INSTITUTE FOR ADVANCED RESEARCH
LETTER
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Special interview

Operating a complex system as if it were part of himself? High-precision on-campus production has established his research style that is unique in the world.

Hiroki ROKUJO

What is a baby really like? What can one learn about babies and families through numerous encounters and in-depth sharing with them?

Masako NAGATA

Pure intellectual curiosity and matching advanced abilities — the strengths underlying a researcher who continues to lead his field

Hitoshi SAKAKIBARA

Research Highlights

Topological Phase Transitions in Low-dimensional Multicomponent Superfluidity
Koichiro FURUTANI

Reconstructing the History of Exchange Between the Indian and Kanji Cultural Spheres through Interdisciplinary Research
Naiqi LI

Burying the Dead: Funeral Practices and the Relationship Between the Living and the Dead in West Asian Neolithic Societies
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Interplay between flavor and collider physics to probe new physics
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Multiscale Modeling and Simulation of Polymer Degradation, Decomposition and Fragmentation
Takato ISHIDA

Position-independent refinement of vagus sensory-motor wiring
Takuya KANEKO

Terpenoids and biological membrane evolution
Yosuke HOSHINO

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NAGOYA UNIVERSITY
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The Showcase for Advanced Research and Development of Research Person of Talent

— Voyage for New Standards of Academia —

The Institute for Advanced Research (IAR), Nagoya University, was established in 2002 to promote the world's top-level research, and to contribute widely to society through the outstanding research outcomes. The IAR is among the first such organizations established in Japanese universities with the first director Prof. Ryoji Noyori. The IAR has since maintained promoting especially in Nagoya University's pure research from a broad perspective that transcends the conventional disciplinary boundaries. Today, the mission has expanded to include the promotion of academics at the Nagoya University, support for excellence in research, developing the next generation of central research and researchers, and conducting international research exchanges. The IAR aim to promote exploring the new research field as worthy of one of the world's leading research universities. We have been hosting IAR lectures and seminars, including the Nagoya University Lectures, delivered by eminent researchers, to whom the president of Nagoya University awarded special lectureship. The IAR has been also serving as a steering committee member of the University-Based Institutes for Advanced Study (UBIAS) which is the international network of the other institutions of this sort around the world. Furthermore, the IAR has been encouraging early-career researchers to be the next generation's leaders through the Young Leaders Cultivation (YLC) program and Young Researcher Unit. As Nagoya University aims to become one of the world's leading research universities in the framework of Tokai National Higher Education and Research System, the IAR aims to further expand the functions as a hub for research information and human resources, and as the showcase of research, research activities, and the development of research personnel. I keenly look forward to your continued support with your guidance and encouragement for the IAR.

Kunio AWAGA

Kunio AWAGA

Director of Institute for Advanced Research

Director
Kunio AWAGA

23
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LETTER

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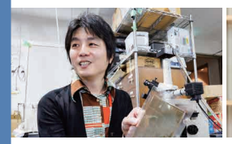





Cover Picture : GRAINE project, 2023, scientific balloon launch, JAXA

Special Interview 1

Hiroki ROKUJO

Assistant Professor, Advanced Measurement Technology Center (AMTC), Institute of Materials and Systems for Sustainability / Fundamental Particle Physics Laboratory, Graduate School of Science, Nagoya University

Dr. Rokujo observes gamma rays with the originally developed nuclear emulsion technology in the Gamma-Ray Astro-Imager with Nuclear Emulsion (GRAINE) project he leads. He has also developed many of the elemental technologies and instruments necessary for the project.

Operating a complex system as if it were part of himself? High-precision on-campus production has established his research style that is unique in the world.

Going on a photo-shooting trip with his handmade silver halide camera to an unexplored corner of the universe...

This is not a fairy tale or science fiction, but the imagery Dr. Rokujo has been passionately pursuing through his research since its beginning. Now that his experiments have reached a sufficient level of precision, he is getting close to exploring the frontiers of astronomy that no one has ever ventured into.

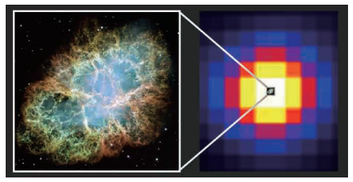
"We have been developing our own ideas, making mistakes, and moving forward one step at a time. Our circle of members has been expanding. Now is the time. Starting from scratch, we have been improving our research across the board."

Dr. Rokujo's research dates back to around 2007, when he was an undergraduate student. He operated equipment to observe particles (such as alpha rays, beta rays, and muons, which are invisible to the naked eye but are flying around us all the time) for the first time as part of his in-class experiment and felt firsthand the existence of cosmic rays, particles penetrating the building and raining down on his class. "It was a total shock," he says, looking back.

"Besides, they reach here all the way from outer space. I said to myself, 'What in the world is going on?'"

The next questions he asked were where they came from and how they could be observed. As he researched, his attention was drawn to gamma rays, a type of light. There are various types of light, including the visible light that we see daily and X-rays used for X-ray photography. Of these, gamma rays have the highest level of energy and this means that tracking gamma rays can lead to information on high-energy celestial objects, such as black holes. Just when Dr. Rokujo was becoming increasingly interested in this subject, the Fermi Gamma-ray Space Telescope, a satellite designed to observe gamma rays, was launched in 2008. Its numerous reports carrying new information on high-energy celestial objects scattered around the vast universe fascinated him.

One major obstacle to gamma ray observation is low resolution. He wondered if he could find a brand-new way to observe gamma rays that would completely break away from the conventional approach. This is how his career as a researcher began.



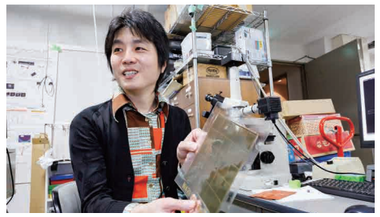
The photo on the left shows the Crab Nebula (NASA, ESA, J. Hester, A. Loll [ASU]). It is a supernova remnant in the constellation of Taurus and is about 6500 light-years from Earth. The photo on the right is an image taken by the Fermi Gamma-ray Space Telescope centered on the Crab Nebula.(1) A copy of the left-hand photo scaled down to match the right-hand photo is superimposed. This shows the low resolution of the current gamma ray observation.

(1) A. A. Abdo et al. (2010). Fermi Large Area Telescope Observations of the Crab Pulsar And Nebula. Astrophysical Journal, 708: 1254

In the forefront of technology with the age-old craftsmanship of silver halide camera

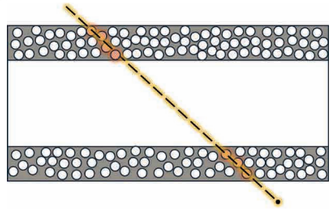
"Our technology has the potential of realizing experiments that have never been possible in the previous big projects."

Dr. Rokujo has set his eyes on nuclear emulsion film or, simply put, silver halide film. It is a plastic film coated on both sides with an emulsion mainly consisting of gelatin and silver bromide (AgBr). Electricity-charged cosmic rays react upon striking silver bromide crystals, leaving traces, which can then be recorded.

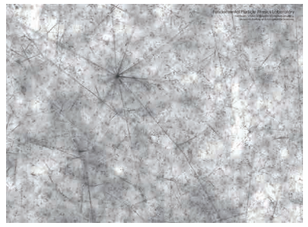


Dr. Rokujo holding a nuclear emulsion film

One difference between nuclear emulsion and ordinary silver halide films is that the former has an added thickness due to the coated emulsion layers. Although it is thin, approximately 0.05 mm on each side, it is thick enough to record the trajectory of a particle about 1 micrometer (0.001 mm) or less in width. The thickness makes it possible to capture the trajectory of a particle three-dimensionally, enabling scientists to accurately read from which direction the particle came, and this is a major feature not found in other technologies.



This drawing illustrates a cross section of a nuclear emulsion film. The white circles represent silver bromide crystals, surrounded by gelatin filling each layer. The three-layered structure (emulsion-plastic-emulsion from the top to bottom) three-dimensionally records the trajectory of a particle as a sequence of reacted silver bromide grains (red circles in the drawing).



Magnified microscopic photos of a nuclear emulsion film: a total of 25 photos arranged in five vertical rows and five horizontal rows to form a 0.5 mm x 0.7 mm square. Within this small area, many trajectories are found. From the point in the upper left center, lines extend radially, indicating collisions of particles in the film.

Previously, researchers manually copied trajectories left on nuclear emulsion films in a highly labor-intensive manner while looking at them through a microscope. In the 1990s, digital cameras appeared and automated this process, greatly expanding the use of nuclear emulsion films. At the same time, however, the rapid development and spread of digital cameras also proved to be an unexpected blow: the companies that developed and manufactured silver halide film have been withdrawing one after another from the film manufacturing business. As a result, nuclear emulsion films indispensable for experiments are no longer available. This is how Prof. Mitsuhiro Nakamura (retired in March 2024, now Professor Emeritus), who took over the leadership of the laboratory in 2010, decided on on-campus production of nuclear emulsion film from scratch.

One major challenge involved in this production was making the emulsion agent mainly composed of silver bromide and gelatin. Although it may sound simple, it was not easy to realize stable high-quality production. This challenge was overcome thanks to cooperation from researchers of a company that was conducting R&D on film at that time. They generously offered assistance to the laboratory, breathing new life into the knowledge and technology that were about to be lost amid changes of the times.

"They were excellent researchers responsible for the company's sizable share in the global market. Their knowledge and enthusiasm were outstanding, and they were willing to share with us, regardless of our inexperience."

By combining various techniques such as the precise addition of silver ions and bromide ions, accurate temperature control, and careful stirring, the laboratory successfully manufactured an emulsion. As a result, Nagoya University has become the only research institution in the world capable of developing nuclear emulsion films.

Emulsion production system: Silver ion and bromine ion liquids are set separately in the four columns in the back. They pass through the tubes while being precisely temperature-regulated to be carefully stirred and mixed in the container, which Dr. Rokujo is checking by hand in the photo. Then, the emulsion is completed.

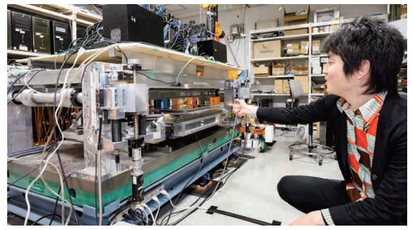
This system has made it possible to regulate with precision nuclear emulsion films, the key component of experiments, according to desired conditions. For example, the one developed by Dr. Rokujo for gamma-ray observation is characterized by 0.075-mm-thick emulsion layers, that is, thicker than usual, achieved with the use of a thickening agent. This thickness is necessary because gamma rays can pass through an emulsion layer without reaction if it is too thin, but too thick a layer is difficult to develop. Many other factors are taken into consideration, and adjustments are made with precision.

The on-campus production of nuclear emulsion films has been a great success. Soon the laboratory began receiving an increasing number of inquiries, and a mass production system was called for. The laboratory responded by developing and operating equipment for emulsion production and film coating with a capacity 30 times the original system. Dr. Rokujo has directed these developments.

"I make sure to operate the system in the laboratory while knowing who is doing what in each process. This way it is easy to figure it out when a problem or failure occurs."

Dr. Rokujo can operate the system as if it were part of himself because it is original technology developed with the utmost care step by step. He has thus developed a research style that is unique in the world.

Nuclear emulsion film coating system: the laboratory has developed this system in-house, which applies emulsion automatically onto films that travel on a belt conveyor, instead of coating films manually one by one. The system keeps the thickness of emulsion layers uniform and even performs optimized drying.



High-speed nuclear emulsion read-out system, Hyper Track Selector 2: One of the laboratory's key technologies, it reads tracks on developed nuclear emulsion films at the world's fastest speed, automatically converting results into data.

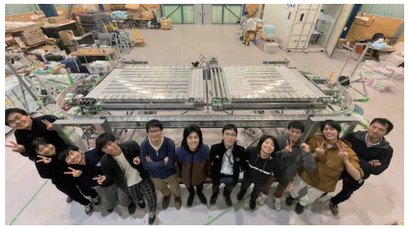
Skyward with everyone's dreams

Dr. Rokujo has been participating in the Gamma-Ray Astro-Imager with Nuclear Emulsion project (GRAINE), a research project for precision gamma-ray observation since his student days, and it also represents his current pivotal research theme.

"I have been developing all sorts of things to realize gamma-ray observation."

Gamma rays do not reach the ground on Earth because they are blocked by the atmosphere. So a balloon comes into the picture. A balloon carries nuclear emulsion films to an altitude of about 35 km above ground, where the atmosphere is thin, and flies horizontally for one to two days while gamma ray traces are recorded. The balloon is dropped once sufficient data are accumulated. The balloon launch site is located in Alice Springs in the Northern Territory in Australia. The vast plains in this area enable the balloon to be retrieved on land after dropping.

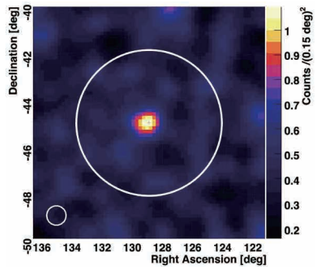
A gondola storing nuclear emulsion films, weighing about 700 kg in total, is lifted by a crane truck and taken to the launch site. For the outer membrane of the white capsule, a tent membrane like ones used for the roofs of domed stadiums is used to reduce weight. The capsule is inflated by increasing the internal pressure.



Inside the gondola, researchers and students who participated in the balloon experiment: Each of the two units on the left and right is stacked with 100 layers of nuclear emulsion films for recording. The gondola is also equipped with devices for measuring the gondola position and tilt and the time to enable accurate analysis of gamma rays leaving traces on the films in terms of time and direction of their origin.

At 6:32 a.m. local time on April 30, 2023, a balloon packed with cutting-edge technologies was released. (The front cover of this issue features a photo of the balloon immediately after the release.) At 15:30 p.m. local time on May 1 of the same year, the gondola was safely recovered at the drop site. The nuclear emulsion films were sent to Japan, and the reading and analysis of gamma ray traces are currently being performed.

Within the framework of the GRAINE project, a balloon experiment has been conducted in 2011, 2015, 2018, and 2023. The 2018 experiment, which was about one-sixth the size of the latest experiment, was already successful in its observation of celestial objects, achieving a much higher resolution than that of the Fermi Gamma-ray Space Telescope.[2] Even greater achievements are expected from the analysis of the 2023 experiment results currently underway.



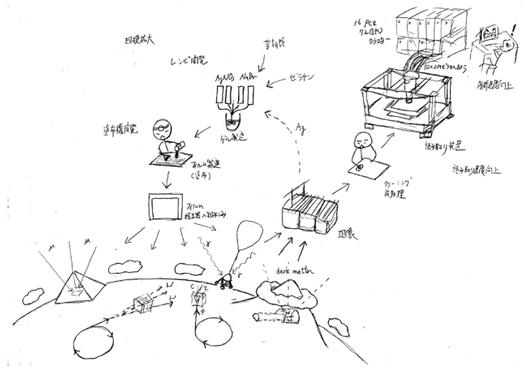
Refer to Figure 21 in the cited paper.[2] This image visualizes high-energy gamma-ray observation data centered on the gamma-ray emitting celestial object "Vela Pulsar" in the Vela constellation. When observed using the conventional resolution method, the outline of the celestial body becomes blurred to the size of the large white circle in the center. The smaller white circle in the lower left represents the size of the outline achieved in this study, demonstrating that the source can be pinpointed with more than 40 times the precision.

(2) S. Takahashi et al. (2024). First Emulsion γ-Ray Telescope Imaging of the Vela Pulsar by the GRAINE 2018 Balloon-borne Experiment. Astrophysical Journal, 960: 47

"F-Lab" on the world map of research

Dr. Rokujo belongs to the Fundamental Particle Physics Laboratory, which is commonly known as "F-Lab." Its members form a solid team that contributes to research projects around the world using nuclear emulsion films. They are now used not only for gamma ray observation in the GRAINE project but also in a wide range of applications, including the observation of neutrinos, dark matter, and the interior of pyramids.

"Research using nuclear emulsion films is diversifying. The number of presentations at the Physical Society of Japan relating to nuclear emulsion films has tripled in the last decade. We are determined to continue exploring new observation possibilities that nobody has done before."



This is an illustration by Professor Emeritus Mitsuhiro Nakamura showing, on the lower left side, how nuclear emulsion films are used all over the world, while nuclear emulsion film production and analysis processes are described on the upper right side.

あらゆる装置は身体の一部？細部にわたる内製化による、世界で唯一無二の研究スタイルの構築

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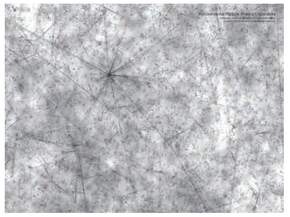
名古屋大学 未来材料・システム研究所 / 大学院理学研究科
基本粒子研究室（F研） 助教

独自技術の原子核乾板を応用し、主にガンマ線観測を行う。宇宙ガンマ線精密観測計画、通称GRAINE計画（Gamma-Ray Astro-Imager with Nuclear Emulsion）を主導。必要な要素技術や装置の開発も数多く手がけている。

「これまでの巨大プロジェクトでは到底できないような実験を、自分たちのテクノロジーならできる。そんな可能性を秘めています」

ブラックホールや超新星残骸といった高エネルギー天体からのガンマ線を、従来法よりはるかに高い精度で捉えるために六條さんが使用するのは原子核乾板（げんしかくかんぱん）というフィルム。プラスチック板の両面に、ゼラチンと臭化銀（AgBr）を主とした乳剤を塗布したもので、簡単に言うと銀塩フィルムだ。

実はこの原子核乾板、今や簡単に購入することはできない。デジタル技術の普及にともない、銀塩フィルムの開発、製造を行っていた企業が続々と撤退したためだ。それでも使い続けるのには理由がある。たとえば、乳剤層に片面約0.05ミリメートルの厚みを持たせていること。非常に薄いように思えるが、およそ1マイクロメートル（0.001ミリメートル）以下の細さの飛跡を記録するには十分な厚さだ。ガンマ線がどの方向から飛来したのかを三次元で正確に読み取れるのが他の技術には無い大きな強みだ。



原子核乾板の顕微鏡画像を拡大したもの。縦に5列、横に5列、計25枚の画像をつなぎ合わせ、縦0.5ミリメートル×横0.7ミリメートルの大きさに仕上げている。この狭い範囲にもたくさんの飛跡が刻まれている。写真中心左上の点から線が放射状に延びており、原子核乾板の中で粒子同士がぶつかったことがわかる

六條さんが所属する基本粒子研究室、通称F研は、原子核乾板が入手困難になった逆境をチャンスに変えた。様々な苦労を乗り越え、フィルムの製造、現像、解析の全てを研究室内で行える体制を整えたのだ。そのうち、たとえば最新型の乳剤製造装置や原子核乾板塗布装置の開発を指揮したのは六條さんだ。これらによって、各実験の条件に合わせ、乳剤層の厚さ や臭化銀の密度などを自由自在にカスタマイズできるようになった。

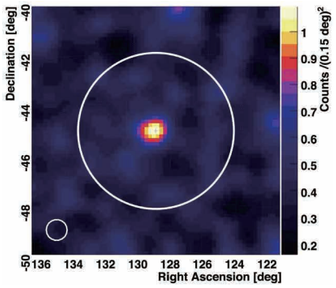
「各工程で誰が何をしているか把握しながら研究室で運用しています。トラブルや失敗が起こっても、すぐに見当がつきます」

乳剤製造装置。奥に4本並んだ柱に銀イオン、臭素イオンの薬液を別々にセットする。正確に温度管理されながらチューブを通り、六條さんの手元下の容器で丁寧に混合、攪拌されて乳剤が完成する

原子核乾板塗布装置。一枚ずつ手塗りするのではなく、ベルトコンベヤー式で自動的に乳剤を塗る装置を自前で開発した。乳剤層の厚みを均一にコントロールしつつ、最適な乾燥まで行う

一つずつ、丁寧に開発してきたオリジナル技術だからこそ、まるで身体の一部のように動かせる。世界的にもユニークな研究スタイルが確立していった。六條さんが学生のころから参加し、現在最も軸足を置いている研究テーマである宇宙ガンマ線精密観測計画、通称GRAINE計画（Gamma-Ray Astro-Imager with Nuclear Emulsion）でも研究成果が出始めている。原子核乾板を気球に乗せ、大気の影響を受けづらい高高度でガンマ線を観測する実験だ（本誌表表紙に気球実験の様子の写真を掲載）。2018年には、これまでの方法では実現しえなかった精度でガンマ線天体を撮像することに成功(1)したのだ。F研の独自技術が、世界でもトップレベルの研究成果を次々と生み出している。

「原子核乾板を用いた研究が多様化しています。日本物理学会での関連発表件数は10年前に比べて約3倍になりました。今後も前人未到の観測に挑戦していきたいです」



引用論文[1]中、図21参照。「ほ座」のガンマ線放射天体「ベラパルサー」を中心として、高エネルギーガンマ線の観測データを可視化した画像。従来法の解像度で観測した場合、中央の白い円の大きさまで天体の輪郭がぼやけてしまう。左下の白い円が今回の輪郭の大きさで、線源を40倍以上の精度で絞り込めることを実証した

(1) S. Takahashi et al. (2024). First Emulsion γ-Ray Telescope Imaging of the Vela Pulsar by the GRAINE 2018 Balloon-borne Experiment. Astrophysical Journal, 960: 47

Special Interview 2

Masako Nagata

Psychological Development and Family Division, Psychological Support and Research Center for Human Development, Graduate School of Education, Nagoya University

Prof. Nagata specializes in perinatal to early childhood family support and clinical care for developmental disorders. She is also an NBAS Master Trainer certified by the Brazelton Institute. In addition to writing and presenting her research papers, she has produced an educational DVD titled "Supporting Babies and Mothers: What Observation Can Show Us" (in Japanese) and organizes a range of training programs to accumulate and disseminate her clinical knowledge. In April 2024, Prof. Nagata was appointed Vice President at Nagoya University.

What is a baby really like? What can one learn about babies and families through numerous encounters and in-depth sharing with them?

"Surprisingly, people don't know much about babies."

What would it take to really get to know a baby? Needless to say, we are not entirely ignorant about or powerless vis-à-vis babies. In fact, we have learned to save many babies' lives over the years. In Japan, about 27% of newborns died around 1950.(1) Today, the percentage is down to 0.8%.(1) While the work should continue until the ultimate goal of 0% is attained, we can fully appreciate changes in the social environment, medical advances, and the tireless efforts by healthcare professionals that have brought about the progress.

And the birth of a new life is the beginning of life. As the rate of newborns being saved increased, a new area of research came into focus around 1990: a study of mothers and fathers who grow as persons along with their babies and support for them and others around them. Paying close attention to the baby's innate strengths and accumulating and sharing resultant findings—these endeavors constitute steps to truly getting to know a baby.

(1) e-Stat (Japanese government website publishing statistical data), Vol. I, 6-2, "Annual data on the number of neonatal deaths by sex and neonatal mortality rate (per 1,000 live births), sex ratio of neonatal deaths and the percentage of neonatal deaths among infant deaths" (survey conducted in 2023, published [updated] on September 17, 2024).

Simply being there can provide moral support

When Prof. Nagata was a student, she was a member of a research group studying university-based support for children with severe mental and/or physical disabilities and their families. Through the group's activities, she met many parents in challenging situations.

"They told me how hard it was just after their children were born, how they simply wished for someone who would listen to them."

In those days, the healthcare community, especially in medical institutions that had many cases of premature babies requiring special care and support, was gradually realizing the need for psychologists who would look after mother-child mental health, which could not be fully covered by medical professionals alone. In 1995, upon completing graduate school, Prof. Nagata entered the field, the neonatal intensive care unit (NICU) at a general hospital, with which she had built ties through her previous

activities. At that time, however, she only worked on a voluntary basis once a week because neonatal psychological care was still in its infancy with no fixed posts.

Things were not easy on the ground. In those days, psychologists without medical qualifications were in a limbo of a sort. While physicians and nurses busily performed their medical duties, babies kept crying, and the parents were only given extremely limited visiting time with their babies. Psychologists were not allowed to touch the babies or treat them in any way. Prof. Nagata recalls: "I just felt helpless, and it was like this for a long time." Even so, she was grateful that she had been accepted as a psychologist; otherwise, it would have been impossible to set foot in the NICU. She was encouraged by the doctors who worked alongside her and her supervisors who said: "Hang in there; you're doing something important. Do what you believe is necessary; I'll take full responsibility for whatever you do."

"So I said to myself: I can't run away; the parents won't run away from their babies."

Here is a story of a family that Prof. Nagata cannot forget. A baby was born at the 25th week, weighing less than 1,000 grams. The baby had intracranial hemorrhage, and intensive medical care was provided. On the fourth day, the mother asked for the discontinuation of treatment. This upset the medical professionals, who were feeling hopeful about the baby's vitality. They wondered: Should we give up on this life? However, Prof. Nagata touched the mother's heart at that time. She thought she heard in the words the mother squeezed out amid so much pain and emotion, with no easy way out, the most sincere appreciation of the baby's life.

"In the past, my baby might have been stillborn. He is alive now, attached to a life support system and with a lot of medical attention. You may say it's the baby's vitality. But how can you say that when in fact he can't stay alive on his own without a respirator? The medical team's mission may be to save life no matter what, but the life saved, we must live it ourselves, with permanent disabilities, for good. How could you say, 'We've done our job, now it's your turn'? I feel like throwing these chairs at the incubator, and I don't care if that kills my child..." (2)

The mother was in full acceptance of this small, fragile life that could disappear at any moment, so much so that the immense weight of this baby's life was palpable to everyone present.

"'I want to take him home... I want to place him between us on our bed, to sleep together like many families do. But that will kill him,' said the mother and broke down." (3)

The mother did not ask for the discontinuation of medical care without serious thought. The medical team and the psychologist worked out a plan to secure a place where the parents could spend time with the baby. The baby would eventually go home to live with the parents, although the brain damage would remain.

A psychologist's role in cases like this is to closely accompany the parents in a way that leads to concrete support measures. This is the essence of a psychologist's role, which cannot be fulfilled otherwise. It is not easy for a psychologist to build a relationship of trust that allows the baby's mother, father or other parental figure to share their innermost feelings, having taken a deep look at themselves. In the case cited, Prof. Nagata began by meeting and listening attentively to the mother, who had earlier been evaluated to be a straightforward person. She stayed by the mother's side and listened to her during her meetings with the medical team. She accompanied the mother during her visits with the baby and later discussed with her any perceptible change in her behavior. If the parents fell silent during the meetings, she shared that silence with them, patiently waiting for them to gather their thoughts. She stayed with them, even if no words came out. She went through this process over and over again and shared her findings with the medical team. Eventually, the baby went on to live with the parents, as a family.

Prof. Nagata says: "What a privileged role I play. There are cases where the parents seem to reject me during the most difficult period, and years later when I run into them, they tell me that my presence and words back then actually brought them a lot of support and comfort. When I hear such remarks, I feel encouraged, feeling that my work has not been for nothing."

(2) *Inochi to mukiaukoto, Kokoro wo kanjirukoto –rinshosinri no genten wo toraenaosu* Supervised by Shuji Goto, and co-edited by Masako Nagata and Miwako Hori, Nakanishiya Shuppan, published on May 24, 2023, p.34 - 35
(3) Ibid., p.35

The babies and the parents are all right.

Prof. Nagata became more seriously interested in babies after having worked at the hospital as a volunteer for a year, observing babies and their diverse strengths and personalities. The timing was good since she had just been hired as a part-time clinical psychologist and become determined to make it her career.

She looked for objective ways to observe babies in great detail, and the Neonatal Behavioral Assessment Scale (NBAS),

developed by Dr. T. Berry Brazelto, a pediatrician, came into the picture. She had heard of the method through her research and headed for Nagasaki to attend an NBAS training course at Nagasaki University. The course was a by-product of Dr. Brazelton's visit to the Goto Islands in Nagasaki Prefecture for his comparative culture research.

As babies develop, they become aware when someone is talking to them and learn to tilt their head, turning their attention to the person. Normally, babies get increasingly better at this. Such a seemingly natural yet important gesture is among many signs of infant development, which could be overlooked. NBAS is used to observe a baby's, especially a newborn's, state of development by focusing on four main aspects of development: autonomous nervous system balance, motor performance, the regulation of sleep, wakefulness, and other states of consciousness, and the ability to interact with the outside world.

A scene from the educational DVD "Supporting Babies and Mothers: What Observation Can Show Us": the baby is turning its head to Prof. Nagata as she says "Look this way."

What do the stress signs that a baby shows mean? What responses are necessary, and when? Posing such questions makes it much easier to understand a baby's behavior than if a baby is vaguely observed. Sharing this kind of information within the family also makes it possible for the entire family to closely evaluate the baby's personality and growth. Prof. Nagata continued to clinically apply NBAS, engage in activities to disseminate it, and use it as a research method. In May 2024, she was officially certified as an NBAS Master Trainer by the Brazelton Institute at Boston Children's Hospital.

In recent years, progress has been made in risk management concerning babies' and mothers' wellbeing, including the prevention of abuse and postpartum depression. Meanwhile, too much emphasis on the risk aspect of infant development and parenting can only add to families' anxiety. Some parents wonder if they are in a bad way simply because a psychologist wanted to talk to them. Prof. Nagata hopes to see positive changes in the way young parents deal with babies and receive support.

"To be sure, there are risks for both the baby and the parents. Still, I hope people realize that they are in fact very powerful. Instead of just worrying about the risks, I want people to know that they can get off to a good start by having a warm, caring heart."

Research on babies up to now and going forward

Some 30 years have passed since Prof. Nagata began her activities, and the importance of perinatal psychological care is being recognized today, as attested to by the placement of psychologists in 80 to 90% of the healthcare establishments providing perinatal care. In 1997, six people, including Prof. Nagata, formed a small group called the Perinatal Clinical Psychologist Network, which has now spread nationwide with a total of 241 members as of March 2023. The younger generation of psychologists trained and active in respective regions across the country is gaining power and playing central roles in the Network.

For any type of organization, however important its activities may be, it is not easy to start from scratch and expand to such a scale. Among the numerous endeavors that Prof. Nagata has taken up along this long path are writing research papers and presenting them at scientific conferences.

"You can't change the situation just by mumbling about your work to those around you. Evidentiary accumulation has been essential."

Strongly encouraged by her superiors at the hospital, Prof. Nagata continued her research in parallel with her clinical duties. Her many research achievements include some large-scale surveys, such as a study of the relationship between infants' temperament and child-rearing stress, with the presence/absence of siblings and birth order taken into consideration,(4) and a study of the relationship between maternity blues and maternal attachment to babies born in normal full-term birth.(5) Incidentally, she met the founding members of the Perinatal Clinical Psychologist Network at the scientific conferences she attended. Her vigorous research and communications have certainly changed the situation.

Nevertheless, given the persistent difficulty in collecting data, research on newborns is still considered to have just begun.

"I still learn a lot by listening to specialists from various domains, including medicine, psychology, and neuroscience. In this sense, I think perinatal psychological care represents an interdisciplinary research field where people from many different domains can get together for discussion. I would like us to put our findings together to build a solid body of knowledge to determine what influences newborns' development in what way and what kind of support should be provided and how, to achieve what outcomes."

Therefore, Prof. Nagata intends to continue clinical care and learn from it while pursuing research to improve clinical care.

"I believe good research is about taking something intuitively understood on-site but couldn't quite put into words, and systematically theorizing or documenting it so that everyone can say, 'Yes, that's exactly it!' I hope to continue such research."

(4) Shuji Honjo, Rie Mizuno, Miyoko Ajiki, Atsuko Suzuki, Masako Nagata, Yumie Goto, Takanori Nishide (1998). "Infant temperament and child-rearing stress: birth order influences". *Early Human Development*, 51: 123-135
(5) M. Nagata, Y. Nagai, H. Sobajima, T. Ando, Y. Nishide1, S. Honjo (2000). "Maternity blues and attachment to children in mothers of full-term normal infants". *Acta Psychiatrica Scandinavica*, 101: 209-217

赤ちゃんって、いったいどんな存在？ たくさんの繋がりとともに深く向き合う中で、何が見えてくるのか

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周産期～乳幼児期の家族支援および発達障害の臨床を専門とする。Brazelton Institute公認NBASマスタートレーナー。研究論文の執筆、発表に加え、教育研修用DVD「赤ちゃんとお母さんを支える～観察することで見えてくること」の制作や各種研修をはじめ、臨床知見の蓄積、普及を行う。2024年4月より名古屋大学副総長も務める。

「皆さん、意外と赤ちゃんのことを知らないのです」

赤ちゃん自身が生まれ持つ力にしっかりと目を向けること。それだけでなく、赤ちゃんとともに成長するお母さんやお父さんをはじめ、周りの人たちと向き合い、支援すること。赤ちゃんを本当の意味で知るために、こうした全てを永田さんは積み重ねてきた。

活動現場の一つ、新生児集中治療室。サポートが必要な小さな赤ちゃんが多く生まれる現場だ。ここでは、母子のメンタルヘルスケアをはじめ、医療者だけではカバーしきれない役割を心理職が担っている。こうした心理職は現在、周産期医療の8～9割の場で活躍している。しかし、本格的な導入が始まったのは、実は1990年代以降のこと。この流れを切り拓いた一人が永田さんだった。

1995年に大学院を卒業したのち、週1回のボランティアから始まった。当時は決まった役割がなく、医療の資格を持たない心理職の立場は宙に浮いていた。「ただただ、どうしていいものやら」という日々だったそうだ。それでも、永田さんはあきらめなかった。

「逃げちゃだめだと思っていましたね。だって、家族は逃げられないのですから」

小さく生まれた赤ちゃんの生を受け入れていくことは、決して簡単なことではない。生死をさまようことも多く、無事に峠を越えても障害が残る可能性がある。そのような状況の中で、母や家族が自らと深く向き合い、そこに波打つ感情に目を向ける苦しさは並大抵のものではない。心に寄り添い、信頼関係を築き、具体的な支援につないでいくこと。他の立場では担えない心理職の役割がここにある。

「なんて役得、と思います。当時は背を向けられたような方にも、何年後かに会ったとき、『実はあのとき声をかけてもらって本当はすごい支えになっていた』と言われると、無駄じゃなかったんだと思えます」

病院にボランティアとして飛び込み、1年がたったころ。いろんな赤ちゃんが持つ力や個性を見る中で、赤ちゃんのことをもっと知りたい、と思うようになった。ちょうど非常勤として採用され、現場の心理職として続けようと腹をくくったタイミングだった。赤ちゃんを客観的に、より詳しく見る方法はないか。そこで登場するのが、ブラゼルトン新生児行動評価（NBAS：The Neonatal Behavioral Assessment Scale）。主に自律神経系のバランス、運動機能の成熟のようす、睡眠と覚醒をはじめとした意識状態の調整、そして外界と関わる能力の4つの観点から、特に生まれたばかりの赤ちゃんを観察する。ただ漠然と見るよりも断然、赤ちゃんの反応を理解しやすくなる。たとえば赤ちゃんは、自分が声をかけられたことに気づき、うまく首を傾け、そちらに意識を向けるようになる。それがだんだん上手になる。当たり前のようで、見逃しがちなサインでも、立派な成長の証だ。

教育研修用DVD「赤ちゃんとお母さんを支える～観察することで見えてくること」のワンシーン。「こっち、こっち」と声をかける永田さんに、赤ちゃんが顔を向けている

臨床現場の活動と並行して、永田さんは論文執筆と学会発表も積極的に行った。

「ボソボソつぶやくだけでは現状は変わりません。エビデンスの積み重ねが大事でした」

こうした活動により、全国で同じように活動していた心理職との出会いにもつながった。1997年、永田さん含め当時6人で、「周産期心理士ネットワーク」の立上げを行った。現在、2023年3月時点で総会員数241名の規模まで成長している。精力的な研究と発表が、確かに状況を変えたのだ。

それでも今なお、新生児の研究はデータを蓄積するのも難しく、まだまだ始まったばかりだそうだ。

「医学、心理学、神経科学など、いろんな分野の先生の話を聞くと、今でもすごく勉強になります。その意味で、たくさんの人が集まって議論し合える、学際的な研究分野なのだと思います。皆で知見をすり合わせながら、なにがあの子たちの発達に影響していて、どういうふうに、いつから支えてあげればどう育っていくのかということを、しっかりとまとめていきたいですね」

Special Interview 3

Hitoshi Sakakibara

Department of Applied Biosciences, Graduate School of Bioagricultural Sciences, Nagoya University

Prof. Sakakibara's research focuses on the mechanism of signal transduction between plant cells, including a plant hormone called cytokinin. Selected as a "Highly Cited Researcher" by Clarivate Analytics every year since 2014, he has been at the forefront of his field. He was decorated with the Medal with Purple Ribbon in November 2023.

Pure intellectual curiosity and matching advanced abilities—the strengths underlying a researcher who continues to lead his field

Prof. Sakakibara loved experiments as a graduate student. He belonged to a laboratory with a free-spirited atmosphere and spent hours immersed in experiments every day. His research supervisor was sincere and open-minded about the results his students produced. He did not talk down to them, and his praises were genuine. Prof. Sakakibara recalls when he told the research supervisor his intention to go on to the doctoral course, although not totally sure of himself. The supervisor simply said: "Oh, yes. You've made up your mind. Good." The supervisor looked very happy, which reassured the student. In 1990, he entered the doctoral course, embarking on a researcher's journey.

The supervisor, Emeritus Professor Tatsuo Sugiyama of Nagoya University, was a researcher willing to explore new fields. In those days, the Faculty of Agriculture had an unofficial culture of the division of research fields whereby researchers remain in their strictly defined area of specialization. However, Prof. Sugiyama was in favor of freely crossing over the disciplinary boundaries when he felt it was necessary.

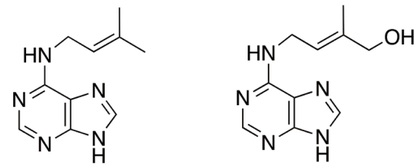
"It is hard to make a breakthrough if you stick to your own way, avoiding other areas and technologies you are not familiar with. I am glad I inherited Prof. Sugiyama's approach, which has turned out to be very positive for me."

Prof. Sakakibara's research style, which he developed as a doctoral student, is flexible, involving frankly pursuing what interests him without being constrained by prefixed methods. He has overcome numerous challenges and solved many problems thanks to this style.

Delving into an unknown territory by combining two areas and approaches

In the late 1990s, the field of gene and genome research blossomed as a result of the accumulation of scientific knowledge and technological advances, triggering fierce competition among researchers. A genome refers to the entirety of all genetic information of an organism, its blueprint of a sort. Genes make up part of this blueprint. ("Genome" is a coined word combining "gene" and "ome," which means "totality.") The decoding of genomes and genes had a great impact on the research community, and expectations were high. Prof. Sakakibara discovered several important genes in plant genomes, but in the face of raging competition among scientists all over the world, he felt that such approaches were not enough.

Genetic research can be a powerful tool to learn about living organisms. For this reason, many research projects were conducted, narrowly focusing on the genetic approach and absorbing enormous amounts of intellectual, technological, and human resources. Yet, what happens inside a living organism is extremely intricate and complex. Molecules of varying sizes, created based on the genetic blueprint, undergo numerous chemical reactions to change, develop a form, and maintain themselves. Genetic information alone does not explain many phenomena inside a living organism. Prof. Sakakibara delved into this area of uncertainty. To explain what he did about the plant hormone called cytokinin, for example, compare the two molecules below and look for differences.



(I) (II)

Above are structural formulas of cytokinin; there are many types of cytokinin that are found in different organisms and perform different functions. (I) is isopentenyladenine and (II) is transzeatin.

They have only one difference: the presence or absence of "OH" in the upper right corner. This difference is so slight that you might want to call it an error, but the fact is that plants cannot grow normally unless these molecules are produced differently. They are produced in the plant root and signal the absorption of nutrients to the leaves, stems, and flower buds, thus giving the green light for growth. The signaling does not go well without the function of "OH."

The photo shows *Arabidopsis thaliana* (thale cress) grown in a laboratory for 37 days. The rightmost plant is a mutant without "OH" and is noticeably smaller than the others (L-R: wild *type, cyp735a1* mutant, *cyp735a2* mutant, *cyp735a1cyp735a2* double mutant). The photo is from Fig. 2 (E) in the paper referenced below.[1]

The plants are known to have a gene to produce a protein that serves as a tool to attach "OH." However, it was impossible to tell which one was the "tool" simply by looking at the genes. Even if the gene for the "OH"-attaching tool protein were identified, that alone would not lead to the elucidation of the mechanism in detail, discovering the specific molecular form and when and where in the body the protein works. Today, the tool protein is known as and named "CYP735A." Prof. Sakakibara's research group is credited with both its discovery and the elucidation of its mechanism. This research achievement was possible because the group was able to combine the knowledge of genetics with high-precision chemical analysis.

"In the Department of Agricultural Chemistry, I had already learned the basics of chemical analysis. As a research scientist, I had learned not to be complacent about the results without solid confirmation at the material level. I have been able to stay in a leading position in my field probably because I have been able to combine genetics and chemical analysis well."

Prof. Sakakibara also thinks that his affiliation with RIKEN at that time greatly helped the development of his chemical analysis method. Full-time specialized technicians at the institute made it easy to accumulate know-how through collaboration. The researchers' ideas coupled with the technicians' high-precision skills enabled the birth of a method that was needed at the forefront of research. To illustrate how essential precision is, note that enhancing accuracy with which molecules, such as cytokinin, are extracted and detected leads to the reduction of the quantity of samples needed for experiments. This improvement is highly significant for scientists in the laboratory because cytokinin, although essential for plant growth, is only present in trace amounts, and the preparation of plant samples in large quantities can be difficult if the target plant section is a part of the stem tip. Around the year 2000, plant samples were required for research in the quantities between 10 and 100 grams, whereas by 2009 technical improvement changed the unit of quantity required to 10 to 100 mg.[2] Further improvement is still being made today, reducing the required quantity to 0.1 to 1 mg in some cases.

"I am grateful that RIKEN provided me with the research environment that enabled us to develop a technology that can be properly reproduced by any researchers. We still work with people there, and we still maintain the highest technical standards."

(1) Takatoshi Kiba, Kentaro Takei, Mikiko Kojima, and Hitoshi Sakakibara (2013). Side-Chain Modification of Cytokinins Controls Shoot Growth in Arabidopsis. Developmental Cell, 27: 452-461

(2) Mikiko Kojima, Tomoe Kamada-Nobusada, Hirokazu Komatsu, Kentaro Takei, Takeshi Kuroha, Masaharu Mizutani, Motoyuki Ashikari, Miyako Ueguchi-Tanaka, Makoto Matsuoka, Koji Suzuki, and Hitoshi Sakakibara (2009). Highly Sensitive and High-Throughput Analysis of Plant Hormones Using MS-Probe Modification and Liquid Chromatography–Tandem Mass Spectrometry: An Application for Hormone Profiling in *Oryza sativa*. Plant & Cell Physiology, 50: 1201–1214

_____ A paper opened the door to a major discovery—all that has been done so far converged in a moment of déjà-vu.

Prof. Sakakibara explains the fun he experiences doing his research saying, “Cytokinins tell neat stories.” He has read numerous papers related to cytokinins, including ones whose immediate connection to his own research is unclear. He can recall some parts of such papers without even trying, probably because they represent the body of information he has amassed purely out of genuine curiosity. In fact, he launched his research on CYP735A, the tool molecule that attaches “OH,” because he remembered a phenomenon that had previously been reported in only one paper.

“Looking back now, I think it was like a gamble. But I don’t think its success was 100% luck, either.”

Prof. Sakakibara shares with us an impressive episode, a story of a major discovery, a dramatic turnabout that got the paper he jointly wrote with other scientists to be published in *Nature* in 2007, his first *Nature* publication.[3]

It concerns a rice mutant named LOG (short for “Lonely Guy”), which was isolated by Dr. Junko Kyozuka (now at Tohoku University), a member of the joint research team. The flower of this mutant has no pistil and has only one stamen. The LOG gene that causes this had been sequenced, but the molecule produced from the LOG gene and its functions were not yet known. The only clue was that the characteristics of the flower bud formation suggested the phenomenon resembled what happens when the cytokinin function is weakened.

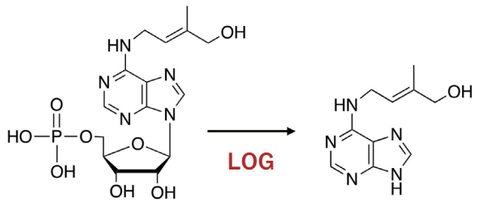
Prof. Sakakibara began by searching the database of genes of various organisms for any with a structure similar to that of the LOG gene. There were about 100 hits, sorted in order of similarity from the top. He began going through the list from the bottom for no special reason and immediately felt there was something familiar to him.

Where does this déjà-vu come from? Looking around, his eyes fell on a paper[4] casually placed on the desk. It was a paper about a pathogen that deforms plants with the use of the cytokinin function. The paper described a mysterious gene that works with the cytokinin-producing gene like its partner, without which the pathogen’s cytokinin does not function. He noticed that this “partner” gene had a sequence similar to that of the LOG gene.

“Looking back, I am amazed at the mysterious way human memory and consciousness work. At that crucial moment, I suddenly recalled something that would have been completely forgotten under normal circumstances.”

It completely deviated from the conventionally established theory, but he thought, “This can’t be a mere coincidence.”

“At that moment, we had everything working for us. We had become quite advanced in our analysis technology by then. We combed through the data and reached the conclusion in two weeks. Our paper was accepted as if we had a free pass.”



The above shows the final reaction of cytokinin biosynthesis. The lower half of the transzeatin precursor (left) is detached by a protein produced by the LOG gene to form transzeatin (right). The rate and area of leaf production depends on the location and timing of the LOG function. The loss of the LOG gene also greatly affects rice flower bud formation.

(3) Takashi Kurakawa, Nanae Ueda, Masahiko Maekawa, Kaoru Kobayashi, Mikiko Kojima, Yasuo Nagato, Hitoshi Sakakibara, and Junko Kyozuka (2007). Direct control of shoot meristem activity by a cytokinin-activating enzyme. Nature, 445: 652-655
(4) Marin Crespi, Danny Vereecke, Wim Temmerman, Marc Van Montagu, and Jan Desomer (1994). The *fas* Operon of Rhodococcus fascians Encodes New Genes Required for Efficient Fasciation of Host Plants. Journal of Bacteriology, 176: 2492-2501

_____ Vast knowledge and technical expertise that do not allow easy imitation

Prof. Sakakibara’s team continues to lead the field of research on plant hormones, especially cytokinin.

“The information that appears in our papers is only a small fraction of the total body of knowledge we possess. We have already tried everything that we can think of, having that much knowledge. I don’t think it’s easy to close the gap.”

Having undergone fierce competition in genetic research, the team has been making dedicated efforts to improve the chemical analysis method. Prof. Sakakibara says that he no longer feels the intensity of the competition as strongly as before. Nevertheless, he has not slowed down. As soon as he perceives the need for new technology, he avidly works to adopt it by making full use of the network of scientists he has built.

“You can’t make new discoveries without continuously adopting key technologies. Being capable of quick moves is also essential for researchers.”

With pure curiosity at the heart and free from conventional approaches, Prof. Sakakibara continues to explore new research in his flexible style.

ORF6
6361 AATGCCCGCGACTACGGTCTCGGCACAGGCCCGCCCGACCCCCAAGAGCGTCACGGTCTTCTGCGGAGCTATGCCAGGGCGCGGGACCAAATATGGACAGCTCGCAGAGGGGATGGGGCG
M P A T T V S A Q A R P T P K S V T V F C G A M P G R G T K Y G Q L A E G M G R
6481 TGCGATTGCTAGATCGAAGCTGCGCCTCGTTTATGGTGGCGCCCGAGTCGGCCTCATGGGCACCCTCGCGAACGCGGCCTTGGACTCCGGCGGAACCGTCGTTGGCGTGATCCCTGAGAG
A I A R S K L R L V Y G G A R V G L M G T L A N A A L D S G G T V V G V I P E S
6601 CTTCACTGCGATACCCGAGGCTGCGCATCATGGACTGACAGAACTACACGTCGTCCATGACATGCACCAACGCAAAGCTCTCATGGCCGAACTCGGTGACGCATTCATTGCCCTCCCCGG
F T A I P E A A H H G L T E L H V V H D M H Q R K A L M A E L G D A F I A L P G
6721 CGGTGTCGGAACCGCAGAAGAGTTCTTCGAGGTCCTTACGTGGTCACACCTGGGGCTTCACAATAAACCCTGTGTACTGCTGAACGACAACGAGTATTACCGCCCCTTGCTCTCCTACAT
G V G T A E E F F E V L T W S H L G L H N K P C V L L N D N E Y Y R P L L S Y I
6841 CGAGCACGCTGCCGTCGAAGGATTTATCACCCCCGCAACCCGGTCTCGCGTAATCGTCTGCAAAGACATCGAGGGGGCTATCGCGGCCATTCGCTCACCCTAATTAGTGGGACTTCTGCC
E H A A V E G F I T P A T R S R V I V C K D I E G A I A A I R S P .

The gene sequence of the pathogen that Prof. Sakakibara vaguely recalled as similar to the LOG gene sequence (from Fig. 2 [ORF6] in the paper referenced below[4]).

純粋な好奇心とそれにこたえる技術力～分野を牽引し続ける研究者の底力とは？

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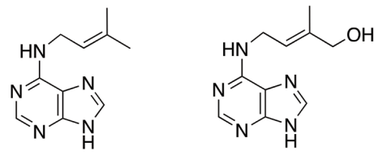
植物ホルモン「サイトカイニン」をはじめとした、植物細胞間の情報伝達の仕組みについて研究を進めている。クラリベイト・アナリティクス（Clarivate Analytics）による「高被引用論文著者 (Highly Cited Researchers)」に2014年から毎年選出されており、分野の最先端を走り続けている。2023年11月紫綬褒章受章。

植物ホルモン「サイトカイニン」は、様々な情報伝達を担っている分子だ。たとえば根で作られると、栄養を吸収したことを葉、茎、花芽に知らせ、成長のGOサインを出す。このときの分子の形状について、以下2つを見比べて間違い探しをしてほしい。



植物ホルモンの一種、サイトカイニンの構造式。生物や、体内での用途に合わせて、数多くの種類が存在する。（Ⅰ）はイソペンテニルアデニン、（Ⅱ）はトランスゼアチン

2つの違いは、右上に「OH」が付いているかどうかのみ。誤差と言いたくなるほどわずかな違いだ。しかし、2つを作り分けられないと、根からのメッセージが葉にうまく伝わらず植物は育たない。用途に合わせて分子の形が巧妙に作り分けられていることがわかる。サイトカイニン研究においては、こうした分子の微妙な違いを見分ける高度な化学分析手法も必要となる。

榊原さんにとって印象深いエピソードがある。まさに逆転劇の大発見。2007年、自身初のNature誌掲載が実現した共同研究[1]だ。物語の始まりは、あるイネの突然変異体。花に雌しべが無く、雄しべが1本しかできないことから、log（=Lonely Guy：孤独な男）と名付けられた。共同研究者の経塚淳子さん（現：東北大学）が単離したものだ。壊れている原因遺伝子が特定されていたものの、その仕組みがわかっていなかった。榊原さんは手始めに、原因遺伝子に似た構造をもつものがないか、様々な生物の遺伝子が掲載されているデータベースで検索した。100個ほどがヒットし、似ている順番に上から並べられていた。そのとき、何気なく下から見始めた榊原さんはすぐに、「どこか見覚えがある」と感じたそうだ。

その見覚えはどこから来たのか？机の上を探していると、ポンと置かれた論文[2]に目が留まった。サイトカイニンの作用を利用し植物を奇形にする病原菌についての論文だった。そこには、サイトカイニンを作る遺伝子と”相棒”のように働く謎の遺伝子が掲載されており、それが無ければ病原菌のサイトカイニンが機能しない、というものだった。まさにその相棒遺伝子が、logの原因遺伝子の配列（下図）に似ていることに気づいたのだ。

「振り返ると、人間の記憶力や意識ってすごいなと思います。ふつうなら忘れてしまうような知識をそのとき思い出せました」

一方、このときのことを、「100パーセント運かというと違うと思っています」と榊原さんは話す。サイトカイニンに関連した論文は、自身の研究に直接繋がるかわからなくてもたくさん読み込んできた。純粋な興味をもとに情報収集してきたからこそ、ふとした瞬間に思い出せるのかもしれない。

ORF6
6361 AATGCCCGCGACTACGGTCTCGGCACAGGCCCGCCCGACCCCCAAGAGCGTCACGGTCTTCTGCGGAGCTATGCCAGGGCGCGGGACCAAATATGGACAGCTCGCAGAGGGGATGGGGCG
M P A T T V S A Q A R P T P K S V T V F C G A M P G R G T K Y G Q L A E G M G R
6481 TGCGATTGCTAGATCGAAGCTGCGCCTCGTTTATGGTGGCGCCCGAGTCGGCCTCATGGGCACCCTCGCGAACGCGGCCTTGGACTCCGGCGGAACCGTCGTTGGCGTGATCCCTGAGAG
A I A R S K L R L V Y G G A R V G L M G T L A N A A L D S G G T V V G V I P E S
6601 CTTCACTGCGATACCCGAGGCTGCGCATCATGGACTGACAGAACTACACGTCGTCCATGACATGCACCAACGCAAAGCTCTCATGGCCGAACTCGGTGACGCATTCATTGCCCTCCCCGG
F T A I P E A A H H G L T E L H V V H D M H Q R K A L M A E L G D A F I A L P G
6721 CGGTGTCGGAACCGCAGAAGAGTTCTTCGAGGTCCTTACGTGGTCACACCTGGGGCTTCACAATAAACCCTGTGTACTGCTGAACGACAACGAGTATTACCGCCCCTTGCTCTCCTACAT
G V G T A E E F F E V L T W S H L G L H N K P C V L L N D N E Y Y R P L L S Y I
6841 CGAGCACGCTGCCGTCGAAGGATTTATCACCCCCGCAACCCGGTCTCGCGTAATCGTCTGCAAAGACATCGAGGGGGCTATCGCGGCCATTCGCTCACCCTAATTAGTGGGACTTCTGCC
E H A A V E G F I T P A T R S R V I V C K D I E G A I A A I R S P .

榊原さんがLOG遺伝子の配列と「似ている」と見覚えを感じた、病原菌の遺伝子配列（植物病原菌の論文（2）中、図2の一部（ORF6）を抜粋）

閃いてからは速かった。そこから結果を出すまで、わずか2週間。遺伝学の知見に加え、卓越した化学分析の技術も持ち合わせていたことが決定打となった。原因遺伝子が作り出すタンパク質の働きを分子レベルで解明したことで証拠が揃い、論文は素通りのように受理された。

純粋な好奇心によって集められた情報の量と質。鍛え上げられた技術力。こうして進められる研究は追随を許さない。今まで出版してきた数々の論文も氷山の一角だと榊原さんは話す。

「論文に出している情報量はほんの一部です。そこから思いつくようなことは、僕らはすでにトライしています。簡単にその差は埋まらないと思います」

(1) Takashi Kurakawa, Nanae Ueda, Masahiko Maekawa, Kaoru Kobayashi, Mikiko Kojima, Yasuo Nagato, Hitoshi Sakakibara, and Junko Kyozuka (2007). Direct control of shoot meristem activity by a cytokinin-activating enzyme. Nature, 445: 652-655
(2) Marin Crespi, Danny Vereecke, Wim Temmerman, Marc Van Montagu, and Jan Desomer (1994). The *fas* Operon of Rhodococcus fascians Encodes New Genes Required for Efficient Fasciation of Host Plants. Journal of Bacteriology, 176: 2492-2501

INFORMATION | Activities & News

Nagoya University's Institute for Advanced Research (IAR) was able to organize several on-site events this year, including international conference.

The 7th IAR Webinar

The IAR Webinar "When and Where Does Consciousness Reside? – Exploring Our Identity Through Neuroscience" was held on January 12, 2024, in collaboration with Academic Research & Industry-Academia-Government Collaboration. Dr. Yasuko Nakamura, Dr. Hideki Ohira, Dr. Shuntaro Sasai, and Science Communicator Ryu Miyata, four experts from different fields, were invited, and the discussion was streamed both online and onsite. Dr. Nakamura presented an analysis of Freud's research history from the perspective of the humanities, Dr. Ohira explored the relationship between interoception and the brain's neural mechanisms in experimental psychology, and Dr. Sasai discussed the connection between brain function and consciousness in neuroscience. Meanwhile, Science Communicator Miyata shared initiatives aimed at promoting the societal implementation of neuroscience. Scientists from various fields exchanged questions with one another, and numerous inquiries were raised from the audience, sparking a lively discussion on human consciousness.

The 8th IAR Webinar

The IAR Webinar "Imagining the Lives of Prehistoric Stoneworkers – Stonemasons × Archaeologists × Linguists" was held on August 6, 2024. Dr. Seiji Kadowaki, Dr. Kimi Akita, and Stonemason Ms. Azusa Ueno, along with other scientists and artisans, were invited, and the discussion was streamed online. Dr. Kadowaki presented on stone tools and prehistoric lifestyles from the perspective of archaeology, Dr. Akita discussed onomatopoeia and the origins of language in the field of linguistics, and Ms. Ueno shared insights into stoneworking techniques and their methods of transmission. Scientists from different disciplines and the stonemason exchanged questions, reflecting on the lives of prehistoric stoneworkers and sparking the imagination of the audience.

Research exchange meeting: Special visit to Japan by Professor Emerita Joan Tronto

Research project* headed by Professor Yayo Okano of Doshisha University's Graduate School of Global Studies and the IAR jointly hosted a research exchange meeting with Professor Emerita Joan Tronto of the University of Minnesota and the City University of New York. Professor Emerita Joan Tronto is a world-renowned political theorist whose books “Moral Boundaries” and “Caring Democracy” have been translated into Japanese. After the lecture, we held an exchange workshop with graduate students and early career researchers.

*Constructing a New Theory of the State through Feminist Theory: From the Reconstruction of the Concept of Care and the Concept of Security (Japan Society for the Promotion of Science, Grants-in-Aid for Scientific Research, 2023/04 -2027/03, Grant-in-Aid for Scientific Research (B), Doshisha University)

Nagoya University Lecture 2023

January 27, 2024

The Nagoya University Lectures, Nagoya University's most important academic lecture series, invites world-class scientists as lecturers every year. On January 27, 2024, the 2023 Nagoya University lecture series celebrated Dr. Aaron Ciechanover, winner of the 2004 Nobel Prize in Chemistry, with guests invited on site at the Shirotori Hall, Nagoya congress center. The Lecture was co-hosted with the International Peace Foundation to commemorate the 50th anniversary of Japan-ASEAN Friendship and Cooperation. Dr. Aaron Ciechanover was presented with a ceremonial plaque, and Mr. Uwe Morawetz, chairman at the International Peace Foundation, gave a congratulatory address. Dr. Aaron Ciechanover then gave a lecture titled “The journey to new drug development in our time.” In his lecture, he gave a very passionate talk about the perspective where our approach to treatment is “one size fits all” and enter a new one of “personalized medicine” where we shall tailor the treatment according to the patient’ s molecular/mutational profile. An archive of his lecture is available on the IAR website (http://www.iar.nagoya-u.ac.jp/eng/performance/1815/).

The 11th IAR Symposium

October 29, 2024

IAR highlights both its established and cutting-edge research to the wider university community and beyond. This 11th symposium focused on what plant scientists can do to prepare for climate change, as we are increasingly facing various natural disasters driven by climate change, such as an increase in extremely hot days, the frequent occurrence of linear precipitation zones, and intensified typhoon damage. These changes are having a profound impact on plants, directly affecting food shortages in our immediate environment and altering plant ecosystems on a global scale.Dr. Iizumi from the National Agriculture and Food Research Organization spoke about the climate change impacts and adaptation strategies for global grain production; Dr. Masutomi from the Center for Climate Change Adaption, National institute for Environmental Studies discussed the development of crop models for assessing impacts and adaptation to global warming; Dr. Matsubayashi from the Graduate School of Sciences addressed the mechanisms by which plants survive in fluctuating nitrogen nutrition environments; Dr. Kinoshita from the Institute of Transformative Bio-Molecules at Nagoya University delved into the Elucidation of stomatal signaling and control of stomatal aperture to enhance crop yield; and Dr. Ashikari from the Bioscience and Biotechnology Center at Nagoya University presented on the Applications of stress tolerance to plant breeding, with Dr. Sakakibara from the Graduate School of Bioagricultural Scineces as the moderator, panel discussions on the themes of “What can plant researchers do to prepare for climate change?” were conducted featuring speakers.

YLC Seminar

The YLC seminar aimed to provide members with opportunities in order to understand each other's research interests to assist in interdisciplinary collaboration research. The 33rd YLC seminar was organized in Hybrid on March 1, 2024. Dr. Akira Yoshinari (Institute of Transformative Bio-Molecules) talked about "Cell polarity in plant nutrition: exploring the functions and mechanisms of membrane transporter polar localization in plants," and Dr. Atsushi Usami (Institute of Transformative Bio-Molecules) talked about "Bioproduction of functional molecules." The 34th YLC seminar was organized in Hybrid on July 4, 2024. Dr. Jie Huang (Graduate School of Humanities) talked about "The Syncretism of the Worship of the God of the Land in Thailand: A Comparative Perspective with the Immigrant Religion," and Dr. Yuki Sugiyama (Graduate School of Science) talked about "Exploring cell biology of sieve elements with an improved phloem induction system." The 35th YLC seminar was organized in Hybrid on December 5, 2024. Dr. Koyo Tsujikawa (Graduate School of Medicine) talked about "The missing genetic link between infant-onset and elderly-onset disorder," and Dr. Ryo Higuchi (Graduate School of Humanities) talked about "Buildings tell us their history: Reconstructing the Katholikon of Zemen Monastery in Bulgaria."

YLC Collaborative Research Grant

The YLC collaborative research grant was launched in 2018 to support the interdisciplinary collaboration between YLC faculties. YLC faculty voluntarily organized the grant contents, schedule, and selection process. In this year, YLC selected two research groups: one group was led by Dr. Sari Jammo (Nagoya University Museum) with the title "Molecular Archaeology – Interface between Archaeology and Natural Science to Reconstruct Prehistoric Anthroposphere in the Near East," and the other by Dr. Hisashi Hayakawa (Graduate School of Science) with the title "Frontier Exploration of Archaeoastronomical Analyses."

"Invitation to the Advanced Researchers" IAR Lecture Series

This lecture series includes lectures by the IAR academy and faculty members, IAR fellows, and Nagoya University researchers and targets Nagoya University students. This series aimed to communicate the fun of academic research. In the academic year 2024, there were 15 lectures :

1. "The Dark Side of the Universe,"
Prof. **Naoshi Sugiyama**
(President of Nagoya University)

2. "Science Started from Observation,"
Prof. **Sumio Iijima**
(Distinguished Invited Professor at Nagoya University and Professor at Meijo University)

3. "What are building blocks of the universe?"
Prof. **Yoshitaka Itow**
(Deputy Director of IAR and Institute for Space-Earth Environmental Research)

4. "Material Science—Fun and Useful,"
Prof. **Ichiro Terasaki**
(Graduate School of Science)

5. "Think about infinity,"
Prof. **Hiroshi Ohta**
(Graduate School of Mathematics)

6. "The Present in Historical Studies: Excavate the Hellenism Civilization,"
Prof. **Yoshiyuki Suto**
(Graduate School of Humanities and Eighth Director of IAR)

7. "Analyze Democracy,"
Prof. **Hiroko Takeda**
(Deputy Director of IAR and Graduate School of Law)

8. "Gender and Literary Studies,"
Prof. **Yuko Iida**
(Graduate School of Humanities)

9. "Analyzing society and economy through the eyes of game theory,"
Prof. **Akihiko Yanase**
(Graduate School of Economics)

10. "Education of the Unconventional,"
Prof. **Ryo Uchida**
(Graduate School of Education and Human Development)

11. "Signaling Molecules Make Plant Life Resilient,"
Prof. **Hitoshi Sakakibara**
(Deputy Director of IAR and Graduate School of Bioagricultural Sciences)

12. "Mechanisms underlying the mysterious existence life,"
Prof. **Kazuhiro Nakamura**
(Graduate School of Medicine)

13. "Unraveling life systems using chemical and genetic approaches,"
Prof. **Shigeki Kiyonaka**
(Graduate School of Engineering)

14. "Next-Generation Bio-imaging,"
Prof. **Shigehiro Yamaguchi**
(Graduate School of Science and Institute of Transformative Bio-Molecules)

15. "Physical chemistry of energy and the environment,"
Prof. **Kunio Awaga**
(Director of IAR and Graduate School of Science)

Short-Term Fellowship Program

To facilitate international scientific cooperation, this program supports short research visits of overseas researchers (maximum of 4 weeks), including related activities such as holding a symposium. In the academic year 2024, Dr. Kim Cuong Ly (Assistant Professor at Nottingham University), Dr. José Floriano Pereira Lima Filho (Collaborating researcher at Sao Paulo University), and Dr. Vincent Robert (Professor at Strasbourg University) were selected for this fellowship.

Foreign Principal Investigator Fellowship Program

The Foreign Principal Investigator Fellowship Program invites excellent researchers from foreign countries with outstanding research achievements for 3–4 months of fellowship to promote the Universities' academic research. In the academic year 2024, Dr. Ireneusz Ulidowski (Associate Professor at Leicester University), Dr. Yonggang Meng (Professor at Tsinghua University), and Dr. Cynthia Chen (Professor at Washington University) were selected for this fellowship.

Topological Phase Transitions in Low-dimensional Multicomponent Superfluidity

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INTRODUCTION

Phase transitions are ubiquitous in nature such as the liquid-gas transition, melting of solids, and magnetic transitions. The phases are characterized by the ordering of an observable quantity, such as magnetization established against fluctuations. Low-dimensional systems host large fluctuations and therefore, transition to an ordered phase was believed to be absent. In 1973, however, Kosterlitz and Thouless proposed a phase transition induced by topological defects in two dimensions [1]. This *topological phase transition* was a new type of phase transition, and they were awarded the Nobel Prize in Physics in 2016. Topological defects are excitations protected by the system's broken symmetry. In an inviscid superfluid, a quantized vortex with a quantized circulation (charge) in the unit of Planck constant is a topological defect. This results in the Berezinskii-Kosterlitz-Thouless (BKT) transition by unbindings of vortex-antivortex pairs and the proliferation of free vortices at a transition temperature in two dimensions (Figure 1) [1,2]. A salient feature of these topological phase transitions is the universality due to the topological character. It is driven by topological excitations such as vortices in fluids or dislocations in crystals, which appear not only in condensed matter but also in nuclear matter or cosmology. Nowadays, the BKT transition is still one of the central targets in a broad range of modern physics.

In contrast to single-component systems composed of a single atomic species, for instance, multicomponent systems host fruitful kinds of topological excitations. Since the BKT transition is induced by topological excitations, a variety of topological excitations makes the phase transition richer. In general, the connection between the mathematical structure (homotopy group) of topological defects and the resulting topological phase transitions has not yet been clarified.

BKT TRANSITION IN MULTICOMPONENT SUPERFLUIDITY

In a two-component superfluid, the vortex charge is no longer quantized due to the fraction of the two populations. In a population-balanced mixture, half-quantized vortices appear. However, they are not always stable, depending on the interaction between the two components. Indeed, a finite exchange interaction (Rabi coupling) makes them unstable. Instead, two half-quantized vortices winding in both components respectively form a *vortex molecule* connected by a kink (Figure 1). Consequently, the topological excitations responsible for the BKT transition are changed depending on the Rabi coupling. This picture was predicted by numerical simulations [3], but analytic study and the resulting thermodynamic properties had been unexplored. We performed analyses using the renormalization group approach to reveal the phase diagram of the miscible binary Bose superfluid and the thermodynamic properties [4]. We found that a finite Rabi coupling enhances the BKT transition temperature while it behaves nonmonotonically with respect to the two-body inter-atomic interaction. Our result indicates that superfluidity is sustained in higher temperatures than in the single-component one. These distinct behaviors are found to originate from two branches of elementary excitations in addition to the exotic vortex excitations [4].

An effective approach to capture the physical property of a system is to see the system's response to an external perturbation. More intuitively, by shaking a fluid slowly, a wave propagates with a certain velocity. How fast does it propagate? It is exactly the response

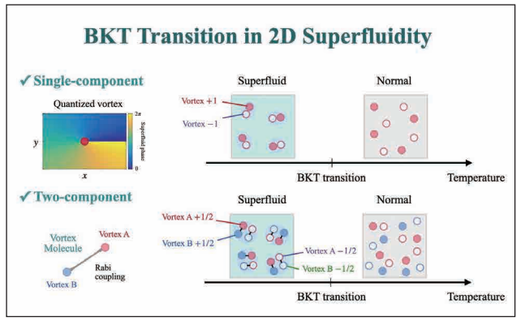

Figure 1 . Overview of the Berezinskii-Kosterlitz-Thouless transition in a single-component and a two-component superfluid, respectively.

to density perturbations determined by the thermodynamics of the system. The sound velocity is a good probe for understanding the equilibrium properties of a system and is widely investigated. Particularly, in addition to the density wave (first sound), a superfluid has another sound mode called *second sound* associated with the propagation of the entropy wave [5,6]. It is peculiar to superfluidity and dies out in the normal phase. We analyzed the sound velocities in the two-component superfluid subject to the BKT transition. The second sound exhibits a discontinuous jump to zero at the BKT transition point. Moreover, it turned out that the low-temperature behavior of the first and second sound modes is qualitatively different from the one in a single-component superfluid. Based on our theoretical analysis, we found that these special behaviors can be explained by the twocomponent character of the superfluid [4]. In cold atom experiments, one can precisely control the inter-atomic interactions as well as the Rabi coupling, which would verify our predictions.

CONCLUSION

Our ultimate goal is to understand the connection between the mathematical structure of topological defects and the topological phase transitions, which provides a comprehensive perspective of multicomponent quantum systems. As a first step, we theoretically studied the BKT transition in a two-dimensional binary Bose superfluid. Vortex excitations vary from the single-component one, and as a result, the BKT transition is significantly affected. Currently, topological properties of quantum materials are crucial for quantum technology, including quantum computation. Our study would also build up the basis for these applications.

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Reconstructing the History of Exchange Between the Indian and Kanji Cultural Spheres through Interdisciplinary Research

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INTRODUCTION

CCivilizations in Asia, have been shaped primarily by exchanges and fusions of Indian and Kanji (Chinese) cultures. This study addresses the global issue of the history of exchange and fusion between the Indian and Kanji cultural spheres, with linguistic archives as the primary research subject.

We focus on ancient Buddhist dictionaries that reflect actual exchanges between the Indian and Kanji cultures at the ideological, cultural, and linguistic levels, surveying and reprinting ancient Buddhist dictionaries from various parts of the world. Based on these texts, we will conduct cross-disciplinary research integrating the fields of linguistics, bibliography, Buddhist studies, and Dunhuang studies. Furthermore, we will develop and publish a comprehensive "Database of Ancient Buddhist Dictionaries" by combining traditional methods of historical material analysis with the cutting-edge technology of the digital humanities. Building on these findings, we aim to foster interdisciplinary research and fundamentally reconstruct the history of exchange and fusion between the Indian and Kanji cultural spheres.

RESEARCH ON BUDDHIST DICTIONARIES

It has been approximately 2,000 years since the translation of Buddhist scriptures began. However, these translated scriptures remain challenging to understand. One reason for this is that the translation of Buddhist scriptures is itself a complex, multilayered endeavor. Today, attention is typically focused on completed translations of the Buddhist scriptures, but various related materials were produced within the translation process. These include materials for translating, interpreting, and recording the "characters" and "words" of the Buddhist scriptures. Such materials are known as "Buddhist dictionaries." Buddhist dictionaries are a rich source of information on Buddhist culture and the history of the time.

Buddhist dictionaries provide detailed annotations of numerous Buddhist terms from various perspectives. As the description format is consistent across each source, they are structurally well-suited for comparative research. In addition, the contents of the annotations vary by period, region, and sect. Consequently, Buddhist dictionaries have been studied across various research fields, leading to distinct findings. However, a comprehensive study of Buddhist dictionaries has yet to be undertaken.

In this study, we will undertake a cross-disciplinary approach integrating the fields of philology, digital humanities, Buddhist studies, Chinese studies, Japanese studies, and Dunhuang studies, using Buddhist dictionaries from various parts of the world. Specifically, we will construct and publish the "Database of Ancient Buddhist Dictionaries" to facilitate comprehensive research on Buddhist dictionaries. By compiling the findings, we aim to clarify the history of Buddhist dictionary translation. Ultimately, our goal

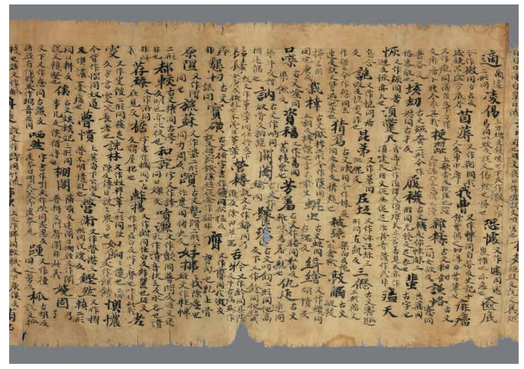

Figure legend. *Yiqiejingyinyi* 一切経音義 (Pelliot chinois 2901)
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is to reconstruct the history of exchange and fusion between the Indian and Kanji cultural spheres.

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Burying the Dead: Funeral Practices and the Relationship Between the Living and the Dead in West Asian Neolithic Societies

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INTRODUCTION

Ancient societies in West Asia experienced rapid cultural transformations when the nomadic hunter-gatherer lifeway during the Natufian period (c. 12,500–10,000 BC) shifted to settled farming societies in the Neolithic period (c. 10,000–5,500 BC). The transition to a farming way of life was associated with major changes regarding life and death, funerary practices, and burial location. Natufian people, in general, tended to bury their dead inside the caves and on cave terrace. In the Pre-Pottery Neolithic A (PPNA: c. 10,000-8500 BC) and Pre-Pottery Neolithic B (PPNB: c. 8,500-7,000 BC) periods, the dead were buried under the floor of residential buildings and buildings bearing symbolic significance, and in courtyards (Fig. 1). Researchers discuss that the building-burial relations were intertwined with rituals, and the dead were buried in/or close to the place where the funeral practices took place. This legacy continued into the Pottery Neolithic period (PN c. 7,000-5,500 BC), however, a shift from indoor to crowded outdoor cemeteries has been documented. I suggest that in this period a decline in building-burial relations occurred, which might be attributed to social changes during the transition to the Pottery Neolithic period. People in the PN period did not maintain a fixed place for their dead. Rather, there was diversity in the burial context that reflected the diversity of household practices and increased household autonomy.

FUNERAL PRACTICES AND BURIAL LOCATION

People in the Neolithic period tended to keep their dead close, which indicates that the dead held meaning to the living. During this period, people undertook funerary rituals and took special care of human body, particularly the skull. The skull of many dead was separated from the rest of the body, and some were coated with a plaster layer and decorated with facial features. Detached skulls were later deposited separately in skull cache, in shrines and beneath building floors. It is suggested that these practices were planned and performed with ceremonies on a societal scale, and they were carried out to maintain social cohesion and reaffirm social identity. These rituals were usually associated with the residential area within habitation buildings or buildings bearing ritual significance. Therefore, there was a spatial-based relationship between the location of the burials and the communal activities that were undertaken which also reinforced memories of place.

The transition from the Late PPNB to the PN period has shown distinct changes. The skull-related practices decreased sharply, and the custom of burying the dead beneath residential buildings was, in many instances, abandoned. As such, the prevalent concept of house-based identity in the former periods may not be applicable as the PN period progressed. I argue that the buildings in the PN period bear domestic and economic significance for food preparation, cooking or storage, rather than for social activities

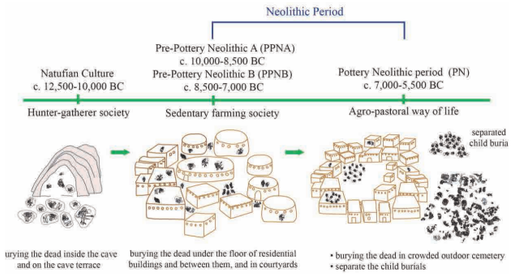

Figure 1. Changes in burial locations during the development of ancient West Asian societies

such as rituals or meetings. Therefore, the dead were liberated from the buildings and buried outdoors in extended household burials.

CHILD BURIAL

People in the Neolithic communities buried both adults and children in different contexts in the settlement. Evidence from a handful of Pottery Neolithic sites illustrated an increase in interest in child burials compared to adults. For the first time in this period, pottery vessels were used as burial containers of infants and small children. In addition, evidence for separate of child burials from adults were documented. Further, child burials were accompanied with more grave gifts compared to former periods.

Life and death in the Neolithic period have been long investigated from adults' points of view. However, the increased evidence of child funeral practices have raised the possibility of carrying out studies through child experience. The long development of farming societies and changes in the socio-economic conditions may have affected burial traditions over time. On the other hand, the variation in the mortuary treatment of children, dedicate grave gifts, and burying separately and in pottery jars are undoubtedly meaningful suggest that the age at death is a considerable matter.

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Observing wildlife from the sky

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INTRODUCTION

Animal behavior and ecology have evolved within natural environments; therefore, it is crucial to understand their behavior and ecological patterns in these wild settings. Additionally, as the global environment undergoes rapid changes, continuous monitoring becomes an urgent task. Consequently, we need new technologies to accurately quantify their behavioral and ecological data in the wild.

QUANTIFICATION OF BEHAVIOR IN THE WILD

Animals often inhabit inaccessible areas and range widely. Unmanned Aerial Systems (UAS) are revolutionizing data collection in the wild, enabling the simultaneous capture of behaviors from multiple individuals [1]. Additionally, UAS facilitate the quantification of the environment surrounding animals. However, another challenge is data analysis. Aerial images and video clips provided by UAS are usually large in size and contain complex information. Deep learning-based object detection and tracking aid in data processing and analysis. Beyond mere position tracking, posture tracking can also quantify their detailed movements and infer body orientation. Using these technologies, it is becoming possible to collect and analyze data in the actual environments where animals live.

EX.1) QUANTIFICATION OF ATTENTION THROUGH GAZE

Attention is arguably the fundamental component required to achieve collective behavior, as information about other individuals is mostly transmitted through visual cues. In primates, including humans, it is believed that the direction of attention has a structured pattern, such as subordinate individuals paying attention to dominant ones.

We have developed a method to quantify the attention of wild Japanese macaques living on Koshima Island, Miyazaki, Japan. These monkeys have been observed since the 1970s by researchers from Kyoto University. Individual IDs and kinship have been recorded. We combined this ID information with UAS and tracking technology to reveal the attention patterns within their troop.

As expected, the most dominant individuals were frequently observed by others. However, a hierarchical structure was not apparent. This suggests that the most dominant individual, generally referred to as the alpha, may occupy a significantly different social position within the troop. While our results are not yet comparable with those from other study sites, future comparative studies could provide insights into the relationship between social dominance and attention.

EX.2) COUNT NUMEROUS INDIVIDUALS FROM THE AERIAL VIEW

UAS can focus on population dynamics. Population size is fundamental information for ecology and conservation, yet accurate estimation is challenging because animals inhabit inaccessible areas and move over vast ranges. Furthermore, counting species that form large colonies is inherently difficult.

We developed a new framework to accurately estimate the

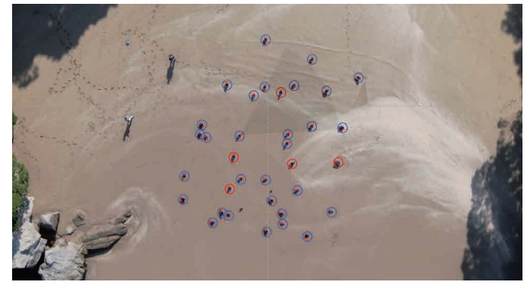

Figure 1. Example of tracking and reconstruction of a visual fields of individuals in an aerial videoclips

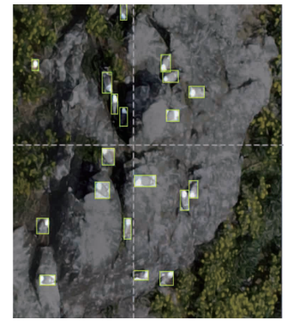

Figure 2. Example of bird detection in aerial images.

population size of seabirds. In our framework, UAS-based colony-level census and bio-logging-based individual-level behavioral data were combined. For this study, a colony of black-tailed gulls in Kabushima, Aomori, Japan, served as a model system. The colony-level census provided time-series data on the number of individuals in the colony, while the individual-level behavioral data revealed the proportion of absent individuals. Data fusion of these two distinct time-series through a statistical model was accomplished. The estimated population size was about 30,000 individuals, which aligns with previous studies. Our framework also allows for the estimation of uncertainty, which is often lacking in previous methods.

Considering uncertainty and reducing personal dependency are essential for the sustainable monitoring of wildlife. State-of-the-art technology enhances population monitoring and deepens our understanding of wildlife.

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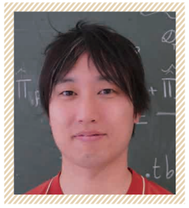
Interplay between flavor and collider physics to probe new physics



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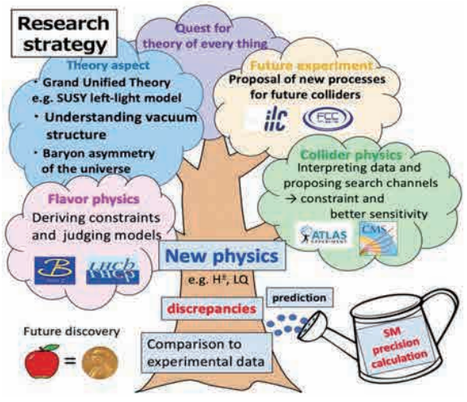
INTRODUCTION

The standard model (SM) of elementary particles can describe most of experimental data and the last piece of the SM, Higgs boson was discovered in 2012 at Large Hadron Collider (LHC) [1,2] hosted by the European organization for nuclear research, known as CERN. However, it is widely known that the SM is not the ultimate theory since it cannot explain baryon asymmetry of the universe, dark matter, neutrino mass, and so on. There are many proposed theoretical models which address those puzzles while it is not clear which morel is the correct one. In 1973, the measurement of the charge-parity (CP) symmetry violation in a K meson decay inspired Kobayashi and Maskawa to propose the model with more than 3rd generation fermions [3]. Similarly, the current anomalies (deviations between the SM prediction and experimental measurement) known in flavor physics might be a hint of the new physics (NP) which help us to single out the NP model. Currently we have several discrepancies of 3-4 standard deviations, in the B meson decays e.g. $B\to D^{(*)}\tau\nu$, $B\to K^{(*)}ll$, $B\to DK$, potentially implying new particles with the mass of tera electron volt (TeV) scale. At the LHC they accelerate and collide protons to directly produce new particles with the center of mass energy of 13-14TeV and hence it is natural to probe those particles with collider physics.



STATUS OF FLAVOR ANOMALIES IN B MESON DECAYS

To claim a discrepancy in B meson decays of interest there are two key ingredients, precise experimental data and accurate theoretical prediction. We have on going Belle II experiment at Tsukuba, Japan and LHCb experiment at CERN, and they expect to reduce the uncertainty of a factor of 3-5 compared to the previous experiments. The theoretical description of those semileptonic decays needs B meson to other mesons transition form factors while they involve quantum chromo dynamics (QCD) effect which we cannot calculate perturbatively. Recently several experimental data and Lattice QCD result became available which help us to improve those form factors. Currently the uncertainty in the SM prediction is smaller than the experimental one, however, in view of upcoming data, sharpening the SM prediction is also important [4,5]. Currently there are about 4σ, 4σ, 5σ, deviation in $B\to D^{(*)}\tau\nu$, $B\to K\,ll$, $B\to DK$ decays, respectively.

ILISTING NEW PHYSICS MODELS

In light of the new experimental results reported in this two years and remaining large discrepancy in $B\to D^{(*)}\tau\nu$ we revisited the global fit and summarized new physics candidates and its distinct predictions which allow us to discriminate these particles in table [6].

	Spin	Charge	Operators	R_D	R_{D^*}	LHC	Flavor
$H^{\pm}$	0	$(\mathbf{1},\mathbf{2},1/2)$	O_{S_L}	✓	✓	$b\tau\nu$	$B_c\to\tau\nu$, $F_L^{D^*}$, $P_\tau^{D^*}$, M_W
S_1	0	$(\bar{\mathbf{3}},\mathbf{1},1/3)$	O_{V_L}, O_{S_L}, O_T	✓	✓	$\tau\tau$	ΔM_s, P_τ^D, $B\to K^{(*)}\nu\nu$
$R_2^{(2/3)}$	0	$(\mathbf{3},\mathbf{2},7/6)$	O_{S_L}, O_T, (O_{V_R})	✓	✓	$b\tau\nu$, $\tau\tau$	$R_{\Upsilon(nS)}$, $P_\tau^{D^*}$, M_W
U_1	1	$(\mathbf{3},\mathbf{1},2/3)$	O_{V_L}, O_{S_R}	✓	✓	$b\tau\nu$, $\tau\tau$	$R_{K^{(*)}}$, $R_{\Upsilon(nS)}$, $B_s\to\tau\tau$
$V_2^{(1/3)}$	1	$(\bar{\mathbf{3}},\mathbf{2},5/6)$	O_{S_R}	✓	2σ	$\tau\tau$	$B_s\to\tau\tau$, $B_u\to\tau\nu$, M_W

INTERPLAY BETWEEN FLAVOR ANOMALIES AND LHC

A sub-TeV charged Higgs boson ($H^{\pm}$) within a general two Higgs doublet model, which is one of the simplest extensions of the SM, has been known as a good candidate of the simultaneous explanation of $B\to D^{(*)}\tau\nu$ and $B\to K^{(*)}ll$ anomalies [7]. By recasting the previous LHC data, we excluded the scenario with charged Higgs mass larger than 0.4TeV while it turned out that the lighter possibility is difficult to probe at the LHC due to the overwhelming number of background (BG) events [8]. Based on this observation we proposed a new method, so-called b-tagged method, to highly suppress the BG events while keeping the signal events. We found that this light mass window could be probed with existing data once they perform the analysis based on our proposal [9]. Furthermore it is shown that this charged Higgs scenario can also address the 3σ excess in exotic top quark decay [10]. Since the ongoing LHC operation will finish in 20 decades, evaluating physics potential of the next collider is a very important task for our community. We showed that the future circular electron positron collider serves not only as a precision machine to check electroweak sector of the SM but also flavor factory which plays a unique role in heavy flavor physics such as Bc meson decays [11].

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Multiscale Modeling and Simulation of Polymer Degradation, Decomposition and Fragmentation

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RESEARCH THEME: TIME OF MATERIALS

My research revolves around the interplay between materials and time, focusing on the scientific exploration of how materials evolve over time and their implications in environmental contexts. The core of my interest lies in understanding the changes in material properties with long-term use, evaluating whether these changes are favorable or not. Such aging scenario is determined by the relationship between the inherent timescales of each material and the timescales at which external chemical reactions or mechanical stimuli occur. For instance, soft materials such as rubber and polymers are generally considered to be softer and more deformable compared to concrete or metallic materials. This is because the global molecular motion timescale is close to the actual usage and performance evaluation time scales, allowing for significant deformation by dynamically altering the internal structure. Thus, the effective time experienced by a material varies depending on its unique time scale, and it is never uniform across different materials.

In addition, I suppose materials aging over time is not inherently negative. For instance, the aging of wood enhances its aesthetic appeal, and the capability for CO_2 absorption of cementitious materials serves as positive examples. My approach is to observe general aging phenomena from a primitive mind. I primary study on aging and recycling of polymers and microplastic formations. I currently employ a combination of simulation and experimental techniques.

MODELING OF POLYMER DEGRADATION

To date, there has been no simulation method capable of representing the gradual oxidative degradation of polymer materials that occurs over an extended period of several months to years. The reason for this is that calculating the movement of each individual atom results in prohibitively high computational costs. Even when using supercomputers, such simulations can only realistically achieve calculations on the scale of microseconds. Therefore, based on the concept of coarse-graining, we have successfully simulated long-term phenomena such as aging by significantly reducing computational costs through calculations focused on key degrees of freedom in target systems. By integrating the kinetics of oxidative aging phenomena into this coarse-grained simulation, we have developed a model that seamlessly connects the microscale and mesoscale [1, 2].

For instance, oxidative degradation, a phenomenon known to progress through the involvement of radicals, was visualized experimentally in the 2000s, resembling the spread of an infectious disease. However, since then, no computational science approach capable of effectively representing this process has been presented in the field. In 2023, I introduced a computational technique that makes this representation possible [1]. According to the results, it was revealed that the competition between the relaxation time of molecules and the time scale of hydrogen abstraction reactions, which are characteristic of oxidative aging, leads to a spatial progression resembling an infectious disease, as pointed out in previous studies, when the reaction is sufficiently faster than molecular chain relaxations. Additionally, we recently have been extending this modeling approach to crystalline polymers.

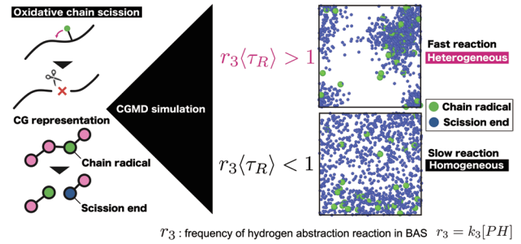

Figure legend. Conceptual diagram of coarse-grained molecular simulations of oxidative aging. Heterogeneous degradation occurs when the frequency of hydrogen abstraction reactions precedes molecular relaxation.

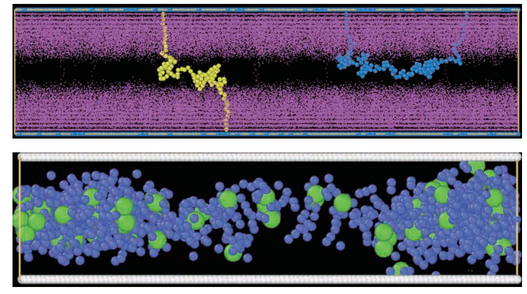

Figure legend. (Top) Representation of the geometry of the amorphous region in crystalline polymers on a computer. Pink indicates tight loop molecules, yellow indicates tie molecules, and blue indicates loose loop molecules. (Bottom) Spatial progression of oxidative aging. Blue represents scission sites, and green represents chain radicals.

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Position-independent refinement of vagus sensory-motor wiring

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INTRODUCTION

Many essential functions of our body (e.g., digestion, heartbeat, and breathing) are controlled by brain-body communication through the vagus nerve. The vagus nerve is a bundle of sensory and motor neurons that extends from the brain and innervates a broad array of internal body parts, such as muscles in the throat and tissues in visceral organ (e.g., heart and stomach). Vagus sensory neurons send sensory information from these body parts to the brain. In turn, vagus motor neurons reflexively return motor commands from the brain to the body to induce appropriate bodily reactions. Importantly, different sensory information results in distinct motor responses, indicating specific sensory-to-motor signaling via brain neural circuits. For example, when sensory neurons detect high blood pressure, they signal heart-innervating motor neurons to decrease the heart rate. Meanwhile, when sensory neurons detect a potentially harmful item in the throat, this information activates throat-innervating motor neurons to contract throat muscles and prevent swallowing. Inappropriate sensory-to-motor signaling can cause serious adverse conditions that include swallow-induced cardiac arrest implicated in the sudden infant death syndrome, or SIDS. However, vagus motor neurons that induce different body reactions (e.g., throat muscle contraction vs. heartrate arrest) are not anatomically separated in the brain but spatially intermingled. It remains unanswered how intermingled motor neurons are integrated into separate brain circuits for precise body regulation.

INVESTIGATION OF VAGUS SENSORY-MOTOR WIRING IN LARVAL ZEBRAFISH

Since the vagus nerve is widely conserved across vertebrates, I selected the tractable zebrafish system for investigating sensory-to-motor signaling in the brain. I combined (1) an optical method to provide sensory stimulation locally along the gastrointestinal tract and (2) the calcium imaging method to monitor neural activity responses from vagus motor neurons. With this method, I first identified that, when noxious (i.e., pain-like) stimulation is delivered to the throat, this sensory information specifically induces throat muscle contraction with neural activity responses from throat-innervating vagus motor neurons. The throat sensory information does not induce other unnecessary body reactions through the vagus, demonstrating high specificity in sensory-to-motor signaling in tractable zebrafish. Remarkably, I found that sensory-to-motor signaling is less specific in "just-hatched" young larval zebrafish which have not started feeding. They react to noxious stimulation from the throat with nonspecific activations of diverse vagus motor neurons and consequently broader body reactions. The immature sensory-to-motor signaling in young zebrafish larvae is a reminiscent of inappropriate signaling in prematurely born infants implicated in SIDS.

POSITION-INDEPENDENT SENSORY-MOTOR WIRING IN THE ZEBRAFISH VAGUS

What is the mechanism that enables selective activation of throat-innervating vagus motor neurons among intermingled vagus motor populations? To address this question, I transplanted the cell body of single vagus motor neurons to an ectopic position so that single throat-innervating neurons are surrounded by

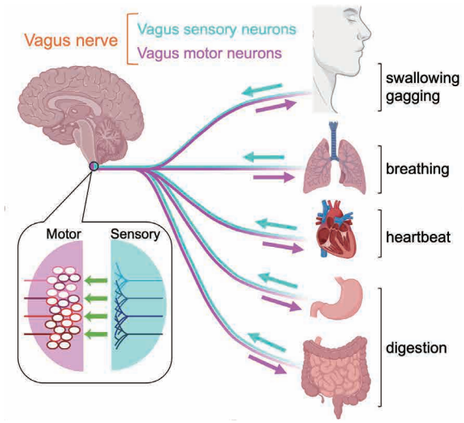

Figure legend. Diverse body functions are independently regulated by specific signaling from vagus sensory neurons to vagus motor neurons inside the brain.

non-throat-innervating motor neurons. I found that, despite the artificial mispositioning, sensory stimulation from the throat successfully activates the ectopic throat-innervating motor neurons for adequate throat muscle contraction. This observation suggests that precise sensory-to-motor signaling via brain circuits is independent of motor neuron position. This finding contrasts with motor neurons in the spinal cord, whose mispositioning results in inappropriate motor activation and, consequently, abnormal behavior. I further identified that mispositioned throat-innervating motor neurons extend their dendrites towards the brain region where throat-innervating motor neurons originally reside. This "adaptive" dendritic extension may underlie the ability of motor neurons to appropriately respond to corresponding sensory information, despite intermingled positioning.

EXPERIENCE-DEPENDENT SENSORY-MOTOR WIRING

I provided evidence that sensory-to-motor signaling is fine-tuned post-embryonically through experience. I suppressed the ability of vagus motor neurons to induce motor outputs (e.g., muscle contraction) through the inhibition of neurotransmitter release from the axon terminals. This manipulation reduced the number of throat-innervating motor neurons that respond to the throat noxious information. Additionally, when I mixed neurotransmission-intact motor neurons with neurotransmission-deficient motor neurons, only intact motor neurons responded to sensory stimulation. Thus, brain circuits are refined by motor performance so that sensory information selectively signals motor neurons that are effective in producing intended motor outputs. This experience-dependent circuit refinement presumably guides the development of specific sensory-to-motor signaling for precise body control from the originally immature circuit in young larvae.

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Terpenoids and biological membrane evolution

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INTRODUCTION

Terpenoids are universal building blocks of all life forms on Earth and are the largest group of natural compounds, encompassing nearly 100,000 compounds. Due to the diverse chemical structures and functions, terpenoids are involved in various membrane-associated cellular processes, including respiration, photosynthesis, cell signaling and membrane organization. Therefore, the evolution of terpenoids is deeply intertwined with the evolution of life itself. The overarching goal of my research is to establish a unified theory to elucidate the origin and the evolution of biological membranes in the three domains of life – Archaea, Bacteria and Eukarya, by addressing the evolutionary trajectory of terpenoids and their interactions with other membrane lipids and proteins. My research aims at not only gaining fundamental insights into the emergence of cellular life, but also applying the obtained insights about membrane organization to next-generation molecular engineering fields such as molecular cybernetics and synthetic biology.

DIVERSIFICATION OF TERPENOIDS

I have examined the distribution of terpenoid biosynthesis pathways across all known organisms and reconstructed the stepwise expansion of terpenoid diversity since the period of the last common ancestor of all three domains - i.e. the Last Universal Common Ancestor (LUCA) (Hoshino and Villanueva, 2023). For instance, the cellular membrane of Archaea is entirely composed of terpenoid-based phospholipids, while bacterial/eukaryotic membranes that are mainly made up of fatty acyl phospholipids (Fig. 1). However, eukaryotes additionally contain steroids – polycyclic terpenoids that are critical for the eukaryotic-specific membrane dynamics (Sezgin et al., 2017). Hence, Archaea and Eukarya owe their evolution to the presence of particular terpenoids. While terpenoids are not universal in the bacterial membrane, it was in Bacteria that the terpenoid-based membrane regulation first evolved, which was later transferred to proto-eukaryotes and paved the way to the emergence of Eukarya. Overall, organisms in individual domains have distinct terpenoid repertoires that are optimized for their lifestyles and hence tracing the evolution of terpenoids leads to trace the evolution of membrane organization and associated dynamics that enabled the emergence of life as we know it.

CROSS-DISCIPLINARY APPROACH

At Nagoya, I launch a new project to understand this deep relationship between terpenoids and membrane dynamics. To fulfill this goal, the interaction between membrane proteins and terpenoid lipids is utilized as an indicator for the biophysical environment of membranes. Some membrane proteins are ubiquitously distributed in all three domains and were likely present in LUCA. The function and structure of those proteins are dependent on the physical property of membranes (Drew and Boudker, 2024) and this renders membrane proteins good

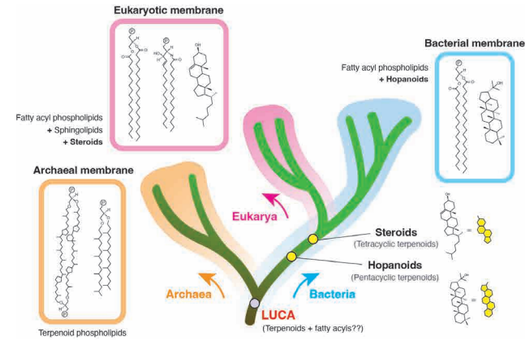

Figure 1. Relationship between terpenoids and membrane evolution. Hopanoids in bacteria were later transformed into steroids in eukaryotes. The evolutionary trajectory of membrane is different from the species tree of life. The figure was modified from (Hoshino, 2024).

candidates as a universal indicator to mirror the physical condition of membranes, which contain different compositions of terpenoids and therefore represent different evolutionary stages of life and taxonomic lineages. The ancestral sequence reconstruction technique enables me to resurrect ancestral proteins that were present in membranes at different evolutionary stages and hence reconstruct the developmental history of membrane environments and associated dynamics, ranging from the primordial membrane of LUCA to highly dynamic and near-critical membranes of modern eukaryotes. This ambitious project is achievable not by pursuing specific scientific disciplines, but only by integrating techniques and insights from multiple disciplines, in particular membrane biology and structural biology, in addition to my core expertise in geobiology and molecular biology. The diverse and collaborative research environment at IAR, without conventional departmental barriers, is highly beneficial to foster innovative research ideas to tackle the enigmatic origin and the subsequent divergence of cellular life.

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Research Field : Political Sociology, Politics

Yukinori KAWAE

Affiliation : Professor at Center for Digital Humanities and Social Sciences / Professor at Nagoya IAR
Research Field : Egyptian Archaeology, Pyramid, 3D Survey

Satomi KANNO

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

Tsutomu FUKUDA

Affiliation : Designated Lecturer at Nagoya IAR
Research Field : Particle Physics, Astrophysics

Tatsuro AYATUSKA

Affiliation : Science Communicator
Research Field : Science Communication

IAR Steering Committee

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

Koji YAMANAKA

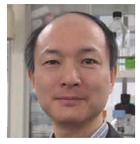
Affiliation : Vice President of Nagoya University / Professor of the Graduate School of Medicine
Research Field : Neuroscience, Neurology

Kumiko KATO

Affiliation : Professor of the Graduate School of Humanities
Research Field : Southeast Asian History, Tai History

Shigeki KIYONAKA

Affiliation : Professor of the Graduate School of Engineering
Research Field : Chemical Biology



Kazuhiro NAKAMURA

Affiliation : Professor of the Graduate School of Medicine
Research Field : Autonomic Neuroscience, Physiology

Hiroshi OHTA

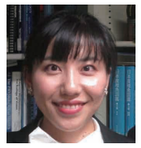
Affiliation : Steering Committee / Professor of the Graduate School of Mathematics
Research Field : Mathematics, Geometry

Akihiko YANASE

Affiliation : Professor of the Graduate School of Economics
Research Field : International economics, Economic theory

YLC Program Faculty

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



Hanako HAGIO

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

Hisashi HAYAKAWA

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

Tomoya NAKAYAMA

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

Ryo HIGUCHI

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

Minoru HIROSE

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

Jie HUANG

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

Matthew Paul SU

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

Yuichiro TADA

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

Sanae ITO

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Humanities
Research Field : Assyriology

Elena KOZGUNOVA

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Field : Plant cell division

Hideki UMEHATA

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Field : Astronomy, Astrophysics

Akira YOSHINARI

Affiliation : Designated Assistant Professor at Nagoya IAR and Institute of Transformative Bio-Molecules Sciences
Research Field : Plant Biology

Fanny BELLEGARDE

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Bioagricultural Sciences
Research Field : Plant nutrition, Hormone biosynthesis, Epigenetic

Satoshi IKEGAYA

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Engineering
Research Field : Condensed Matter Physics (Theory)

Shohei IYOSHI

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Medicine
Research Field : Cancer Biology, Chemical Biology

Shohei SAGA

Affiliation : Designated Assistant Professor at Nagoya IAR and Kobayashi-Maskawa Institute (KMI)
Research Field : Observational cosmology

Yuki SUGIYAMA

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Field : Plant Cell Biology

Koyo TSUJIKAWA

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Medicine
Research Field : Neurology, Genome biology

Atsushi USAMI

Affiliation : Designated Assistant Professor at Nagoya IAR and Institute of Transformative Bio-Molecules (ITbM)
Research Field : Biotechnology

Jia WANG

Affiliation : Designated Assistant Professor at Nagoya IAR and Institute of Materials and Systems for Sustainability (iMaSS)
Research Field : Novel P-type Doping of Nitride Semiconductors

Koichiro FURUTANI

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Engineering
Research Field : Condensed Matter Physics

Naiqi LI

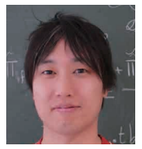
Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Humanities
Research Field : Philology, Linguistics, Cultural History

Sari JAMMO

Affiliation : Designated Assistant Professor at Nagoya IAR and Nagoya University Museum
Research Field : Neolithic, Prehistory, Funerary Archaeology

Sota INOUE

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Environmental Studies
Research Field : Ethology



Syuhei IGURO

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

Takato ISHIDA

Affiliation : Assistant Professor Department of Materials Physics, Nagoya University
Research Field : Materials Science, Engineering

Takuya KANEKO

Affiliation : Designated Assistant Professor at Nagoya IAR and Graduate School of Science
Research Field : Developmental biology, Neuroscience

Yosuke HOSHINO

Affiliation : Designated Assistant Professor at Nagoya IAR and Synchrotron Radiation Research Center
Research Field : Evolutionary Biology, Organic Geochemistry

IAR
Visiting Professor & Associate Professor

Takaho ANDO

Affiliation : Visiting Professor at Nagoya IAR / Professor at Chubu University
Research Field : History of Social Thoughts

Yasuro ABE

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

Dapeng CAI

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

Atsushi J. NISHIZAWA

Affiliation : Visiting Associate Professor at Nagoya University /Associate Professor at Gifu Shotoku Gakuen University
Research Field : Observational Cosmology, Astronomy

IAR
Honorary Directors

Ryoji NOYORI

2001 Winner of the Nobel Prize in Chemistry University Professor, Nagoya University Establishment of chirally catalysed hydrogenation reactions

Yuan Tseh LEE

1986 Winner of the Nobel Prize in Chemistry Ex-President, ICSU Honorary Doctorate, Nagoya University Clarification of the dynamics of chemical elementary processes

IAR
Academy

Hiroshi AMANO

2014 Winner of the Nobel Prize in Physics Professor, Nagoya University Invention of blue light-emitting diodes

Sumio IIJIMA

2009 Order of Culture, Japanese Government Distinguished Invited University Professor, Nagoya University Discovery of carbon nanotubes

Tsuneko OKAZAKI

2021 Order of Culture, Japanese Government University Professor, Nagoya University Discovery of Okazaki fragments

Makoto KOBAYASHI

2008 Winner of the Nobel Prize in Physics University Professor, Nagoya University Discovery of the Kobayashi-Maskawa theory

Shoichi SATO

2002 The Japan Academy Prize, Professor Emeritus, Nagoya University Creation of the science of textual configuration

Kazuo SHINOZAKI

2016 Person of Cultural Merit, Japanese Government University Professor, Nagoya University Study on molecular mechanisms of stress response in plants

Masahiro SUGIURA

2009 Person of Cultural Merit, Japanese Government University Professor, Nagoya University Determining the DNA sequence of the tobacco chloroplast genome

Masatoshi TAKEICHI

2004 Person of Cultural Merit, Japanese Government University Professor, Nagoya University Discovery of Cadherins, the molecular basis governing cellular adhesion

Ryoji NOYORI

2001 Winner of the Nobel Prize in Chemistry University Professor, Nagoya University Establishment of chirally catalysed hydrogenation reactions

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