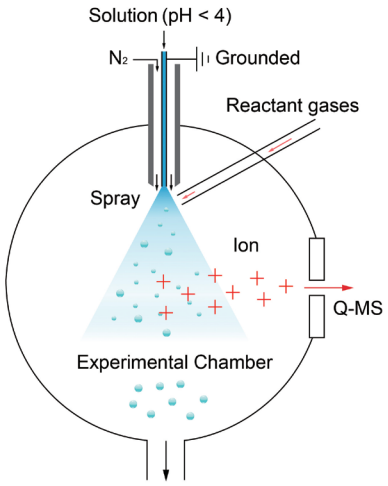

Figure 2: A scheme illustrating online detection of reaction intermediates forming at the air-water interface of microjets. The microjets are exposed to reactant gases, and the ionic products re-emitted into the gas phase are detected by quadrupole mass spectrometry (Q-MS).

A gaseous unsaturated hydrocarbon impinging to mildly acidic water surfaces is easily protonated by less hydrated hydronium ions $H_3O^+(H_2O)_{n\leq 4}$, which can initiate cationic chain reactions.

$$R\,(g) + H_3O^+\,(int) \rightarrow RH^+\,(int) + H_2O\,(int) \quad (R1)$$

The cationic intermediates then react with neutral unsaturated hydrocarbons repeatedly to form oligomers via the following chain-propagation reaction.

$$R_nH^+\,(int) + R\,(g) \rightarrow R_{n+1}H^+\,(int) \quad (R2)$$

Surprisingly, the microjet experiments revealed that isoprene (C_5H_8) and β-pinene ($C_{10}H_{16}$), major atmospheric gases emitted from plants, are very efficient monomers for oligomerization at the air-water interface.[1–4] This is in contrast with well-known polymerization chemistry in bulk organic solutions. The product MS signals suggested that partial water coordination facilitates the chain-propagation reactions (R2) of the atmospheric gases at the air-water interface.[4] The partial hydration with water molecules at the air-water interface may let the reactions proceed differently from the aqueous and the gas phases. The resulting high molecular weight species have lower vapor pressures; they partition into particle liquid/solid phases, contributing to the formation and growth of organic aerosol. We propose the mechanism as unrecognized pathways for organic aerosol formation.

Size-Dependent Structures of Atmospheric Aerosols The spray ionization experiments revealed that the hydration state at the air–solution interface is the key, indicating that chemical reactions of aerosols are sensitive to their phases. Atmospheric aerosols are usually composed of mixtures of various organics and inorganic salts. Recent advances given by cryo-electron microscopy showed that such mixtures include inhomogeneous structures depending on size.5 However, in an experimental system where a large number of particles are dispersed, the heterogeneity of each particle and size-dependent phenomena are obscured because of the inevitable averaging effect.

Optical trapping is one of the most rigorous techniques for single particle manipulation. It offers investigations of levitated submicron to a micrometer-sized single particle that is relevant to the atmosphere (Fig. 3). A levitated particle is dragged to the focus center by optical pressures leading to stable trapping of a single aerosol. The optical trapping experiment combined with a microscopic system enables us to follow size changes, phase transition, and chemical reactions of a submicrometer particle in response to the changes in temperature, humidity, and interactions with gaseous molecules. How are the inhomogeneous structures generated? How do the phase states affect chemical reactions at the air–solution interface? I tackle these questions by using the optical trapping technique.

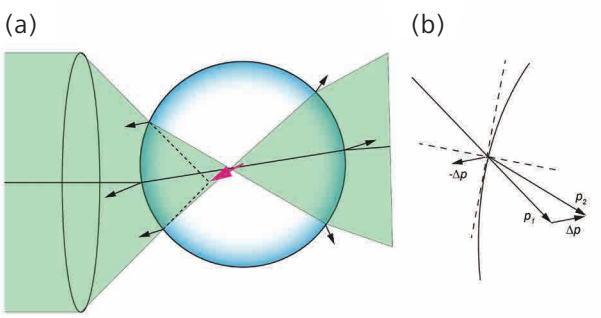

Figure 3: A schematic illustrating optical trapping of single aerosol by focusing laser light. (a) Optical forces dragging the particle to the focus center arises from (b) refractions at interfaces.

Acknowledgements

I am grateful to Prof. Michihiro Mochida (Nagoya Univ.), Dr. Shinichi Enami (National Institute for Environmental Sciences), and Prof. Ruth Signorell (ETH Zurich) for supporting the research.

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Exploring the Connections between Hearing, the Circadian Clock, and Mating in Mosquitoes

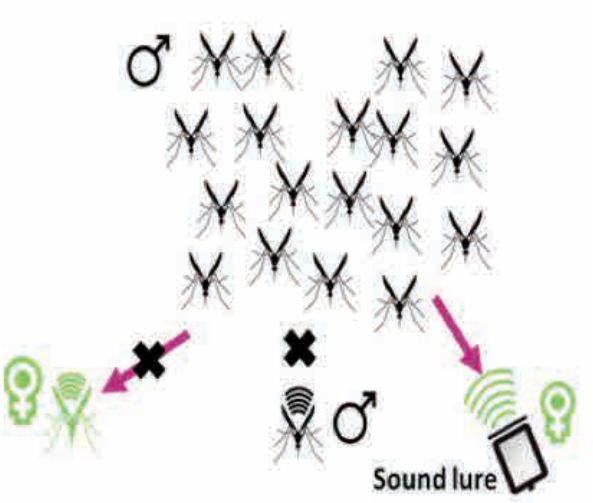

Figure 1: Mosquito mating occurs within large groups known as swarms which form only at certain locations and times of day (particularly sunset); the left image shows an ideal swarming location. Male mosquitoes in a swarm can be attracted to speakers playing the sounds of flying females (known as sound lures), rather than to actual females, as in the right image. This attraction can be exploited for mosquito control.

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Recent years have seen a rapid increase in viral infections transmitted by the yellow fever mosquito *Aedes aegypti,* with around 50% of the world' s population now at risk from diseases spread by this mosquito species. Previous methods of vector control have proven inadequate, making new methods with novel targets desperately needed. *Aedes aegypti* mating represents one such target as it is a highly conserved behavior involving both sexes. However, there remain large gaps in our understanding of mating which must be addressed before effective interventions can be tested. This is especially true with regards to hearing, which male mosquitoes rely on to locate conspecific females. My research therefore focuses on elucidating the molecular and neuronal bases of mosquito hearing behaviors. I am especially interested in the influence of the circadian clock on mosquito hearing, and thus mating.

INTRODUCTION

When female mosquitoes bite humans to obtain a blood meal, they can transmit deadly pathogens such as the dengue and Zika viruses. Over half of the world's population is now at risk of infection by these viruses, making them a significant public health concern1. The enormous increase in the at-risk population in the past few decades has been driven by the global spread of the yellow fever mosquito Aedes aegypti (*A. aegypti*) which acts as the major disease vector.

One novel method of controlling *A. aegypti* mosquitoes is by exploiting the male attraction to the sound of a flying female[2]. This attraction is so powerful that male mosquitoes are drawn to speakers playing female flight tones, where they can be trapped and removed from the mating population (Figure 1 right). However, preliminary field tests of sound-based traps have largely failed to trap large numbers of mosquitoes[2]. In order to enhance the effectiveness of these traps, our knowledge of the fundamental bases of mosquito hearing systems and behaviors needs to be drastically improved. In particular, males show attraction to sound only within small time periods each day at dawn and dusk (Figure 1 left), suggesting a circadian influence on mosquito hearing, and thus mating[3].

MOSQUITOES HAVE POWERFUL, SENSITIVE EARS

Mosquito ears have two components; a flagellum, which protrudes from the head, and a Johnston's organ (JO), which is attached to the base of the flagellum. The mosquito flagellum is covered in fine hairs which increase its surface area, and thus sensitivity to mechanical stimuli such as sound. Movement of the flagellum leads to the opening of ion channels within the JO, which is the site of auditory mechanotransduction, making the JO therefore similar to the human cochlear.

The mosquito ear is one of the most complex auditory systems in the insect kingdom[2]. Not only does the JO contain many thousands of neurons (over 20 times more than the fruit fly *Drosophila melanogaster*), the mosquito ear also boasts a system of auditory efferents which connects the brain to the ear directly[3]. Mosquitoes are the only insect species known so far to have such a system, which allows for modulation of hearing function via release of neuromodulators such as octopamine or GABA.

Although both males and females share this basic ear structure, there are still significant differences between the sexes in terms of both morphology (Figure 2) and function. For example, the male flagellum has many more hairs than the female equivalent and vibrates at a distinct frequency. Furthermore, the male JO contains around 15000 neurons as compared to the 7000 neurons housed in the female JO; these neurons also respond to different frequencies of sound. Significant differences in anatomy have also been identified between distinct mosquito species[3].

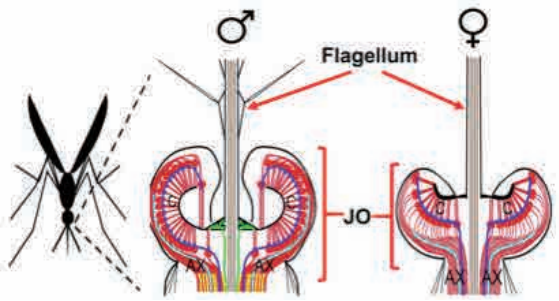

Figure 2: Male and female mosquito ears show clear evidence of sexual dimorphisms in both components: the male flagellum is covered with more hairs, and the male Johnston' s organ (JO) contains almost twice the number of neurons as the female JO.

Beyond sexual dimorphisms in ear anatomy, mosquitoes also demonstrate dimorphisms in hearing behaviors. Whilst female *Ae. aegypti* appear to show no clear hearing behaviors, as mentioned above male mosquitoes are strongly attracted to the sound of flying females[2]. This phonotactic attraction to sound is a key element of mosquito mating. In the wild however mosquitoes do not mate in lone pairs but instead in large groups, adding layers of complexity to this phenomenon.

MOSQUITO MATING OCCURS WITHIN MALE-DOMINATED GROUPS KNOWN AS SWARMS

Mosquito mating occurs mainly within male-dominated groups known as swarms. Males then locate females which approach the edge of these swarms using hearing. This is possible because male and female flight tones are distinct, with the male flight tone frequency at least 200Hz higher than the females. Thus, although the vast majority of swarming mosquitoes are male, individual males are able to easily distinguish between the sexes.

Mosquito swarms form only at highly specific times of day (dawn and dusk). This swarming behavior is therefore highly circadian in nature. Given that male phonotaxis occurs within these swarms, male hearing may also have a circadian basis. Recent research has also suggested a direct circadian clock influence on hearing function in other animals[4]. It is currently unknown however which components of the molecular circadian clock could influence swarm formation or hearing in *Ae. aegypti.* Without understanding the molecular basis of the mosquito circadian clock, it will not be possible to effectively disrupt clock function to interfere with mating behaviors.

THE MOSQUITO CIRCADIAN CLOCK HAS A MOLECULAR BASIS SIMILAR TO, BUT DISTINCT FROM, OTHER INSECTS

The core mosquito molecular clock consists of two heterodimers; Clock-Cycle (CLK-CYC) and Period-Timeless (PER-TIM). This system is similar to other insect clocks, with these dimers forming a negative feedback loop. The rhythmic cycling of core clock components regulates the expression patterns of many other genes which influence the majority of essential mosquito behaviors.

Despite the central importance of the circadian clock, *Ae. aegypti* based research has been largely limited to dsRNAi knockdown of clock genes due to a lack of genetic tools. These restrictions are gradually being lifted however as mosquito mutant generation becomes increasingly easier. This has enabled not only research into the effect of individual clock components on mosquito behavior, but also identification of key differences between the mosquito clock and that of other insects. These differences, alongside significant differences in behavior, mean that mosquito circadian research can only reliably been conducted using mosquitoes rather than other model organisms (such as *Drosophila melanogaster*).

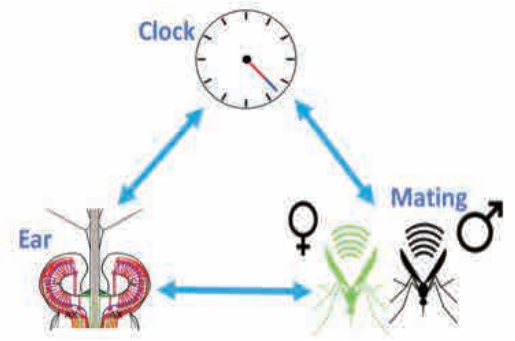

Figure 3: Potential connections between mosquito ears, circadian clocks and mating. Interfering with any one component could have significant influences on the other components.

SUMMARY AND FUTURE WORK

Mosquito ears and circadian clocks are highly promising targets for novel vector control tools. Only by exploring the underlying connections between the clock, hearing and mating however will targeted disruptions be possible (Figure 3). We are currently working to investigate these connections using a combination of molecular and behavioral analyses. Using CRISPR/cas9, we are generating novel *Ae. aegypti* gene KO mutants to facilitate explorations into the molecular and genetic bases of core mosquito hearing and clock-related behaviors. At the same time, we currently testing the effect of clock-targeting compounds on circadian behaviors, and comparing the results of pharmacological and genetic interventions. We intend to trial promising interventions in semi-field conditions with international collaborators in the future to test the feasibility of application outside of a lab environment.

Acknowledgements

I would like to thank Prof Azusa Kamikouchi for her constant support, as well as my collaborators Prof Joerg Albert and Dr Chun-Hong Chen, and my fellow lab members Lee Tai-Ting, Loh YuMin and Xu YiFeng.

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Asymptotic Symmetry in Flat Space and Holography

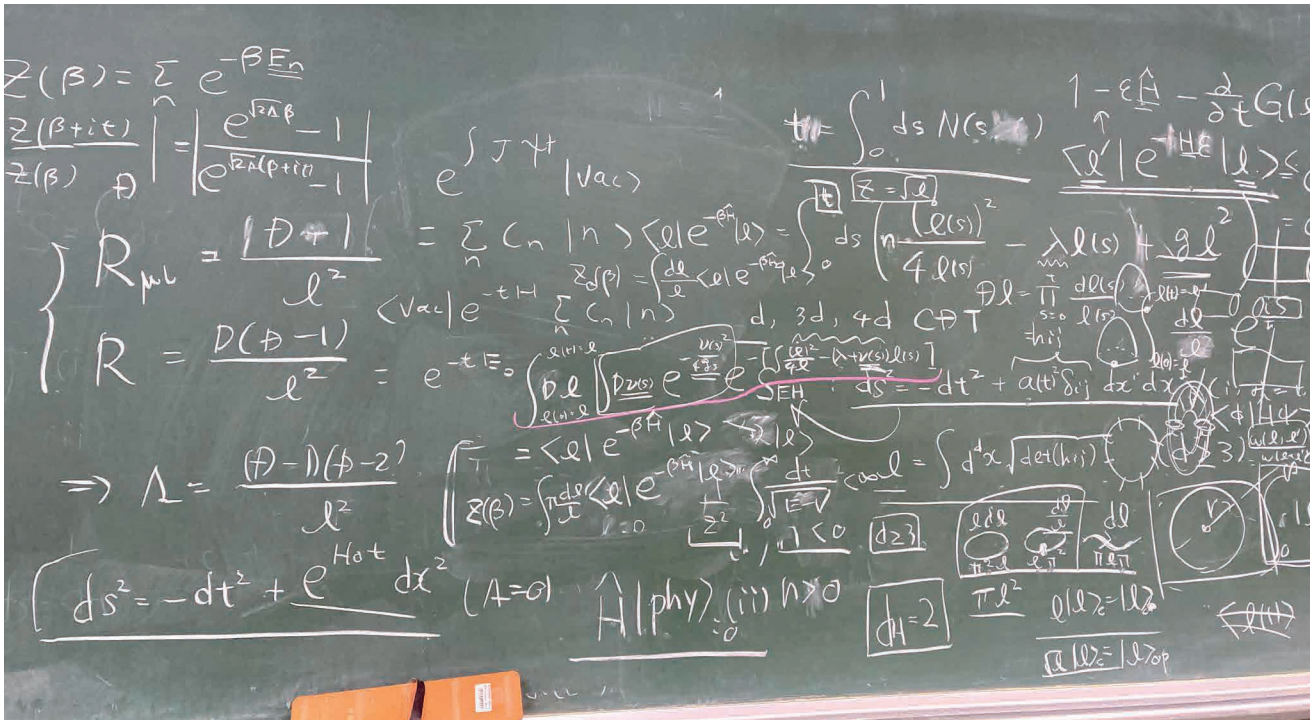

Figure 1: Picture of a blackboard after a discussion on quantum gravity. Discussions using mathematical expressions are a fundamental method for developing research in theoretical physics.

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Quantum gravitational theory provides a theoretical explanation for the mystery of how our universe begins. The theory describing our universe is still under construction. Holography is the hypothesis that a quantum spacetime emerges like a hologram from a low-dimensional spacetime. I am working on the holography from various points of view to construct the theory of quantum gravity. In particular, I would like to understand the holography of flat spacetime with the help of asymptotic symmetry.

QUANTUM GRAVITY

One of the long-standing issues in theoretical physics is constructing a theory of quantum gravity describing our universe. Physical phenomena occurring on a microscopic scale can be well described in the framework of quantum theory. On the other hand, macroscopic gravitational phenomena can be explained by Einstein's general theory of relativity. In general relativity, the dynamics of spacetime itself are the object of the theory, and gravity is realized as spacetime changes. Hence quantum gravity should be a quantum theory of spacetime. Studies suggest the universe in the far past was so small that the quantum effects of spacetime could not be ignored. We need a theory of quantum gravity to explain the physical phenomena in such a microscopic universe. The theory of quantum gravity could provide a theoretical explanation for the mystery of how our universe begins. Quantum gravity is also necessary to describe the physics of black holes in a consistent manner.

HOLOGRAPHY

Holography is an amazing idea of quantum spacetime. It is a hypothesis that a fluctuating spacetime emerges like a hologram from a low-dimensional spacetime where gravity does not exist. Since there is no spacetime fluctuation in this low-dimensional spacetime, the framework of ordinary quantum theory can be used. Therefore, this hypothesis gives us a way to formulate theories of quantum gravity. The mechanism of this hypothesis and the extent

to which we can apply it are not well understood. I am investigating this holographic hypothesis from various points of view, aiming to construct quantum gravity theory.

AdS/CFT

The anti-de Sitter (AdS)/conformal field theory (CFT) correspondence is an example of the holographic conjecture. It conjectures that a quantum theory of gravity on a spacetime with negative dark energy called the AdS spacetime corresponds to a quantum field theory called CFT. Since observations suggest that the dark energy in our universe is not negative, the AdS spacetime would be a theoretical virtual spacetime. Although it is a toy model of quantum gravity, the AdS/CFT correspondence is studied widely to gain insight into quantum gravity. I also wrote some papers related to AdS/CFT [1, 2, 3].

ASYMPTOTICALLY FLAT SPACETIME

Whether holography is valid in spacetimes other than the AdS spacetime is unclear. Recently, progress has been made on holography in asymptotically flat spacetime. According to Einstein's equation, the presence of matter such as stars and black holes causes the deformation of spacetime around them. However, if you get far enough away from the star, the spacetime is almost flat. An asymptotically flat spacetime represents such a situation. There is a huge symmetry hidden in gravitational theory on spacetime. Symmetry has an interesting physical interpretation and might be a key to the holographic description of gravity on asymptotically flat space (see Figure 2).

SYMMETRY

In modern physics, elementary particles and gravity are well described in the framework of field theories. Symmetry is an important guiding principle in the construction of models in terms of field theories. If a theory is invariant under a transformation of the dynamical variables, we say that the theory has the symmetry of the transformation. There is a conservation law associated with symmetry (Noether's theorem). A conservation law means that there is a conserved quantity that always takes the same value under the time evolution of the universe. An example of a conserved quantity is the total electric charge of the universe. In this world, there are electrically charged objects such as electrons and protons (electrons have a negative charge, protons have a positive one). The sum of these charges in the universe is thought to remain the same at all times. General relativity is a field theory of spacetime dynamics. Its guiding principle is symmetry under general coordinate transformations, which states that physics is invariant under transformations of the coordinates used to describe spacetime. In addition, the standard model, which is a field theory describing elementary particles, has a symmetry under transformations called gauge transformations (general coordinate transformations are also a kind of gauge transformations). Although gauge symmetries are important to construct theories, most are not true symmetries because they are simply redundancies in the theoretical descriptions. We cannot observe the conserved charge associated with gauge symmetry. A true symmetry in physics is one in which the associated conserved quantities are observable. CFT have a special symmetry called conformal symmetry, which is a true symmetry. This symmetry makes the analysis of the CFT relatively easy compared to other field theories. The gravitational theory on the AdS spacetime has a true symmetry, called the asymptotic symmetry. Moreover, this symmetry has the same algebraic structure as the conformal symmetry exactly. This miraculous coincidence of the symmetry is one of the evidence of the AdS/CFT correspondence.

ASYMPTOTIC SYMMETRY ON FLAT SPACETIME

ILet us return to asymptotically flat spacetime. The gravitational theory on asymptotically flat spacetime also has a true asymptotic symmetry. If a low-dimensional theory has this symmetry, it is a candidate for a holographic description of the gravitational theory. Thus, it is natural to investigate this

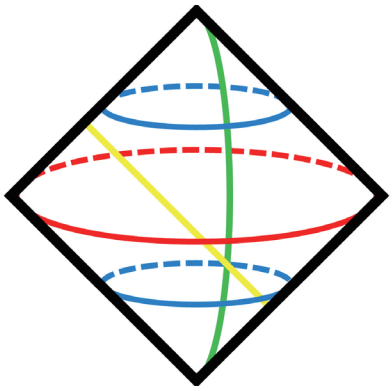

Figure 2: Penrose diagram of asymptotically flat spacetime. Penrose diagrams, named after Roger Penrose, are useful to illustrate the causal structure of four-dimensional spacetime by a two-dimensional figure. The black diamond represents the asymptotic boundary of spacetime. The gravitational theory might be described only by degrees of freedom on the diamond.

symmetry. As mentioned above, if there is symmetry, there is a conservation law associated with it. We have shown that the conservation law associated with the asymptotic symmetry in the electromagnetism on flat spacetimes corresponds to the memory effect [4]. The electromagnetic memory effect relates the electromagnetic wave associated with a scattering of charged particles to the configuration of the charged particles before and after the scattering. Although this effect has not yet been observed, it can be easily derived from Maxwell's theory, the fundamental equations of electromagnetism. If we observe the memory effect in the future, we can say that asymptotic symmetry is an experimentally established concept. The asymptotic symmetry also imposes restrictions on the phenomenon of particle scattering [5, 6]. The scattering of elementary particles is formulated using the S-matrix. At first sight, the S-matrix appears to be not well-defined because of the problem of the infinite volume of flat spacetime. However, this is fake. If we correctly take the effect of the asymptotic symmetry into account, the problem of the infinite volume is resolved. Thus, asymptotic symmetry is an important concept in holography and in various aspects of quantum field theories. We hope that further investigation of the asymptotic symmetry will lead to insights into holography on flat spacetime.

Acknowledgements

The author thanks all his collaborators. He also thanks Dr. Yuki Sato for the discussion shown in Figure 1.

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Stochastic Approach to Cosmic Inflation

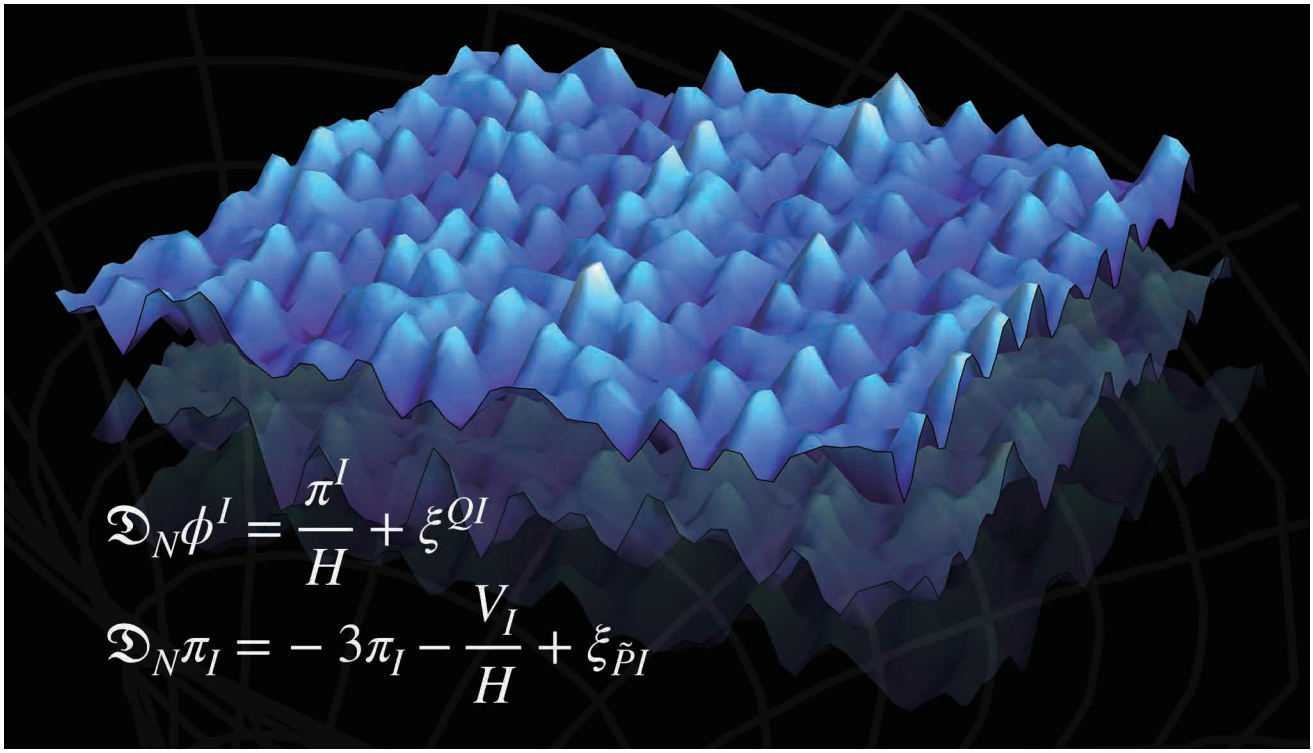

Figure 1: The dynamics of the cosmic inflation can be understood as correlated stochastic processes and analyzed using stochastic calculus techniques.

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We are working on the so-called *stochastic approach* to cosmic inflation. Inflation is the accelerated expansion of the early universe, and it produces the initial density fluctuations causing the current cosmological structures such as stars, galaxies, etc. In the stochastic approach, we treat inflation as a random process to investigate these initial density fluctuations. We formulate the algorithm for the initial density fluctuations as differences in the duration of inflation in the stochastic formalism. We also reformulate the stochastic approach itself so the equation of motion can be written in a covariant way.

INTRODUCTION

In the standard cosmological scenario, our universe is thought to undergo an accelerated expansion phase called *inflation* at the beginning of its history. One of the most important roles of inflation is to generate initial density fluctuations in the universe. Once the initial density fluctuations are realized, dense regions can attract surrounding matters by gravitation and cause stars and galaxies, or otherwise our universe would have an empty structure today. Inversely speaking, precise measurements of the current cosmic structure enable us to trace back to the detailed inflation mechanism. Also, we must precisely compute the produced initial density fluctuations in each possible inflation theory on the theoretical side.

STOCHASTIC INFLATION

Why can inflation generate the initial density fluctuations? It is understood as follows. Not only during inflation, quantum mechanics suggests the existence of tiny fluctuations on very micro scales, called *quantum zero-point fluctuations*. They are the superposition of creation and annihilation and do not affect macro physics basically. However, in the inflationary universe, such fluctuations are stretched to macro sizes and even affect the expansion rate of the universe! At that time, the universe "observes" fluctuations in a sense and they become "real" fluctuations just like Schrodinger's cat. These fluctuations finally cause the initial density fluctuations at the end of inflation.

The fluctuations during inflation are often computed as tiny quantum fluctuations on the spatially homogeneous background universe. However, there is no guarantee that the universe is almost homogeneous because, in fact, the universe fluctuates! Then we sometimes directly treat the fluctuated universe as random processes, which is called the stochastic approach to inflation. In this approach, the assumption that the fluctuations are very small is not needed any longer, and thus, a more precise prediction of the initial density fluctuations is possible. The precise calculations of fluctuations in the stochastic approach are my main research topic.

STOCHASTIC-∂N FORMALISM

One question remains: inflation anyway ends at some time, so are the fluctuations during inflation inherited by the later universe? The answer is yes: the fluctuations during inflation cause the perturbed gravitational potential, and whatever happens inside the gravitational potential is conserved. Therefore, we merely have to calculate the gravitational potential generated by quantum fluctuations. However, this picture causes another problem. Previously, even if we can treat large fluctuations in the stochastic approach, the conversion from quantum fluctuations to the gravitational potential has required the fluctuations to be small enough. Then we focused on the so-called *∂N approach,* which claims that the final gravitational potential is nothing but the difference in the duration of inflation. In the standard quantum approach, such a time difference is calculated as it is caused by small quantum fluctuations on the homogeneous background. On the other stochastic side, the duration of inflation automatically fluctuates because the universe behaves as a random process! In other words, for the initial density fluctuations, we just have to calculate the time fluctuations from some initial condition to the end of inflation along several random processes (which is called *first passage time* in the context of stochastic calculus, see Fig. 2). This approach no longer needs the assumption that the perturbations are small, and in fact, we have shown that the power spectrum of the initial density fluctuations can be computed in this way [1].

COVARIANT STOCHASTIC FORMALISM

Now, we have formulated how to calculate the initial density fluctuations in the stochastic formalism. However, we found that there was some uncertainty in the stochastic formalism itself. To describe this problem, let me introduce the particle called *inflaton.* The inflaton is the driving particle of inflation. Its potential energy plays the role of "dark energy" and acceleratedly expands the universe. The inflaton may be single, or some multiple inflatons may contribute to inflation simultaneously. The inflatons' status is often expressed by the *inflatons field values.* Practically, we solve the equation (stochastic equation in the stochastic approach) for the inflaton fields. Here it should be noted that the inflatons field values themselves are NOT physical (in contrast to energy density, etc.) and we can arbitrarily redefine the inflaton fields. The equation for the inflaton fields can also be written such that the form of the equation is unchanged even if the inflaton fields are redefined. Such a form of equation is called *covariant under the field redefinition.* While the standard quantum approach can be formulated in a covariant way, the (old) stochastic formalism was non-covariant due to the indifferentiability of random process (random process is infinitely "jagged"). It was formulated in a "natural" way in a single-inflaton case, but of course, the "naturalness" is not a rigorous definition. Furthermore, there is no longer "natural" definition of the inflaton fields in a complicated mixed multi-inflaton case. Therefore, the correct stochastic approach to inflation had not been defined in such a case. After we found this problem, a French group and I revisited the stochastic formalism from scratch, saw when the quantum system could be connected to the random processes, and finally reformulated the stochastic approach in a fully covariant way whose equations are exhibited in Fig. 1 [2]. Now the stochastic formalism can be applied to a general inflation theory.

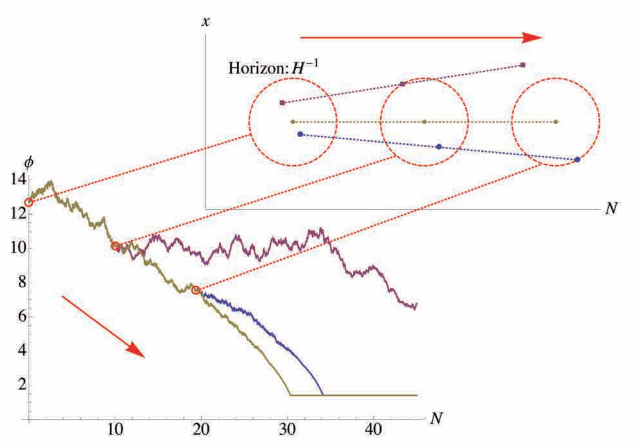

Figure 2: The initial density fluctuations can be calculated as fluctuations on the first passage time for correlated stochastic processes.

ONGOING WORK

We are now working on the analysis of several complicated inflation theory with use of the above stochastic approach. In addition to the power spectrum, we are also formulating how to calculate the probability density function of the initial density fluctuations, which is another kind of statistics of random variables. We hope that the stochastic approach opens a novel physics in the near future.

Acknowledgements

This work is in collaboration with Tomohiro Fujita, Masahiro Kawasaki, Lucas Pinol, Sébastien Renaux-Petel, Tomohiro Takesako (alphabetical).

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Architecture as Historical Evidence: What Byzantine Architecture Tells.

Interior 3-D model of Hagios Iōannēs (St. John) Chrysostomos in Geraki, Greece, recorded by photogrammetry.
The rights to the depicted monument belong to the Ministry of Culture and Sports.
The Church of Hagios Iōannēs Chrysostomos in Geraki is within the domain of the Ephorate of Antiquities of Lakonia.
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While Orthodox Christianity and wall painting framework were standardized during the middle Byzantine period (9th–12th centuries), architectural forms followed various types, while the churches had different roles. This study aims to investigate why middle Byzantine architecture took various architectural forms and to understand the role of the churches in Byzantine society through a detailed and comprehensive analysis of surviving architecture as historical evidence. This study acquires the data of the churches using onsite surveys. It creates 3-D models using photogrammetry, then historical analysis concerning architectural design, planning, construction engineering, and environmental engineering.

INTRODUCTION

The culture of the Byzantine Empire (Figure 1) governed the eastern Mediterranean world from the 4th century to the 15th century, affecting both modern Orthodox countries and their contemporaries in the western European and Islamic worlds. Roman influences evident in early Byzantine society (until the 7th century) gradually disappeared through the battle against the Islamic Empire and the Iconoclasm conflict. The middle Byzantine era (9th–12th century) acquired its distinctive characteristics. For example, doctrines specific to Orthodoxy formed after the Iconoclasm and wall paintings inside the churches were also standardized.

DIVERSIFICATION OF BYZANTINE ARCHITECTURE

Byzantine church architecture (Figure 2) strongly affected such social changes and, as Mango (1976) reported, middle Byzantine architecture "acquired a distinctive physiognomy." For instance, ecclesial architecture, the most important element of Byzantine architecture, shifted from large earlier churches full of light to later ones that were smaller and darker. Kalopissi-Verti and Panayotidi-Kesisoglou (2010) pointed out 34 architectural types in the middle Byzantine period, as opposed to fewer types in the early Byzantine era. Thus, the famous modernistic aphorism "Form follows function" cannot encompass the proliferation of architectural

types after the standardization of Orthodox doctrine and the arrangement of wall paintings.

ARCHITECTURE AS HISTORICAL EVIDENCE

Even though many such buildings have already disappeared, remaining churches have been documented but not systematically analyzed. These sites often reveal traces of people like patrons, master builders, painters, bishops, and other local people. Therefore, ecclesial architecture offers information about these anonymous people that historical documents often leave out. In other words, the architecture can fill the lacunae left by historical documents.

However, previous studies have overlooked this potential of architecture, and the nature of Byzantine architecture does not lend itself to complex analysis. For example, the complexity of interior space, one of the most important characteristics of Byzantine architecture (Ousterhout 1996), has been underestimated in the predominant two-dimensional analysis. Previous plan-based typologies have distinguished more and more types of church structures but have not examined their relationships. My previous studies have analyzed the cross-in-square churches, one of the most popular architectural types of middle Byzantine architecture, showing that two-dimensional typologies cannot encompass the development of this architectural genre. Still, comprehensive architectural analysis based on design, architectural planning, and construction methods can illuminate its development (Higuchi 2019).

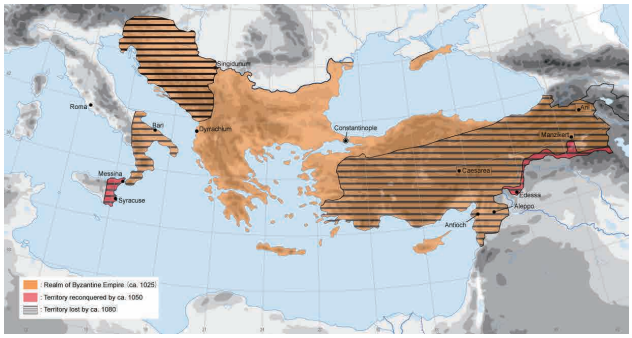

Figure 1: The largest extent of the middle Byzantine empire, 11th century (author, redrawn after J. Haldon, *The Palgrave Atlas of Byzantine History,* London: Palgrave, 2005).

Figure 2: Exterior of the monastery of Osios Loukas, a typical example of middle Byzantine architecture in Greece (10th to 11th century).

RESEARCH FOCUS

This study investigates why middle Byzantine architecture took various forms and to understand the role of churches in middle Byzantine society: in other words, to learn about the people involved in the church through its architecture. As no architectural theory book has survived the Byzantine realm similar to *De architectura* by Vitruvius in Rome, this must be determined based on the remaining buildings. Accordingly, this study analyses more aspects of these churches than previous studies: that is, in terms of design, architectural planning, construction engineering, and environmental engineering.

WHAT ARCHITECTURE REVEALS

Although surviving churches contain various traces of the people who connected with these sites, previous studies have not recorded such traces in detail. Accordingly, this study starts with an onsite survey, recording these remains using 3-D modeling and photogrammetry (cover figure). The inscription gives evidence about patrons. The wall discloses traces of builders cutting activities, wall paintings tell the blushes of the painters, and the arrangement of rooms or artworks evoke the ways churches were used. In this study, I analyze architecture in terms of three phases: architecture: pre-construction, construction, and post-construction. Pre-construction analysis describes the site characteristics, while design and environmental engineering would interpret decisions made by patrons or bishops. Construction analysis gives an account of construction methods, while design and construction engineering help interpret the work of master builders and painters. Post-construction analysis helps tell the story of how churches were used, and architectural planning, design and environmental design as well as the arrangement of wall paintings provides information about users and their activity. Such analyses may clarify the variety of middle Byzantine church architecture, and social and cultural roles of the churches in the middle Byzantine period.

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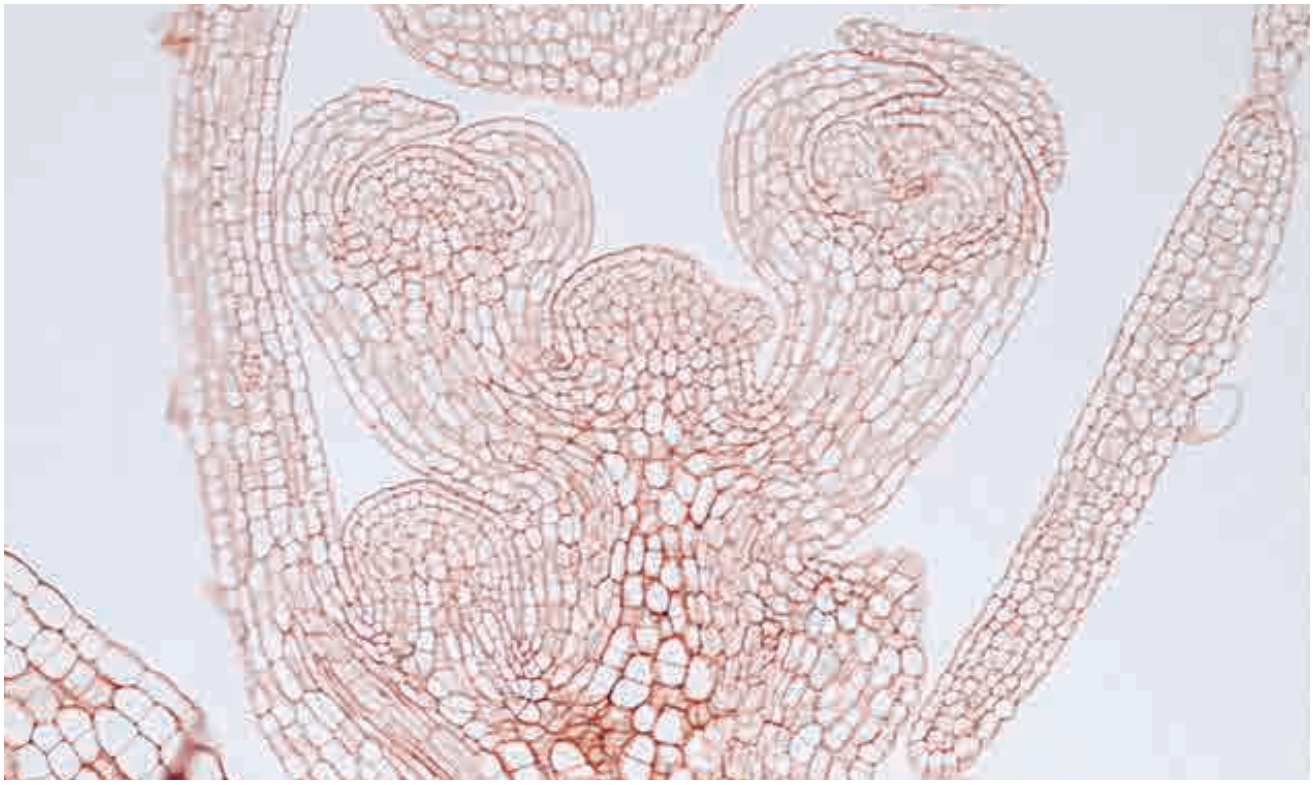
How do Flowering Plants Orchestrate the Growth of the Whole Body for Reproductive Success?



A vertical section of the stem tip of the model flowering plant ***Arabidopsis thaliana*** shows floral organs develop from the shoot apical meristem. The cell walls are stained in red.

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Unlike animals, land plants, which live their whole life at the germination site, need to sense their surrounding environmental changes and develop reproductive organs at the appropriate time for reproductive success. Land plants have thrived by evolving various methods of reproduction and life cycles as a survival strategy. The above-ground organs of flowering plants, including germ cells, are formed from shoot apical meristem, a tissue located at the tip of the stem that contains a pluripotent stem cell population. In this article, I briefly introduce my recent research results on the evolution of male germ cells in land plants and the changes in stem cell characteristics that differentiate germ cells and future research vision.

INTRODUCTION

As land plants are sessile organisms, they need to sense and respond to the surrounding environmental dynamics to form reproductive organs appropriately for reproductive success. The aerial part of plants, such as leaves and flowers, are generated from the dome-shaped shoot apical meristem (SAM) located at the tip of the stem and contains stem cells. In order to form floral organs at the appropriate time, it is necessary to change the identity of the SAM from a leaf-producing vegetative SAM to a flower-producing reproductive SAM in response to environmental changes. The angiosperms that we often see in our daily lives generate pollen as the male parents. In contrast, early-diverging land plants such as bryophytes and ferns use motile sperm as male parents. This evolutional change in sexual reproduction is a trait for reproductive success in arid environments for plants that evolved from water to land. Among land plants, annual plants reproduce only once in their whole life, i.e., reproduction and individual death occur simultaneously, and there are also perennial plants that reproduce multiple times. Immobile plants have evolved a variety of sexual reproductive modes that have allowed them to thrive on land. It is of great interest to understand the mechanisms that plants have acquired for successful reproduction.

IDENTIFICATION OF TRANSCRIPTION FACTORS RELATED TO THE EVOLUTION AND ORIGIN OF SPERM CELLS IN LAND PLANTS

Plants that have advanced from water to land have greatly altered the morphology of their male germ cells to reproduce in arid environments successfully. However, understanding the evolution of reproduction in land plants had not progressed because there had been no research at the genetic level on spermatogenesis in evolutionary basal plants. Therefore, we used a liverwort *Marchantia polymorpha,* which generates motile sperm for sexual reproduction (Figure 1). We found some transcription factors are conserved among *Marchantia* and *Arabidopsis,* which generates immotile sperm cells delivered to egg cells by pollen tube [1]. Based on the results from *Marchantia* studies, we further developed our research on the origin and evolution of transcription factors regulating sperm-cell differentiation. Then we finally found that one of the transcription factors, DUO1, which is the central regulator of *Arabidopsis* sperm cell differentiation, is conserved among sperm cell developing plants. The neo-functionalization of DUO1 is associated with the evolution of sperm morphology in land plant lineage [2]. Using the *Marchantia* as a model for motile sperm differentiation of plants located at the base of land plants, we clarified the evolution of transcription factors involved in the evolving reproduction in land plants.

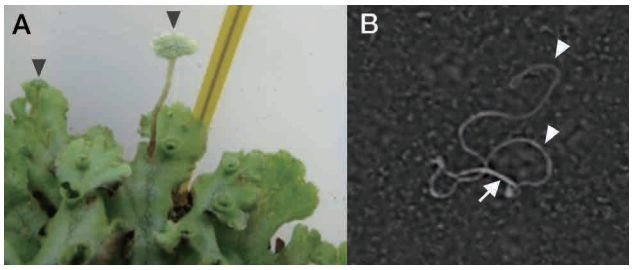

Figure 1: Male sexual branches (arrowheads) are generated at the tip of thalli (A). Motile sperm of *Marchantia* with long nuclei (arrow) and two flagella (arrowheads) (B).

ELUCIDATION OF EPIGENETIC DYNAMICS AND ITS REGULATORY MECHANISM IN RICE STEM CELL TISSUES

The above-ground tissue of flowering plants, including germ cells, is developed from SAM, stem cell tissue located at the tip of the stem. After germination, SAM is in the vegetative stage and generates leaves. Under appropriate conditions, SAM undergoes a phase transition to the reproductive phase (called flowering) and starts to differentiate flowers, including germ cells. During germ cell differentiation, in addition to distinct gene expression changes, the genome is protected by genomic imprinting and epigenetic modifications such as transposon repression and chromatin condensation to ensure safe transmission of the genome to the next generation. We established a unique method to isolate small, leaf-surrounded rice SAM in a short time and with high purity and have conducted various omics analyses. By integrating these results, we have been studying the dynamics of DNA methylation, which is one of the epigenetic modifications and its regulation during flowering. We found that DNA hypomethylation-induced transposon repression in germ cells begins during flowering and that this DNA hypomethylation is regulated by a small RNA-mediated pathway [3]. Previous studies on establishing the distinct epigenetic state of germ cells have focused only on the process of germ cell formation. They have failed to provide a whole picture of DNA methylation dynamics. Our study has shown that epigenetic change for germ cell differentiation begins in the SAM at the beginning of sexual reproduction.

FUTURE RESEARCH VISION

In multicellular organisms, the growth of the entire body needs to be coordinately controlled by signals among different organs. The SAM is considered the receptor of signals from leaves and roots to respond to environmental changes. However, based on the insights of my previous studies, I have come up with the idea that the SAM is not merely a passive tissue but is also a tissue that actively transmits signals to existing organs and integrally controls the growth of the entire plant body. After flowering, systemic growth changes occur, such as accelerated secondary hypertrophy of the vascular xylem, metabolic changes, and initiation of senescence. Still, the mechanism by which factors cooperatively regulate these growth changes throughout the whole body is unknown. I want to find regulators that orchestrate the growth of the plant body for reproductive success.

Acknowledgements

I would like to express my sincere appreciation to Prof. Takashi Araki, Dr. Frederic Berger, Prof. Tomokazu Kawashima, Prof. Hiroyuki Tsuji and all the collaborators.

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Multiple Zeta Values

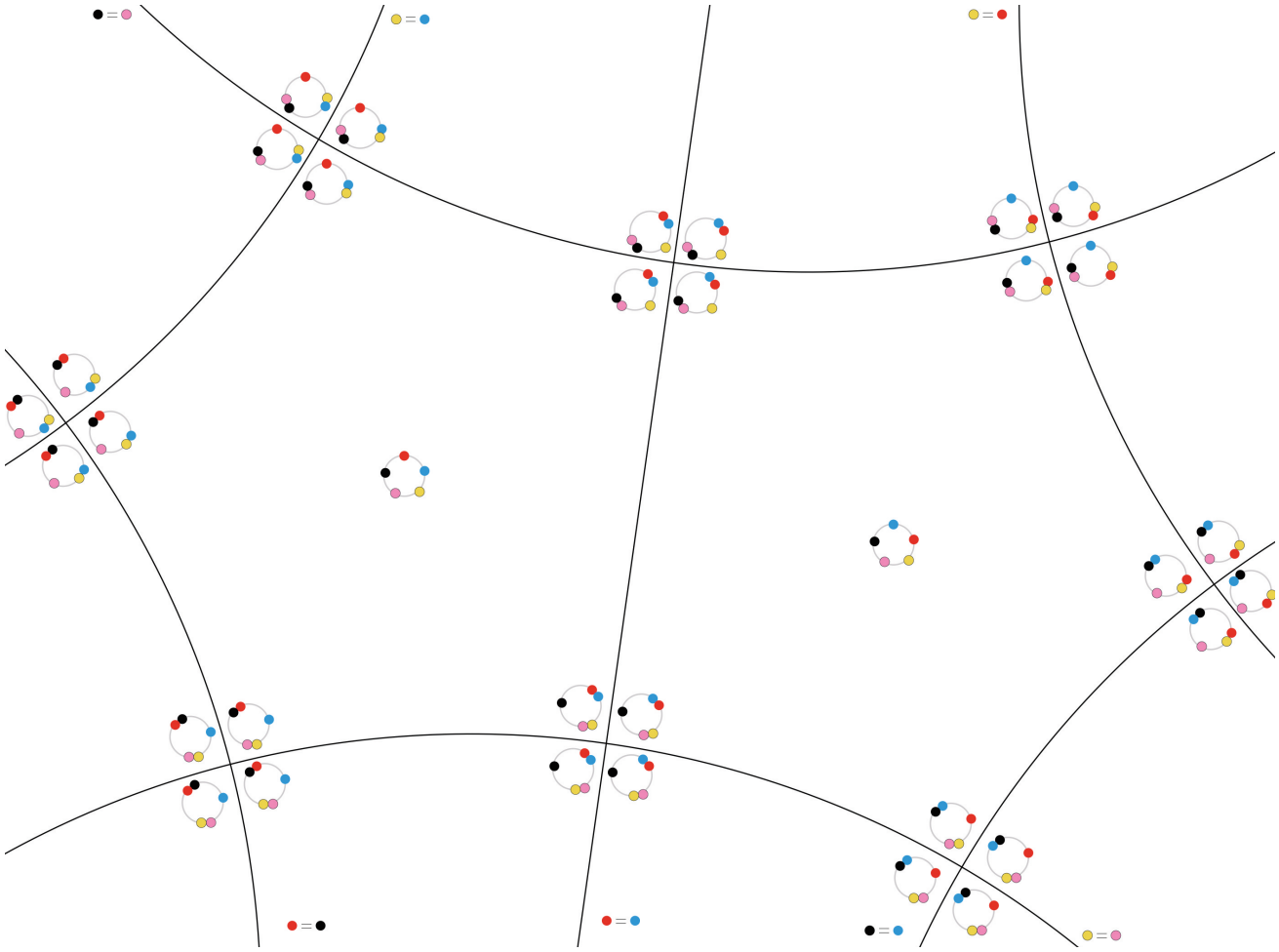

Figure 1: A part of $M_{0.5}(\mathbb{R})$. Very roughly speaking, $M_{0.5}(\mathbb{R})$ is a set of configurations of five points (red, blue, yellow, pink, and black bullets in the figure) on a circle. The whole $M_{0.5}(\mathbb{R})$ is divided into 12 pentagons. Circling any one of them results in many algebraic relations among multiple zeta values.

Minoru HIROSE

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I have been working on multiple zeta values and their surroundings. Multiple zeta values are real numbers defined by simple infinite series. They have rich and deep algebraic structures with connections to various other areas. In this article, I briefly review multiple zeta values and introduce part of my research.

INTRODUCTION

The value of an infinite series has been one of the major research topics in mathematics since ancient times. For example, Mādhava, an Indian mathematician and astronomer from 14th to 15th century, obtained the following formula:

$$1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\cdots=\frac{\pi}{4}.$$

This formula can be shown by using the Maclaurin expansion of the arctangent function. The more non-trivial example is the following formula proved by Euler:

$$\sum_{n=1}^{\infty}\frac{1}{n^2}=\frac{\pi^2}{6}.$$

Using the Riemann zeta function $\zeta(s)=\sum_{n=1}^{\infty}1/n^s$, Euler's formula can be

expressed as $\zeta(2) = \pi^2/6$. Furthermore, Euler also showed that for any natural number k, the values $\zeta(2k)$ can be expressed as the rational multiple of π^{2k}. On the other hand, it is strongly believed that the Riemann zeta values at positive odd integers, i.e., $\zeta(3)$, $\zeta(5)$, $\zeta(7)$, ... do not have such expressions. Multiple zeta values $\zeta(s_1,\ldots,s_d)$ are generalizations of the Riemann zeta values, defined by the following series:

$$\sum_{0<n_1<\cdots<n_d} \frac{1}{n_1^{s_1}\cdots n_d^{s_d}}.$$

Here $s_1,\ldots,s_d$ are positive integers and s_d is assumed to be unequal to one for convergence. Like Euler's theorem, some multiple zeta values are rational multiples of powers of π, but the most multiple zeta values do not have such explicit expression. Instead, the researchers are interested in linear relations among multiple zeta values such like $\zeta(1,2) = \zeta(3)$.

DIMENSION OF MULTIPLE ZETA VALUES

One of the fundamental questions is 'How many linear relations are there among multiple zeta values?'. Regarding this question, Zagier conjectured that the dimension of the $\mathbb{Q}$-linear vector space spanned by multiple zeta values $\zeta(s_1,\ldots,s_d)$ with $s_1+\cdots+s_d = k$ is equal to d_k where d_k is defined by $d_0 = 1$, $d_1 = 0$, $d_2 = 1$, and $d_k = d_{k-2} + d_{k-3}$. Zagier's conjecture implies that there are so many linear relations among multiple zeta values. For example, there are 262144 multiple zeta values such that $s_1+\cdots+s_d = 20$, but there are many relations. At most, there are only 114 linearly independent multiple zeta values. The other 262030 multiple zeta values can be expressed as linear sums of these 114 multiple zeta values. Later Deligne-Goncharov [1] and Terasoma [2] independently proved that the dimension is not greater than d_k. Their result is almost the best possible answer to Zagier's conjecture. The remainder of Zagier's conjecture concerns the linear independence of multiple zeta values, and seems to be out of reach of present-day mathematics.

CONFLUENCE RELATIONS AND PENTAGON RELATIONS

Families of linear relations among multiple zeta values are one of the main topics in studying multiple zeta values. Here, I would like to introduce the confluence relation that I discovered with my collaborator Nobuo Sato [3]. Multiple zeta values can be written as special values of hyperlogarithms

$$I(a_1,\ldots,a_k) := \int_{0<t_1<\cdots<t_k<1} \prod_{j=1}^{k} \frac{dt_j}{t_j - a_j}$$

whose parameters $a_1,\ldots,a_k$ are 0 or 1. The idea of the confluence relation is to consider hyperlogarithms with parameters 0, 1, or indeterminate z. Any such hyperlogarithms can be expanded to a $\mathbb{Q}$-linear sum of multiples of multiple zeta values and hyperlogarithms whose parameters are 0 or z. Then by specializing these expansions, we obtain the linear relations among multiple zeta values, which are confluence relations. The idea of confluence relations is simple, but they are powerful enough to (conjecturally) produce all linear relations among multiple zeta values. Later, Furusho [4] showed that the confluence is essentially equivalent to the pentagon relations of associators. The pentagon relations are relations of multiple zeta values coming from the iterated integrals on $M_{0,5}$ (Figure 1).

MODULAR FORMS

One example of surprising connections of multiple zeta values to other fields is modular forms. Modular forms are functions having rich symmetries. There are several types of connections between multiple zeta values and modular forms, and one of them is Gangl-Kaneko-Zagier's theorem [5]. This theorem says that cusp forms for $SL_2(\mathbb{Z})$ engender linear relations among Riemann zeta values and $\zeta(k,l)$'s where k and l are odd integers greater than one. Here a cusp form for $SL_2(\mathbb{Z})$ is a kind of modular form. For example, the famous cusp form

$$\Delta(z) = q\prod_{n=1}^{\infty}(1-q^n)^{24}$$

gives the following linear relation:

$$28\,\zeta(3,9) + 150\,\zeta(5,7) + 168\,\zeta(7,5) = \frac{5197}{691}\,\zeta(12).$$

Here $SL_2(\mathbb{Z})$ means the symmetry that $\Delta(z)$ has. So, it is natural to ask how about the modular forms with other symmetries. I found an analogy of Gangl-Kaneko-Zagier's theorem for modular forms with other symmetries [6]. Put

$$\zeta_a(k,l) = (-1)^a \sum_{b=0}^{a} \binom{k+b-1}{k-1}\binom{l+a-b-1}{l-1}\zeta(k+b,l+a-b).$$

Then the theorem I found says that cusp forms for Γ_A engender linear relations among Riemann zeta values and $\zeta_k(l+1,1)$'s where k and l are positive odd integers. For example, the most basic cusp form for Γ_A is the square root of $\Delta(z)$

$$\Delta^{1/2}(z) = q^{1/2}\prod_{n=1}^{\infty}(1-q^n)^{12},$$

and this modular form engenders a linear relation

$$6\,\zeta_1(4,1) - 6\,\zeta_3(2,1) = 11\,\zeta(6).$$

It seems that this is the first non-trivial example of the analogy of Gangl-Kaneko-Zagier's theorem for modular forms other than $SL_2(\mathbb{Z})$. There are many kinds of generalizations of modular forms for $SL_2(\mathbb{Z})$ or Γ_A, but whether there are analogies of Gangl-Kaneko-Zagier's theorem for them is unknown.

Acknowledgements

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Toward New Theory of Folk Beliefs in Southeast Asia: How Are Indigenous Beliefs Syncretic with Foreign Religions?

Figure 1: A Thai woman tying 3-color fabric around one of the Pillar Imitations in Bangkok City Pillar Shrine.

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My research investigates and explains the dynamics or contemporary development of folk beliefs in Southeast Asia through case studies of the syncretism of indigenous beliefs and foreign religions in Thailand. It is a common phenomenon of a substratum of Mainland Southeast Asian societies since the 20th century. Through observing such phenomena that do not fit into prevailing religious frameworks and conducting a comparative study of field investigations across mainland Southeast Asian countries, my research tries extending new theories of folk beliefs in Southeast Asian studies.

INTRODUCTION

From the beginning of the 20th century to the present, immigration has progressed, and various foreign cultures have fused with local culture in the urban area of Thailand. In the aspect of religion, the folk beliefs that the Indian immigrants or Chinese immigrants brought are syncretic with the indigenous beliefs of Thai people, which shows a unique dynamic of Thai religion. My research target, the synergism of the city pillar shrine (called "lak muang" in the Thai Language), which is a worship of the god of the land, is one such phenomenon. Thai people recognize the city pillar shrine as an indigenous belief and sacrifice it with a special ceremony as indicated in Figure 1. However, according to my direct experience in Thailand, the worship of lak muang is syncretic with various foreign religions around it, such as Theravada Buddhism, folk beliefs originated from Han-Chinese culture and Hinduism, etc. For instance, there is a syncretism between the lak muang shrine and the worship of the city god brought in by Chinese immigrants in Bangkok. This is also consistent with the fusion of belief of Han nationality and ethnic belief among Dong people (an ethnic group belongs to the Tai-Kadai language family) that I have investigated so far in

South China and the syncretism of Shinto and Buddhism (Shinbutsu-shugo) that I have seen in various parts of Japan.

Previous research on Thai religion has analyzed folk beliefs and Buddhism, based on a static schema of functional divisions that situated Buddhism on a higher level [1]. In recent years, some scholars have tried to transcend this static research pattern and began to pay attention to more dynamic non-Buddhist factors [2, 3], such as the worship of the gods of the land, spirit worship, or worship of and sacrifice to the spirit medium in Buddhist societies. Moreover, most studies divided folk beliefs into indigenous beliefs and foreign religions and grasped them separately. However, this research regarded spirit worship like the city pillar shrine as a pure indigenous belief, without paying enough attention to the situation of its syncretism with foreign religions, so that the inner reality of folk beliefs themselves has not been explored thoroughly.

Therefore, to clarify the actual situation of the contemporary development of Thai folk beliefs, I conducted a field investigation in urban Thailand, where indigenous beliefs are usually syncretic with immigrant religions because of the large influx of immigrants. The research also tries expending new theory and field of studies of folk beliefs in Thailand by referring to the theory and approach of the syncretism theory in Japan (the Shinbutsu-shugo ideology). Previous studies have grasped the related research within a unified nation or a single ethnic group and have not paid enough attention to cross-cultural research. Thus, my research makes efforts on reexamining the perspective with the comparative study between Southern China and Southeast Asia. Through these, I aim to build a theoretical model of the folk religion in Asia, a world of multi-cultural coexistence, and contribute to Southeast Asian studies and South China studies. The following are some results.

CASE IN BANGKOK

To achieve the research purpose mentioned above, I mainly focused on the City God Temple of Chinese immigrants enshrined in Bangkok and Teochew (a city in Guangdong Province, China). I carried out a field investigation and comparative study on the worship of the God of the Land of these immigrants with that of their hometown. According to the previous investigation, the guardian spirit (called "Lau Ya" in Teochew) found in every local village in Teochew had been brought into Bangkok by the Chinese immigrants since they reside in the city. Moreover, they worshiped this temple as equivalent to the city pillar shrine.

Figure 2: A Teochew Temple worships Sia Ueng Kong (Chinese city god) located in Bangkok Chinatown is called Chao Pho Lak Mueang Shrine by Thai people.

The City God Temple in Bangkok Chinatown (see Figure 2) is the god of the land brought by Chinese immigrants from their birthplace Teochew. This temple was built and enshrined near the sea, protected the peace of their early migration, and played important roles as the local temple in Teochew. Especially when people were dead, they had to report it to the city god and sent the remains back to their hometown by ship. Some Chinese immigrants who live in Chinatown or surrounding areas still worship in the prayers of business today. The interesting point of this temple is that it is considered identical to the Bangkok city pillar shrine by Thai people.

CASE IN CHIANGMAI

Compared with central Thailand, many ethnic groups in the northern part immigrated from neighboring countries. Because of the weak influence of national power, their folk beliefs retain more characteristics of their original residence. Here is an example. A village in the Pasang District of Lamphun Province named Ban Vieng Vong is where the first Yong (an ethnic group of Burma) settled in northern Thailand. Although the Yong immigrants reinforced their ritual power and social stratification after arriving there, their oldest monastery shelters the four guardian spirits of their former Muang Yong in Burma, which they took with them when they resettled. As shown in Figure 3, these four sacred idols named suranna, pittiya, lakkhana and thewada, have been symbolized as white stone elephants. The Yong people worship and appease these spirit beings and see their identity and history as a people intricately bound up with the safe transport of these idols from their original homeland. Even when Thai spirit worship develops in this Yong habitation this day, these guardian spirits keep functioning as the lak muang thrine, and their worship and sacrifice remain active.

Figure 3: The guardian spirit of the Shan who moved from Burma is brought in and enshrined in the temple of Lamphun Province, Thailand.

As what we can see in the synergistic phenomenon of the city guardian spirit in Bangkok and Chiangmai, when moved and inhabited into urban areas in Thailand, foreign immigrants also brought the beliefs of their homeland with them to the local community. These beliefs have either been integrated with the existing local beliefs that performing a similar function, or expressed in new forms under the influence of Thai culture. Therefore, I think it is necessary to inquire into the similar reality between the indigenous beliefs and foreign religions in the future.

Acknowledgements

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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 Field : Ancient Greek History

Research Interests

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 Field : Molecular Plant Physiology, Phytohormone

Research Interests

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 Field : condensed matter physics (experiment)

Research Interests

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 Field : Political Sociology, Politics

Research Interests

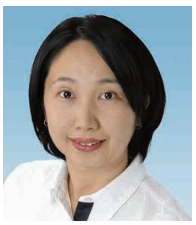
My research can be mapped out in an intersection of the following three major elements; political sociology, gender and Japan / UK. Political Sociology is my disciplinary background. In particular, I developed a keen interest in the studies on governmentality. As for gender, I have long been interested 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 Field : Egyptian Archaeology, Pyramid, 3D Survey

Research Interests

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 Field : Plant Physiology, Plant nutrients

Research Interests

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 Field : Observational Cosmology, Astronomy

Research Interests

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.

Naoshi
SUGIYAMA
Steering Committee

Affiliation : Vise President of Nagoya University / Director of NAIAS / Professor of the Graduate School of Science
Research Field : Cosmology, Astrophysics, Structure Formation in the Universe

Research Interests

I am working in the field of cosmology to understand dark components in the Universe. The Universe is known to consist of various components including atoms, photons, dark matter and dark energy. The ultimate goal of modern cosmology is to understand the nature of dark matter and dark energy. Since dark matter plays an essential role for the formation of structure through gravity, and dark energy controls expansion of the Universe itself, both have significant impact on structure formation in the Universe. Utilizing the observation data of structure of the Universe, including galaxies, clusters of galaxies, large-scale structure of the Universe, and temperature fluctuations of cosmic microwave background radiation, which is a fossil of big bang in the very early Universe, I try to reveal the nature of dark matter and dark energy.

Mitsuru
SUGIMOTO
Steering Committee

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

Research Interests

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 Field : Biochemistry, Glycobiology

Research Interests

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 Field : Photoresponsive polymer thin films

Research Interests

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 Field : nanobioscience, biomedical engineering

Research Interests

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 Field : History of Science and Technology

Research Interests

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 Field : History of Social Thoughts

Research Interests

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

Yasuro
ABE
Visiting Professor

Affiliation : Visiting Professor at Nagoya IAR
Research Field : Medieval Japanese Culture and Texts

Research Interests

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 Professor

Affiliation : Visiting Professor at Nagoya IAR / Professor at Nanzan University
Research Field : International Economics

Research Interests

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.

YLC
Program Faculty

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

Kazuhide
SATO
Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

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 Field : Particle Physics, Astrophysics

Research Interests

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.

Hidenori TAKEUCHI

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

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.

Shingo KAZAMA

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

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.

Teppei KITAHARA

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

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 Field : Quantum gravity

Research Interests

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 Field : Plant Molecular Physiology, Biochemistry

Research Interests

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.

Hiroki FUJINO

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

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.

Ai SUGIE

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

Research 1: 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 Field : Solar Physics, Space Weather

Research Interests

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 Field : Condensed matter physics (theory)

Research Interests

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 Field : Molecular biology, Plant reproduction

Research Interests

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.

Aaron CHAN

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

I research in the representation theory of algebras and related structures, which originates from the approximating (i.e. `representing') abstract mathematical objects using linear algebra. I am particularly interested in tilting theory. This studies different methods in modifying a category of representations in a way that preserves homological properties. I am also involved in a similar theory-cluster-tilting theory-which is a theory in the algebraic analogue of resolution of singularities.

Angela MENESES-GUTIERREZ

Young Leaders Cultivation Program Faculty (YLC)

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

Research Interests

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.

Daichi KASHINO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Science
Research Field : Astrophysics

Research Interests

The present-day Universe contains a variety of elements and is a rich world in which stars, galaxies, and life exist. I aim to understand the material evolution in the Universe. We are especially paying attention to a phenomenon called cosmic reionization that completed until about 1 billion years after the Big Bang. Cosmic reionization is a phenomenon in which the Universe, which was initially filled with electrically neutral hydrogen gas, was ionized by the ultraviolet rays emitted by stars and galaxies born in the early Universe, and is the first step in material evolution. We are carrying out various observations using large telescopes to understand the physical process of reionization.

Shunsuke KOSAKA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Humanities
Research Field : History, Ancient Roman, Late Antiquity

Research Interests

I am studying the history of the Roman Empire in Late Antiquity (c. 3rd to 8th centuries CE). My research subject is the historiographical work written by Ammianus Marcellinus (late 4th century) and the city of Rome, where the author lived and composed his writings. I am trying to clarify the social and political background of the text as well as the author's view against them.

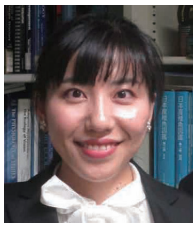
Tomoya NAKAYAMA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Bioagricultural Sciences
Research Field : Animal physiology, Molecular biology

Research Interests

In temperate zones of the earth, dynamic environmental fluctuations occur at the annual seasonal cycle. To cope with these seasonal changes, many animals adapt their physiology and behavior. Although some of these seasonal activities, such as reproduction, growth and hibernation are known to be controlled by endogenous annual rhythmicity, which is called circannual rhythm, in some animals, the molecular mechanism is still unknown. We use medaka fish as a model to understand this mechanism.



Hanako HAGIO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Bioagricultural Sciences
Research Field : Fish Neuroscience

Research Interests

Two ascending visual pathways to the telencephalon are present in mammals. However, some species of fish possess two visual pathways, while others one pathway. Our studies in several fish species suggest that the common ancestor of actinopterygians possessed two pathways, and later one pathway was lost in the common ancestor of acanthopterygians, which include many fishes for fisheries. We try to elucidate functions of visual pathways using genome editing and microscopic live imaging analyses on visually-evoked neural activities. We would like to find visual stimuli attractive for fishes and utilize its characteristics in fishing gear to contribute to the academic field and fisheries industry.

Hisashi HAYAKAWA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Institute for Space-Earth Environmental Research
Research Field : Space Weather, History, Solar Activity

Research Interests

Hisashi Hayakawa is working on historical space weather events and long-term solar activity based on the contemporary analog records. He consults analog records for sunspots, solar flares, geomagnetic measurements, and auroral sightings to reconstruct chronology and intensity of the space weather events, namely sequence of solar flares, interplanetary coronal mass ejections, geomagnetic storms, and auroral displays. He also analyses historical sunspot records to quantitatively reconstruct and improve long-term solar variability. Thus he chronologically extends the time series of the existing scientific databases for centuries and quantitatively contextualises the modern data into longer time series.

Manabu BESSHO-UEHARA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Science
Research Field : Biology, Evolution, Bioluminescence

Research Interests

Bioluminescence, light production by living organisms, is one of the most common traits of the animals on the Earth (75-90% of macroscopic individuals in the ocean can emit light). Bioluminescence evolved among diverse taxa independently, which is the best model to study evolution. The molecular mechanisms involved in the light emission are poorly understood except for a few well-studied animals. In addition, I recently discovered kleptoprotein, stealing protein from the prey, for bioluminescence. I study the molecular mechanisms involved in the luminescent reaction, luciferin and luciferase, to understand extreme convergent evolution of bioluminescence.

Toshiki MATSUSAKA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Mathematics
Research Field : Number theory

Research Interests

Modular forms are vital objects in classical and modern mathematics. This theory plays a crucial role as a bridge between number theory, topology, harmonic analysis, arithmetic geometry, combinatorics, representation theory, mathematical physics, etc. My research interest is investigating the roles of its generalization called "non-holomorphic modular forms" in this wide range of fields. In particular, I have been working on it from the viewpoints of number theory and knot theory.

Qidong ZHOU

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Science
Research Field : Particle physics and astrophysics

Research Interests

Dark matter, matter dominance universe, there are phenomena still could not be explained by the current framework of theory in particle physics, the standard model (SM). To explore the new physics beyond standard model, it is a useful approach to precisely measure the decay reactions under the environment just like the beginning of our universe which is created by colliding-beam accelerator. Belle II is an experiment dedicated to explore new physics beyond SM based on this approach. It has already started collecting data since April 2018. I am preforming the detector upgrade and data analysis in parallel. In coming years, these data will help us to understand the origins of matter and the universe.

Shinnosuke ISHIZUKA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Institute for Space-Earth Environmental Research
Research Field : Laboratory Atmospheric and Astrochemistry

Research Interests

Nano to sub micrometer sized particles is ubiquitous in the nature and play central roles in chemical evolution. Cosmic dust diffused into interstellar space act as catalyst providing complexed molecules and are building blocks of the solar system. Aerosols in Earth's atmosphere impact the climate system by light absorption and scattering and by promoting cloud formation. However, little attention has been paid for specific-chemistry of the fine particles. We experimentally reveal how the tiny characters affect their lives.

Matthew Paul SU

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Science
Research Field : Mosquito neuroscience and behavior

Research Interests

Male mosquitoes rely on hearing to locate females for mating. Novel control tools which interfere with mosquito hearing are thus highly promising, as they could prevent copulation from occurring. However, our understanding of the underlying bases of mosquito audition remains poor. My research focuses on the elucidating the molecular and neuronal bases of mosquito hearing behaviors in order to improve this understanding. In particular, I am interested in the connections between mosquito mating, hearing and their circadian clocks, as these clocks influence the time at which mating can occur.

Sotaro SUGISHITA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Science
Research Field : Quantum Gravity, Quantum Field Theory

Research Interests

My research field is theoretical physics, with a particular interest in quantum gravity, a quantum theory of spacetime. Quantum gravity provides a theoretical explanation for the mystery of how our universe begins. The theory describing our universe is still under construction. Holography is the hypothesis that a quantum spacetime emerges like a hologram from a low-dimensional spacetime. We have not understood well the mechanism of this hypothesis and to what extent we can use it. I am working on the holography from various points of view to construct the theory of quantum gravity.

Yuichiro TADA

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Science
Research Field : Early Universe

Research Interests

My main interest is physics of the early stage of our universe. In particular, I have so far focused on inflation, the accelerated expansion preceding the hot Big-Bang universe. I have proposed a novel analysis approach to inflation with use of mathematics of random noise called stochastic calculus. Primordial black hole is also my research topic as a direct consequence of particular dynamics of the early universe. I'm also working on several production mechanism of gravitational waves

Ryo HIGUCHI

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Humanities
Research Field : History of Architecture

Research Interests

While the framework of Orthodox Christianity and wall painting was standardised during the middle Byzantine period (9th–12th centuries), the forms of the architecture followed various types while the churches themselves had different roles. The purpose of my study is to investigate why middle Byzantine architecture took various architectural forms and to understand the role of the churches in Byzantine society, through a detailed and comprehensive analysis of surviving architecture.

Asuka HIGO

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Center for Gene Research
Research Field : Plant development, Sexual reproduction

Research Interests

Annual plants need to orchestrate the growth and death cycle of whole body to end the sexual reproduction before dying. The signals and receptors for this important regulation is totally unknown. I want to identify the integrator secreted from the stem cell tissue and its receptor and also understand the evolution of plant life cycle variation : annual vs perennial plants.

Minoru HIROSE

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Mathematics
Research Field : Number Theory

Research Interests

I am working on multiple zeta values and its surroundings. Multiple zeta values are concrete numbers defined by simple infinite series, but their algebraic structure is deep and interesting. Also, multiple zeta values are related to various areas such as mixed motif theory, Lie algebras, absolute Galois groups, knot theory, fundamental groups of moduli spaces, modular forms, calculations of amplitudes in string theory, and so on.

Jie HUANG

Young Leaders Cultivation Program Faculty (YLC)

Affiliation : Designated Assistant professor at Nagoya IAR and Graduate School of Humanities
Research Field : Cultural anthropology

Research Interests

My research interest lies primarily in the cultural anthropology studies on the dynamics or contemporary development of folk beliefs in Southeast Asia countries. My research mostly focusing on the syncretism of indigenous beliefs, with foreign religions in the substratum of Mainland Southeast Asian societies from the 20th century to the present. Through case studies of the syncretism of the city pillar shrine and other folk beliefs in urban Thailand, my research tries extending new theories of folk beliefs in Southeast Asian studies.

Because of concerns due to the coronavirus disease 2019 pandemic, some annual plans have been canceled or postponed. Nonetheless, Nagoya University's Institute for Advanced Research (IAR) accelerates to organize several online events in 2021.

IAR Symposiums

IAR symposiums are aimed at communicating the established, novel, and cutting-edge research of Nagoya University to all of its members. Usually, we focus on two different fields: first, literature and social science and, second, natural science and engineering. The first symposium of this series has been held on January 22, 2021. The title of this symposium was "Worth and Contribution of Academic Discipline—Impacts of the Research and Dialogs." We had a guest speaker Dr. Susumu ANNAKA from the Waseda Institute for Advanced Study (WIAS). Three researchers from Nagoya University gave talks. The second symposium has been held on June 23, 2021, focusing on biology and medicine. The title was "A new perspective to 'observing lifes'—advanced technology and philosophy." Four speakers from Nagoya University gave talks.

Nagoya University Initiative Webinar

Since 2020, IAR and the Institute of Innovation for Future Society have jointly hosted a special online webinar to have better communications between fundamental and applied sciences. This year, we had two webinars. The first webinar was held on July 29, 2021, titled "Life and Artificial Intelligence." Two Young Leaders Cultivation (YLC) faculties from IAR and two professors from Institute for Innovation gave a talk. The second webinar was held on December 13, 2021, titled "Dialogue between physicality and Advanced Technology." Two professors from both institutes gave talks. For both symposiums, we had a fruitful panel discussion to promote the interaction not only between the two institutes but also among the audiences from Nagoya University.

UBIAS ICA 1 Online Course Published

The online class material "Off the Clock: The Many Faces of Time" has been published in Coursera. This is the significant outcome from the first UBIAS Intercontinental academia workshop, which is jointly organized by Nagoya IAR and the University of Sao-Paulo in 2015 and 2016. As of the end of 2021, more than 700 people around the world has learned the course.

UBIAS ICA 4

The 4th University-Based Institutes for Advanced Study (UBIAS) Intercontinental Academia has been held with the title of "Intelligence and Artificial Intelligence." Professor Toshio Fukuda (Meijo University/IEEE president), a former IAR faculty, gave a public seminar as a mentor, and Professor Yasutomo Kawanishi (RIKEN), a former faculty at Nagoya University, was awarded as the participant of the workshop. The introductory workshop was held online in June 2021, and the main workshops were held in Paris from October 18 to 27, 2021. The workshop in Belo Horizonte will be held from November 7 to 16, 2022, both in-person and online.

UBIAS Directors' Conference 2021

On April 12–14, 2021, UBIAS's online conference participated by directors worldwide was held. The Institute for Advanced Study at Aix–Marseille University (IMéRA) virtually hosted the 6th Directors' Conference. Nagoya IAR has long played a central role as a steering committee of UBIAS. Dr. Suto, director of Nagoya IAR, has been elected as co-chair of the steering committee, so-called "Triumvirate" (coordination team), together with the directors in Marseille and Ghana.

2021 Young Leaders Cultivation Program

The YLC program is a strategic program of Nagoya IAR on the basis of the premise that it is crucial to secure an appropriate quantity and quality of young researchers to sustain the development of outstanding education and research in the future. Nagoya IAR recruits and trains young faculty members regularly and systematically. In the academic year 2021, Dr. Jie Huang (Graduate School of Humanities), Dr. Ryo Higuchi (Graduate School of Humanities), Dr. Sotaro Sugishita (Graduate School of Science), Dr. Yuichiro Tada (Graduate School of Science), Dr. Minoru Hirose (Graduate School of Mathematics), Dr. Shinnosuke Ishizuka (Institute for Space-Earth Environmental Research), Dr. Asuka Higo (The

Center for Gene Research), and Dr. Su Matthew Paul (Graduate School of Science) 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 each other's research interests to assist interdisciplinary collaboration research. The 24th YLC seminar was virtually held on March 23, 2021. Dr. Manabu Bessho-Uehara (Graduate School of Science) talked about " How a fish steals a light from its prey" and Dr. Hisashi Hayakawa (Institute for Space-Earth Environmental Research) talked about "Tentative reconstructions of extreme space weather events using historical archival records." The 25th YLC seminar was also virtually organized on June 22, 2021. Dr. Yuki Sato (Graduate School of Science) talked about "Do wormholes matter for your universe?" and Dr. Aaron Chan (Graduate School of Mathematics) talked about "Surface triangulation and its categorification." The 26th YLC seminar was organized both in-person and online on December 14, 2021. Dr. Daichi Kashino (Graduate School of Science) talked about "Evolution of galaxies and intergalactic gas," and Dr. Tomoya Nakayama (Graduate School of Bioagricultural Sciences) talked about "Towards understanding the seasonal adaptation mechanisms in vertebrates."

YLC Collaborative Research Grant

The YLC collaborative research grant was launched in 2018 to support interdisciplinary collaboration between YLC faculty. YLC faculty voluntarily organized the grant contents, schedule, and selection process. In this year, YLC selected two research groups; one was led by Dr. Hisashi Hayakawa (Institute for Space-Earth Environmental Research) with the title "Feasibility researches on the quantitative environmental history: a case study for the crisis of the 17th-century and its comparison with other historical crises." The other group was represented by Dr. Ai Sugie (Graduate School of Environmental Studies) with the title "Analysis of structural problems concerning harassment during fieldwork and establishment of security measures."

IAR Freshmen Lecture Series

Targeting first-year students of the Nagoya University, this lecture series includes lectures delivered by members of the IAR Academy, IAR Faculty members, IAR Fellows, and Nagoya University researchers. The series was aimed at communicating the fun of academic research. In the academic year 2021, the following 14 lectures took place online:

1. **"Science Started from Observation,"**
by Professor Sumio Iijima
(Guest Professor of Nagoya University and Professor of Meijo University)
2. **"The Research History of Particle Physics,"**
by Professor Makoto Kobayashi
(Director of the Kobayashi Maskawa Institute and 2008 Nobel Laureate in Physics)
3. **"The Dark Matter of the Universe,"**
by Professor Naoshi Sugiyama
(Graduate School of Science, Director of NAIAS and Vise-President of Nagoya university)
4. **"Material Science—Fun and Useful,"**
by Professor Ichiro Terasaki
(Graduate School of Science and Deputy Director of Nagoya IAR)
5. **"The Present in Historical Studies: Excavate the Hellenism Civilization,"**
by Professor Yoshiyuki Suto (Graduate School of Humanities, Director of Nagoya IAR)
6. **"How to Use Contemporary Economics,"**
by Professor Jiro Nemoto (Graduate School of Economics)
7. **"Visualize—Science About the Blessing of Nature,"**
by Professor Ryo Kohsaka (Graduate School of Environmental Studies)
8. **"Analyze Democracy,"**
by Professor Hiroko Takeda (Graduate School of Law and Deputy Director of Nagoya IAR)
9. **"Fascination with an Introduction to the History of Thought,"**
by Professor Takaho Ando (Chuo University/Sixth Director of Nagoya IAR)
10. **"Next-Generation Bio-imaging,"**
by Professor Shigehiro Yamaguchi
(Graduate School of Science and Institute of Transformative Bio-Molecules)
11. **"Genome Breeding to Solve the Food Crisis,"**
by Professor Makoto Matsuoka (Graduate School of Bioagricultural Sciences)
12. **"Are Chemically Reacting Molecules 'Visible'?"**
by Professor Akiyoshi Hishikawa (Research Center for Material Scienc)
13. **"Chemistry of Anthocyanin—Make It Bloom the Blue Roses,"**
by Professor Kumi Yoshida (Graduate School of Informatics)
14. **"How Is the Brain Formed? Research on Cell Development,"**
by Professor Takaki Miyata (Graduate School of Medicine)

Awards

Dr. Takahiro Seki (Professor of Graduate School of Engineering) received The Japanese Photochemistry Association Special Lectureship Award (September 2021).

Dr. Atsushi J. Nishizawa (IAR faculty) received the Publication of Astronomical Society of Japan Excellent Paper Award (March 2021).

Dr. Ryo Higuchi (YLC/Graduate School of Humanities) received the Architectural Institute of Japan, Young Researcher Award 2021. (September 2021)

Dr. Kazuhide Sato (YLC/Graduate School of Medicine) received The Young Investigator Award of the Japanese Association for Molecular Target Therapy of Cancer (May 2021), Encouraging Prize of Japan Bioindustry Association (July 2021), Masao Horiba Awards (July 2021), and Kondou Kinen Academic Encouragement Award 2021 (December 2021).

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